CIB Joint International Symposium 2009

CONSTRUCTION FACING WORLDWIDE CHALLENGES

Dubrovnik, September, 27-30

Introduction

This volume contains executive summaries of papers submitted to the CIB Joint International Symposium, Construction Facing Worldwide Challenges, held in Dubrovnik, Croatia, from September 27 to 29, 2009. The associated compact disk contains the full papers. This is the annual meeting of two CIB Commissions and one Task Group:

- W055 Building Economics
- W65 Organisation and management of construction
- TG65 Management of Small Construction Firms

The two commissions and the task group operate under the umbrella of International Council for Research and Innovation in Building and Construction (CIB). CIB was established in 1953 as an association whose objectives are to stimulate and facilitate international cooperation and information exchange between governmental research institutes in the building and construction sector, with an emphasis on those institutes engaged in technical fields of research. CIB has developed into a worldwide network of over 5000 experts from about 500 member organisations active in the research community, industry, and education, who cooperate and exchange information in over 50 CIB Commissions covering all fields in building and construction related research and innovation.

The symposium is organised by the Faculty of Civil Engineering at the University of Zagreb, and it is supported by several international associations: International Project Management Association (IPMA) and International Construction Project Management Association (ICPMA), Croatian Association for Construction Management (HUOG), and Croatian Association for Project Management (CAPM).

The volume contains twelve sections according to the themes covered at the symposium:

1. Education and Training
2. Construction Performance
3. Economic Aspects of Construction
4. Information and Knowledge Management
5. Human Resource Management and Culture
6. Sustainable Construction
7. Management of SMEs
8. Academic and Industrial Collaboration
9. Project Portfolio Management in Construction Sector
10. Management and Economics of Complex Projects
11. Project Management as a Facilitator of Business Success
12. Construction Project Management at All Levels

All the papers were reviewed by the International Scientific Committee and about 250 delegates attended the symposium.

We would like to thank all the authors for their contributions. Our deepest gratitude goes to the members of the Organising Committee, international members of the Scientific Committee, as well as supporting associations, sponsor companies, and the City Council of Dubrovnik who made this symposium possible.

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CUSTOMER ATTRACTION IN A DESIGN-BUILD-FINANCE-MAINTAIN-OPERATE CONTRACT

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In the Netherlands, large public customers use integrated contracts more and more often for complicated civil engineering and architectural works. Projects with integrated contracts such as Design, Build, Finance, Maintenance and Operate require tenderers to behave differently than they are accustomed to in traditional projects. This paper discusses the different requirements tenderers have to meet in terms of communication with their customers in order to create sufficient customer value in projects with integrated contracts. Customer value theories provide insight into the elements of these contracts that demand greater attention. Application of these elements in a case study shows that responsiveness, interaction moments and visualisation are the primary 'soft elements' that can bring about improvements in the communication with public customers.

KEYWORDS: public customer, (customer) value, DBFMO contract, soft elements.

INTRODUCTION

Nowadays, an increasing number of Dutch government projects are being developed in Public-Private Partnerships (PPP). The main reason to develop projects this way is to create added value. The Dutch government believes that PPP's can add more value compared to the traditional types of contract by combining the strengths of the public and private sector. In this context only the most commonly used PPP form in The Netherlands has been taken into account in this research: Design-Build-Finance-Maintain-Operate (DBFMO)

The focus of PPP contracts in the tender phase is on the Economically Most Attractive Bid (EMAB). In comparison with the traditional contract the focus isn't only on the price but also on the quality of the bid. The quality of the bid can be described as the requirements of the client, such as flexibility and comfort.

Just as the traditional contract the price and the result is a part of the bid. These are called the hard elements. However, to create added value, one of the characteristics of a PPP contract, the tenderer has to know the requirements of the public client to offer the economically most attractive bid. Soft elements may provide a solution to recognize these requirements and so the tenderer can offer the client a bid which is exactly what they expected and needed. By using soft elements the client receives a bid which meets his expectations.

The question is which elements to use to come up with a bid that meets the client's expectations. The aim of this research is to gain insight in the soft elements that contractors can use in order to come up with the Economically Most Attractive Bid.

Business-to-Government

There are different types of client-customer relationships. Business-to-Business (B2B) and Business-to-Government (B2G) are industrial markets which are confronted with private firms and public entities that need the procured goods to ensure their existence. Next to that, the Business-to-Customer (B2C) market is confronted with consumers that need an immediate and simple fulfilling of needs (Matthijssens en De Rijcke, 1982).

The B2G market consists of public and private parties that develop agreements with each other. According to Alison (1980), the most important difference between public and private parties is that private parties have the aim to make profit and public parties execute their tasks according to the political needs. In this research, the focus is on the B2G market.

Purchasing

According to Webster and Wind (1972) and Sheth (1973) the influence of psychological, social, organisational and external factors on the purchasing process is big. Both authors describe the complexity of the purchasing process in organisations. Decisions are usually not made by one person, but by a so called Decision Making Unit (DMU). The DMU of a DBFMO tender usually consists of 20-25 persons.

According to Van Weele (1994), the industrial purchasing process can be seen as an interaction-process in which two organisations participate. An interaction process has been divided into physical and social characteristics by Hakansson et al. (1977). Physical characteristics are the (a) number of times that the organisations meet each other, (b) the characteristics of the purchased good, (c) the way of formalising the process and (d) the characteristics of the parties involved. The social characteristics of an interaction are: (1) the smoothness of the process, (2) trust between the parties and (3) understanding between the parties.

Value

Value is a subjective concept that is determined by the client's needs and the expected benefit of the transaction. This value differs for each client and is therefore subjective. A private party will try to keep their clients satisfied. They will do this by creating customer-value. Heskett (1997) developed a model (see figure 1) to determine customer value. This "costumer value formula" can be split up in two elements. First the hard elements:

- The Result (What do I get?)
- The Price (What will it cost?)

Secondly the soft elements:

- The Process (How will I get my product?)
- Emotion (What do I feel with the product?)
- Effort (What do I have to do for it?)

All these elements have influence on the determination of the customer value and so it's important as 'seller' to be aware of the influence of all these elements. The soft elements that are used in this paper are:

<u>Processes</u>

1. Responsiveness can be defined as the way in which a person or organisation responds to an external stimulus.
2. Interaction moments are the moments on which client and contractor physically meet each other during the tendering process.
3. Visualisation is a means of clarifying something to the customer. Visualising helps to make implicit knowledge explicit.

<u>Emotion</u>

4. Trustworthiness
5. Image of the contractor

<u>Effort</u>

6. Uncertainties: the extent in which the contractor can help solving the uncertainties of a client.

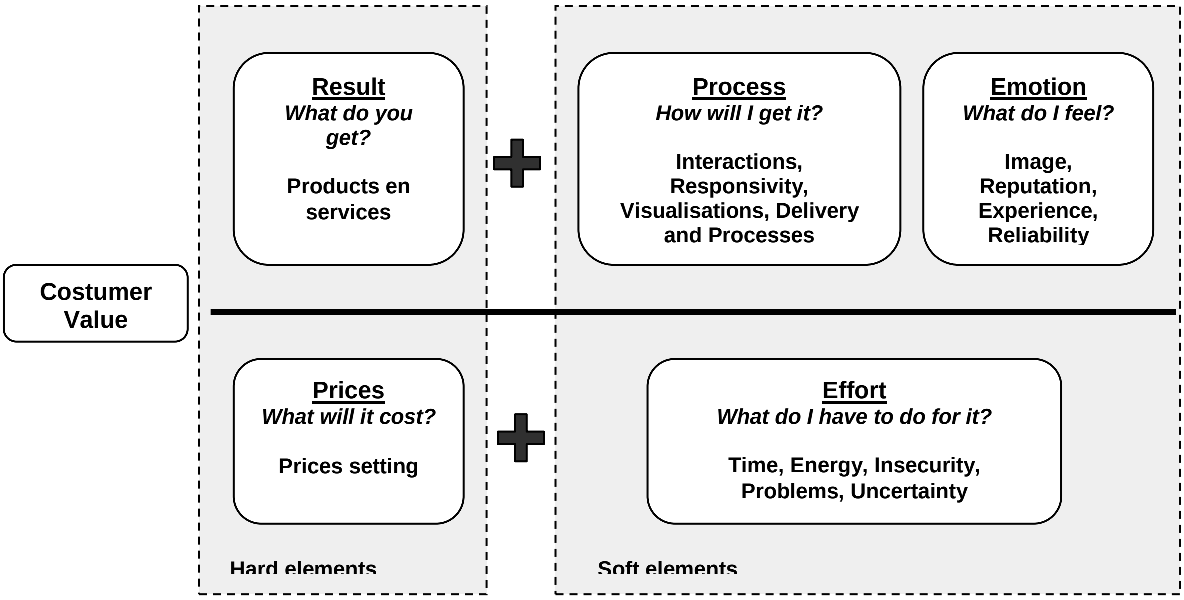

Figure 1: “Customer Value comparison” of Heskett (1997)

METHODOLOGY

The challenge for a DBFMO consortium is to come up with the most valuable bid for the client. In the last paragraphs has been discussed that the relation between the consortium and the client is a Business-to-Government relationship. The consortium has to attract the client during the tendering phase which is a part of the purchasing process. In this study the focus is on the value that a consortium can add to the bid in order to meet the client’s expectations. In order to do this, two case studies have been done. These cases were:

- The construction of an office building for the Dutch Tax Authorities in Doetinchem
- The construction of a prison for the department of juridical institutions on Rotterdam Airport

Interviews have been held with 5 experts from the field that have participated in these projects. Next to that two reports that evaluated the project have been used. The data from these interviews and reports have been put in a confrontation matrix. In a confrontation matrix the theoretical elements of customer value are ‘confronted’ with the practical elements from the open interviews with the client and with the data from the reports. The confrontation matrix provides insight into the elements that require attention. The aim of this confrontation is to see if there is influence of soft elements in the process of DBFMO tenders.

RESULTS

In order to be able to develop the confrontation matrix, a stream diagnostic chart has been made. A stream diagnostic chart is an analytical method determining how elements are interrelated to each other. In the study the stream diagnostic chart is been used for the soft elements. The question was; 'What is the influence and the dependence of the soft elements?' The conclusion is that responsiveness, one of the sub elements of Process, has the most influence on 'creating' customer value. Responsiveness will influence all other elements. The stream diagnostic chart that has been developed can be seen in figure 2.

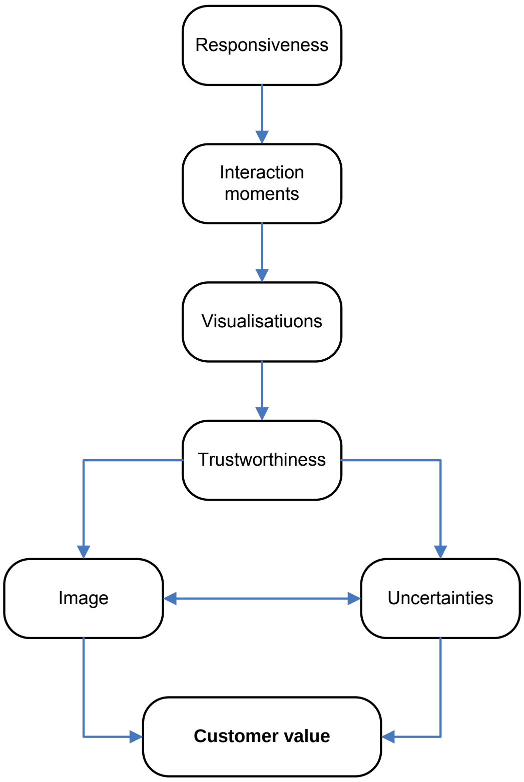

Figure 2: Stream Diagnostic Chart

This stream diagnostic chart can be used for filling in the confrontation matrix. The results of the interviews were 47 statements that the interviewees made. These 47 statements were placed in the confrontation matrix. Next to that the six soft elements were placed in the matrix and confronted with the statements.
In table 1 the confrontation matrix can be seen.

Table 1: the confrontation matrix

		Interaction moments	Responsiveness	Visualization	Trustworthiness	Image	Uncertainties
	Report BAFO MinFin, 16January 2006						
1	" The direction in which the consortium wanted to go was not very clear during the tendering phase. A lot has been discussed without any feedback."	x	x	x	x	x	x
2	" The design that the consortium made as well as their organisation looked fragmentary. There is not one total concept with one vision."	x		x	x	x	x
3	" The consortium did not really understand the client's culture, while the client clearly showed his culture in the documentation."	x	x	x	x	x	x
4	" The client's questions were not always rightly interpreted."	x	x	x	x	x	x
5	" Stay with your own design!".	x	x	x	x	x	x
6	" There was not one integrated organisation."	x	x	x	x	x	x

7	“ The monitoring system is not clear.”	x	x	x	x	x	x
8	“ The quality of the consortium's tender documents was very high.”			x	x	x	x
9	“ The presentation was not convincing.”	x		x	x	x	x
	Report BAFO MinFin, 22 February 2006						
10	“During the tendering phase, the design has been improved strongly.”	x	x	x	x	x	x
11	“Not all the client's requirements have been rightly interpreted by the consortium.”	x	x	x	x	x	x
12	“Some of the client's critics haven't been used at all by the consortium.”	x	x	x	x	x	x
13	“ The design does not fit the user's culture.”	x	x	x	x	x	x
14	“ The consortium could not present itself as one organisation.”	x		x	x	x	x
15	“ The consortium's tender documents were highly appreciated.”			x	x	x	x
	Interviewee 1, Government Architect						
16	" The consortium must be able to tell why they made certain choices.”	x	x	x	x	x	x
17	“ The consortium should be able to empathize with the situation and the environment. “	x	x	x	x	x	x
18	" Architect's reference works are very important."	x	x	x	x	x	x
19	“ We are no robots, of course we can go into raptures about a nice scale-model. ”	x		x	x	x	x
20	“Young architect have no chance in PFI projects because the can not show reference works."	x	x	x	x	x	x
21	“ For a new project, one subconsciously knows which architect is suitable for the project.”				x	x	x
22	“ The ambition document prepared by the client is list of ingredients that ask for an architect that is able to prepare the best meal out of it.”	x	x	x	x	x	x
23	" The client must recognize one self in the design. "	x	x	x	x	x	x
	Interviewee 2, employee Dutch Government Building Department						
24	“ Consortiums carelessly handle the client's tendering documents. “	x	x	x	x	x	x
25	“ It is not very good if a consortium does not meet the standard criteria.”	x	x	x	x	x	x
26	“ The client likes to be surprised by innovations and novelties. "	x	x	x	x	x	x
27	“ The consortium's presentation is highly important. “	x		x	x	x	x
28	“ The softer sides of the process are also important for the client.”	x	x	x	x	x	x
29	“ The way the consortium treats their architect, tells you something about the consortium. “				x	x	x
30	" The consortium must show their ability to let several parties integrate successfully. "	x	x	x	x	x	x
31	" A consortium with firms that belong to one company might be a little one-sided. "				x	x	x
32	" The client likes to see one integrated consortium. "	x	x	x	x	x	x
33	" The client can be very compliant, if the consortium uses the right arguments. "	x	x	x	x	x	x
34	" Consortia need to find their own distinguishing characteristics. "				x	x	x
	Interviewee 3, employee Dutch PFI knowledge centre						
35	“ Cooperation in the process is very important. “	x	x	x	x	x	x
36	“ The consortium should search for aspects that the client did not think about, but which he finds important. “	x	x	x	x	x	x
37	“ We search for a consortium that is focused on solutions. “	x	x	x	x	x	x
38	“ Consortia rather negotiate on the risks than thinking about the solution for the client. “	x	x	x	x	x	x
39	“ Searching for solutions together, makes a better result.“	x	x	x	x	x	x
40	" There is often a lack of cooperation between client and consortium. "	x	x	x	x	x	x
41	" It is important to empathize with the client. "	x	x	x	x	x	x
	Interviewee 4, employee Department of Juridical Institutions						
42	“ It is important to ask a lot of questions and suggest solutions during the dialogues.”	x		x	x	x	x
43	“ Cocksureness leads to vexation.”	x		x	x	x	x
	Interviewee 5, Consultant						
44	“ Interaction moments and a focus on service are the most important during the tendering phase.”	x		x	x	x	x
45	“ Visualisations stay in the clients' minds.“			x	x	x	x
46	“ A consortium with firms that belong to the same company is seen as arrogant. “				x	x	x
47	“ Always be kind and make sure that you won't be seen as a nagging consortium."	x		x	x	x	x

DISCUSSION AND CONCLUSION

The elements that are used to confront the statements are elements of a social nature, the soft elements. A characteristic of this is that they are subjective and, therefore, difficult to measure. To what extent does a tenderer's image plays a role in attracting the customer? The only thing that can be said about that is that it does play a role, but the extent to which is not clear and is not examined any further in this study.

All 47 statements from the study can be connected to the six soft elements (responsiveness, interaction moments, visualisation, image, reliability and uncertainties) from the customer value comparison. It can be assumed, therefore, that even though officially clients award the project based on the final result and the price (hard elements), they also, subconsciously, take into account the soft elements. From this study can be learned that the six soft elements that have been found in literature: responsiveness, Interaction moments, Visualization, trustworthiness, and contractor's image are all important for the contractor to keep in mind when participating in a (DBFMO) tender. Soft elements can increase or decrease customer value.

REFERENCES

Allison, G.T. (1980), Public and Private Management: are they fundamentally alike in all unimportant aspects? OPM document, 127-51-1, 27-38

Grönroos, C., Service Management and Marketing: a customer relationship management approach, Wiley, New York, 2001 (2nd edition).

Hakansson, H., Johansson, J. & Wootz, B. (1977), Influence tactics in Buyer – Seller Processes, Industrial Marketing Management, pp. 319-332

Heskettt, J.L., Sasser, W.E., Schlesinger, L.A., (1997), The Service Profit Chain, The Free Press, New York.

Kessels, J.W.M. (2001), Learning in organisations: a corporate curriculum for the knowledge economy environment. Futures, 33, 497-506

Matthijssens, P. en de Rijcke, J. (1982), Unieke dimensies van industriële marketing, Tijdschrift voor marketing, Juli / augustus, pp. 3-10

Murray, J.G. (2001), Local government and private sector purchasing strategy: a comparative study, European Journal of purchasing & supply Management, Vol. 7:91-100

Otter den, A.F.H.J. en Kastelein, A. (2005), Reader Proces- en projectmanagement, uitgave van de TU Eindhoven, Faculteit Bouwkunde

Sheth, J.N. (1973), A model of industrial buyer behaviour, Journal of Marketing, oktober

Tillema, H.H. en Westhuizen van der, G.J. (2003), Knowledge productive teams: professionals learn collaboratively. Lifelong learning in Europe, 19-25

Webster, F.E., Wind, Y. (1972), Organizational buying behavior, Englewood Cliffs : Prentice-Hall, 1972

Weele, A.J., (2005), Purchasing and supply chain management: analysis, strategy, planning and practice, 4th edition

Woodruff, R.B. (1997), Customer Value: The Next Source for Competitive Advantage, Journal of the Academy of Marketing Science, 25 (2), 139 – 153.

EFFECTS OF PROCUREMENT ON PROJECT PERFORMANCE: A SURVEY OF SWEDISH CONSTRUCTION CLIENTS

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In order to increase the efficiency of the construction industry development and improvement of procurement procedures is vital. The purpose of this investigation is to increase the understanding of how procurement procedures affect project performance. A procurement model including eight hypotheses is first developed on the basis of a literature review and then tested through multivariate statistical techniques based on empirical data collected through a survey investigation of 106 Swedish construction clients. The results of hierarchical regression analyses show that cooperative procurement procedures positively affect collaboration among project actors and that collaboration in turn have positive effects on project performance. In general, however, cooperative procurement procedures do not have direct effects on project performance.

KEYWORDS: procurement, project performance, collaboration.

INTRODUCTION

Traditional competitive procurement procedures cause adversarial relationships and many problems in all stages of the buying process (Cheung *et al.*, 2003, Eriksson and Laan, 2007). Although procurement procedures need to be tailored to enhance the fulfilment of different project objectives (Cox and Thompson, 1997, Wardani et al., 2006), clients tend to choose those procurement procedures they have a habit of using, regardless of any differences between projects (Laedre *et al.*, 2006, Eriksson, 2008a). In order to enhance change, an increased understanding of how different procurement procedures affect different aspects of project performance in different types of projects is therefore vital. In spite of procurement procedures' importance for project success, earlier research on this topic is limited to a few investigations focusing on how only one or a few procurement aspects affect a few project outcomes. Examples are bid evaluation effects on cost and schedule growth (Assaf and Al-Hejji, 2006, Wardani et al., 2006), and partnering tools' effect on partnering success (Chan *et al.*, 2004, Tang *et al.*, 2006). In order to achieve successful governance of construction projects a holistic and systemic approach to procurement procedures is crucial (Cox and Thompson, 1997, Eriksson, 2008b). The purpose of this investigation is therefore to increase the understanding of how a broad range of procurement procedures affect various aspects of project performance. Through a comprehensive literature review a procurement model is first developed and then empirically tested.

PROCUREMENT EFFECTS ON PROJECT PERFORMANCE

Traditionally, researchers and practitioners have focused on the three project performance criteria of cost, time and quality. In this section cooperative procurement procedures' effects on these three criteria and achieved collaboration are discussed and proposed.

Joint specification

Design-bid-build (DBB) involve a complete specification prior to contractor procurement, resulting in a divorce between design and construction (Pietroforte, 1997, Dubois and Gadde, 2002). This separation results in long project durations and decreased joint problem-solving (Korczynski, 1996), compared to design-build (DB) contracts. Other studies show that DBB ensure better quality (Cheung et al., 2001) and improved budget performance (Chua et al., 1997) than DB. Joint specification (Eriksson and Nilsson, 2008), or concurrent engineering, make parallel and integrated design and construction possible (Brown et al., 2001). In order to decrease the risk for defective design, increased coordination between designer and contractors is suitable (Andi and Minato, 2003). Early involvement of contractors facilitates cost saving and shortened project duration due to increased buildability (Brown *et al.*, 2001, Andi and Minato, 2003), increased client satisfaction since the client maintains the possibilities to influence and control the design work (Pietroforte, 1997, Eriksson, 2008b), and better joint problem-solving and collaboration (Korczynski, 1996, Rahman and Kumaraswamy, 2004). We therefore propose the following hypotheses for joint specification:

H_1: The higher the level of collaboration between client and contractors in joint specification: (a) the better the economical performance, (b) the better the time performance, (c) the better the quality and (d) the better the collaboration.

Limited bid invitation

Compared to open invitations a limited number of invited bidders can decrease project duration due to shortened bidding stage. It also increases the chance for lasting relationships and a continuous workload for the selected contractors, which facilitate cooperation (Bresnen and Marshall, 2000a, Eriksson, 2007) and client satisfaction through increased knowledge about the client's demands (Eriksson, 2009). For economical performance, the outcome is less certain. While an open bid is likely to result in a lower bid, a closed bid may be better in terms of avoiding cost overruns as there is less reason for underestimating costs for bidders in this situation (Korczynski, 1996). Thus, we propose the following for bid invitation:

H_2: The fewer the number of contractors that are invited in the bid invitation: (b) the better the time performance, (c) the better the quality, (d) the better the collaboration.

Soft evaluation parameters

By focusing on low bid price the client aims to select the contractor who performs the work to the lowest cost. However, it increases the risk for cost and schedule growth due to a higher amount of change orders (Assaf and Al-Hejji, 2006, Wardani *et al.*, 2006). Soft parameters related to competence and experience, such as poor site management, supervision, and planning on behalf of the contractor, are common causes of cost and time overruns (Chan and Kumaraswamy, 1997, Odeh and Battaineh, 2002, Assaf and Al-Hejji, 2006) and poor customer satisfaction (Maloney, 2002). Careful partner selection considering desired competences, experiences and attitudes can therefore reduce cost growth (Chua *et al.*, 1997, Iyer and Jha, 2005, Wardani *et al.*, 2006) and time overruns (Chan and Kumaraswamy, 1997), and improve quality performance (Yasamis *et al.*, 2002). Furthermore, appropriate attitudes and competence are very important for cooperation to emerge (Ng et al., 2002). Hence, bid evaluation based on suitable soft parameters improves cooperation (Rahman and Kumaraswamy, 2004). Accordingly, we propose the following relationships:

H_3: The higher the focus on soft parameters in the bid evaluation: (a) the better the cost performance, (b) the better the time performance, (c) the better the quality, (d) the better the collaboration.

Joint subcontractor selection

Cooperative relationships between client and main contractor do not automatically spread to subcontractors, which are often traditionally procured by main contractors (Alderman and Ivory, 2007). Hence, clients who wish to integrate subcontractors in teamwork and joint problem-solving have to get involved in the procurement of subcontractors. Careful joint subcontractor selection by both client and main contractor in collaboration is therefore important in order to increase subcontractors' involvement and cooperation (Eriksson *et al.*, 2007), which in turn may have many positive effects on project performance. Earlier research have found that increased subcontractor integration may facilitate improved economical performance (Errasti *et al.*, 2007), time performance (Gil et al., 2004, Elfving *et al.*, 2005), and quality (Errasti *et al.*, 2007). Thus, we propose the following relationships:

H_4: The higher the extent both client and contractors are jointly involved in subcontractor selection and integration: (a) the better the economical performance, (b) the better the time performance, (c) the better the quality, (d) the better the collaboration.

Incentives

Fixed price provides the client with a more or less accurate estimation of the total project cost already in the bid evaluation stage. However, due to increased amount of change orders, the risks for cost and schedule overruns are higher (Assaf and Al-Hejji, 2006, Wardani et al., 2006). Compensation based on incentives connected to different aspects of project objectives facilitates economical performance (Tang et al., 2006), time performance (Chua et al., 1999, Eriksson, 2009), quality (Eriksson, 2009), and a good project performance in total (Olsen et al., 2005). Reimbursement coupled with incentives also facilitates cooperation (Korczynski, 1996, Bayliss *et al.*, 2004, Kadefors, 2005, Eriksson, 2008b). Based on the abovementioned arguments we propose the following hypotheses:

H_5: The more the compensation is based on incentives connected to joint objectives, (a) the better the economical performance: (b) the better the time performance, (c) the better the quality, (d) the better the collaboration.

Collaborative tools

Since client and contractors have to interact in the construction process, it may be suitable to use various collaborative tools such as: joint objectives, joint office building, teambuilding activities, partnering facilitator, joint IT-tools, and joint risk management (Bresnen and Marshall, 2000b, Olsen *et al.*, 2005, Eriksson, 2009). High usage of collaborative tools will improve cooperation (Cheng *et al.*, 2000, Cheng *et al.*, 2001, Cheung *et al.*, 2003, Eriksson, 2008b). For instance, *joint objectives* facilitate the development of a win-win situation in which all actors are striving together towards the same goal (Eriksson, 2008b). *Joint IT-tools* enhance integration and communication among different project actors (Cheng et al., 2001). A *joint project office* on site in which all members of the partnering team is located facilitates face-to-face encounters which are important for joint problem-solving (Olsen *et al.*, 2005, Alderman and Ivory, 2007). Hence, the following hypotheses are formulated:

H_6: The higher the use of collaborative tools in the project: (d) the better the collaboration.

Contractor self-control

Traditionally, construction clients perform most of the control, of both work in progress and the final product, instead of leaving it up to the contractor (Eriksson, 2008a). Such tight monitoring of contractors' behaviour and performance increase the risk for opportunism and hampers cooperation (Korczynski, 1996). Increased reliance on contractors' self control can instead save both money and time (Eriksson and Nilsson, 2008, Eriksson, 2009) due to earlier identification of defects and a less comprehensive end inspection. Self-control also has the potential to increase the contractors' concern for quality since they cannot rely on others to control the quality of their work (Eriksson, 2009). In line with this discussion we propose that performance evaluation affect project performance in the following ways:

H_7: The more the performance evaluation is based on contractors' self control, (a) the better the economical performance: (b) the better the time performance, (c) the better the quality, (d) the better the collaboration.

Collaboration

For collaborative relationships, such as partnering, to function well a good collaborative climate is needed. Earlier research have shown that collaboration facilitates: economical performance in terms of decreased cost overruns (Iyer and Jha, 2005), time performance (Chan et al., 2003), quality and customer satisfaction (Eriksson, 2009). We therefore propose that collaboration can work as a mediator, enhancing project performance:

H_8: The better the collaboration among project actors: (a) the better the economical performance, (b) the better the time performance, (c) the better the quality.

Model of hypotheses

The developed model presented in Figure 1 proposes positive relationships ($H_{1a\text{-}c}$ - $H_{7a\text{-}c}$) between cooperative procurement procedures and construction project performance. H_{1d} - H_{7d} propose that cooperative procurement procedures facilitate collaboration among project actors, and H_8 propose that achieved collaboration enhance project performance.

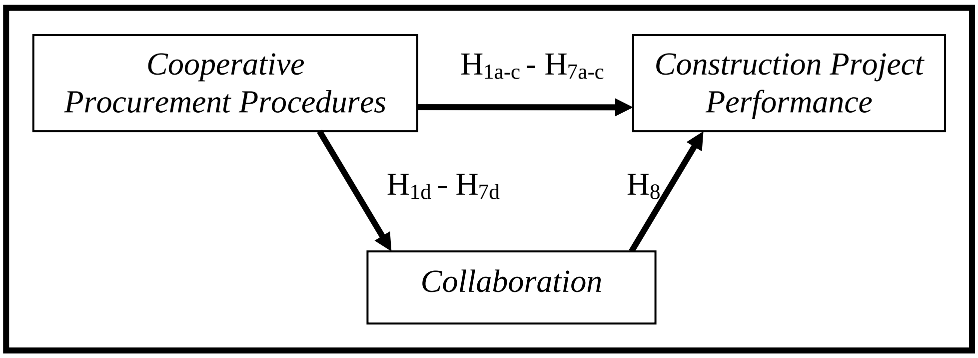

Figure 1: The proposed overall model for the study

METHOD

Sample

The empirical data were collected through a questionnaire to a population of 140 construction client organizations that are members of The Swedish Construction Client Forum (SCCF). The population consists of regional, national or international industrial and property companies, municipalities and regional authorities, and also government services and agencies. Hence, this population provides a suitable representation of Swedish construction clients. The organizations where initially approached by the CEO of SCCF through a letter describing the purpose of the investigation and its importance for SCCF and its members. In a second step the registered contact persons were telephoned, in order to inquire theirs or other more suitable person's willingness to participate in the study. Consequently, it was up to the contact person to choose the most suitable persons, given that the survey involved procurement, project management processes and project performance. At this stage six respondents declined participation due to lack of time. In a third stage, questionnaires were posted to the 134 potential respondents that had agreed to participate in the investigation. After two reminders a total of 111 responses were received. In a fourth stage respondents who had not answered all questions were telephoned and asked to respond to these questions. This resulted in minimization of the amount of missing values. Nevertheless, in five responses there were a lot of missing values, for which reason they were discarded. Accordingly, 106 usable responses were received, resulting in a response rate of 76%.

Measure: procurement, collaboration and project performance

The respondents were asked to what extent they use different procurement procedures in their construction projects, and how satisfied they are with the collaboration among project actors, and various aspects of project performance. The questions were measured using seven-point Likert scales anchored by 1 = very seldom/very dissatisfied and 7 = very often/very satisfied. The questions did not measure these aspects in a particular project but involved firm-level behavior and project performances in the clients' portfolios of procured and finished projects. Furthermore, three control variables were measured through a nominal scale: if the organization follows public procurement regulations or not, if the construction activities involve new construction/rebuilding projects or continuous maintenance work, and if the client is active on a local/regional or national/international market.

EMPIRICAL RESULTS

The ten items measuring project performance and collaboration are theoretically related to the four aspects of cost, time, quality and collaboration. In order to investigate if the empirical data supports such a classification the ten items were subjected to a principal component factor analysis (PCFA) with Oblimin rotation, which was forced into four solutions (Table 1).

Table 1: Principal component factor analysis of project performance indicators

	Item Mean	Factor 1 Quality	Factor 2 Time	Factor 3 Cost	Factor 4 Collaboration
Function according specification	5.75	**0.91**	0.04	0.13	-0.14
Expected quality is achieved	5.70	**0.90**	0.01	-0.03	0.03
High customer satisfaction	5.90	**0.77**	-0.04	-0.06	0.20
Time schedule is minimized	4.70	-0.09	**0.92**	-0.02	0.07
Within time schedule	5.61	0.25	**0.60**	0.30	-0.06
Within project budget	5.51	0.01	0.05	**0.94**	-0.07
Project cost is minimized	4.95	-0.06	0,14	**0.77**	0.16
Life cycle costs are minimized	4.87	0.32	-0,24	**0.48**	0.20
Negotiations are solved	5.18	-0.10	-0,05	0.18	**0.87**
Good cooperation	5.41	0.30	0.19	-0.12	**0.67**
Percentage of variance		42.16	14.76	9.70	8.74
Cronbach alpha (CA)		0.87	0.60	0.73	0.59
Factor mean value (MV)		5.76	5.17	5.09	5.73

The Kaiser-Meyer-Oklin (KMO) value was 0.76 and the Bartlett Test of Sphericity reached statistical significance (0.00), supporting the expected four factor solution, explaining 42.2%, 14.8%, 9.7% and 8.7% of the variance respectively. The identified factors are; 1) Quality (CA = 0.87, MV = 5.76), 2) Time (CA = 0.60, MV = 5.17), 3) Cost (CA = 0.73, MV = 5.09) and 4) Collaboration (CA = 0.59, MV = 5.73). The factor mean values (5.09-5.76) indicate that the clients are rather satisfied with project performance. To be able to address H_8 the collaboration factor will be computed into a separate construct and also used as an independent variable potentially affecting the performance factors quality, time and cost.

Procurement procedures' impact on project performance

The constructs formed in the PCFA were then used (as average summated scores) to test any significant relationships between the procedures and the performance criteria by hierarchical multiple regression. In Table 2, the statistically significant values are highlighted.

If we first look at procurement procedures' effect on performance we see that the only individual procedures that significantly affect performance are limited bid invitation and soft parameters. Limited bid invitations have a negative effect on cost performance, whereas soft evaluation parameters positively affect both time- and quality performance, supporting ($H_{3b,c}$). However, testing of the overall model shows that cooperative procurement procedures as a group do not have a significant effect on project performance. Second, achieved collaboration is positively affected by both the overall model, including all cooperative procurement procedures, and by the individual procedures of soft evaluation parameters, joint subcontractor selection and collaborative tools, supporting hypotheses $H_{3d,4d,6d}$. Incentives have, on the other hand, a negative effect, indicating that incentives are detrimental for collaboration. This may be due to that negotiations regarding change orders' impact on the target cost can lead to disputes that impair collaboration. Third, looking at collaboration's effect on performance we see that hypothesis H_8 is supported since collaboration positively affects all three performance criteria, especially cost and quality.

Table 2: Hierarchical multiple regression

	Quality performance		Time Performance		Cost Performance		Collaboration	
Procedures	**B**	**Sig**	**B**	**Sig**	**B**	**Sig**	**B**	**Sig**
H_1 Joint spec	0.042	0.510	-0.058	0.351	0.099	0.188	-0.001	0.984
H_2 Limited bid	-0.052	0.572	0.084	0.364	**-0.281**	**0.012**	-0.110	0.251
H_3 Soft parameter	**0.219**	**0.019**	**0.231**	**0.013**	0.124	0.260	**0.210**	**0.029**
H_4 Joint SC-select	0.053	0.364	-0.077	0.185	0.003	0.962	**0.133**	**0.029**
H_5 Incentives	-0.077	0.465	0.143	0.174	0.085	0.499	**-0.293**	**0.008**
H_6 Coll tools	0.006	0.952	0.091	0.396	-0.063	0.627	**0.260**	**0.021**
H_7 Self-control	0.013	0.877	-0.045	0.579	0.029	0.767	0.112	0.180
Overall model	**ΔR^2**	**Sig**	**ΔR^2**	**Sig**	**ΔR^2**	**Sig**	**ΔR^2**	**Sig**
Control variables	0.011	0.757	0.059	0.103	0.045	0.190	0.024	0.482
Procedures H_1- H_7	0.115	0.100	0.112	0.088	0.099	0.156	**0.241**	**0.000**
Collaboration H_8	**0.235**	**0.000**	**0.072**	**0.005**	**0.237**	**0.000**		

The overall model developed in this paper proposed that cooperative procurement procedures have positive effects on construction project performance (H_{1a-c} - H_{7a-c}) and collaboration among project actors (H_{1d} - H_{7d}), and that collaboration enhance project performance (H_8). The results of this study show that cooperative procurement procedures are positively related to collaboration but not to construction project performance. Looking at these main relationships in the model the results suggest that only the relationship proposed by hypothesis H_8 is fully supported by the empirical data, suggesting that collaboration is important for construction project performance. The overall relationship between cooperative procurement procedures and collaboration is also significant, although only the hypotheses H_{3d}, H_{4d} and H_{6d} are strongly supported. This indicates that cooperative procurement procedures as a group have a positive impact on collaboration. It is especially important to choose the right partners and put effort in facilitating the collaboration. The overall relationship between cooperative procurement procedures and performance is not significant. The only individual procedure that has a positive effect on performance is soft parameters. Hypotheses H_{3b-c} are supported, indicating that the use of soft parameters in bid evaluation have positive effects on time and quality.

CONCLUSIONS

In recent years there has been an increasing interest in the use of partnering in order to improve collaboration among construction project actors (Bresnen and Marshall, 2000b). However, Cox and Thompson (1997) mean that confusion exists between the means and the end in much of the partnering literature. There is a danger that collaboration becomes the objective rather than a vehicle for achieving successful project performance (Cox and Thompson, 1997, Bresnen and Marshall, 2000b). The model developed and tested in this paper indicates that collaboration indeed is crucial for the achievement of project success. In fact, collaboration works as a mediating factor between cooperative procurement procedures and project performance. Cooperative procurement procedures do not automatically result in improved project performance. Instead they facilitate increased collaboration which in turn enhances project performance. If increased collaboration is not obtained cooperative procurement procedures do not do any good. Due to the systemic and holistic perspective of this investigation and the comprehensive literature review the theoretical contribution of the model is high. The results contradict earlier performed case studies that argue for direct links between specific procedures and project performance. Our results show that cooperative procurement procedures need to result in increased cooperation in order to impact performance positively. From a practical perspective the model can serve as an alert for clients that the implementation of cooperative procurement procedures must be taken seriously and be executed in a purposeful way, otherwise better project performance will not be achieved.

REFERENCES

Alderman, N. & Ivory, C. (2007) Partnering in Major Contracts: Paradox and Metaphor. International Journal of Project Management, 25 (4)**,** 386-393.

Andi, S. & Minato, T. (2003) Design Documents Quality in the Japanese Construction Industry: Factors Influencing and Impacts on Construction Process. International Journal of Project Management, 21 (7)**,** 537-546.

Assaf, S. & Al-Hejji, S. (2006) Causes of Delay in Large Construction Projects. International Journal of Project Management, 24 (4)**,** 349-357.

Bayliss, R., Cheung, S., Suen, H. & Wong, S.-P. (2004) Effective Partnering Tools in Construction: A Case Study on MTRC TKE Contract in Hong Kong. International Journal of Project Management, 22 (3)**,** 253-263.

Bresnen, M. & Marshall, N. (2000a) Motivation, Commitment and the Use of Incentives in Partnerships and Alliances. Construction Management and Economics, 18 (5)**,** 587-598.

Bresnen, M. & Marshall, N. (2000b) Partnering in Construction: A Critical Review of Issues, Problems and Dilemmas. Construction Management and Economics, 18 (2)**,** 229-237.

Brown, D., Ashleigh, M., Riley, M. & Shaw, R. (2001) New Project Procurement Process. Journal of Management in Engineering, 17 (4)**,** 192-201.

Chan, A., Chan, D. & Ho, K. (2003) An Empirical Study of the Benefits of Construction Partnering in Hong Kong. Construction Management and Economics, 21 (5)**,** 523-533.

Chan, A., Chan, D., Chiang, Y., Tang, B., Chan, E. & Ho, K. (2004) Exploring Critical Success Factors for Partnering in Construction Projects. Journal of Construction Engineering and Management, 130 (2)**,** 188-198.

Chan, D. & Kumaraswamy, M. (1997) A Comparative Study of Causes of Time Overruns in Hong Kong Construction Projects. International Journal of Project Management, 15 (1)**,** 55-63.

Cheng, E., Li, H. & Love, P. (2000) Establishment of Critical Success Factors for Construction Partnering. Journal of Management in Engineering, 16 (2)**,** 84-92.

Cheng, E., Li, H., Drew, D. & Yeung, N. (2001) Infrastructure of Partnering for Construction Projects. Journal of Management in Engineering, 17 (4), 229-237.

Cheung, S.-O., Lam, T.-I., Leung, M.-Y. & Wan, Y.-W. (2001) An Analytical Hierarchy Process Based Procurement Selection Method. Construction Management and Economics, 19 (4), 427-437.

Cheung, S., Ng, T., Wong, S.-P. & Suen, H. (2003) Behavioral Aspects in Construction Partnering. International Journal of Project Management, 21 (5), 333-343.

Chua, D., Kog, Y., Loh, P. & Jaselskis, E. (1997) Model for Construction Budget Performance - Neural Network Approach. Journal of Construction Engineering and Management, 123 (3), 214-222.

Chua, D., Kog, Y. & Loh, P. (1999) Critical Success Factors for Different Project Objectives. Journal of Construction Engineering and Management, 125 (3), 142-150.

Cox, A. & Thompson, I. (1997) Fit for Purpose Contractual Relations: Determining a Theoretical Framework for Construction Projects. European Journal of Purchasing & Supply Management, 3 (3), 127-135.

Dubois, A. & Gadde, L.-E. (2002) The Construction Industry as a Loosely Coupled System: Implications for Productivity and Innovation. Construction Management and Economics, 20 (7), 621-632.

Elfving, J., Tommelein, I. & Ballard, G. (2005) Consequences of Competitive Bidding in Project-Based Production. Journal of Purchasing & Supply Management, 11 (4), 173-181.

Eriksson, P. E. (2007) Cooperation and Partnering in Facilities Construction - Empirical Application of Prisoner's Dilemma. Facilities, 25 (1/2), 7-19.

Eriksson, P. E., Dickinson, M. & Khalfan, M. (2007) The influence of partnering and procurement on subcontractor involvement and innovation. Facilities, 25 (5/6), 203-214.

Eriksson, P. E. & Laan, A. (2007) Procurement Effects on Trust and Control in Client-Contractor Relationships. Engineering, Construction and Architectural Management, 14 (4), 387-399.

Eriksson, P. E. (2008a) Procurement Effects on Coopetition in Client-Contractor Relationships. Journal of Construction Engineering and Management, 134 (2), 103-111.

Eriksson, P. E. (2008b) Achieving Suitable Coopetition in Buyer-Supplier Relationships: The Case of AstraZeneca. Journal of Business to Business Marketing, 15 (4), 425-454.

Eriksson, P. E. & Nilsson, T. (2008) Partnering the Construction of a Swedish Pharmaceutical Plant: Case Study. Journal of Management in Engineering, 24 (4), 227-233.

Eriksson, P. E. (2009) A Case Study of Partnering in Lean Construction. The 5th Nordic Conference on Construction Economics and Organisation. Reykjavik, Island.

Errasti, A., Beach, R., Oyarbide, A. & Santos, J. (2007) A Process for Developing Partnerships with Subcontractors in the Construction Industry: An Empirical Study. International Journal of Project Management, 25 (3), 250-256.

Gil, N., Tommelein, I. & Ballard, G. (2004) Theoretical Comparison of Alternative Delivery Systems for Projects in Unpredictable Environments. Construction Management and Economics, 22 (5), 495-508.

Iyer, K. & Jha, K. (2005) Factors Affecting Cost Performance: Evidence from Indian Construction Projects. International Journal of Project Management, 23 (4), 283-295.

Kadefors, A. (2005) Fairness in Interorganizational Project Relations: Norms and Strategies. Construction Management and Economics, 23 (8), 871-878.

Korczynski, M. (1996) The Low-Trust Route to Economic Development: Inter-Firm Relations in the UK Engineering Construction Industry in the 1980s and 1990s. Journal of Management Studies, 33 (6), 787-808.

Laedre, O., Austeng, K., Haugen, T. & Klakegg, O. (2006) Procurement Routes in Public Building and Construction Projects. Journal of Construction Engineering and Management, 132 (7), 689-696.

Maloney, W. (2002) Construction Product/Service and Customer Satisfaction. Journal of Construction Engineering and Management, 128 (6), 522-529.

Ng, T., Rose, T., Mak, M. & Chen, S. E. (2002) Problematic Issues Associated with Project Partnering - The Contractor Perspective. International Journal of Project Management, 20 (6), 437-449.

Odeh, A. & Battaineh, H. (2002) Causes of Construction Delays: Traditional Contracts. International Journal of Project Management, 20 (1), 67-73.

Olsen, B., Haugland, S., Karlsen, E. & Husoy, G. (2005) Governance of Complex Procurements in the Oil and Gas Industry. Journal of Purchasing & Supply Management, 11 (1), 1-13.

Pietroforte, R. (1997) Communication and Governance in the Building Process. Construction Management and Economics, 15 (1), 71-82.

Rahman, M. & Kumaraswamy, M. (2004) Contracting Relationship Trends and Transitions. Journal of Management in Engineering, 20 (4), 147-161.

Tang, W., Duffield, C. & Young, D. (2006) Partnering Mechanism in Construction: An Empirical Study on the Chinese Construction Industry. Journal of Construction Engineering and Management, 132 (3), 217-229.

Wardani, M., Messner, J. & Horman, M. (2006) Comparing Procurement Methods for Design-Build Projects. Journal of Construction Engineering and Management, 132 (3), 230-238.

Yasamis, F., Arditi, D. & Mohammadi, J. (2002) Assessing Contractor Quality Performance. Construction Management and Economics, 20 (3), 211-223.

SHAPING CONCEPTS, PRACTICES AND STRATEGIES: ARBITRATION AND EXPERT APPRAISALS ON DEFECTS

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The purpose of this paper is to analyse how the concept of defects is being shaped by arbitration and expert appraisals along with construction practices and strategies. This study applies the social-constructivist concept of technological frames. The research design included participant observation, documentary methods and qualitative interviews. This paper will illustrate the interpretative flexibility of the concept of defects. The four interpretations are deviance as normalisation, deviance as leverage/liability, deviance as a random effect, and deviance as precedent. Further, the paper will demonstrate how defects are constructed through three processes: concrete negotiations on the gap between expectations and realisation, setting and applying game rules, and by producing structures in the shape of codes of conduct. Finally, this paper will argue that the construction of defects is the result of interaction between two dominant technological frames: the building frame and the juridico-legal frame. Consequently, the system of arbitration and expert appraisals along with construction practices and strategies is co-shaping a culture of deviance/defects that both intentionally prevent defects but simultaneously foster defects unintentionally.

KEYWORDS: defects, arbitration, constructivism, building process.

INTRODUCTION: A STICKY PROBLEM

Defects in construction, say it and everyone has a story to spill. Countless is the number of media reports on the issue with tearful reports from Mr and Mrs Denmark and their two small children live primetime on national television complaining about the property developer or contractor who deluded or even defrauded the family with a defective building.

Looking back in to the history of construction, the issue of defects has been a recurrent policy issue. A number of initiatives etc. have been attempted for the past 20-30 years, but except for the Building Defects Funds not much success has apparently been achieved in reducing the number and seriousness of defects. Thus, the issue reappears over and over again. Apparently, the issue of defects in construction is one of those sticky or unsolvable problems that keep coming back. So, is the construction industry simply incapable of improving its own practices and products like other industries, or do we need a better understanding of the 'fundamentals' of construction?

Recently, an action plan to half the number of defects was drafted by the Danish Enterprise and Construction Agency (2005) in close collaboration with all the actors of the construction industry. Although the action plan deals with a number of relevant issues, it tends to deal with the usual suspects: improved training, refined planning, elaborated control procedures etc. Not much attention is being paid to the institutions penetrating construction and their role in limiting the devastating effects of defects. One of the significant institutions, when it comes to defects, is the Building and Construction Arbitration Court and the building expert inspections and surveys. Having turned 25 years old, the time seems ripe to explore what role arbitration and expert inspection and surveys plays with respect to defects in construction.

Only few studies of the arbitration exist in Denmark. One notably exemption is a recent study by Høgsted (2008, p. 4) concluding that:

- The direct incurred costs exceed 100 million DKK (15 million Euros) per year in the period 2000-2007.

- The number of legal disputes has increased about 50 % in the period 2000-2007 corrected for changes in turnover.

- Many small disputes dominate the cases in the arbitration court. Two-thirds of all disputes concerns claims of less than 0.5 million DKK, and 25 % concern claims of less than 100,000 DKK.

- Indicatively, the number of disputes involving partnering projects seems to be much lower than in traditional projects.

This article reports from a study on arbitration and expert inspections and surveys that was part of a larger three year study (2006-09) 'Defects in construction – strategies, behaviour and learning' financed by the Danish Enterprise and Construction Authority. The project was conducted in collaboration by the Danish Building Research Institute/Aalborg University, the Technical University of Denmark and Copenhagen Business School. The project included four studies on buildability of constructions, arbitration and expert appraisals, exemplary construction project management, and defects in an unpredictable context – the relationship between intention, action and result.

The structure of this paper is as follows. First, the paper introduces the research methodology of the study. Second, the paper presents the analysis of the social construction of defects. Third, the conclusion will summarise the findings of the study.

RESEARCH METHODOLOGY

Theoretical framework

This study applies the social-constructivist concept of technological frames developed by Bijker (1997) as part of the SCOT theory (Social Construction of Technology). The SCOT theory is a response to technological determinism, and it argues that technology does not determine human action. Rather, social actions and technologies mutually shape each other. Further, sociotechnical change can not be understood without understanding how technology is embedded in its context.

The theory includes three main parts. The first part of the theory is the sociological deconstruction of sociotechnical change by applying the two concepts of relevant social groups and interpretative flexibility developed earlier by Pinch & Bijker (1984) in their now classical study of the development of the bicycle. The interpretative flexibility means that an artefact has different meanings to different groups, which in turn generates different problems to be solved. The second part of the theory is the analysis of the social construction of sociotechnical change by the processes of stabilisation and closure. The third part is the explanatory and generalising part of the theory by applying the concept of technological frames and inclusion (Bijker 1997).

The technological frame encompasses goals, key problems, problem-solving strategies, requirements, theories, tacit knowledge, testing procedures, design methods and criteria, user practice, perceived substitution function and exemplary artefacts. The technological frames guide thinking and interaction within and between the different relevant social groups. Three different configurations of technological frames can explain a sociotechnical development: 1) one dominant technological frame, 2) no dominant technological frame, and 3) more than one dominant technological frame.

In her now classical study of the disaster of the space shuttle Challenger, Vaughan (1996: 394) states:

> *'The Challenger disaster was an accident, the result of a mistake. What is important to remember from this case is not that individuals in organizations make mistakes, but that mistakes themselves are socially organized and systematically produced. Contradicting the rational choice theory behind the hypothesis of managers as amoral calculators, the tragedy has systemic origins that transcended individuals, organization, time, and geography. Its sources were neither extraordinary nor necessarily peculiar to NASA, as the amoral calculator hypothesis would lead us to believe. Instead, its origins were in routine and taken-for-granted aspects of organizational life that created a way of seeing that was simultaneously a way of not seeing'*

Vaughan (1996) goes on to argue that three elements constitute a theory of the normalisation of deviance in organisations: the culture of production, the structural secrecy and the production of culture. Drawing on Vaughan (1996) and the concept of technological frames (Bijker, 1997), we would like to suggest to understand defects according to Figure 1.

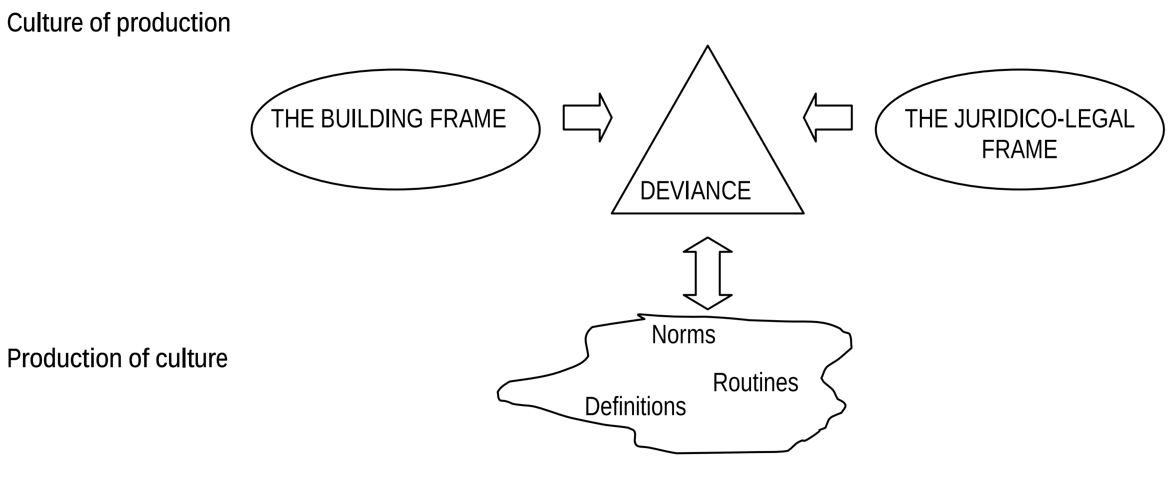

Figure 1. Analytical framework.

As illustrated in Figure 1, two different frames are shaping the concept of defects. The two frames are the building frame and the juridico-legal frame. The first frame is constituted by relevant social groups like building engineers, architects etc., construction technologies etc.

The second juridico-legal frame is constituted by relevant social groups like building experts, arbitration methods, arbitration courts etc.

In the following paragraphs, we will analyse how these two frames are mutually shaping the concept of defects along with the practices and strategies of firms operating within construction. We will follow/identify the controversies on 'defects' between the various relevant social groups in order to render the interpretative flexibility visible in relation to 'defects' as well as the processes that allow the controversies to be closed.

Building defects are considered as deviations from norms – an anomaly. The deviance is the object of an ongoing negotiation, where what is considered norms and what is considered as anomalies change over time and appears as the ongoing result of a mutual shaping process. Consequently, we will use the term 'deviance' rather than defects in our analysis to liberate ourselves from any of the connotations that is so deeply ingrained in the use of the term 'defects'.

Research design

This study used a variety of methods including participant observation, documentary methods and qualitative interviews.

First, participation observation in a two-day course for building experts in arbitration has given important knowledge on how the arbitration process is taking place, what tasks and duties the building expert is supposed to undertake, and how the building expert is being trained to conform to the code of conduct of a building expert in arbitration.

Second, documentary material has been obtained from various sources. The documentary material includes e.g. agreed documents, guidelines on arbitration, reports on arbitration and information on different types and procedures of conflict resolution.

Third, qualitative interviews have been conducted with the various actors of a construction project (client, consultant and contractor), a representative from the secretariat of the board of arbitration and arbitration experts. The interviews were carried out as semi-structured interviews and the themes included:

- What is perceived as defects, failures and shortcomings.
- Experience of using the court of arbitration and expert appraisals.
- Effect of the use and judgements on the firm's practice and strategies.

The interviews were recorded and transcribed in full. Eventually, the interviewees had the opportunity to comment on the transcripts. Subsequently, the interviews were analysed using a meaning condensation approach, rather than a narrative, interpretative or categorisation approach (Denzin & Lincoln, 1994; Kvale 1996).

CONSTRUCTING DEFECTS – DEFECTS IN CONSTRUCTION

The Danish Building and Construction Arbitration Court was established at January 1 1973. The Building and Construction Arbitration Court facilitates dispute resolutions within building and construction according to the agreed documents for construction works, design-build and consulting services covered by AB92, ABT93 and ABR89 along with the statute of the board. Other dispute resolutions or legal measures also exist like approved appeal tribunals, private lawsuits etc. The secretariat of the arbitration board is responsible for the administration of the activities of the arbitration board, including liaison between the opponents, lawyers, building experts, arbitrators etc. The arbitration board encompasses the following dispute resolution methods: Inspection and survey by experts, expert opinions on security provided etc., normal or simplified arbitration, pre-emptive conflict resolution, conciliation and mediation.

The liabilities of consultants and contractors are usually defined according to the agreed documents ABR89, AB92 and ABT93. When it comes to errors and negligences, the consultant are liable for damage occurring in connection with work assumed by him when such damage is the result of a lack of the necessary professional skill or care. The consultant cannot be held liable for damage arising from conditions which cannot be considered generally known in professional circles, for accidental damages, or for errors committed by the client or by others engaged by the latter (National Building Agency & Danish Association of Consulting Engineers, 1989). The liabilities of contractors are defined by the agreed document AB92 General Conditions for the provision of works and supplies within building and engineering (Danish Ministry of Housing, 1992, p. 9):

> *'§ 30. If the work has not been performed in accordance with the contract, with due professional care and skill or in accordance with any instructions given by the employer under § 15, it shall be deemed to be defective. The same shall apply whenever the contractor has failed to provide other services agreed upon in relation to the work.'*

Let us start the analysis with some empirical observations on the number of defects. This is exemplified by the pattern of dispute resolution in one of the case firms (see Figure 2).

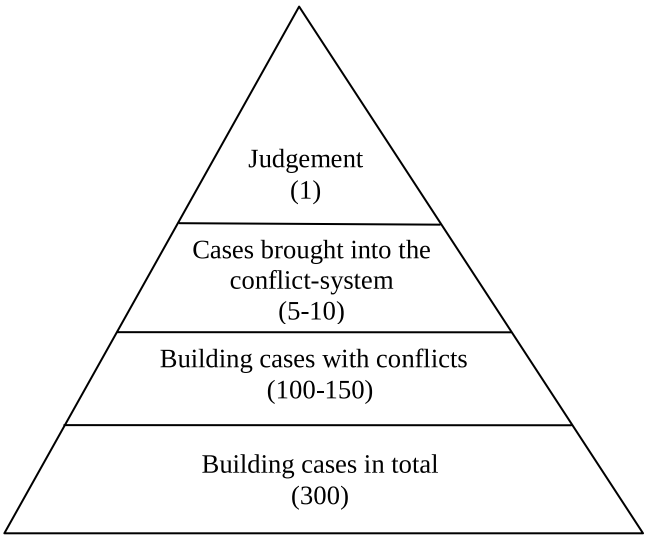

Figure 2: The dispute hierarchy in a construction firm. Source: Forman & Haugbølle (forthcoming).

The numbers in brackets refers to the number of building projects per year. These numbers are taking from a large consultancy firm. Clearly, the absolute numbers will depend on the size of the firm. Further, the numbers will depend on the type of firm in question. For example, the number of legal cases at a contractor is typically higher. In the contracting firm some 30-40 building projects per year was the norm. Now, the exact numbers are not that important. What matters is the scale or magnitude of disputes.

In the following four subchapters, we will deconstruct the interpretative flexibility of the concept of defects starting from the bottom and moving upwards. Further, we will move on to analyse the social construction of defects at three levels: the concrete negotiations, ground rules and structures. Finally, we will explain it by reference to two technological frames.

First interpretation: 'normalisation of deviance'

In Figure 2, the total number of building projects in one of our case firms of a major consultancy is estimated at a total of some 300 building projects per year. Of these 300 projects, about half of them will be finalised with revisions, modifications and alterations, but without any grave disagreements that would involve some measure of conflict resolution.

The execution of these building projects is predominantly being shaped by the building frame with its associated relevant social groups of architects, engineers and contractors, building technologies, design methods etc. This is not to say that the juridico-legal frame is not shaping the activities, but the juridico-legal frame reigns in silence and is mostly only directly activated when signing the contracts by the signatory powers and legal officers of the involved firms.

At the level of concrete negotiations, the actors will use e.g. project meetings, site meetings or a walk-through of the site to discuss and debate the progress of the building project and whether a design solution or the workmanship conform to general performance standards e.g. issued by the Danish Building Research Institute, Danish Standards or similar. At this concrete level, there is a constant check of solutions and performance against a more or less well-defined backdrop of what counts as satisfactory. The actors share a common perception of the expected outcome and what counts as a proper code of conduct. Thus, the gap between expectations and outcome is rather small. This is not to say that e.g. the contractor does not need to redo work and the consultant will need to redesign solutions, but there is a ready acceptance of the need to redo work since it is considered to be fair and reasonable. But revisions, modifications or alterations are viewed as an integral part of project based work. Thus, all actors of the building process expect the process to be an iterative process where changes are constantly made. An integral part of working in projects developing buildings is to recognise that no one solution exists at the outset. Rather, having numerous alternative roads ahead as well as final results is fundamental to building. Further, numerous interpretations of building brief, drawings, descriptions etc. have to be made during the course of a building project in order to produce the final product.

At the level of rules of the game, the actors readily accepts a playing field formed by the phase model and the agreed documents for construction works, design-build and consulting services covered by AB92, ABT93 and ABR89. Having signed a contract according to the agreed documents also implies acceptance of de facto fulfilling the contract even if that entails the need to redo work without obstruction, additional payment etc.

At the structural level, the interaction of actors produces a norm or code of conduct of what counts as 'normal practice'. This norm is productive in two ways. First, within a broad scope the norm sets the standard for what counts as satisfactory design and workmanship. Second, the code of conduct acknowledges the need for revisions and modifications as business as usual. Consequently, deviances become the norm, very similar to the processes described by

Vaughan (1996) in her now classical study of the disaster of the space shuttle Challenger. In fact, an argument often raised in the policy debate on defects is that these revisions and modifications should *not* count as defects since they are an integral part of the project team becoming wiser as the project moves on. Thus, our first observation is related to what could be coined the 'normalisation of deviance'.

Second interpretation: 'deviance as leverage/liability'

Moving up one step of the ladder in Figure 2 marks a significant shift in the interpretation of the concept of defects. According to our interview persons, the firm is likely to experience disagreements and disputes in up to half of its 300 building projects that require some level of legal action in order to cope with the disputes.

At the level of concrete negotiations, these disputes may concern all possible aspects of the building project: extensions of time limits and delays, extra payments for additional work, errors and negligences on behalf of the consultant, insufficient workmanship etc. These disputes may be resolved in various ways. It is however characteristic that in order to settle the disputes some measure of legal action is required. This may be in the form of e.g. letters of formal notice, involvement of some kind of dispute resolution board, replacement of personnel, withholding payments or having parts of work being done by others. The solution in each building project may differ from the next, but essentially the resolutions are drawn from a commonly known pool of options.

At the level of rules of the game, these disputes are managed internally in the project or possibly between firms at the level of senior executives. But external building experts or the court of arbitration are seldom directly involved in solving the disputes. This is not to say that the legal system of arbitration is not playing a role. Indeed, the concrete negotiations taken place between the actors will often make use of the rules of the game by referring to the agreed documents, contracts etc. in order to make e.g. the contractor comply with what the client and consultant consider appropriate. In this respect arbitration is used as a leverage to further the interest of one actor towards another actor in the building process. Thus, it acts as a ground rule for dealing with defects.

In most cases, the settlement of disputes is postponed until the project is finished and the hand-over is or has taken place. In another paper, Forman and Haugbølle (forthcoming) have argued that this constitutes a double-strategy on behalf of the construction companies. Although progress of the building project is imperative, both parties in the dispute will start putting together as many claims as possible against the opponent.

At the structural level, the interaction of actors of both the building frame and the juridico-legal frame produces a norm or code of conduct of what counts as 'defective practice'. Although all actors of the building process expect the process to be an iterative process where changes and deviations from the intentions of the plan are constantly made, deviance is no longer just viewed as normal practice. Rather, accusations of bad workmanship, defective designs, bad intentions etc. are now filling the air. Deviances are now considered to be detrimental to the objectives and intentions of the building project, and they are no longer deemed excusable and immediately being rectified by the responsible actor by own code of conduct. On the contrary, we are now close to the amoral calculator hypothesis as described by Vaughan (1996).

Summing up, the execution of this group of building projects is no longer predominantly being shaped by the building frame alone. Rather, the juridico-legal frame becomes more prominent in the shaping of the course of building projects and the interpretations of what counts as a defect. Thus, defects may act as tactical negotiation resources that can be used as leverage or be a liability in the settlement of payment of each party. Consequently, disputes and defects are no longer so much about e.g. the building technical content as it is a matter of payment. Thus, a seemingly technical defect on e.g. poor workmanship, defective products, reduced technical performance of a construction is being translated (Latour 1987) into a liability/leverage and further into an issue of payment.

Third interpretation: 'deviance as a random effect'

Taking one step further up the ladder of Figure 2 denotes another significant shift in the interpretation of defects in construction. Figure 2 illustrates that in a rather small number – some 5-10 building projects per year – disagreements escalate into a literally legal dispute where arbitration and building experts are directly brought into play. Again, these disputes may concern all possible aspects of the building project: extensions of time limits and delays, extra payments for additional work, errors and negligences on behalf of the consultant, insufficient workmanship by the contractor etc.

At the level of concrete negotiations, disputes are no longer managed internally in the project or possibly between firms at the level of senior executives. Rather, external building experts or the court of arbitration are being directly involved in settling the disputes. Thus, the shaping of the concept of defects by the building frame is now to a much larger extent being directly shaped by the presence of the juridico-legal frame. A core challenge facing the actors is the selection of expert and appraisal themes along with the state of evidence (notably documentation) is crucial to what will be defined as a defect at the level of concrete negotiations.

When it comes to the rules of the game, the third level in the dispute hierarchy marks a significant shift in the course of events. An interview person expresses it this way: 'Bad blood has entered the project'. However, this does not entail that the project is being held up or stopped normally. Rather, the imperative of the building frame is still progress. Thus, the project will not be held up (at least not for long) but a building expert may be summoned to ensure the necessary evidence related to the dispute. In most cases, the examination and opinion of the building expert will form the backdrop for a settlement of the dispute before it is taken to the court of arbitration. The secrecy of settlements and the use of defects as a tactical negotiation resource by project participants are setting the ground rules for coping with defects.

In most cases, the settlement of disputes is postponed until the project is finished and the hand-over is or has taken place. In another paper, Forman and Haugbølle (forthcoming) have argued that this constitutes a double-strategy on behalf of the construction companies. Although progress of the building project is imperative, both parties in the dispute will start putting together as many claims as possible against the opponent.

At the structural level, the contested nature of defects displayed by the open adversarial relation between the actors of the building process along with the secrecy of the out-of-court settlements and the importance of the selection of building expert and appraisal theme produces an image of the verdicts and closure of disputes as being a random effect. Although the wordings of each of our interview persons are different, one quote nicely captures the perception among building professionals of arbitration and building expert surveys: 'It is simply a lottery'. Whether this is true in any 'objective' sense, is not really that important. The important issue is how the actors perceive defects and arbitration, and how the actors act correspondingly to cope with this uncertainty and randomness.

Fourth interpretation: 'deviance as precedent'

Of the rather small number of building projects escalating into a legal dispute where a building expert or other dispute resolution methods are brought into play, Figure 2 illustrates that no more than a few building project per year is likely to be taken to the court of arbitration for judgement. Again, these disputes may concern all possible aspects of the building project: extensions of time limits and delays, extra payments for additional work, errors and negligences on behalf of the consultant, insufficient workmanship by the contractor etc.

Disputes are now staged predominantly by the juridico-legal frame. Thus the game rules have altered significantly. What started out as a disagreement in a building *project* has now turned into a legal *case*. Further, the time frame has changed dramatically from that of a more or less fixed deadline for the handing-over of the final building to the legal statute of limitations. A significant shift in actors or relevant social groups has also occurred. First, building experts, lawyers, insurance companies, legal officers and arbitrators are the prominent actors. Second, although the building professionals still have a role to play, their roles as project manager, consultants, contractor etc. has now been redefined as the roles as plaintiff and defendant as well as witnesses to be called to the stand. In this respect the building frame has been subordinated to that of the juridico-legal frame.

Consequently, the concrete negotiations have moved in to the courtroom, where the lawyers will litigate for their clients. The lawyers will do their best to 'establish fact' on compliance or non-compliance on the issue in question. A key item of this process is the ability of the respective parties to make a good case based on the documentation at hand. Or as one interview person bluntly puts it: 'It is not about being right, it is about *proving* that you are right.'

Another key item is the questioning of the statements made by the building expert. It is worth noting however that the inspection and survey report done by the building expert can not be appealed to other courts. Thus, one of our interview firms is considering whether it would be more appropriate to skip the provisions in the agreed documents on the arbitration court (for private clients only) and have the cases judged in civil-court instead, where appeals are possible and the building expert can be countered by other experts. Another important observation is that the insurance companies are often pushing hard for a judgement in the arbitration court.

What is the structural implication hereof? The concept of defects is now predominantly being shaped by the juridico-legal frame. Reaching a verdict or judgement presupposes a definition of what counts as 'normal practice'. A practice carried by, described by and assessed by the building expert summoned by the court of arbitration as the expert. A practice that is not only open for interpretations but also contested (this is exactly why the particular dispute ended up as a legal case in the first place!).

Two observations are important here. First, the use of normal building practice as benchmark rather than best practice effectively forms structures that lock construction into the current state of affairs. An example of the implication hereof was given by a client complaining that even a very high number of less grave defects would not justify the rejection of the takeover of a building. As the interview person put it: 'Even 10,000 paint spots are not enough'. Second, the interest and push by insurance companies for judgements in arbitration court is closely linked to safeguard the insurance policies, insurance premiums, insurance cover, insurance clauses etc. Thus, the insurance companies as well as public construction clients (being obliged by law to do so) will seek to create a precedent in order to define what counts as compliance and non-compliance.

CONCLUSIONS

In a schematic sense our core argument throughout this paper looks like this: Institutions like the legal system of arbitration is co-forming norms for performance, code of conduct etc. These norms along with other forces shape the behaviour of actors. The behaviour produces results and (sometimes) defects. In turn, the defects stimulate learning – correct or not (Kreiner & Damkjær, forthcoming). The lessons learned either maintains existing behaviour or re-shapes a new behaviour. The behaviour will reinforce norms for performance, code of conduct etc. In turn, the norms establish the foundation for institutions like arbitration.

This paper has illustrated the interpretative flexibility of the concept of defects or deviance, as we would prefer it. The four interpretations are deviance as normalisation, deviance as leverage/liability, deviance as a random effect, and deviance as precedent. Further, we have demonstrated how defects are constructed through three main processes: concrete negotiations on the gap between expectations and realisation, setting and applying ground rules for the game, and by producing structures in the shape of norms or codes of conduct. Finally, we have argued that the construction of defects is the result of interaction between two dominant technological frames: the building frame and the juridico-legal frame. Consequently, the system of arbitration and expert appraisals along with construction practices and strategies is co-shaping a culture of deviance/defects that both intentionally prevent defects but simultaneously foster defects unintentionally.

REFERENCES

Bijker, W. E. (1997). Of Bicycles, Bakelites, and Bulbs. Towards a Theory of Sociotechnical Change. Cambridge, MA: The MIT Press.

Danish Enterprise and Construction Authority (2005). Byggeriets handlingsplan mod fejl og mangler (in Danish). København: Erhvervs- og Byggestyrelsen.

Danish Ministry of Housing (1992). AB92. General Conditions for the provision of works and supplies within building and engineering. Copenhagen: Danish Ministry of Housing.

Denzin, N. K. and Lincoln, Y. S. (1994). Introduction: Entering the field of qualitative research. In N. K. Denzin and Y. S. Lincoln (Eds.) Handbook of Qualitative Research (pp. 1-17). Thousand Oaks: Sage Publications.

Forman, M. and Haugbølle, K. (forthcoming). Arbitration and expert appraisals of defects in construction: what do companies learn? Proceedings of 25th Annual Conference ARCOM 2009. United Kingdom.

Høgsted, M. (2008). Partnering og tvister i byggeriet – del 1: Omfang, data og vurderinger (In Danish: Partnering and disputes in construction – Part I: Size, data and experiences). København: PLUS-netværket/Boligfonden Kuben.http://www.boligfonden.dk/fileadmin/files/documents/pdf_docs/2008/Projektdokumenter/2007_20_tvister_og_partnering_rapport1.pdf

Kvale, S. (1996). InterViews. An Introduction to Qualitative Research Interviewing. Thousand Oaks, London & New Delhi: SAGE.

Kreiner, K. and Damkjær, L. (forthcoming). Learning and imagination in construction. Proceedings of 25th Annual Conference ARCOM 2009. Nottingham, United Kingdom.

Latour, B. (1987) Science in Action. How to follow scientists and engineers through society. Cambridge, MA: Harvard University Press.

National Building Agency & Danish Association of Consulting Engineers (1989). ABR89. General conditions for consulting service. Copenhagen: Danish Association of Consulting Engineers.

Pinch, T. J. & Bijker, W. E. (1984). The social construction of facts and artifacts. Social Studies of Science, Vol. 14: 399-431.

Vaughan, Diane (1996). The Challenger Launch Decision: Risky Technology, Culture and Deviance at NASA. Chicago: University of Chicago Press.

SIMULATION OF UNIQUE CONSTRUCTION PROCESSES - METHODS TO MODEL REALITY

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Simulation of construction processes imply the description of a vast amount of individually experienced construction conditions and also the development of special strategies for the consideration of changing site conditions during construction.

The paper describes conceptual approaches developed by the authors. Showing some real construction projects, the simulation of special work tasks and their optimization is shown as well as the interaction between work progress and simulation update. Getting the right day-to-day information is essential for updates of the simulation model during construction and therefore takes a special focus in the presentation.

Everyday construction progress is undergoing a lot of changes. Modelling this in simulation, needs a high level of abstraction and still calls for some major simplifications. In order to keep the number of variations under control, special basic strategies for the application on unique construction processes are presented.

KEYWORDS: simulation, optimization, process monitoring, construction strategies, day-to-day data.

INTRODUCTION

In the stationary industry simulation is a well established tool for the planning of production processes. In use are discrete event-based simulation models for production and logistic planning in order to optimize the deadline controlling and resource management. Simulation models can as well be used in the building industry in order to improve the implementation planning. The simulation of building processes allows a detailed and more realistic process scheduling and optimization. Further more robust prognoses can be made.

Everyday life on construction tasks as dry walls, façade building and infrastructure construction sites (especially as road-, railroad- or bridge building projects) is commonly characterized by enormous pressure of time and costs as well as difficult logistic requirements. For better solving these problems, Information Technologies are to be used more intensely to find new creative and efficient methods of construction.

The amount of data and information, which has to be processed in construction, has increased enormously during the last decade. Thus modern simulation tools can be applied with growing success. But up to now these tools are predominantly used only in the start-up phase of a project, in order to achieve an optimisation of construction and logistic processes.

The topic of this paper has been developed along the question: what are the capabilities of using simulation tools which incorporate the available information about the actual status of a construction site to improve the tracking of the progress and dynamic scheduling as well as to enhance the process accompanying optimization. This aspect is an issue at stake particularly in infrastructure projects, because these projects are subject to multiple critical constraints as blocking interference times, cramped field conditions and further complex influences.

Therefore this paper deals with 3 aspects of significance:

The first aspect answers the question, how to describe the building process. Construction processes imply the description of a vast amount of individually experienced construction conditions and also the development of special strategies for the consideration of changing site conditions during construction. The generating of models and the adjustment of the many parameters in a simulation model are difficult tasks.

This paper focuses on the special challenges to develop suitable parameters for the description of construction processes for on-site work. Reaching far beyond the simple process of prefabrication and assembling on site, the progress of labour and machinery work on a construction site is highly dependent of the efficiency of machinery and manpower. They again depend on many parameters as change orders, approval of plans, weather conditions, technological conditions, but also on shortcomings in labour resources, machinery failure and other obstacles. Everyday construction progress is undergoing a lot of changes. Modelling this in simulation, needs a high level of abstraction and still calls for some major simplifications.

As a second aspect the presented paper outlines an approach based on accurate day-to-day data for the current project state at any time. For the optimisation of construction processes in operation, actual and constantly changing boundary conditions must be controlled, which implies the control of the steady progress of construction to a sufficiently detailed degree.

The critical point is to capture appropriate signs of actual state, which will necessitate corrective actions. Up to now this depends very much on the competence and experience of the site manager. Particularly the estimation of long-term consequences is a difficult task. Therefore the objective is a simulation model, which verifies and visualises “overnight” the consequences of the possible corrective actions. But a daily accurate simulation model requires significant day-to-day data. Thus capturing the construction progress with sufficient exactness is needed. Consequently the following questions must be answered: Which choice of data is actually needed for evaluating the current on-site status with regard to a simulation model? Which instruments can effectively be used and combined for the data evaluation? These data then facilitate the simulation of possible variations for ongoing optimization. Thus, the critical path monitoring and the flexibility in case of changes will be improved immensely; signs for long-term consequences will be spotted at early stages.

As a third aspect, the paper gives considerations, how to design building processes in general, and which basic strategies can be used for it or must be applied to, sometimes overlapping and even contradicting each other. In many cases, in which the sequence of processes is not clear, because technologies allow variations, it is appropriate to define general guidelines, which are at first logic and possibly more economic than others. This reduces the number of variations for a better and faster simulation and development of feasible solution patterns.

SIMULATION

Most research approaches, which deal with process modelling in building management, strive for the support of decision making processes. Therefore linear optimization models are used that implicate relevant influences and boundary conditions. Besides the linear optimization, simulation tools are used more and more intensively for decision making. Intended is the support of an objective decision making by analysing and optimizing dynamic processes.

Even if the results are not automatically at optimum, they provide appropriate solutions for complex problems. If processes are more complex and more influences have to be considered, then the use of simulation tools is more attractive. In simulation the mathematical complexity can be kept at a lower level compared to the linear or nonlinear optimization. (Tecnomatix, 2006)

Other branches of industry as the automobile (Bayer, 2003) or shipbuilding industry (Beißert, 2007) already use simulation very successfully. Examples are the planning of assembly lines and logistic processes.

A special challenge is the transfer of methods from stationary industries to the building industry. Compared with other industries the building industry is distinguished by individual products that vary in construction type, size, function, material and many more attributes. Moreover the construction conditions change with every new project. And within a construction site the working places change and move as the construction process progresses.

The authors use event-based Simulation, as in Tecnomatix Plant Simulation, which is already successfully utilized in stationary industry. The research then strives for developing specialised tools for the simulation of unique construction processes.

DESCRIPTION OF THE ON-SITE STATUS

For logic and digital description of building processes the requirements and dependencies of the processes must be captured and edited. But predominantly this knowledge is based on the experience of site managers, foremen and engineers. It is neither documented nor accessible for processing in simulation. The experienced people organize the site and optimize the appropriate process planning simply by intuition or “educated guess”. Therefore the right ideas, methods and decision making strategies must first be captured and described in an appropriate way for the intended simulation tools.

For capturing these valuable experiences the building processes of real construction projects were documented. The authors have first started with a highly detailed documentation of selected processes as drywall finishing, the assembling of façades and the production of bridge curbs. The example given in this paper is taken from bridge construction. Bridge curbs were chosen, because they represent a typical self-contained element of reinforced concrete. Therefore the examination results will be transferable to other concreting processes. That opens a great variety of prospect, because reinforced concrete is a widely used building component.

The building process of bridge curbs is hardly described in literature. Therefore the building process of several bridges was monitored, highly detailed captured and documented. Selected were different road bridges with varying degrees of complexity und different constraints. In the following one project is described in detail.

This largest of all monitored bridges is a 445 m long highway-bridge in Germany with 12 spans and a double-webbed t-beam cross-section made of pre-stressed concrete. This bridge was built with a mobile scaffolding and formwork structure standing on the ground.

This bridge shows multifaceted boundary conditions, which highly influence the building process and methods as well as the time scheduling. The bridge spans two farm tracks, an interstate highway, a railroad track and a river. The railway track belongs to a highly frequented main line. Thus all disturbances including a number of blocking interferences had to be kept to a minimum. The river is part of a drinking water protection area and is subject to strict environmental restrictions.

During the executing phase right from the beginning the construction sequence deviated and had to be constantly rescheduled by the site manager. Obviously the ongoing steering of the building progress was based only on the site manager's competence. He had to act on a day-to-day basis. A thorough consideration of long-term consequences was almost impossible.

Within the monitoring of the real running process, all interferences and the following deviations as well as the corrective activities were documented in order to use them for the presented approach as well as for future simulation scenarios. Furthermore the duration of all activities as well as the exact need of material, machines and manpower was monitored.

In this way also other bridges were monitored for gathering a reliable data source. Based on these data a universally valid and conventionalized construction process of a bridge curb was designed.

Process modelling

The development of an appropriate process model is needed for visualising and analysing dependencies within the building process. Because of their transparency event-driven process chains (EPC) are suitable for structuring the construction process in a first step.

Thus the building process is structured into single processes and activities. These are analyzed regarding their dependencies, duration, required resources, fault liability, error probability, and flexibility of execution order and date respectively parallel processes and possible correction strategies, etc. The objective is to evaluate their significance to the aggregated process. Inter alia the critical path method is utilized for this evaluation.

For ranking the processes by the mentioned criteria the AHP (Analytic Hierarchy Process) method was used in order to identify key processes, which are of particular importance for the ongoing optimization. Later these processes are identified by significant events in the construction process. For checking the plausibility of the criteria and their emphasis in the AHP a sensitivity analyses is implemented.

The idea for those significant events is to identify "grid points". The term is adopted in analogy to the analytic algebra. With it a curve's shape can be defined, if a sufficient number of discrete points and the type of curve are known. In the same way a sufficient amount of reliable process information will be used to define the actual status of work. This information will be taken as grid points for the indication of the actual state of the construction progress. Grid points are set up as control gates, where signal information can be generated or taken from. Clearly or with sufficient certainty they indicate, which events have taken place and which activities are in progress. Therefore the kind and density of needed information has to be determined. Figure 1 illustrates this approach. Single data allow concluding to grid-points, which then sum up to event information that describes the ongoing building process.

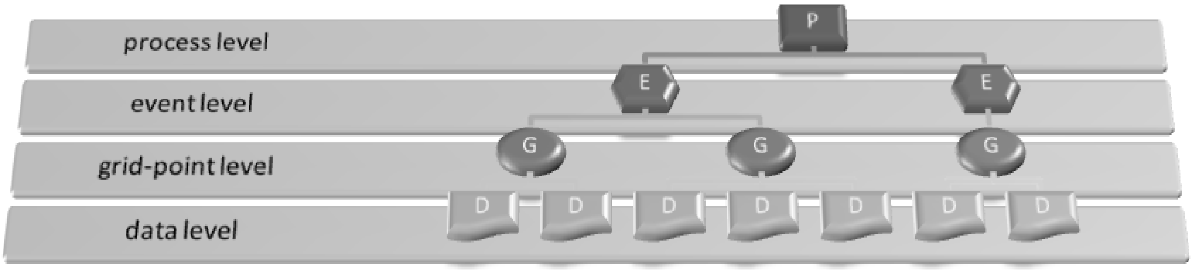

Figure 1: 4-level-Modell according to (Achilles, 2004)

Each process starts with an event, which can be the start of a certain activity for example. These events have to be identified and described as grid points. Appropriate grid points are for example: events required before a certain procedure can start (material delivery), events assigned to the completion of a procedure (milestone) and easy-to-describe intermediate states (acceptance of reinforcement), and placement of certain types of rebar and installation units. Some of these are comparable to milestones in time schedule.

The level of detail is deducted from the simulation requirements. Processes are described as detailed as they are realistically portable to simulation tools. It also depends much from the level of detail, which is needed to identify and implement correction strategies.

DATA SOURCES – DAY-TO-DAY DATA

Which instruments can effectively be used for the data evaluation? The answer to this question is going to be complex. Up to now most research projects develop and analyse data gathered from one type of source, for example RFID or laser scanning. But the reality in construction is so various, that different techniques of data gathering have to be combined. Thus an appropriate mix of these techniques will be established within the ongoing research project. Therefore different sources of information are identified, that in total can give significant information about the current state of the construction (Bargstädt/Ailland, 2008).

Traditional information sources

For the design of a most efficient and realistic controlling tool, the approach starts with the identification of documents and other information sources that are widely used on most construction sites. Documents like construction records, minutes of meetings or delivery notes have to be recorded by law, by contract or for controlling and are associated with the everyday life on each construction site.

Up to now they have more or less not been evaluated in terms of a daily accurate capturing of the building progress. The documents are analysed with reference to the information they yield with respect to the degree of completion and material deliveries (Table 1). Therefore AHP will be used as well.

Table 1: assessment criteria

content aspects	quality aspects	time aspects	technical aspects
signification	certainty of capturing	actuality/frequency	capturing technique
base	reliability		data format
degree of completion			
primary/secondary data			
direct/indirect conclusion			

Signal information as described above is a matter of particular interest. Furthermore the common data format, in many cases handwriting, is registered. In a following step its applicability for digitalization and automation is discussed.

The analysis of documents that are usually generated on bridge construction sites yields that the following types of data can be extracted (Table 2). That information will be evaluated by the above mentioned criteria and will then be related to grid-points.

Table 2: definition types of data

category	resource	capacity	production output	production influences	production conditions
type of data	delivery data	personal data machine data	measurement data testing/acceptance data	progress documentation	weather data

Data pooling, which is based on the above mentioned information sources, describes the building process not yet as accurate as needed. On one hand it is handwritten and often biased. On the other hand it is not yet sufficient for a complete picture of the status of the construction. Depending on the intended optimization further information must be captured. Therefore more sophisticated instruments for data evaluation are considered. Also it must be kept in mind, that additional information sources should be less from personal observation and be more trustworthy and not biased.

Instruments for the data evaluation

Current technical instruments are for instance RFID, GPS, Photogrammetry, Laser scanning, Tachymetry and Bar codes. In all of these fields fast improvements are to be realized. As a result of further developments in most technologies it is possible to push the boundaries that were limiting the application for construction just a few years ago. An example is RFID technology, where the size of a RFID chip has become one tenth within 5 years, and the price has been dropped to 1/100.

Furthermore increasingly powerful screening machines open new visions for better application. For example the storage capacity of Photogrammetry increased enormously. It is possible to exploit much more data points in less time. Even real time feedback seems to be realistic in the near future (Kutterer, 2006).

In addition the exchange and storage via internet has opened new skies. Nowadays it is possible to transfer huge amounts of data to any place in the world, to process them in a central location, and to transfer them back to site. The task is to identify the relevant evaluation instruments and register and analyse them in regard to their qualification of recording real-time data. This comprises speed, data volume, precision and automation of data. It leads to the question, which instruments are appropriate to recognise parameters relevant for the building progress. Constraints and requirements needed for the application of different instruments are considered. Significant parameters are functionality, type of information, degree of automation and type of equipment.

COMBINING PROCESS MODELLING AND DATA EVALUATION

The so far developed basics concerning process modelling and data evaluation will now be combined into one model (Figure 2). By using process modelling, the building progress is structured into processes and additional grid points pursuant to the requirements of deadline monitoring and simulation. Thus it defines where and when information should be captured.

Now those points will be matched with the possible data sets. Preference is given to real-time data. In a first step the model is fed with data, which are taken according to availability and actuality (information sources). These data are in any case reviewed with regard to their relevance and ability of describing the status at a considered grid point. Data with less relevance will be hold back for further usage, for example checking on the plausibility.

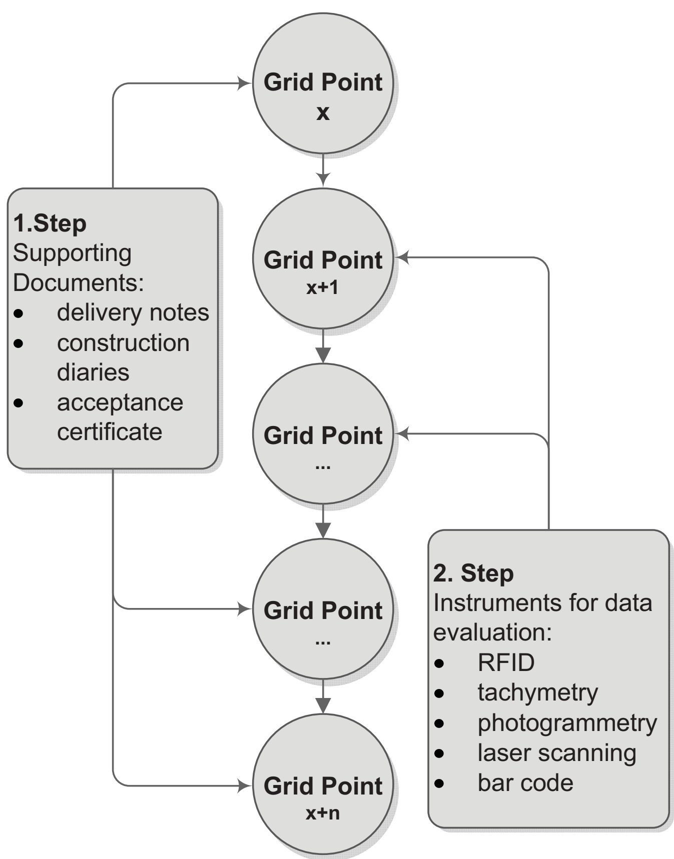

Figure 2: Conception

Thus monitored, the model of the building process is still incomplete, but generated in some main elements. For completing the monitored situation, now further appropriate instruments for the data evaluation will be selected and activated. They will supply the monitored model with sufficient information for the remaining grid points. This supplementary data gathering is taken by means, which are chosen based on the aforementioned multi criteria comparison.

Again the question has to be answered, which instruments will be appropriate to capture the necessary information at certain grid points. At first glance almost all instruments for data gathering have the potential for as much as possible and accurate data, as long as time and costs do not have to be considered. But in practice neither these resources are unlimited nor is it adequate to extrapolate to infinity the further development of the tools.

In the generalization phase for the time and status being a catalogue with a classification will be established pointing out, which instrument is appropriate to best describe every significant construction status. Nevertheless the opportunities of increasing the reliability and significance by capturing more data, by using more sophisticated instruments or by referring to recent developments in monitoring instruments are also considered.

STRATEGIES

A special aspect of simulation is the question, how can the vast amount of possible solutions and variations be kept to a manageable number. Often the construction sequence is not clearly given due to technological constraints, but can be varied to a high degree.

Often this degree of freedom is synonymous with a lack of clearly defined objectives in a project. The better the objectives for a project are defined, the easier the finally binding conditions can be defined. Governing parameters can be given by the investor as well as by the design engineers, by the construction companies as well as by any other parties involved in the whole project.

Concerning the example given in this paper, the vast possibilities of influencing parameters by parties other than the construction company shall not be considered. Focussing on the construction company it is even assumed, that at the beginning the construction project is not exposed to limiting conditions. Thus a high degree of freedom is given, how to manage the construction process and how to choose a feasible sequence.

In simulation tools this freedom allows to search not only for an optimum given by former experience, but also to include possible other and new sequences. At this point experienced site managers might argue, that, by this approach, most of the randomly generated sequences and dependencies must be checked by hand, whether they can be realised in reality and how they can be valued in terms of time and resources.

A concept for a more precise solution space is the definition of certain construction strategies. They are extracted from gained experience, but described in a generalised manner. Then they are used to check on the improvement of solutions from simulation.

Two alternatives of defining construction strategies are possible. The first alternative is the standardisation of proved patterns from former construction projects. This can be considered as a tool kit, including standardised and detailed processes, which can be included as subroutines within a bigger set of simulation frames. It works like a library of simulation subroutines with sets of parameters in order to fit them into the general frame of a simulation model.

The second alternative is the definition of main features of construction strategies. This aims on simple and transparent assumptions in order to enforce certain clear sequences within a complex project. Since they are also deducted from experience, they are easily understood and – as well – easy to be checked on.

Even complex construction processes yield a lot of possible basic strategies. Starting with the construction sequence, certain pattern ("from left to right", "from bottom to top", along a certain axis etc) can be defined, which then govern all of the following work steps. Other strategic base lines can be "from coarse to fine", "first inner, then outer structures" or "destruction before construction".

Other conditions are more likely to be characterised as arguments for favourable priorities. This allows distinguishing between activities with short and long duration. It enables to differentiate between dirty and clean activities, between wet and dry processes etc. Concerning the analysis of sequences on real construction sites, often one of several of these patterns is underlying the favourable solution (Bargstädt, 2008).

In the start of a simulation the most likely basic strategy is applied first, then others are introduced besides the technological constraints, which have to be checked constantly. So different variations are calculated and simulated, which are to a high degree distinct to each other.

On the next level of complexity the strategies are not kept constant throughout the whole construction process, but the priority will be changed according to the transition from one construction phase to the other. For example in the construction of bridge curbs the formwork for the concrete curbs cast in place might be chosen according to the linearity of the bridge, whereas the finishing elements will be installed according to their rank of complexity.

CONCLUSION/PERSPECTIVES

One objective of this research is to evaluate possibilities and limitations to the simulation of unique construction processes. It starts with the concept of "grid points".

Using simulation in construction processes, which have been developed at Bauhaus-University Weimar (König, 2007), the prototype implementation of different instruments for data generation is added to the simulation model. Thus the effects of different performances can be analysed.

Simulation models are suitable for developing construction sequences, as shown in (König, 2007). This approach considers the monitoring aspects of construction sites. Data gathering, data processing and the following steering processes are implemented in the simulation model. It yields information about the importance of precision, velocity, automation, redundancy and significance of data capturing during construction processes. There the results, the advantages, disadvantages, weak points and application limits can be adjusted to different construction conditions. Furthermore the error-proneness can be tested. One aspect will be missing data and how the simulation will react in case of uncertainties or, for example, a missing delivery note.

With the knowledge from these simulation experiments the results will be verified on a prototype. Even if the model suggests a complete control of the construction process, the reader should be aware, that construction is far too complex to just rely on the automation. The presented approach is a way to improve the information on ongoing construction sites. It will enable the construction manager to better concentrate on real obstacles, which have not been encountered in advance, and to have better information sources for routine processes to be steered. Thus the time to react will be shortened. Is it then also possible to evaluate effective counteractions by using the simulation tool in combination with real-time data gathering.

Since high degrees of freedom and flexibility are main features of construction processes, this vast amount of variations must be guided by general strategies, which at first glance have a good plausibility for economic processes. The chosen variations are kept transparent and thus matter of revision in case of alterations and further optimisation. Nevertheless they are used as basic patterns for the search of feasible sequences for construction processes.

REFERENCES

Achilles, M. (2004) Konzeption eines systematischen Dokumentation der Bauausführung aus baurechtlich-baubetrieblicher Sicht: VDI Verlag, 3-18-319804-5

Bargstädt, H.-J. (2008) Montagestrategien und die Logik der Bauprozesse: Tag des Baubetriebs 2008, Tagungsbeiträge, pp 81-94, Weimar

Bargstädt, H.-J., Ailland K. (2008) Capturing the real time state of construction for simulation: IABSE Conference, Helsinki, Finland

Bayer, J. (2003) Simulation in der Automobilproduktion: Springer, Berlin

Beißert, U., König M., Steinhauer, D., Bargstädt, H.-J. (2007): Constraint-Based Simulation of Outfitting Processes in Shipbuilding and Civil Engineering: 6th EUROSIM Congress on Modelling and Simulation, Conf. Proceedings, Ljubljana, Slovenia

König M., Beißert, U., Bargstädt, H.-J. (2007): Constraint-Based Simulation of Outfitting Processes in Building Engineering: 24th W78 Conference, Conf. Proceedings pp.491-497, Maribor, Slovenia

Kutterer H., Hesse C. (2006) High-speed laser scanning for near real-time monitoring of structural deformations: Tregoning, P., Rizos, R. (Eds.): Dynamic Planet – Monitoring and Understanding a Dynamic Planet with Geodetic and Oceanographic Tools, IAG Symposia, Vol. 130, Springer, 776 - 781.

Tecnomatix (2006) Tecnomatix Plant Simulation, Step-by-step Help: Handbook Version 8.1., Stuttgart

TOWER CRANE LOCATION ON SITE FOR BUILDINGS

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The tower cranes belong to essential building machines which are widely used for transport of the construction products from storage area or vehicle to their final positions in process of building-up of the constructions. Their positioning affects a fluency, costs and total consumed time of building-up. This article is concerned with analysis of possibilities of the tower crane placing in site, with risk identification for each single variant and recommendations on design of tower crane positioning in case of several situations. It also analysis the problematic of mounting and dismounting of tower cranes and risks related to design of higher number of the cranes. At the close it defines a procedure how to determine optimum distance of the tower crane with folding jib and the building.

KEYWORDS: crane, site, construction.

INTRODUCTION

Tower cranes represent crucial construction mechanisms influencing the course of high-rise construction. The cranes project specifying their number, type and location is decisive for work organisation on site, construction term and construction costs.

In Slovakia, crane project is drafted prior to the issuing of construction permit. The permitting authority requires for the submitted project documentation to also include “Construction Organisation Plan” which is to document that the project is feasible. Further, it shows environmental impacts throughout construction (Lavrincikova, 2001). This part of project documentation deals with the construction organisation concept and also defines the types of tower cranes, lengths of beams, their location, method of cranes fixation and their maximum heights, method of construction materials supply, method of cranes assembly and disassembly, as well as electric power requirements (Makýš, et al., 2005), (Szalayova, 2004). Utility managers voice their opinions on the proposed facts, including air traffic authority in case of high-rises. The entire documentation is studied by the permitting authority. This documentation only deals with construction concept. Therefore, the facts on cranes are only general and require further detailing.

Actual and detailed plan of tower cranes is prepared by the contractor (Kozlovská et al, 2005). The contractor modifies facts included in the Construction Organisation Plan depending on the actual project status and types of cranes available at the time of construction. Further, the contractor studies crane load on subgrade, which represents a basis for suitable foundation structure.

The development of a tower cranes plan is not a simple task. The attempt to speed up the construction process is manifested in the higher number of tower cranes used within one site (Figure 1), whereby, optimisation of their distribution on the site is one of the key tasks of the plan. Tower cranes distribution plan needs to be processed so as to provide for the following:

- Coverage of places requiring load transport (construction material, parts, various equipment or structures) by a crane with sufficient carrying capacity;
- Coverage of load supply places, the best would be directly above transport means, by a crane with sufficient carrying capacity;
- Crane positioning in a place posing minimum obstacle to construction progress and on-site transport;
- Sufficient crane system performance enabling project supply at the required rate;
- Cranes installation and removal;
- If necessary, cranes anchoring in the high-rise structure, and last but not least
- Maximum operating and standby safety.

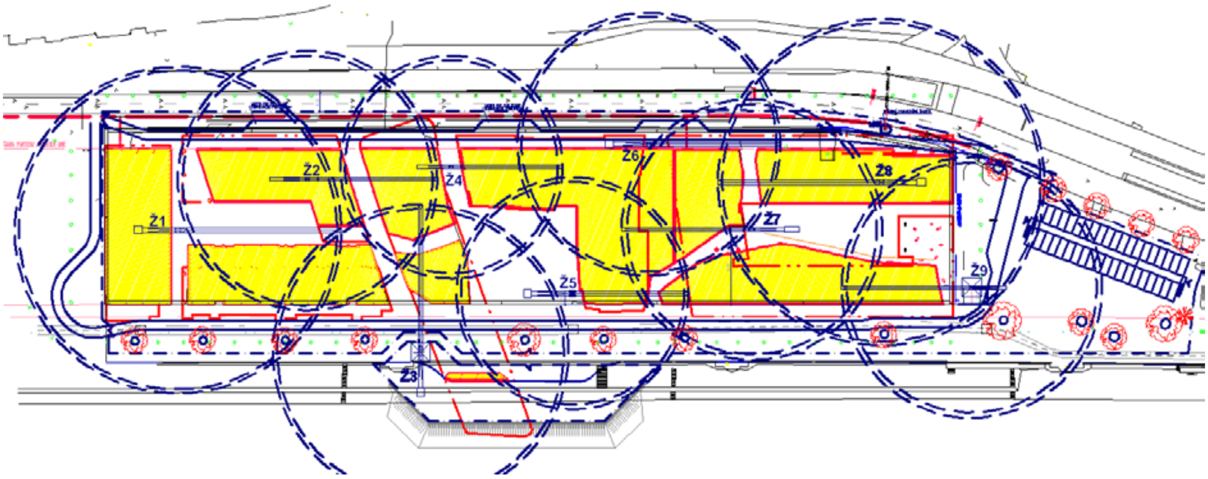

Figure 1: Tower Cranes Plan – Multifunctional Complex RiverPark Bratislava

Depending on crane positioning within the site, we may speak of a position outside or inside the construction project floor plan.

CRANE POSITIONING OUTSIDE THE CONSTRUCTION PROJECT FLOOR PLAN

In terms of construction progress, it is better to place a tower crane outside the floor plan of the constructed structure. Such crane does not pose an obstacle to construction work progress and, if necessary, the date of its removal may be shifted with no negative impact on construction process. It also enables early crane installation prior to the first work on foundation structures. Crane positioning outside the floor plan of the constructed structure provides for simple crane supply with construction material (Motyčka, 2000) and good view from the crane operator's cabin on the transport means during material collection, which speeds up crane work and improves work safety.

However, in this type of crane positioning, complications may be caused existing underground infrastructure services in front of the structure and their protection zones (high-pressure gas pipelines, sewage collector, etc.), outlying underground part of the structure or construction pit for basement complex of the structure. Then, the tower crane needs to be moved away from the structure, to a distance posing no threat to underground infrastructure services or construction pit wall stability, possibly, special foundations have to be prepared for the crane, e.g. micropilots, to avoid load on the construction pit wall. A crane positioned outside the constructed structure may also call for the need to occupy larger site and use more powerful and expensive installation mechanisms with longer reach. Especially the limited special conditions within a site and the desire to minimise crane costs often require crane placement within the constructed structure.

CRANE POSITIONING WITHIN THE CONSTRUCTION PROJECT FLOOR PLAN

Should the crane be positioned within the constructed structure floor plan, it is often installed on the structure’s based structure, which is modified adequately (Figure 2a). Part of the base structure, where the crane is to be anchored, may be constructed in advance, which speeds up the construction process. Placement within the structure minimises requirements for horizontal reach of the crane. Therefore, its beam may be shorter, compared to crane installed outside the floor plan of the structure.

However, crane positioning within the structure complicates construction progress. In most cases, it requires the leaving of assembly holes in ceiling structures for the crane tower (Figure 2b). The position of assembly holes is assessed statically. The size of an assembly hole is designed 1.0 to 1.6 m larger than the size of the crane tower, which avoids tower collision with the ceiling slab due to the work related swing. Assembly hole size also has to enable safe crane disassembly.

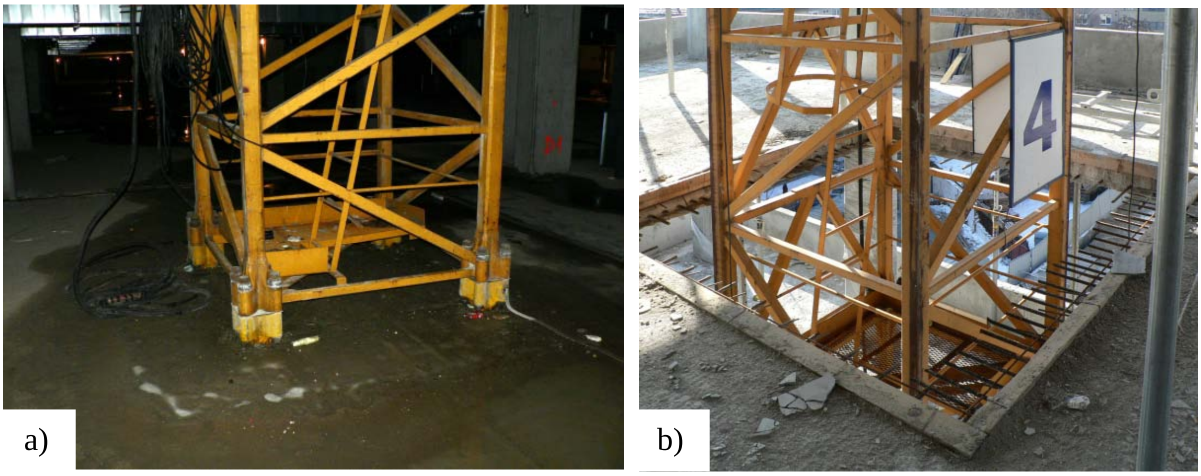

Figure 2: a) Crane Placement on Structure Base Structure, b) Assembly Hole

Assembly holes may be avoided by placing cranes e.g. into elevator shafts, which however need to be spacious enough not only for the crane tower and its assembly and disassembly, but also formwork of the shaft walls (Juríček, 2005). Therefore, elevator shafts are only rarely fit for the placement of cranes.

Inside the floor plan of a constructed structure, tower crane may also be positioned directly onto terrain (Figure 3a) and shifted to give way to further construction following the completion of a certain structure part. This construction method is suitable in projects divided into various sections – usually in low-rise buildings. In this case too, the crane may be installed prior to the first work on foundation structure and a shorter beam crane is sufficient.

On the other hand, crane relocation is only possible following the installation of all heavy parts of the construction structure, which may slow down construction progress. There may also be a problem in case of underground water presence. The said crane installation hinders the completion base structure and construction of watertight basin. In case of underground water presence, its level needs to be lowered by pumping for a relatively long period of time.

In case of high-rises, scansorial cranes may be used. Initially, these cranes are installed onto foundations. Later, however, they detach and climb up along with the building using its structure, to which they are attached (Figure 3b). They are positioned within the structure floor plan, usually inside elevator shafts. Disassembly is done from a helicopter, or via a light columnar support crane. These cranes are little used in the European Union. They are especially known from abroad, e.g. the U.S.A, Dubai. According to informative calculations, they would be feasible for buildings above cca 250 m in Slovakia.

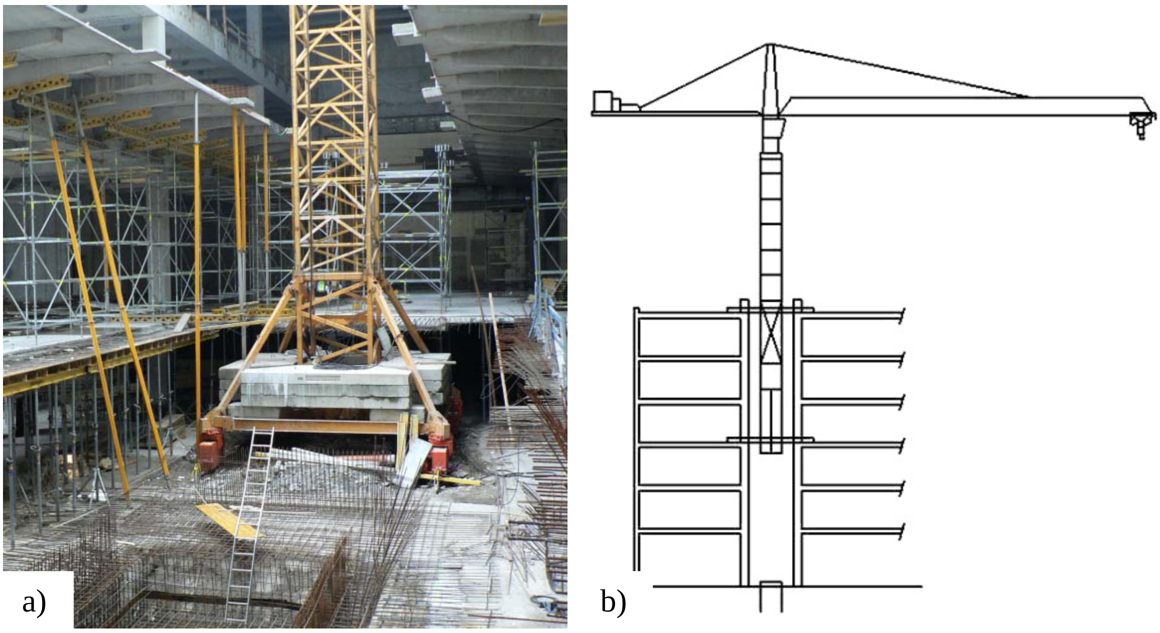

Figure 3: a) Crane Positioning onto Terrain within Structure Floor Plan – Aupark Bratislava, b) Scansorial Crane Scheme

Cramped site conditions, as well as construction progress may establish a situation, in which tower crane needs to be installed onto a completed ceiling structure. This solution is used, e.g. for the installation of support cranes speeding up construction, possibly to relocate tower crane at a later stage. Ceiling structure is assessed by a structural designer and reinforced or supported by struts if necessary (Figure 4a). Struts transfer crane load onto several ceiling slabs under each other, possibly into the base structure. Crane may be installed onto ceiling structure after the bearing structures reach the necessary strength, which impacts construction progress. Smaller and lighter tower cranes tend to be installed onto ceiling structures. However, with sufficient support, even large and heavy cranes may be installed this way.

TOWER CRANES INSTALLATION AND REMOVAL

When drafting a tower cranes plan, crane installation and removal requirements may pose limiting conditions. Many tower cranes are composed of several parts assembled directly on site using other assembly means, usually mobile crane. It has to reach above the centre of gravity of the beam, counter beam and above the tower of the assembled crane and sufficient bearing capacity in these places. Weight of the heaviest crane parts depends on the crane type and may reach from 3 to 12 t. Crane assembly is not coupled with any problems, since the site offers plenty of space in the initial phases and there is good access to the assembly site. When removing a tower crane, the constructed structure establishes a new obstacle. This is a problem especially in the removal of cranes situated within the floor plan of a structure, when the car mounted crane needs to reach the crane to be removed over the edge of the finished structure (Figure 4b). Mobile cranes dispose of high carrying capacity. However, this carrying capacity drops significantly with the beam disengagement. For example, mobile crane Liebherr LTM 1090 has maximum carrying capacity of 90 t with a 3 m overhang. However, this carrying capacity drops by 94% with horizontal overhang of 25 m. Therefore, tower crane may only be installed in a certain distance from the structure's edge that is accessible for removal, where the mobile crane will have reach with the required carrying capacity.

Figure 4: a) Crane on Ceiling Structure of the 3th floor – Gloria Bratislava, b) Removal of Crane Tower from Structure – Aupark Bratislava

Figure 5 represents an example of assembly means for business centre in Bratislava. Significant floor plan size of the structure and construction conditions called for tower crane location as deep in the structure as possible. C1 crane is Liebherr 71 ECB type with 47.5 m long beam with carrying capacity of the heaviest part representing 4.4 t including the required reserve. C2 crane is Liebherr 280 ECH type with 70 m long beam with carrying capacity of the heaviest part representing 11.1 t including the required reserve. C2 crane will be removed using mobile crane (C3 – Liebherr LTM 1400), which needs to use framework beam extension to increase its reach.

In extreme, the tower crane may also be removed using a helicopter. This removal method is especially known from abroad. Today, we have problems with availability of suitable helicopters. Mi-17 helicopter, used for assembly work in Slovakia, has suspended load carrying capacity of only 4.4 t, which is usually insufficient for tower crane installation.

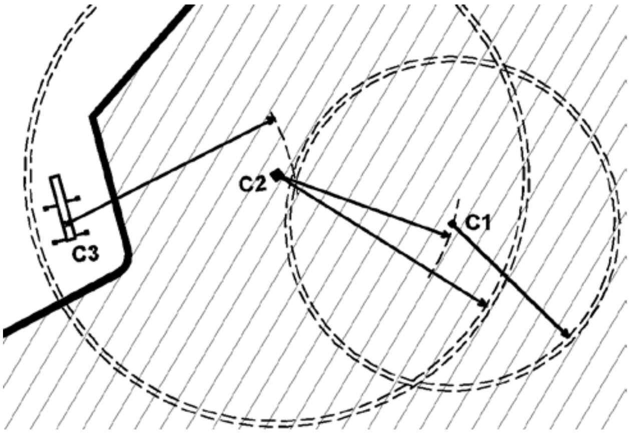

Figure 5: Crane Located within Structure Floor Plan – Business Centre Bratislava Lamač

TOWER CRANES HEIGHT

In larger projects, also with respect to the relatively short construction period, a larger number of tower cranes is usually planned. Plan of their arrangement needs to establish conditions for safe work to avoid their mutual collision (Hulinova, 2005). Therefore, respective cranes are planned with differing levels of beams. Thereby, the distance between any structure of two neighbouring cranes needs to represent minimum 1m, 2m is better. It is also necessary to consider, that to avoid crane tipping in strong wind, the crane needs to be able to position its beam downwind, meaning, that it needs to be able to rotate freely 360°. Therefore, when planning for several tower cranes, their height depends not only from building height, but also from the height of the neighbouring cranes (Figure 6). When using several cranes with partially overlapping reach, some of the cranes may need to be designed in big height.

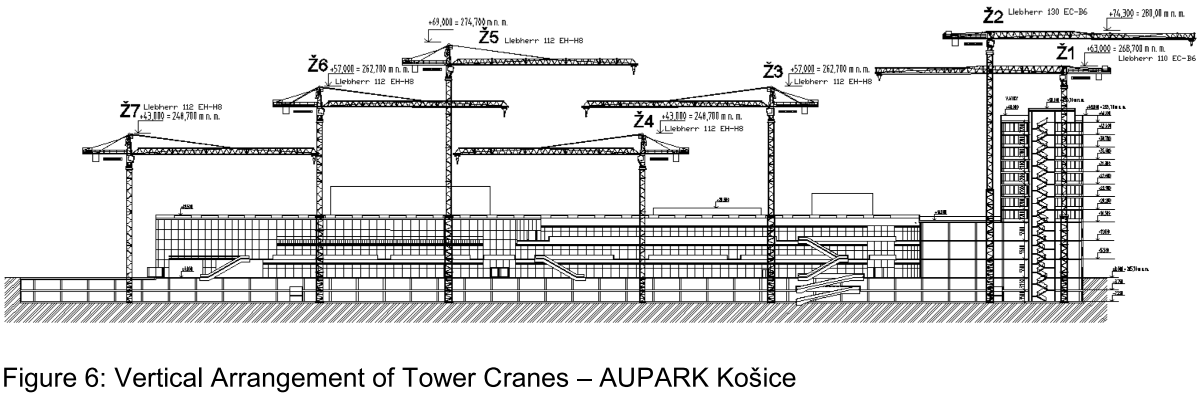

Figure 6: Vertical Arrangement of Tower Cranes – AUPARK Košice

The permitted tower cranes height depends on the permit of the local aviation authority defining not only maximum heights of buildings, but also of any temporary structures, including assembly means. This height is defined so as not to threaten the safety of air traffic.

Thus, through its requirements for maximum height of cranes, the aviation authority may also impact their number and location on site.

FOLDING JIB CRANES

Folding jib cranes are frequently used for construction. With high buildings, their horizontal reach over the building depends not only from the length of the jib, but also from the height of the building and distance between the crane and the building (Figure 7). The dependence between crane to building distance (X_c) and its horizontal reach over building (X_o) can be described with the following formula:

$$X_O = l_v \cdot \frac{(X_c - X_{ot}) \cdot \sqrt{(X_c - X_{ot})^2 + (h_O - h_{ot})^2 - b_r^2} - (h_O - h_{ot}) \cdot b_r}{(X_c - X_{ot})^2 + (h_O - h_{ot})^2} - (X_c - X_{ot}) \qquad (1)$$

where: X_O is crane reach over building (m),
X_c - distance of jib horizontal rotation axis from building (m),
X_v - horizontal reach of crane jib
X_{ot} - horizontal distance between jib vertical and horizontal rotation axis (m),
l_v - length of jib (m),
h_O - height of building (m),
h_{ot} - height of the location of jib vertical rotation axis (m),
b_r - safe distance to building edge (m).

Safe distance (b_r) should prevent the jib from coming into contact with the building. It includes the jib to building distance (50 cm is recommended as a minimum) and jib assembly.

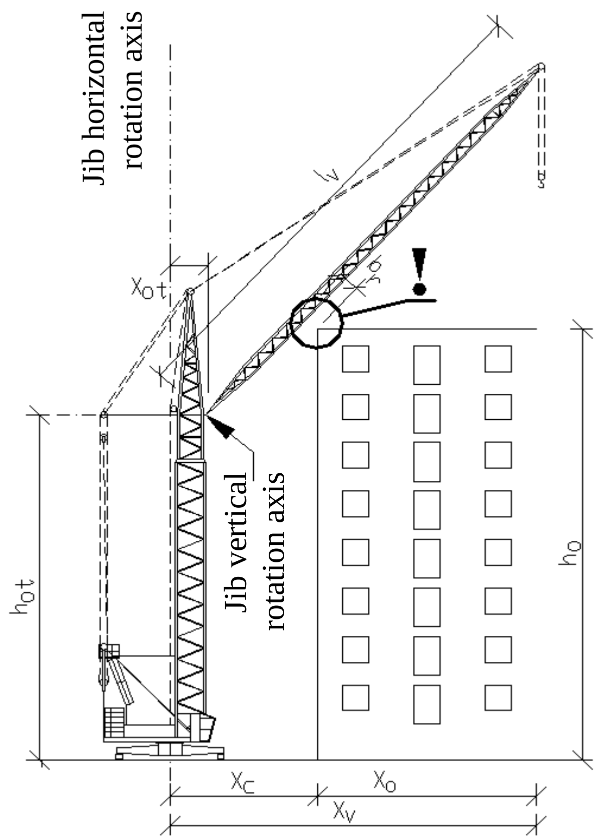

Figure 7: Location of folding jib crane

CONCLUSION

Development of optimum tower cranes plan for the conditions of a project calls for sufficient practical experience and theoretic knowledge. By paying sufficient attention to this process in the preparatory phase, the contractor may establish conditions for smooth and efficient construction (Jarsky, 2000) and observation of the required construction term.

REFERENCES

Hulínová, Z. (2005) Bezpečnosť a ochrana zdravia pri práci v stavebníctve. Brastislava: STU.

Jarský, Č. (2000) Automatizovaná příprava a řízení realizace. Praha: CONTEC.

Juríček, I. (2005) Konštrukcie z monolitického betónu. Bratislava: Eurostav.

Kozlovská, M. and Hyben, I. (2005) Stavbyvedúci – manažér stavebného procesu. Bratislava: EuroStav.

Lavrinčíková, D. (2001) Súčasné konštrukčné a fyzikálne determinanty navrhovania budov. Proceedings of International Conference Globalisation and us. Dunajská Streda. I16 - I21.

Makýš, O. and Makýš, P. (2005) Projekt organizácie výstavby. Bratislava: STU.

Motyčka, V. (2000) Skladovací plochy na staveništi. Proceedings of International Conference TECHSTA. Praha: ČVUT, 112-116.

Szalayová, S. (2004). Modern methods for building reconstruction. Proceedings of Seminarium naukowe Recykling odpadów materialów budowlanych jako czynnik ochrony srodowiska. Kraków: Wydawnica Politechniki Wrosławskiej, 25-28.

EVALUATION OF TURKISH CONSTRUCTION INDUSTRY THROUGH THE CHALLENGES AND GLOBALIZATION

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There is a growing concern of globalization of construction industry. It is affected dramatically from all political dynamics, legal and economic activities and technological aspects. Turkish construction industry represents an important role at the threshold of the European Union membership of Turkey. The current regulatory situation of the Turkish construction industry created necessary enabling environments to promote globalization and the opportunities to enhance its position. The aim of this paper is to identify current potential factors that would foster increasing globalization of the Turkish construction industry within the international markets. Also the global issues in the context of the construction industry is discussed. Another objective of the study is to examine to extent to which factors will facilitate the globalization of Turkish construction industry. Results highlight the current status and discuss the potential directions together with problems and the position through the international arena for global competitiveness of the industry.

KEYWORDS: globalization, international construction, Turkish construction Industry, competitiveness.

INTRODUCTION

Global is a term that captures the extended consequences of actions by citizens in one country as their actions are magnified by world events (Yates, 2007). Global is defined as being “worldwide” or “involving the earth as a whole” (Webster’s Unabridged Dictionary, 2005). Before 1990s, globalization was widely believed to be the antithesis of approaches which emphasized sensitivity to local context and the merit of local cultures. But further research on globalization over the decade and a half has shown that globalization involves many contradictory processes and has diverse outcomes. It has forced a rethinking of locality and context dependency. The situation is not a matter of simple homogenization. The debate has developed away from a binary opposition of either global standardization or local distinctiveness. In place of this dualism, a pattern of hybridity and adaptation has emerged, displacing the “local or global” view of globalization which held sway in the early 1980s. (Shields, 2003). Waters (2001) defines globalization as a social process in which the constraints of geography on economic, political, social and cultural arrangements recede, in which people become increasingly aware that they are receding and in which people act accordingly.

The various types and degrees of possible impacts are echoed in a wide range of definitions and discussion points of globalization. The Oxford Dictionary finds uses of the global dating back 400 years, but to speak of something as globalized and globalization are mid-twentieth century turns of phrase. Academic recognition of globalization is signaled by the argument and collation of 1980s theories of trade and the dissemination of notions of Western civility and civil society (Shields, 2003). Robertson (1992) defined the globalization as a concept refers both to the compression of the world and the intensification of consciousness of the world as a whole.

Such definitions emphasize a process of thinking up and linking up from a local to a trans-national scale. In dictionaries, globalization has continued to mean diffusion and export on a world-wide scale. However, academic analyses reveal not only the specter of a homogenized global cultural and economic space, but a simultaneous phenomenon involving the take up of regional cultures internationally. This involves the creation, in many cases, of new hybrids as ideas and products from elsewhere are integrated with local practice and conditions (Shields, 2003).

The common usage of globalization word did not begin until the late 1950's. Since the end of the Cold War in the late 1980's, the concept of globalization has become more widespread. Today globalization is widely assumed to be crucially important (Najjar, 2003). Generally the concept of globalization is defined as an international system of increasing connectivity between countries, corporation and individuals which involves some form of trade, exchange, sharing or distribution of either quantifiable or non-quantifiable components (Najjar and Weddikara, 2000 and Scholte, 2000). Najjar (2003) expressed the globalization from four perspectives: Economic (increasing capital flows and trade of goods and services); Social (sharing and exchange of ideas, beliefs and values); Legal (rules and regulations of organizations such as the World Trade Organization (WTO)) and Political perspective (international relations and multi trade agreements and trade barriers). The main benefits of globalization are that it provides the opportunity for economic development and higher standards of living through wealth and technology transfer (Najjar et al., 2000).

Construction industry is one of the most important driving forces of the economy with its trigger effect to other industries. Increasing impact of globalization on construction industry is from all aspects of global trends in international markets like technological developments, political, social and environmental changes and economic activities. Turkish construction industry has shrinked in the last decade because of the 1999 earthquake followed by economic crisis. To challenge in a global environment, it is necessary to understand the current situation and future plans of Turkish construction industry. It is important to raise national awareness of the urgent need to embrace globalization as the Turkey path to maintaining competitiveness. Some of the problems observed in Turkish construction industry are discussed in this study. Furthermore, the paper focuses and evaluates the impact of Turkey's membership process in European Union (EU) within the construction industry. Results indicate that stakeholders and organizational structures in developed countries should be investigated in details and compared with Turkish Construction Industry. An effective organization should be established to monitor and evaluate impacts on the industry and challenge in global arena.

IMPACT OF GLOBALIZATION IN CONSTRUCTION INDUSTRY

In the threshold of this century, construction industry is being shaped by global political, social and economic events that are no longer concentrated in western nations because eastern nations are moving to the forefront of global visibility. Construction is a labor intensive industry, hence industrial relations legislations and trades union power have always been undermined in the construction industry by the wide spread use of construction professionals. In order to remain competitive edge in the global market place, construction industry have to be able to adapt quickly to working with people from other cultures, and they have to understand and develop a cultural perspective that is incorporated into their construction projects to manage. Modern educational systems have provided engineers and contractors with solid scientific and engineering backgrounds, but in the twenty-first century, engineering and construction professionals need to be familiar with the eccentricities of other cultures and how to work effectively in the global arena (Yates, 2007).

Most of the scholars (Weddikkara et al., 2001; Ofori, 2000 and Raftery et al., 1998) have focused on the internationalization of construction in relation to globalization. In particular, they have discussed construction industries of developing countries and the influence of large multinational construction organizations operating within their industries (Najjar, 2003). Ofori (2000) argues that the effects of globalization may be illustrated by analyzing construction industry development and its component factors such as development of materials, project documentation and procedures, human resources, technology, contractors and institutions. He also considers that these factors may be used to provide measurable indicators of globalization impacts on the construction industry.

The appearance of international contractors was the first move in the globalization of construction (Ngowi et. al., 2005). When engineering and construction (E&C) professionals work in the global arena, their objectives are the same as when they work in their native countries-to design and construct projects on time, within budget, safely, and with the highest achievable quality. The only additional obstacles in the global environment are language barriers, cultural misunderstandings, and working with personnel with varying degrees of technical education (Yates, 2007). Oz (2001) argues that increasing number of international firms based in developing countries such as Turkey, has an impact on the level of competition intensity in the international construction market.

According to Ngowi et. al. (2005) there are several ways in which construction firms enter the international market : i) Economic booms such as the one resulting from sale of oil as in Middle-East Countries; ii) Bilateral and sometimes multilateral agreements, which set up protocols that enable firms of the participating countries to enter the markets of each other/ one another; iii) Participation in large international projects; iv) International construction market is to carry out construction work for Multinational Corporations. The growth of multinational operations in truly global operations has been an important factor in the internationalization of construction (Ngowi, et. al., 2005).

Global trends affecting construction industry are large and growing concern for nearly every member of the construction industry, from architects and engineers to general contactors. All of the trends examined in global market are expected to have widespread, significant effects on the construction industry. Specific opportunities and threats are region specific, but an understanding of the trends and their driving forces is universally valuable. Change in the construction industry is a synopsis on the global trends that will affect the procurement of international construction over the last twenty years. The construction systems in many countries may need to undergo considerable changes in the (near) future to ensure their continuation. Adaptive strategies can play an important role in efficiently solving impending problems and exploiting emerging opportunities optimally.

Easy and cheap transport and communication technologies create an environment conducive to globalization. Economic incentives, like cheap labor and new markets, are key motives for taking advantage of this effectively shrunken time and space. Cross-border mergers and acquisitions have become an increasingly important means of entering foreign markets since the mid-1980s. The international activities of multinational companies exemplify this for the construction sector. The construction industry is constantly changing along with the rest of the world. Global trends often take diverse forms and have dissimilar impacts on a local scale. Some trends, like increasing political tension, can have highly localized revolutionary effects. Early identification of these chances and threats maximizes our ability to adapt global environment. Foresight studies are a tool for this purpose.

Construction is an important part of global economy with its unique characteristics affected by and affecting all parts of the world. The construction industry has changed significantly within recent years. Increased competition created by issues such as globalization, rapid developments in construction technologies have led many organizations to seek innovative solutions to decrease cost, improve schedule, keep current on technological developments and ensure market share in their dynamic business environment. World is becoming "small global village" because of Increasing Multinational companies and innovative Information & Communication Technologies (Yates, 2007).

Engineering and construction professionals know how to achieve technical objectives, but achieving project objectives in a global environment requires more than merely technical expertise. It is during the execution stage of projects that cultural, political, environmental, religious, legal, and language barriers surface, and it is how these barriers and differences in perspective are addressed that determines the success or failure of global E&C projects (Yates, 2007). Within the general trend of globalization, worldwide economic cooperation and technology transfer are common practice. International construction projects are just one of the activities that involve multinational participants from different political, legal, economic, and cultural backgrounds (Chan, Tse, 2003).

The growth of multinational organizations in truly global operations has been an important factor in the internationalization of construction. The lowering of trade barriers, the movement of funds and setting up of new operations globally has created a platform for interested construction companies to follow and exploit. When multinational companies move out of their domestic markets it is reported that many continue to use their tried and tested suppliers, often the same construction company that built their last domestic project. At the same time the need for local knowledge is recognized and the multinational companies are quick to form joint ventures with local partners, an acknowledged trend in globalization (Mawhinney, 2001). Ofori (2000) argues that construction industry development is complex and multidimensional. He suggest that the component factors of construction industry such as development of materials; project documentation and procedures; human resources; technology; contractors and institutions both public and private may be used to provide measurable indicators of globalization. Najjar (2003) stated that globalization for the construction industry and construction organizations is encompassed in the social, economic, political and legal forces, resulting from of increasing global connectivity, which impact on the capacity, efficiency and effectiveness of the i) processes of production; ii) products and services; and iii) ownership structure of construction industry. According to Valence (2003) the construction industry has become more global, deregulated, open and competitive as a result of changes in the international economic system. He also argues that industry is not suitable for internationally integrated production, thus, the effects of globalization are seen in the rise of international contracting and corporate activity (Valence, 2003).

European countries are in a period of great social, political and economic change, particularly as a result of European integration. Actually most of the countries through the world are changing from an industrial to an information society with progressive urbanization. Especially developed countries aspire to a higher quality of life and economically and socially are placing greater demands on the quality and efficiency of the built environment. On the other hand, the sustainability of physical environment is under threat in the world. Conserving non-renewable resources, environmental protections, destruction of cultural heritage are the keywords for the built environment. Construction needs to offer more attractive employment in an industry where the liberalization of the market has increased opportunity and competition and the domestic industry will be more open to external competition. Information Technology (IT) will be a powerful technological driving force (Irish Council for Science, Technology & Innovation, 2008).

CURRENT SITUATION OF THE TURKISH CONSTRUCTION INDUSTRY

Various indicators can be employed as the basis of analysis in examining the current situation of the construction industry. Among these are economical outputs like GDP or GNP, construction firms, and employment. As highlighted by Pearce (2003), each of these indicators reveals part of the story that is relevant to our understanding of the state of the construction industry. The distinction between the broad and narrow definitions becomes very significant when examining these indicators. In the construction sector GDP is the total production value of building services resulting from domestic construction activities realized by local production units in the building sector in a country after the expenditures incurred have been subtracted from the total value. At the same time it is the total of expenditures made on consumption and investments within a given year. Growth in GDP is not related to growth in capital or the workforce, it is at the same time related to their efficient and profitable use, in other words to total factor efficiency. In 2006 an increase of 5.2% was observed in personal final consumption expenditures on consumer durables, which account for much of the rise in GDP (Turkish Construction Sector Report, 2007). In terms of the number of firms and volume of work for Turkish contractors through the foreign countries by the end of 2007 are shown in Table 1.

Table 1. Foreign contracting works of Turkish companies by the end of 2007

Total Volume of Work	**105 billion USD**
Number of Turkish Contracting Services Abroad	**4300**
The number of countries in 4 continents	**69 countries**

Figure 2 shows the increasing volume of work between 2002-2007 in Turkish Contracting Services Abroad in terms of development of construction industry.

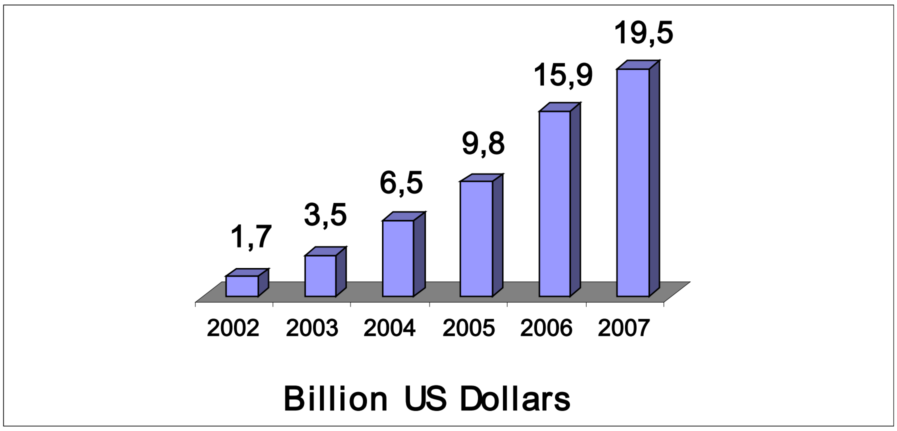

Figure 2. Increasing volume of work between 2002-2007 in Turkish Contracting Services Abroad (Source: The Turkish Contractors Association (TCA)) http://www.tmb.org.tr/index.php?l=eng

The economic crises in 2000 and 2001 have been driving forces for Turkish industry to attack foreign markets, which increased the number of companies who become aware of the requirements for global competition (Elci, 2003). According to the Global Competitiveness Report of the World Economic Forum, Turkey was in 63th position out of 134 countries in the 2008 growth competitiveness index of all EU member and candidate states (The Global Competitivenes Report (2008-2009). Turkish construction industry has an important potential globally despite it has shrinked in the last decade. Especially, during the ten years period between 1993-2003 it has shrinked with the ratio of 22.4%. In 2005 it is increased with the ratio of 19.7%. Currently, it is behind this enormity. Increased competitiveness in construction industry over the mid and long term required the improvement of performance. The impact of EU accession process is critical for Turkey's economical and social development.

Turkish public offices, in general, are renowned for their tedious bureaucratic procedures, which involve tremendous amounts of paperwork, long waiting periods, and many redundant formalities. The current system not only places a burden on the general public, but also creates immense amounts of unnecessary work for public servants. Obtaining construction-related permits, applications go through a hierarchical chain which takes sometimes months for approval. The actual construction process and the restrictions imposed by public authorities are time-consuming and place limitations on change efforts. Although it is obvious that certain changes in the present system are necessary in setting the foundation for a less hierarchical system that will enable less time-consuming process and efficacy, such changes are anticipated to be difficult to implement. Public offices have operated in this manner for years, and public servants have adopted a culture of bureaucracy. The decision-making mechanism has always been passed up a hierarchical ladder, discouraging the development of decision-making skills of lower level staff (Bayramoglu, 2000).

The General Specifications for Public Works (GSPW), which was last updated as a supplement to the State Procurement Law in 1984, shows many inadequacies when applied in today's construction environment. These specifications are also far from reaching international standards. One of the primary problems of the GSPW is that it mandates use of the unit price index prepared by the Ministry of Public Works. Although this index is updated yearly, and certain cost adjustments are made to reflect these changes on projects with duration longer than a year, these changes usually do not fully account for the rapid devaluation of the Turkish Liras, thus puts the contractor at financial risk (Bayramoglu, 2000). In international tenders financed through international creditors (such as the World Bank) the use of “International Administrative Specifications of Civil Works” issued by “Federation Internationale des Ingenieurs Conseil (FIDIC) is compulsory. These specifications not only protect the rights of all parties, but also are continuously updated to comply with social, economic and technological developments. However, since the use of the above mentioned international specifications is limited to international tenders, the local contractors are generally restricted to use GSPW despite its inadequacies (Bayramoglu, 2000). Ocal and Kaya (2000) state that construction specifications and contracts use in Turkey are inadequate and not to sufficient in detail. The consequential uncertainties lead to numerous problems during implementation as follows: The control process becomes difficult, because expected attributes and requirements are not clearly defined; Uncertainties in roles and responsibilities lead to disputes between contracting parties causing delays, and sometimes project termination; Inadequacies in technical and dispute resolution clauses lead to long and expensive court cases; Work completed with defects or incorrectly, due to lack of detail, must be repeated, leading to wasteful expenditure (Ocal and Kaya, 2000).

Turkey is highly dependent on the construction industry in fulfilling its need of infrastructure, residential, commercial, educational, and industrial type construction. The need for construction has multiplied, and gained urgency after the 1999 earthquakes, adding additional emphasis on the time, cost, and quality factors on relief projects. Legislation was passed on April 10, 2000 stating that “control of all construction projects over a certain value is to be undertaken by certified consultants” (Bayramoglu, 2000).

UNDERSTANDING TURKISH CONSTRUCTION INDUSTRY WITHIN THE EU ACCESSION PROCESS

In the context of Turkey’s integration with the European Union the need for sustaining competitive advantage of industrial enterprises through technological innovation has increased. Participation to “European Technology Platforms” enables to develop and implement short and long run strategies to enhance the innovative capacity of Turkey (Dikbaş and Akkoyun, 2006). Strong and weakness, opportunity and threatens are indicates the competitiveness of the in the industry in global arena. That’s why understanding of the Turkish construction industry has an importance to gain a competitive edge in global environment. Vision 2020 report (1999) prepared by CII (Construction Industry Institute) in USA conclude that the globalization is the trigger effect of construction industry and the projects. Report expressed this trigger effect by using the foresight methods and strategically planning works. According to Vision 2020 report (1999) the economy of countries and regions will be integrated in the future; multinational operations within the construction projects will be growth and will create an important factor in the internationalization of construction; BOT (Build-Operate-Transfer) type of projects will become widespread in global environment; procurement systems will be changed within the base of globalization; and stakeholders will be harmonized through the multi-cultural environment through the construction projects.

Most of the developed countries are focused on the research and foresight projects in construction industry. One of the most important project is conducted by EU is the “Communication on the Competitiveness of the European Construction Industry” identifies ten strategic objectives and key factors aimed at enhancing the competitiveness of the sector:

Regulatory Environment, New Procurement Systems, New Management Techniques, Off-site Production, the Role of Government, ICT (Information and Communication Technologies), SME's (Small and Medium Enterprises), Sustainability, Reinforce Research & Development, Labor force (http://ec.europa.eu/enterprise/construction/compcom/compcom.htm)

The five year development plan developed by the State Planning Organization (SPO) operating under the Turkish Prime Ministry is aimed at setting medium to long term development targets and strategies towards optimal improvements in Turkey by the year 2023, which marks the 100th anniversary of the establishment of the Turkish Republic (SPO, 1999). The task of implementation of the Technology Foresight Project in coordination with the related institutions and establishments, pursuant to the decision of the Supreme Council for Science and Technology, constitutes the main axis of the Vision 2023 Project which has been assigned to Turkish Science and Research Institute (TUBITAK). Beyond doubt, TUBITAK Vision 2023 foresight project is the most important project in Turkey when we compared with the world-wide projects in construction industry. But, some of the key issues like new procurement systems, the role of government, sustainability and reinforced research & development need to identify as strategic objective in details. The key issues considered for reconciling the EU accession process of Turkey are investigated in construction industry simultaneously require some serious of desired innovations. Current status of Turkish construction industry through this reconciling process should take into account to contribute maximum contribution for industry.

One of the main topics to evaluate the EU accession process of Turkey is the construction products regulations. Construction Product Directive – CPD (Council Directive 89/106/EEC) on the regulations and administrative provisions of the Member States relating to construction products was signed in 1989. The directive CPD came into force in 2007 in Turkey. The CE Mark was established by the European Union to ensure the free circulation of products in Europe. The Government of Turkey has directed the Turkish Customs Service to ensure that all imported products that fall within a particular EU industrial directive must show conformity to the standard. However, there is no local approved organization for the CE mark enforcement.

CONCLUSIONS

This study can provide a context for assessing the current status of the Turkish construction industry. In addition, the results and the recommendations made in this study can be utilized as a preliminary step for developing a national strategic agenda for the Turkish construction industry. This study is the first step to understand the further process of Turkish construction industry through the EU accession period of Turkey. Industry should be aware of the globalisation and how to benefit more from it. Construction companies as a component factor of the industry should continually change with time and technology. In order to understand globalisation within the industry, all the component factors should be identified and appropriately addressed. Thus, EU accession process has a direct impact on Turkish construction industry with the new directions, standards, regulations, modification of legislations and competitive environment. Risks and opportunities created during this process for industry should be analyzed in detail within the based of all stakeholders of construction industry. For further researches, organizations and their structures in developed countries including EU countries which are conducted foresight and strategically planning projects for construction industry should be investigated to gain competitive edge in global market. A comparative and collaborative research projects between these countries and Turkey should be supported. Furthermore, an effective third party organization should be established to monitor construction industry.

REFERENCES

Bayramoglu, S. (2000) Partnering: applicability in the Turkish construction sector. PhD thesis, Istanbul Technical University

Chan, E. and Tse, R.Y.C. (2003) Cultural Considerations In International Construction Contracts, ASCE Journal of Construction Engineering and Management, Vol.129 (4), pp.375-381

CII - Construction Industry Institute (1999) Strategic Plan, Vision 2020 Report, Construction Industry Institute, Austin, USA

Dikbaş, A. and Akkoyun, I. (2006) ETP: European Technology Platforms - A challenge for Turkey's strategic innovation agenda, A|Z ITU Journal of the Faculty of Architecture Vol: 3, No: 1/2, 53-70, 2006, available at: http://www.az.itu.edu.tr/downloads/papers/vol03-12/pdf/07dikbas-03n1-2.pdf

Elci.S. (2003) Innovation policy in seven candidate countries: the challenges, Innovation Policy Profile: Turkey, Final Report, March 2003, Volume 2.7, Enterprise Directorate-General Contract N°INNO-02-06, available at: ftp://ftp.cordis.europa.eu/pub/innovation-policy/studies/turkey_final_report_march_2003.pdf

Irish Council for Science, Technology & Innovation (2008) Technology Foresight Ireland, Construction and Infrastructure Panel, available at: http://www.forfas.ie

Mawhinney, M. (2001), *International Construction*, Blackwell Science, Oxford; Malden, MA

Najjar, G. R. and Weddikara, C. (2000) Globalization and the Australian Construction Industry, Proceedings, 4th Pacific Association of Quantity Surveyors Congress, Cairns (cited from Najjar, 2003)

Najjar, G.R. (2003) Issues for the Globalization of the Construction Industry, The Organization and Management of Construction 10th International Symposium, Volume 1 of 2, Construction Innovation and Global Competitiveness, edited by Ben Obinero Uwakweh and Issam A. Minkarah, CRC Press, pp: 321-329

Ngowi, A.B., Pienaar, E., Talukhaba, A., and Mbachu, J. (2005) The globalisation of the construction industry—a review, Building and Environment 40 (2005) 135–141

Ocal, M.E., Kaya, N. (2000) Yapi Uretiminde Sozlesme Yonetimine Genel Bir Bakis, 2. Construction Management Congress Proceedings Book, pp:123 -134, Izmir, TURKEY (in Turkish) (cited from Bayramoglu, 2000)

Ofori, G. (2000) Globalization and construction industry development: research opportunities; Construction Management & Economics, Taylor and Francis Journals, vol. 18(3), pages 257-262, April

Oz, O. (2001) (2001) Sources of competitive advantage of Turkish construction companies in ınternational markets. *Construction Management and Economics*, 19 (2): 135- 144

Pearce, D. (2003) The Social and Economic Value of Construction: The Construction Industry’s Contribution to Sustainable Development, nCRISP, London, available at: www.ncrisp.org.uk

Raftery, J., Pasadilla, B., Chiang, Y.H., Hui, E.C.M. and Tang, B.S. (1998) Globalization and construction industry development: implications of recent developments in the construction sector in Asia, Construction Management and Economics, Taylor and Francis Journals, vol. 16(6), pp: 729-737

Robertson, R. (1992) Globalization, Sage, London (cited from Shields, 2003)

Scholte, J. A. (2000) Globalization: A Critical Introduction, Basingstoke, Macmillan (cited from Najjar, 2003)

Shields, R. (2003) Globalisation-Entangled Places, Interface Buildings, Generic Design, (Buildings, Culture & Environment: Informing Local & Global Practices, Edited by Raymond J. Cole and Richard Lorch, Blackwell Publishing

SPO (1999) Memorandum from President Bulent Ecevit, number B.02.1.DPT.0/2456, State Planning Organization (cited from Bayramoglu, 2000)

The Global Competitivenes Report (2008-2009) World Economic Forum, available at: http://www.weforum.org/pdf/GCR08/GCR08.pdf

TUBITAK, Vision 2023 Project (in Turkish), available at: http://vizyon2023.tubitak.gov.tr

Turkish Construction Sector Report (2007) YEM Publication, Istanbul, TURKEY

Valence, G. de (2003) Globalization and Changes in Ownership of the Building and Construction Industry, The Organization and Management of Construction 10th International Symposium, Volume 1 of 2, Construction Innovation and Global Competitiveness, edited by Ben Obinero Uwakweh and Issam A. Minkarah, CRC Press, pp: 556-571

Waters, M. (2001) Globalization, Routledge, London (cited from Shields, 2003)

Webster’s New University Unabridged Dictionary (2005) New York, New World Dictionaries / Simon and Schuster

Weddikara, C. and Devapriya, K. (2001) Development and Supply Trends and Construction Industry Development, The Australian Journal of Construction Economics and Building, 1, pp: 91-105

Yates, J. K. (2007) Global Engineering and Construction, John Wiley and Sons, USA

IMPROVING PROCESSES DESIGN AND SELECTION FOR CONSTRUCTION OPERATIONS

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The design or selection of processes or methods for carrying out the construction operations of a construction project is a critical activity whose output will impact the performance of the work in terms of quality, time and cost. If well designed or selected, the process will enable a very good work performance of the construction operation. If not, the work performance will be deteriorated. This paper addresses this issue and the practices used by companies to design or select the process to be used to perform a construction operation. A survey was applied to a group of housing construction companies to learn about these practices and the effectiveness of their approaches. The main results of the survey are presented and discussed. In addition, a preliminary methodology for the design or selection of a process for a construction operation is proposed. To compare this methodology with common practice, a construction project is analyzed as a case study. The study shows that methods currently used by housing construction companies to design or select the processes for carrying out different construction operations lack the required systematic approach to ensure an efficient and effective process selection or design and, in this way, enhance work performance.

KEYWORDS: processes, construction, operations, design, selection, methodology.

INTRODUCTION

A process can be defined as a set of interrelated tasks developed in a sequence, with the aim of reaching a certain goal which may be a particular product or a service (Ing-Long, 2003). The purpose of this product or service is to satisfy a requirement set by an internal or external customer (Herdoiza, 2003).

An important aspect of a process is its capacity to conform to the required quality, which is the ability demonstrated by the process to maintain its output within the tolerances specified for the product or service (Serpell, 2005). It is therefore important to quantify or measure this capacity, as it will be known since the beginning of an operation whether the selected process will be able to produce the required product or if it must be modified or changed. It can be asserted that the proper design of a process is the basis of its performance. Many of the quality and productivity problems that occur on site are due, among other things, to poorly designed or selected processes for carrying out the different construction work operations.

The problem addressed in this study is to find out why poorly designed processes are selected to carry out construction operations and how this situation can be overcame. In this paper, a process is defined as the way in which a construction operation (for example, wall painting, slab pouring, etc.) is carried out. The working hypothesis proposed for this research is that in housing construction companies in Santiago, Chile, no formal methods for designing or selecting construction processes to ensure proper operational performance are used. From this hypothesis, the stated general objective was to explore the current practices of the design or selection of processes for construction operations employed by housing construction companies and to propose a methodology for the design or selection of processes for construction operations.

BACKGROUND

Process management involves seeing the organization as a system in which all activities taking place are interrelated with the purpose of achieving the satisfaction of internal and external clients. The main objectives of process management are to make processes (Peteiro, 2006): 1) effective in a way of achieving desired results; 2) efficient through resources minimizing and 3) adaptable, as a result of having the ability of adapting to changes.

The design or selection of a process for a construction operation is defined as the selection of a method or procedure for carrying out the operation in an effective and efficient manner, taking into account the resources available. Process design or selection decisions affect the cost, quality, delivery time and flexibility of operations (Schroeder, 1992).

The design procedure includes the selection of input variables, tasks, workflows and methods to produce goods and services. Something very important is that the design should consider the clients requirements to ensure that appropriate decisions are made (Soetanto et al., 2006). The design of a process consists of defining the different tasks and resources that are necessary to carry out an operation. In turn, each task can be performed by several possible alternative methods. The objective of the design procedure is to create the best combinations of methods for the whole process while considering that the choices are technically feasible (Singhal and Katz, 1990).

RESEARCH METHODOLOGY

A survey was applied to a total of 60 construction sites: 22 to houses development projects and 38 to apartments building projects. The survey was applied in person so that additional comments of research interest were recorded.

To construct the questionnaire, an exhaustive literature review was carried out first. From this review, a list of eleven variables that were considered relevant for process design or selection was developed as follows: 1) awareness of the availability of different methods for process design or selection; 2) knowledge about the process requirements; 3) analysis of the process resources; 4) analysis of different work methods; 5) analysis of the process capacity; 6) process design or selection approach; 7) process design or selection verification; 8) process control; 9) corrective/improvement actions; 10) process planning; and 11) process documentation. For each variable, a set of questions was developed.

The scale used for answering the survey was a Likert-type scale of five values: very poor, poor, deficient, good, very good. The survey was verified regarding its correction and reliability through a pilot survey and the application of the Cronbach’s Alpha analysis.

MAIN FINDINGS OF THE STUDY

The overall results of the study are presented in Table 1. The categories with the greater frequency for each variable are shown in gray.

Table 1: Frequency and percentages of answers for each variable (very poor (VP); poor (P); deficient (D); good (G); very good (G))

	Total number of construction projects N = 60									
Variable	Very Poor	%	Poor	%	Deficient	%	Good	%	Very good	%
Knowledge of design or selection procedures	0	0	0	0	39	65	20	33	1	2
Knowledge about process requirements	0	0	0	0	26	43	27	45	7	12
Analysis of process resources	0	0	1	2	33	55	26	43	0	0
Analysis of different work methods	0	0	0	0	23	38	22	37	15	25
Analysis of the capacity of the process	13	22	35	58	11	18	1	2	0	0
Development of the process design	0	0	1	2	38	63	21	35	0	0
Verification of the process design	0	0	13	22	40	67	6	10	1	2
Control of the process application	0	0	0	0	13	22	31	52	16	27
Corrective and improvement actions	0	0	0	0	33	55	25	42	2	3
Planning of the process	0	0	1	2	20	33	27	45	12	20

Main factors associated with each variable

Besides the information presented in the Table 1, respondents were asked for additional information. For example, regarding the knowledge about process design or selection procedures, respondents stated the following aspects: a) the majority of processes for construction operations are designed or selected based on previous experiences; b) they do not always study the processes before work start; they are analyzed on the going; c) when analyzed by each company, most of construction operations carried out in the projects they perform are similar in nature.

Consulted on the level of knowledge of the requirements defined for the work, the following relevant issues were raised: a) essential requirements are known from technical specifications and drawings, although the latter are constantly changing, b) deadlines are also known, c) the most important requirement is the cost and decisions are made concerning processes as money is available, d) no respondent mentioned process safety or environmental requirements explicitly, and e) in larger sites it was noted that it is often assumed that people know the technical specifications and drawings, although this assumption is not verified.

In relation to process resources analysis the following key aspects were identified: a) the budget is crucial in relation to the analysis of resources used in the processes used for construction operations, b) a tendency of buying the materials from suppliers who are able to meet work demands, regardless of their experience and that have their products certified, and

c) the availability of manpower is considered essential in the type of process used for a construction operation, but there is not a formal analysis of this.

When asked if they perform an analysis of the different processes available to perform construction operations, respondents stressed that they are fully aware of other ways of doing things and what they do is to try finding the best, the one that optimizes the resources that are available. However, many times they end choosing the same solutions used previously.

The poorest response was on the analysis of the required capacity of the process. It is assumed that checking if a process is "capable" of delivering the required quality is equivalent to measuring that the process is working well. Additionally, there is not a systematic effort to measure processes' performance in most of the sites.

It was detected that in the majority of the sites, not all that should be involved in the design or selection of the processes needed to carry out construction operations, participate in practice. For example, foremen are not involved. Usually, some people are responsible for this task and in some specific cases, other participants are consulted. Moreover, every effort is made to design very simple processes to avoid confusion, but even the simplest ones often present complications. In general, the process design or selection activity is not a formalized function in these construction companies. Known solutions are usually used and are adjusted or improved as the work is performed.

Asked about the verification of the processes design or selection choice, the responses indicate that in general, there are not pilots or simulations of processes, since these activities will consume considerable time and resources. Processes are tested "on the run."

With regard to construction processes control, despite having very clear understanding of the importance of the control function, in several site works the measurements of performance, quality and others are only done for the most important processes.

Respondents indicated that corrective or improvements actions are not innovative and that the ones that deliver results are the only ones used without being necessarily new. It was also mentioned that there is an interest on constantly improving the processes, however, given the daily work pressure often this is not possible and the time available is left to meet more urgent issues.

Although the majority of the surveyed people said they are concerned about good planning, many others recognized that such activities are not done in detail. In general the most commonly used approach is a simple Gantt chart and planning was not related to the processes design or selection decision.

The survey also asked about the documentation of the process in order to discover the importance given to it within a construction site. Overall, the responses stated that there are three types of documents used on a regular basis for the processes design or selection function: technical specifications, the architecture drawings and the planning and schedule of the construction project being all of them very important since they include the project requirements. Regarding the use of documentation it was indicated that this is affected by two circumstances: 1) the documents are not in the site and 2) the documents are in the site, but are not used.

Given the previous discussion and findings, the research hypothesis can be reasonable approved. Then, it was considered convenient to propose a preliminary methodology to support construction companies in their processes design and selection decisions to get better results.

PROPOSED PROCESS DESIGN OR SELECTION METHODOLOGY

This methodology was designed to be applied at the site work, i.e., once the requirements of the product have already been established and converted into technical specifications and drawings of the project. This methodology is described in Figure 1.

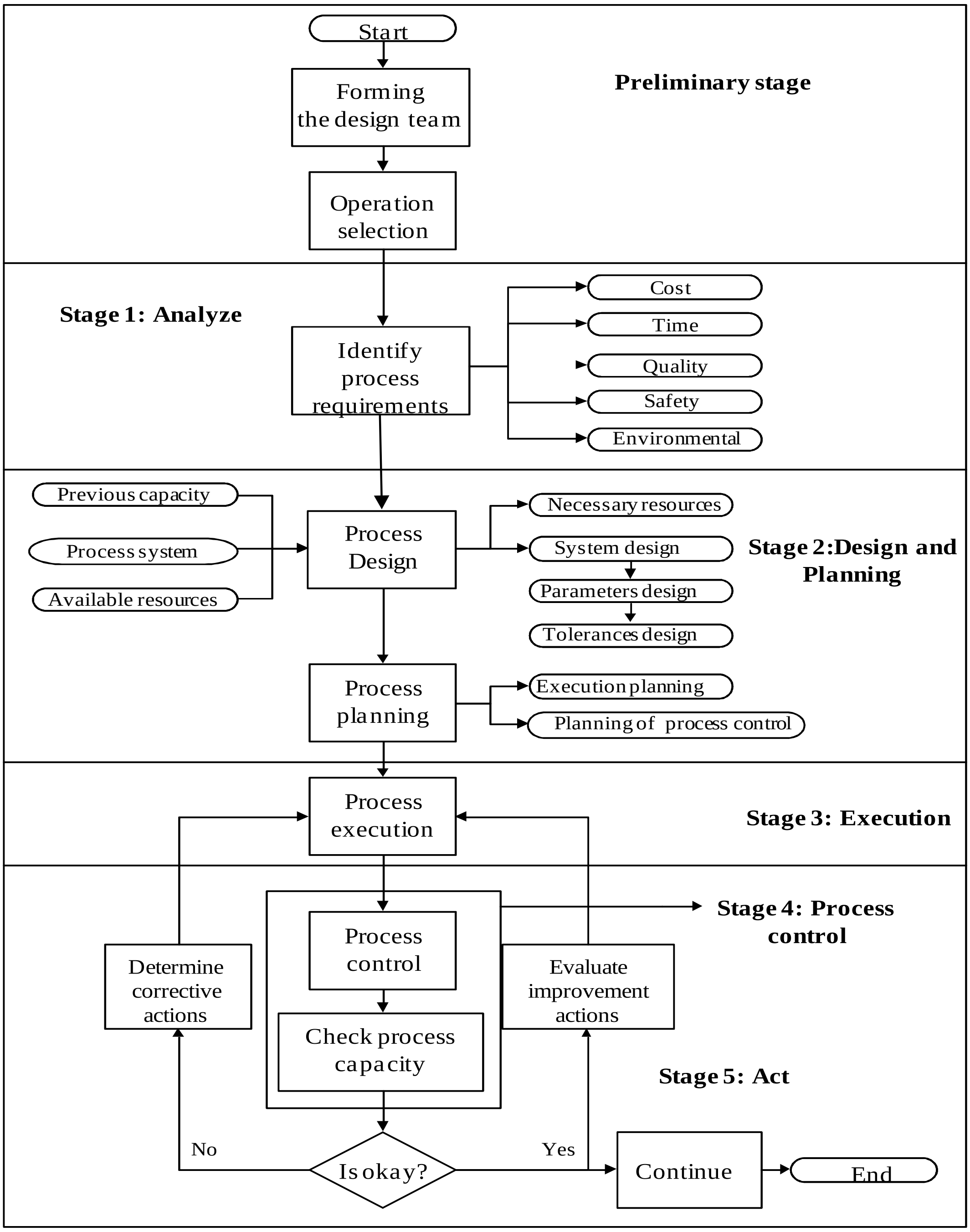

Figure 1: Proposed process design and selection methodology (Tapia, 2007)

It is assumed in the methodology that the design of a process doesn't start from zero each time. A process previously available from experience in the process system can be chosen if it is adequate for the operation under study and modified according to the new information, resources, personnel and others. In this cases, the stage "design and planning" would consist on design modification and planning.

Table 2 details each one of the stages of the methodology. It is important to pinpoint two preliminary activities that should be performed before starting the methodology: formation of the design team and the selection of the construction operation to address. It is recommended that the design team involves people with experience and knowledge on construction and on process design or selection. Also, the selected operations should be those that are more critical for the execution of the construction work. Finally, it is important to document all the stages of the methodology because this documentation will later feed the process system where experiences can be stored for future applications.

Table 2: Details of the proposed methodology

Stage	**Actions**	**Documents**	**Results**
Analyze	-To identify process requirements: cost, time, quality, safety, environmental and others.	-Cause-effect diagram -Specifications -Drawings -Other project documents	Total knowledge of process requirements
Design and planning	-Resource analysis: materials, equipments, technologies, labor, information. -Analysis of previous processes capacity stored in the process system. -Analysis of different construction methods -Failure mode analysis and effect	-Construction instructions -Manufacturers' instructions and recommendations -Quality plan -Standards	-Process flow diagram -Process planning -Process execution procedure
Execute	Carry out defined process tasks	-Process flow diagram -Process execution procedure -Execution plan	Finished construction product
Verify, control and study	-Measuring -Process statistical control -Current process capacity analysis	-Control plan -Control sheets	Information for decision making
Act, correct, improve	-Analysis of alternative corrective actions -Analysis of alternative improvement actions -Corrective or improvement actions implementation	Lesson learned	Corrected or improved process

A COMPARISON OF THE PROPOSED METHODOLOGY WITH CURRENT SITE PRACTICES

A building construction site of a real estate and construction company was selected for a comparison of current practices with the proposed methodology. At the moment of the application, the company was under external control by a consulting company for quality purposes. This condition facilitated the information collection and the carry out of the measuring process. The site was a building consisting in 103 apartments, 16-story high and with a total area of 14,540 square meters. The budget of the project was near US$ 4.7 million.

As a first approach to the subject, several meetings were sustained with the management of the construction site to discuss about research goals and activities. In these meetings the following people participated: the site manager, the purchasing clerk, the general foreman, and the person in charge of quality control of construction processes.

The general approach of the construction team to the design or selection of construction processes is based first on the site manager decisions. He decides how the work of each operation is going to be carried out, where should the work facilities be placed, how many work shift will be used, among other things. Later he meets with the other members of the site management teams and together they keep giving form to the construction approach that is finally used.

With respect to documentation, they give high importance to it, since in the site offices files with information of previous works can be found, including previous performance of suppliers and subcontractors as well as evaluations of their performance. Thus, for a new work, it is easy to know what to do and to whom it should be assigned. Registries of previous buildings constructed by the company are also available, including technical engineering specifications. However, this information is scarcely used.

An interesting finding of the analysis of the current practice of the construction project under study was the fact that during the first three floors of the building, the construction processes were tested and corrected. Methods, materials, equipments and even labor were tested during this stage. It was a kind of a large pilot test that it is used to analyze what should be the definitive general construction method to be used for the construction of the remaining floors in a way of assuring the meeting of the stated requirements. After the fourth floor imperfections are no longer tolerated, since the personnel has had the time to learn how to make the work without mistakes. From the first floor until the third floor the quality is permanently controlled, and from the fourth floor and ahead, both the quality and the work output are controlled.

During the interaction with the site management team, discussions were carried out regarding the application of the methodology proposed in this paper. The general opinions were that the methodology would help them to reduce the testing stage that they currently use in every construction project they carry out. However, cultural problems should be addressed to implement it since construction people is used to face each work without explicitly using past experiences and in many times, making the same mistakes that took place in previous projects. In table 3, a summary of the main differences between the proposed methodology and the current practice is presented.

CONCLUSIONS

The main conclusion of this study is that in many Chilean building construction companies a suitable design or selection of processes to carry out construction operations is not well performed. Generally things like the materials to be used or the people who is going to be in charge of the execution of the processes are defined. Nevertheless, methodologies through which the design or selection of processes for operational work can be done are considered known, and only in the case that the processes being used are not fulfilling the specifications the causes of failure are then studied.

Table 3: Methodology – current practices comparison

Stage	Proposed methodology	Site under study
Preliminary	• Design team forming • Process selection • Documentation study	• The design team is composed by the site manager, the purchasing clerk and the general foreman. • The processes are selected according to the construction plan. • Almost everything is documented.
Analyze	• Identify process requirements • Development of cause-effect diagram	• All the requirements are completely identified and analyzed, except by the specifications of the work packages at the end of the construction work. These are being completed along the work development. • Cause-effect diagram is not used but was considered an interesting and useful tool.
Design and planning	• Analyze the capacity of previous projects in the process system. • Process system with historical information. • Planning of process control. • Processes flow diagrams. • Resource analysis. • Process execution planning.	• Experience is applied but not in a systematic way. There is no real concern about process capacity concept. • First three floors are use as a test and probe stage to find out the obtained performance (what are they capable of). • Structure of processes is not taken into account except during planning. • Process control is not planned because is not done systematically. • Processes flow diagrams are part of the quality system documentation, but are not used for process planning. • Resource analysis is carried out with a high level of detail. • For planning purposes a Gantt chart is developed and used as a communication tool.
Execute	• Implement designed process	• Pilot test during the first three floors. • The remaining floors are constructed using the tested processes.
Verify	• Process control. • Control sheets. • Compute process capacity.	• Process control based on two categories after execution: correct or incorrect. Control sheets are filled with this data. • Subcontractors receive process procedures to communicate them what is required and how are they going to be evaluated. • Process capacity is not calculated.
Act	• Process correction. • Process improvement. • Cause-effect diagram.	• Corrective actions are applied to rejected outputs. Processes are not analyzed systematically. In general it is assumed that error are due to work failures and not process failures. • Improvement ideas proposed by anyone are analyzed; however there is not a formal system for this. • Cause-effect diagrams are not used.

In most of construction sites processes are carried out as they have been always done, since according to experience, results have been good enough. Although there is a concern of being up to date regarding new materials, and in some cases, in enabling the personnel to become more productive, there are very few efforts to analyze step by step what is going to be really done.

The most important issues considered by construction companies with regard to processes design are: knowledge about processes requirements, analysis of different construction methods, and process planning and control. On the other hand, the weakest issues are:

consciousness about processes design or selection procedures, resource analysis, process capacity, process design and design verification, and corrective and improvement actions.

Project and site managers rest on processes control to be sure that the tasks included in the processes are working well. Although process control is very important since the quality of constructed elements depends on it, time and cost will be saved if processes were designed correctly from the beginning, or if a test stage were considered before executing the definitive work.

To calculate the capacity of site processes is difficult to implement since the construction work is carried out against time and it requires more time to write down all the necessary measurements of the processes than to only write down “accepted” or “rejected”. The same happens with the application of statistical process control.

The variable “documentation” is very important for the design of processes, since it avoids that the same errors are committed again and again (when having all procedures and registered nonconformities), and allows to specify each of the steps to follow when carrying out the process and what to do in case of problems, among other things.

Due to the complexity of many construction processes it would be recommendable to count on a test and error stage to prove that the materials, personnel, technology, and in summary, everything that is used to carry out a process are adequate for the operation that is being executed.

In the analyzed construction site the concept of “tolerance until the fourth floor”, which was a kind of working test was used. Nevertheless, waiting until the second or third floor just to prove the construction materials and methods is very late, since at that point a great percentage of the work has been finished. In this site the processes design was quite good in comparison with other construction projects, since there was a great concern about quality since the start. Nevertheless, in spite of this, nonconformities continued to happen.

An approach based on knowledge management would be a very useful application to processes design or selection for construction operations. With such an approach, the process design or selection knowledge would be collected, stored and distributed within a construction company so that every construction management team would be able to make a good use of this knowledge for designing or selecting processes for new construction projects and avoiding in this way the repeating of the same errors of previous works.

REFERENCES

Herdoíza, J. (2003) Metodología para el mejoramiento de procesos de gestión en empresas constructoras (Methodology for management processes improvement in construction companies). Master of Science in Engineering Thesis, Pontificia Universidad Católica de Chile.

Ing_Long, W. (2003) Understanding Senior Management´s Behavior in Promoting the Strategic Role of IT in Process Reeingeneering: Use of the Theory of Reasoned Action. Information & Management. Vol. 41, N° 1, 1-11.

Lochner, R. y Matar, J. (1990) Designing for Quality. Chapman & Hall. Estados Unidos.

Peteiro, D. (2006) La Gestión Tradicional y la Gestión por Procesos (Traditional Management and Process Management). Unloaded on September 12, 2006. Available in: http://www.gestiopolis.com/recursos4/docs/ger/gestitra.htm

Schroeder, R. (1992) Administración de Operaciones (Operations Management). Mc Graw Hill, 3rd. Edition. Mexico.

Serpell, A. (2005) Principios y Prácticas de la Calidad (Quality Principles and Practices). Class Notes, Department od Construction Engineering and Management, Pontificia Universidad Católica de Chile. Santiago, Chile.

Singhal, J. y Katz, J. (1990) A Branch and Fathom Algorithm for the Long Range Process Design Problem. Management Science. Vol. 36, N° 4, 513-516.

Soetanto, R., Dainty, A., Glass, J. y Price, A. (2006) Towards an Explicit Design Decision Process: the Case of the Structural Frame. Construction Management and Economics. Vol. 24, N° 6, 603-614.

Tapia, C. (2007) A Critical Analysis of Construction Processes Design in Chile (in Spanish), Master of Science Thesis, School of Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile.

MODELING THE INTERRELATIONSHIPS BETWEEN COMPETITIVENESS FACTORS AND INDEXES FOR CONSTRUCTION COMPANIES

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The competitive environment faced by domestic construction companies nowadays, has leaded these companies to an urgent need for finding ways to remain competitive along time, by acting over the factors that affect their competitiveness in a very dynamic environment. Nevertheless, to be successful in this endeavor, construction companies need an understanding of: 1) the most important factors influencing their competitiveness; 2) the indexes that measure their current standing; and 3) the most appropriate actions to maintain or improve their position. This research addresses the existing interrelationships between the competitiveness factors and indexes of domestic construction companies at the firm level. This paper proposes a preliminary conceptual model of these interrelationships developed largely from literature review. Later, the model will be corrected and validated by the answers of a number of very experienced personnel from different construction companies. The paper describes the development of the model and the results obtained so far. The application of the model will be later implemented as a methodology to support business decision-making.

KEYWORDS: construction companies, competitiveness, factors, indexes, interrelationships.

INTRODUCTION

The "competitiveness" concept has been largely accepted and handled across all industries and countries since Porter published his book "Competitive Strategy" in 1980. This concept has gained interest for both practitioners and researchers. On one side, practitioners have taken into account the competitive environment that influences their actions and on the other, researchers have been investigating to improve their understanding of this phenomenon.

The construction industry is one of the most important industries in many countries because it usually represents a substantial percentage of the gross domestic product (GDP) (Ericsson and Henricsson, 2005; Flanagan et al., 2005a). For the construction industry, the competitiveness concept has become a very relevant topic lately, because of the fierce global competition and the particular difficulties faced by management in this sector. As explained by Flanagan et al. (2005a), it is vital for nations to increase their knowledge and understanding of competitiveness in the construction industry.

Competitiveness in the construction industry has been analyzed at different levels as follows: country, industry, firm, and project. Several authors have stood out the relevance of competitiveness at firm level: Christensen argues that nations can compete only if their firms can compete ("Micro Foundations & Macro Competitiveness", 1999); Porter (1990, p.33) established “it is firms, not nations, which compete in international markets”; and other authors have also supported its relevance and practicality (Dangerfield et al., 2008; Ambastha and Momaya, 2004).

Current market situation, in a global context, generates in companies the need to be competitive in order to survive. Companies, in response to these competitive pressures, are continually fine tuning the business through several improvements (Mandal et al., 1998). This hyper-competitive age has created the need for an explicit management of competitiveness.

At firm level, the management of competitiveness has two main components. On the one hand, there are factors, sources or determinants of competitiveness; on the other hand, there are indexes showing the competitive performance of the construction company at a specific point of time. Construction companies act over the factors that increase their competitiveness, trying to impact the most relevant objectives and goals according to their strategy. The competitiveness indexes are the indicators to measure the results achieved through the actions carried out by the company. Then, it would be very useful to know the interrelations that exist between such factors and indexes. To reduce the ambiguity, the terms firm and company are used in what follows to denote that portion of a company's operations which is wholly contained within the construction industry (Rumelt, 1991).

Several authors have analyzed the interactions between a group of factors and indexes of competitiveness (Phua, 2006; Cheah et al., 2007). However, a more comprehensive analysis is needed, which will largely support the management of competitiveness in construction companies later. Flanagan et al. (2007) argues that there needs to be more research that helps firms to formulate competitive strategies or tactics. Then, in line with this need, this paper presents a preliminary conceptual model of the interrelations between competitiveness factors and indexes at the firm level that were derived mostly from literature. In addition, the paper includes a critical review of the most relevant elements of the concept of competitiveness. Finally the expected utility of this study and directions for further studies are addressed.

LITERATURE REVIEW

Relevant components in the concept

Despite its wide usage, there is not a consensus about the meaning of competitiveness (Flanagan et al., 2005a; Lu, 2006). However, there are many definitions for this concept, and so, we can extract some important parts from them and the relevant elements to get a better understand about competitiveness. Some of the most important elements of these definitions of competitiveness are presented in Table 1.

Table 1: Elements that are relevant for defining competitiveness

It is a concept more powerful than traditional economic indicators such as profitability, productivity or market share	Lu, 2006
It is a cause, an outcome, and a means	Waheeduzzan and Ryans, 1996
Associated with achieving an objective	Flanagan et al., 2005a

It is relative to competitors	Buckley et al., 1998
It belongs to the eye of the beholder (it means different things for different people)	Waheeduzzan and Ryans, 1996; Flanagan et al., 2007
Not only reflects past performance, but also allows the perception of potential…	Buckley et al, 1998
It must satisfy the needs of clients	Momaya and Selby, 1998
It must satisfy the needs of the personnel	Momaya and Selby, 1998; Invancevich *et al.*, 1994
It is related to superior quality	Momaya and Selby, 1998
It implies continuous improvement	Flanagan et al., 2005b; Lu, 2006

Besides these elements, competitiveness is also related to high productivity (Flanagan et al., 2005a; Flanagan et al., 2005b), innovation (Momaya and Selby, 1998), value for shareholders (Momaya and Selby, 1998), and profitability (Flanagan et al., 2005b), among other qualities. But, even if the concept is not quite clear, the ultimate purpose of competitiveness is to improving and achieving a better long-term performance for firms, as stated by Flanagan et al. (2007).

Competitiveness at the firm level

At the firm level, there are factors that influence the competitiveness level of a company, and also, there are indexes which altogether measure the competitiveness reached by the firm (see Figure 1).

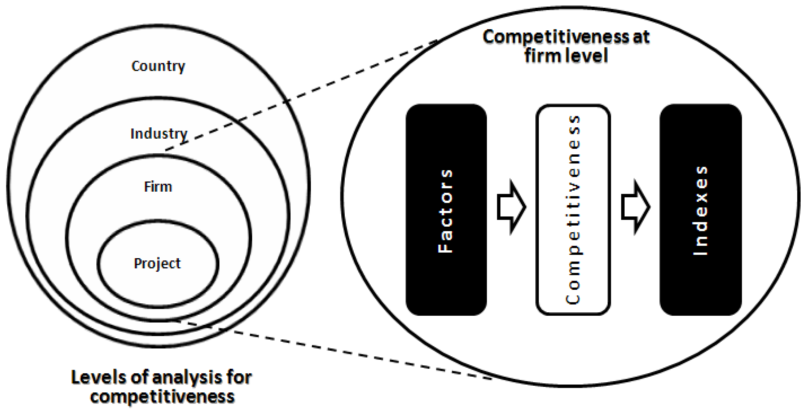

Figure 1: Variables that affect competitiveness at the firm level.

Competitiveness is a very wide concept to be captured just in a single measure (Buckley et al., 1988; Flanagan et al., 2005a; Flanagan *et al.*, 2005b). Besides, since competitiveness is relative to others and it has a subjective component, indexes have different weight depending on the specific interest of each company. We cannot measure all companies with the same scale, even in the same industry, because they don't have the same priorities in their objectives. Then, we propose to handle all indexes separately, allowing managers to arrange them in accordance with their own strategies.

Competitiveness factors for a company can be split in endogenous and exogenous. Endogenous factors are those which are produced inside the company, so management can act on them in order to achieve its goals. Exogenous factors are originated outside the company and management has not, or almost no influence over them. Exogenous factors form the environment in which companies have to compete, thus, each industry or country has different exogenous factors (i.e. external conditions) for companies. Figure 2 is a graphical representation of this, it has three axes: one for endogenous factors, another for business results (i.e. indexes), and the third is for the exogenous factors (i.e. environmental factors). An analysis made under the same circumstances, or in the same environment, for different firms, would be a vertical plane in the graphic. If environmental circumstances are different or they change, the analysis has to be moved along the exogenous factors axis.

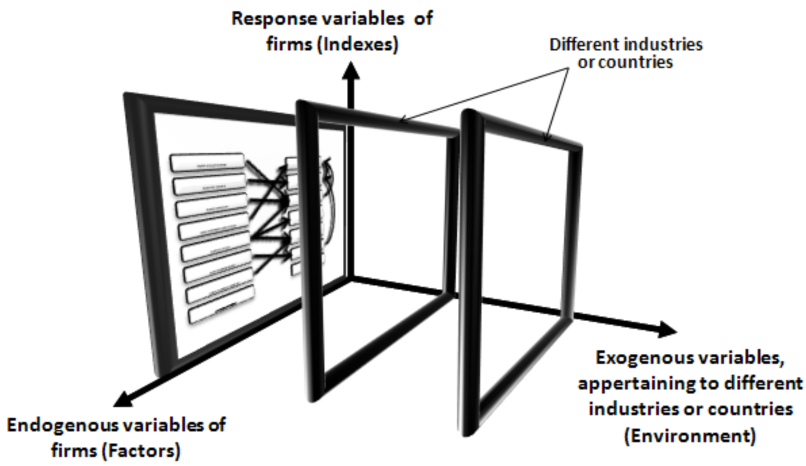

Figure 2: Dimensions for the analysis of competitiveness at the firm level

Competitiveness factors at the firm level

Factors influencing competitiveness can be found in several sources and with different names. Competitiveness factors can be found in literature as Critical Success Factors (CSFs), success factors, attributes, parameters, etc. All of them have the attribute of being one of the main determinants to be successful, competitive, and/or to improve the performance, productivity, efficiency, etc. Competitiveness factors are those areas in which satisfactory performance will bring improvements in firms' competitive performance.

A comprehensive list of factors and sub-factors has been developed from literature. All these factors are regarded as the most important drivers for competitiveness. The literature review includes studies about competitiveness, performance, success, bidding, competitiveness frameworks, business models, TQM studies, and others related.

It has been found 65 endogenous sub-factors, grouped into nine factors. The nine endogenous factors are: (1) strategic management, (2) project management, (3) human resources management, (4) financial capacity, (5) organizational culture, (6) institutional and business relationships, (7) innovation and R&D, (8) marketing and bidding issues, and (9) technical and technological factors. Figure 3 shows an example of sub-factors included in the first two endogenous factors. The factors and sub-factors have been arranged in a descending order based on the number of times that each of them was cited in the literature to get an idea about the relative importance of each one. The number of times mentioned could be an indirect measure for their relevance, but it needs to be confirmed through interviews and surveys directed to construction companies CEOs in the analyzed environment.

FACTORS	SUB-FACTORS	(Yates, 1994)	(Ngowi and Rwelamila, 2001)	(Shen and Chan, 2003)	(Ericsson and Henricsson, 2005)	(Flanagan et al., 2005b)	(Lu, 2006)	(El-Diraby et al., 2006)	(Shen et al., 2006)	(Buckley et al., 1988 and 1990)	(Hatush and Skitmore, 1997)	(Jaafari, 2000)	(Dikmen and Birgünzl, 2003)	(Luu, Kim, Cao and Park, 2008)	(Dangerfield et al., 2008)	(Ambastha and Momaya, 2004)	(Bassioni et al., 2004)	(Flanagan et al., 2005a)	(Baldrige N.Q.P., 2008)	(EFQM®, s.f.)	(Venegas and Alarcún, 1997)	(Hax and Wilde II, 2003)	(Conti, 1997)	(Saraph et al., 1989)	(Flynn et al., 1994)	(Ahire et al., 1996)	(Black and Porter, 1996)	(Mandal et al., 1998)	(Henderson and Mitchell, 1997)	(Oliver, 1997)	(Neely and Adams, 2001)	(Kale and Arditi, 2002)	(Porter, 2005)	(Phua, 2006)	(Cross and Lynch, 1988-1989)	(Kaplan and Norton, 1996)	Total
STRATEGIC MANAGEMENT		●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●		●	●	30
	Customer focus				●	●	●	●						●		●	●	●	●	●	●	●			●	●	●				●				●		17
	Quality focus	●		●		●	●	●	●				●	●		●					●			●	●	●	●	●				●			●		17
	Strategy establishment and implementation				●		●	●		●		●				●	●		●	●			●								●		●		●		13
	Information management / IT usage			●	●		●			●		●	●	●		●	●	●	●				●														12
	Leadership							●				●					●		●	●			●	●				●					●				9
	Operations management								●			●							●	●	●	●											●		●		8
	Flexibility / Adaptability	●	●		●											●		●		●													●		●		8
	Image and reputation			●			●	●	●		●		●		●	●																					8
	Knowledge management				●												●	●	●	●																●	6
	Benchmarking											●								●						●							●				4
	Continuous improvement																		●							●	●										3
	Social focus																●		●	●																	3
PROJECT MANAGEMENT		●		●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●		●	●	●	●		●			●	●		●	●		26
	Process management	●			●		●		●		●					●	●	●	●		●		●	●	●			●			●				●		16
	Quality management	●		●		●	●	●	●				●	●		●			●		●			●		●		●				●					15
	Schedule management			●	●	●	●	●	●					●	●			●														●			●		11
	Supply management			●	●		●	●						●	●		●							●										●	●		10
	Health and safety			●		●	●	●	●		●			●																							7
	Cost Management			●	●		●	●	●																										●		6
	Risk management			●	●		●		●									●																			5
	Contract management			●			●		●										●																		4
	Labor management			●				●	●																												3
	Environmental management			●					●											●																	3
	Subcontractors management			●														●																●			3
	Resource management																●						●														2
	Insurance management						●																														1
	Claim handle						●																														1

Figure 3: Example of literature review about competitive factors and sub-factors.

Besides, as both industry and firm effects are considered important in shaping business results (Rumelt, 1991), we have found 47 exogenous sub-factors, grouped in the following ten factors: (1) regulatory environment, (2) macroeconomic conditions, (3) socio-cultural aspects, (4) competitive environment, (5) technological situation, (6) work force conditions, (7) political issues, (8) international dimension, (9) client aspects, and (10) industry characteristics. It is not the purpose of exogenous factors to evaluate the construction industry of a region or country, but to consider the external factors that mostly affect the competitiveness of construction companies.

Competitiveness indexes at firm level

The basis of formulating performance indicators has been in operation as early as the beginning of our century (Chandler, 1997). The performance indexes traditionally have concentrated on finance performance, but even they tend to measure only the past and the easily measurable (Kagioglou et al., 2001). Since the late 1980s, increased globalized competition has forced companies to consider non-traditional measures (Kagioglou et al., 2001).

Competitiveness is a complex concept, and according to its definition, it comprises several performance measures. According to literature, a company's competitiveness performance is evaluated through nine main indexes: (1) financial indicators, (2) productivity, (3) client satisfaction, (4) market share, (5) society satisfaction, (6) contracts growth, (7) future capabilities, (8) personnel satisfaction, and (9) overall performance. Each of these groups comprises a certain number of indicators. A comprehensive list of competitiveness indexes was developed (an example is provided in figure 4 showing only two indexes with their respective indicators).

INDEXES	INDICATORS	(Phua, 2006)	(Bassioni et al., 2005)	(Flanagan et al., 2007)	(Kale y Arditi, 2002)	(Ambastha y Momaya, 2004)	(Flanagan et al., 2005b)	(Cheah et al., 2007)	(Bassioni et al., 2004)	(Flanagan et al., 2005a)	(Luu et al., 2008)	(Venegas y Alarcón, 1997)	(Bassioni et al., 2004)	(Buckley et al., 1990)	(Buckley et al., 1988)	(Kaplan y Norton, 1993)	(KPI Working Group, 2000)	(KPI Working Group, 2007)	(Kale y Arditi, 2003)	(BNQP, 2008)	(Kaplan y Norton, 2000)	(Oliver, 1997)	(Conti, 1997)	(Kaplan y Norton, 1996)	(Jenkins y Johnson, 1997)	(Porter, 1990)	Total
FINANCIAL INDICATORS		●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		22
	Productivity of investments (ROE, ROA, ROI)	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●			19
	Profit margin / profit growth		●					●	●		●	●		●			●	●					●	●	●		11
	Revenue and revenue growth		●					●			●	●		●		●					●		●	●	●		10
	Cash flow / Liquidity		●								●					●							●				4
	Total assets trend																						●				1
	Debt / equity ratio																						●				1
PRODUCTIVITY				●		●	●		●	●					●		●	●		●	●		●	●		●	13

Figure 4: Example of literature review about indexes of competitiveness

INTERRELATIONSHIP MODEL FOR COMPETITIVENESS

Bassioni et al., (2004) argue that construction companies, by default, are traditionally pursuing a cost leadership strategy instead of designing a competitive strategy better suited for them. They also state that strategic planning has a low profile in construction and receives a low level of attention. This limited interest on strategic planning could be one of the reasons explaining that the construction industry compares poorly with other sectors, as mentioned by (Betts and Ofori, 1992).

In a simple way, strategic planning is about breaking down a goal or set of intentions into steps (Ngowi and Rwelamila, 2001). The strategic planning process, as it has been discussed in Venegas and Alarcón (1997), includes proposing, studying, and choosing action courses intended to reduce the existing gap between current and expected position that involves a whole stage of strategies formulation, evaluation, and selection of action options. Expected position, in a competitive environment, is about having clear goals for the company (expressed through indexes). And in order to get the expected results, managers need to know how factors are associated with those results, so knowledge about what are the most relevant interrelationships and how much are they correlated will be very helpful.

Since managers, at this stage of the strategic planning process, need an adequate amount of information, the proposed preliminary model presents interrelationships between competitive factors (endogenous and exogenous) and indexes that have to be taken into account, helping construction executives to understand the variables, impacts, and effects involved in their decisions, as requested by Venegas and Alarcón (1997). This model has been developed to pursue the organizational strategic goals assuming that there must be significant correlations between endogenous factors and indexes, able to be manipulated by managers. Exogenous factors are taken into account considering that Venegas and Alarcón (1997) have stated that it is necessary to incorporate the impact of environmental variables on the internal ones. Besides, it needs to be evaluated whether exogenous factors affect in the same way to every company in the same market or not.

This preliminary model (see Figure 5) exhibits the variables and interrelationships that would determine competitiveness in a construction firm, and it is used to identify how competitiveness factors impact the firm’s competitive performance. The model has three main components: (1) exogenous factors; (2) endogenous factors; and (3) competitiveness indexes. In the literature, some interactions between endogenous factors and indexes have been analyzed empirically, while others have been assumed theoretically. Hypothetical feasible relationships will need to be created in order to generate a complete network between them.

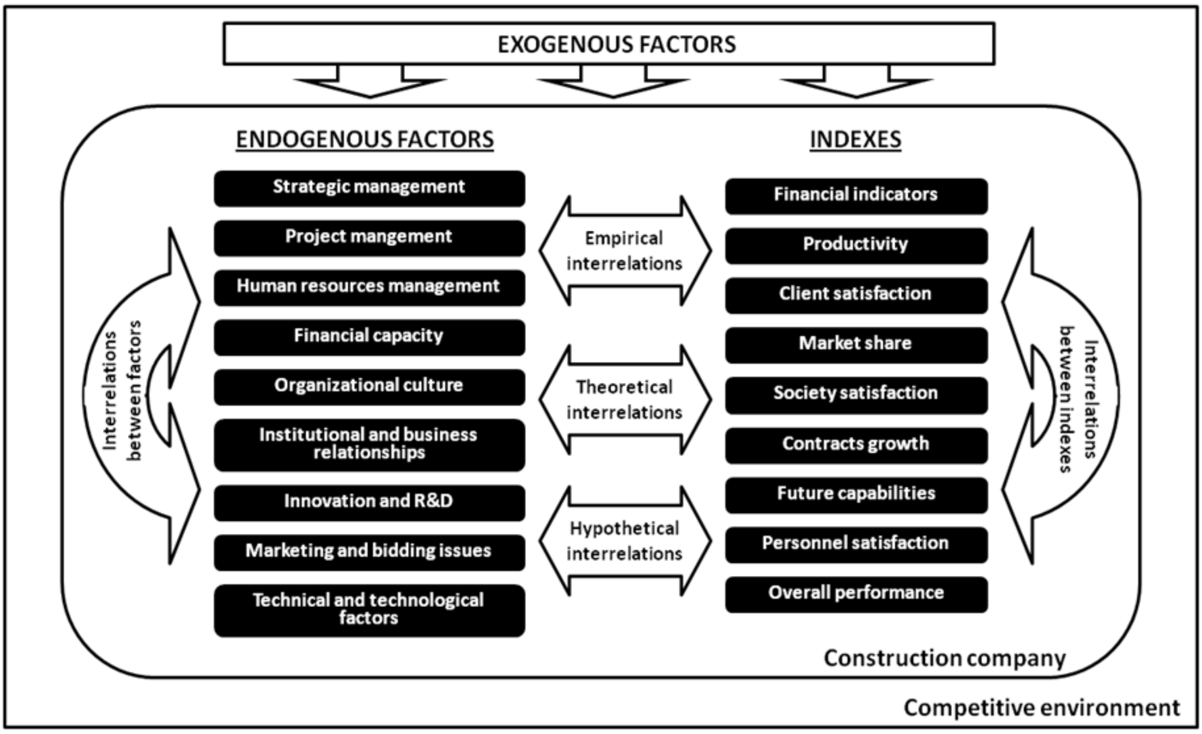

Figure 5: Preliminary conceptual models of competitiveness interrelationships at firm level.

The interrelationships shown in this preliminary model will be quantified and analyzed to find out what are the most important variables for competitiveness and how strongly are they interrelated.

Benefits

The proposed model contributes to a better understanding of the existing interrelationships between variables determining business competitive performance, and this cognition could be associated with the performance of the business, as suggested by Jenkins and Johnson (1997).

This approach intends to support strategic planning in construction companies, by helping managers to direct company's efforts to those factors that mostly contribute to the specific indexes that need to be improved. Besides, managers will be able to evaluate several action plans, supporting their subjective assessments and ensuring they have a better estimate of the expected impact or tendency of the plans over competitiveness.

Knowing the interrelationships allows the identification of the most relevant factors affecting each index, and also what is the magnitude of this impact. As it has been argued by (Kagioglou et al., 2001), it is only by understanding how the organization arrives at a particular performance, that an organization might start to improve and increase its market share.

METHODOLOGY

Both, factors and indexes lists need to be depurated through surveys directed to CEOs of firms in the construction industry. This survey will help clarifying the most important sub-factors that impact over firms' competitiveness. In the same way, CEOs will be asked to assess which are the most relevant indexes interpreting competitive performance of a firm. This procedure has been used before by several studies (Lu, 2006) (Luu et al., 2008).

Once having the most relevant sub-factors and indexes, indicators have to be calibrated under particular circumstances and managers will have to select what are the most representative indicators for each sub-factor or index. Indicators have been suggested by (Lu, 2006; Conti, 1997; Bassioni et al., 2005; Luu et al., 2008; KPI Working Group, 2000; Shen et al., 2003; Mandal et al., 1998; Cheah et al., 2007) among others.

A third survey will be applied in order to measuring indicators. CEOs are going to be asked to evaluate indicators for their own companies. Competitiveness is always in reference to others, so asking what is the CEO's perception of their company against competitors is an easy and fine way to get the information. This subjective method of assessment has been used in several researches (e.g. Phua, 2006; Cheah et al., 2007; Kale and Arditi, 2002) in order to avoid no response caused by confidential information. Kale and Arditi (2002) states that subjective measurement approaches have been commonly used for exploring some organizational factors on construction companies' performance, that the use of this method is widespread in the literature, and that its validity has been justified.

Collected data allow this research to analyze the interrelationship model applying multivariable statistical techniques to find out the most relevant interrelationships and their magnitude.

CONCLUSIONS AND FURTHER WORK

The most relevant elements of the concept of competitiveness help its understanding and allow working to improving firms' long-term performance.

Research about competitiveness at the firm level has to consider three main elements: endogenous factors, exogenous factors, and indexes. They altogether interpret a firm competitive performance and provide the necessary information to analyze how they are interrelated. In this regard, comprehensive lists of factors and indexes are a useful literature basis for further works on competitiveness.

The preliminary conceptual model of competitiveness interrelationships provides another perspective to analyze variables which shape a firm competitive performance. With this model managers could have a greater understanding of the linkages between competitiveness factors and indexes and therefore a broader picture about their business.

Time horizon for this research is cross-sectional, but a systematic measurement of indicators allows capturing indicators trends, and generating a dynamic model for competitiveness. It could be a good starting to analyze long-term competitive performance.

Indicators for this research have been adapted to get information in an easy way, knowing there is a lot of confidential data. A next step in this direction is to develop a competitiveness measurement system for this interrelationship model with hard data for internal use at a company. It allows companies to monitor and to analyze trends in their own competitiveness factors and performance.

REFERENCES

Ambastha, A., & Momaya, K. (2004). Competitiveness of Firms: Review of Theory, Frameworks, and Models. Singapore Management Review, 26 (1), 45-61.

Bassioni, H.A., Price, A.D.F., & Hassan, T.M. (2004). Performance Measurement in Construction. Journal of Management in Engineering, 20 (2), 42-50.

Bassioni, H.A., Price, A.D.F., & Hassan, T.M. (2005). Building a conceptual framework for measuring business performance in construction: an empirical evaluation. Construction Management and Economics, 23 (5), 495-507.

Betts, M., & Ofori, G. (1992). Strategic planning for competitive advantage in construction. Construction Management and Economics, 10, 511-532.

Buckley, P.J., Pass, C.L., & Prescott, K. (1988). Measures of international competitiveness: a critical survey. Journal of Marketing Management, 4 (2), 175-200.

Chandler, A.D. (1997). The visible hand - managerial revolution in American business. Harvard University Press, Boston, MA.

Cheah, C.Y.J., Kang, J., & Chew, D.A.S. (2007). Strategic analysis of large local construction firms in China. Construction Management and Economics, 25 (1), 25-38.

Conti, T. (1997). Organizational self-assessment. London, Chapman & Hall.

Dangerfield, B., Quigley, M., & Kearney, J. (2008). A dynamic policy model to manage temporal performance amongst contracting firms in a competitive situation. The 2008 International Conference of the System Dynamics Society. 20-24 July 2008, Athens, Greece.

Ericsson, S., & Henricsson, J.P.E. (2005). Deconstructing construction competitiveness - The initial results of a Delphi survey in Finland, Sweden and the UK. En A.C. Sidwell (Ed.), The Queensland University of Technology Research Week International Conference. Brisbane, Australia.

Flanagan, R., Cattell, K. and Jewell, C.A. (2005b). Moving from construction productivity to construction competitiveness: measuring value not output. Retrieved: January 7, 2008. From: http://n.1asphost.com/competitiveness/MOVING%20FROM%20PRODUCTIVITY%20TO%20COMPETITIVENESS.pdf

Flanagan, R., Jewell, C.A., Ericsson, S., & Henricsson, P. (2005a). Measuring construction competitiveness in selected countries, Final Report. The Research Team at the University of Reading, 173 pp.

Flanagan, R., Lu, W., Shen, L., & Jewell, C.A. (2007). Competitiveness in construction: a critical review of research. Construction Management and Economics, 25 (9), 989-1000.

Jenkins, M., & Johnson, G. (1997). Linking managerial cognition and organizational performance: a preliminary investigation using causal maps. British Journal of Management, 8 (Special Issue), S77-S90.

Kagioglou, M., Cooper, R., & Aouad, G. (2001). Performance management in construction: a conceptual framework. Construction Management and Economics, 19 (1), 85-95.

Kale, S., & Arditi, D. (2002). Competitive Positioning in United States Construction Industry. Journal of Construction Engineering and Management, 128 (3), 238-247.

KPI Working Group (2000). KPI Report for The Minister for Construction. Department of the Environment, Transport and the Regions. U.K.

Lu, W. (2006). A system for assessing and communicating contractors' competitiveness. Doctoral dissertation, The Hong Kong Polytechnic University, China.

Luu, T., Kim, S., Cao, H., & Park, Y. (2008). Performance measurement of construction firms in developing countries. Construction Management and Economics, 25 (4), 373-386.

Mandal, P., Howell, A., & Sohal, A.S. (1998). A systemic approach to quality improvements: the interactions between the technical, human and quality systems. Total Quality Management, 9 (1), 79-100.

Micro Foundations & Macro Competitiveness. (1999). Retrieved: October 18, 2008. From: http://www.india-today.com/btoday/19990822/global.html

Momaya, K., & Selby, K. (1998). International competitiveness of the Canadian construction industry: a comparison with Japan and the United states.. Canadian Journal of Civil Engineering, 25 (4), 640-652.

Ngowi, A.B., & Rwelamila, P.D. (2001). What is a competitive advantage in the construction industry?. Cost Engineering, 41 (2), 30-36.

Phua, F.T.T. (2006). Predicting construction firm performance: an empirical assessment of the differential impact between industry and firm-specific factors. Construction Management and Economics, 24 (3), 309-320.

Porter, M. (1990). The Competitive Advantage of Nations. New York: Free Press.

Rumelt, R.P. (1991). How much does industry matter?. Strategic Management Journal, 12 (3), 167-185.

Shen, L.Y., Lu, W., Shen, Q., & Li, H. (2003). A computer-aided decision support system for assessing a contractor’s competitiveness. Automation in Construction, 12 (5), 577-587.

Venegas, P., & Alarcón, L.F. (1997). Selecting long-term strategies for construction firms. Journal of Construction Engineering and Management, 123 (4), 388-398.

Waheeduzzan, A.N.M., & Ryans, J.K. (1996). Definition, perspectives, and understanding of international competitiveness: a quest for a common ground. The Competitiveness Review, 6 (2), 7-26.

BALANCE SHEET ANALYSIS OF CONSOLIDATED BUILDING COMPANIES BEFORE THEIR INSOLVENCY

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A lot of national and international working consolidated companies can be found in the building sector. But in the last few years, two of the most important consolidated building companies in Germany went down to insolvency: The consolidated companies of Philipp Holzmann and Walter Bau. This paper shall give an analysis, if it was possible to anticipate their insolvency in time, so that it would have been possible to react sooner and find solutions to rescue these consolidated companies – and of course all the companies, depending on them. The intension is, to find out, if there are typical structures and characteristic key indicators for an imminent insolvency in the balance sheets of these two German consolidated companies.

KEYWORDS: balance sheet analysis, consolidated companies, insolvency.

INTRODUCTION

Insolvency of Philipp Holzmann and Walter Bau

The Philipp Holzmann AG, holding company of the Philipp Holzmann consolidated companies, applied for insolvency at 23.11.1999. Before that, Philipp Holzmann was one of the biggest global players in the building sector and in that time also the biggest German building company. Based on a rescue packet, that was introduced by the Federal Chancellor of Germany in that time, Gerhard Schröder, the commercial operations could be continued, because some financial institutes initialized credits and also a guarantee of the federation was given. But all that could not stop the way down to insolvency. In March 2002 the Philipp Holzmann AG hat to declare, that the financial restructuring has failed. In that time the Philipp Holzmann consolidated company was overindebted and no bank wanted to give any more credit. As a result of this Philipp Holzmann had to declare insolvency at the Date of 21.03.2002.

Another big German consolidated company declared insolvency a few years later: In February 2005 Walter Bau applied for insolvency at the district court of Augsburg, Germany. The reason for that was a big financing hole, based on the years before. With the date of 01.04.2005 the insolvency proceeding was opened by the district court. Parts of the Walter Bau consolidated company were taken over by other well known companies. For example, the new build Dywidag Holding GmbH, part of the Walter Bau consolidated company, was took over by Strabag SE, Austria. All together another big German consolidated company went down to insolvency in 2005 and disappeared from the international building sector.

As described, two of the biggest German consolidated companies disappeared from the market during the last seven years. On of the most important questions is, to find out if there was really no feasibility to anticipate these process in time. Was it really impossible to recognize the danger of the imminent insolvencies? Was it really impossible to face this situation with according reactions in time?

Way of analysis

Based on the different consolidated balance sheets of Philipp Holzmann and Walter Bau, several key indicators shall be identified and calculated. But there shall not be given only a situational Snapshoot – much more interesting and important is to show the chance during the time period before these both consolidated companies had to declare their insolvency.

With a simultaneous examination of the balance sheets of both consolidated companies, key indicators are shown, that are significant in their way of change for companies in the time before going insolvent. Parallelism and regularities are shown. The intention of this is to find out, how it is possible, to anticipate imminent insolvencies as soon as possible. There shall also be given an answer to the question, how long before declaring insolvency, a progress like that can be anticipated.

Philipp Holzmann as well as Walter Bau had been German consolidated companies. Therefore, both companies had to balance and account according to the standards of German trade law, written down in the Handelsgesetzbuch (HGB). Although both consolidated companies balanced basing on the same law, there could be used different appendages for estimating and setting up the balance sheet. The German trading law allows this, because there are given some different options in value settings inside the HGB. This complex of problems grows up all the more, when using consolidated balance sheets, where not only one company is considered but also all companies belonging to the basis of consolidation. Anyhow the calculation and examination of the key indicators are basing on the original consolidated balanced sheets of Philipp Holzmann and Walter Bau. No or only a minimum of structural chance, revaluation or other interferences and corrective actions (like in the future prospect proposed) are done.

In the future prospect and the final conclusion there will be proposed a system of creating a structural balance in which every balance sheet of consolidated companies can be transformed. The intention is to set up the comparability of key indicators and increase the significance of comparisons with financial ratios between different consolidated companies.

The results of such a procedural method will be presented at the CIB Joint International Symposium in Dubrovnik during 27. September to 1. October 2009.

Time of view in the pre-phase of an insolvency

As representative for the pre-phase of insolvency, a time period of ten years before insolvency is defined, starting with the last officially annual report that was open to public. Together with this last visible annual report there are ten years backwards analysed (that means ten annual reports for each consolidated company).

The last open to public annual report of Philipp Holzmann was the report for the financial year 2000. In case of Walter Bau the last open to public annual report was the report for the financial year 2003. In both consolidated companies the financial year starts and ends at the same time as the calendar year (1. January to 31. December). Therefore different times and periods of view can be defined:

- Time of view Philipp Holzmann: 1991 – 2000
- Time of view Walter Bau: 1994 – 2003

DEFINITIONS FOR BALANCE SHEET ANALYSIS

The printed key indicators, showed in this paper, are predicated on the original balance sheets of Philipp Holzmann and Walter Bau. Financial and mathematical corrective actions are not, or only in minimum scale, implied. In Order to allocate the several items of the balance sheet to the fixed or current assets (assets) respectively to equity or loan capital (liabilities) the following handling is utilised.

Special handling of assets

As a special item of the asset part of the balance sheets belonging to Philipp Holzmann, a not with equity covered deficit can be mentioned. As this item is more a compensation (in order not to figure out a negative equity) than a really existing asset, it is consequent to understand it neither as a fixed nor a current asset. According to that, the not with equity covered deficit is not included in the fixed or current assets, while calculating the characteristically key indicators.

Special handling of liabilities side

Special reserves with an equity portion that are shown in the balance sheets are allocated completely to equity capital, knowing that this item is normally a mixture of parts of equity and loan capital. But as a proportional split-up in equity and loan capital is not possible, here this item is allocated completely to equity capital.

Both the Philipp Holzmann consolidated company and the Walter Bau consolidated company do not show the term time of their accrued liabilities. For calculating the financial key indicators, they were set as middle-termed liabilities with a term time from one to maximum five years.

Deferred income and accrued expenses are deemed to be loan capital with a short term time of maximum one year.

BALANCE SHEETS

All the following balance sheets are put out of the annual reports of the respective consolidated company. Before the year 2000 the balance sheets are set up in DM (Deutsche Mark), the official currency in Germany in that time. Later on, the balance sheets are set up in EUR. In order to get a comparable overview, all balanced sheet values that are shown in following figures are annualized with the official currency rate of 1 EUR = 1,95583 DM.

Balance sheets of Philipp Holzmann

Assets	31.12.2000	31.12.1999	31.12.1998	31.12.1997	31.12.1996	31.12.1995	31.12.1994	31.12.1993	31.12.1992	31.12.1991
	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]
Fixed assets	**902.842**	**1.025.313**	**1.140.750**	**1.180.138**	**1.723.812**	**1.639.469**	**1.286.238**	**1.180.224**	**1.024.853**	**883.064**
Intangible fixed assets	9.769	12.339	15.589	21.712	31.754	88.525	85.592	65.529	67.480	85.745
Tangible assets	683.442	777.634	868.519	988.312	1.409.424	1.274.683	929.406	881.562	714.802	594.033
Financial assets	209.630	235.339	256.643	170.113	282.635	276.261	271.239	233.133	242.572	203.286
Current assets	**2.943.040**	**2.894.268**	**3.443.827**	**4.151.260**	**4.686.907**	**4.461.766**	**4.102.330**	**3.282.481**	**2.886.080**	**2.797.723**
Stocks	894.112	979.983	1.016.032	1.238.390	1.370.952	1.419.723	936.409	586.760	678.902	754.936
Other stocks	46.541	43.374	68.620	72.341	95.165	97.566	77.105	66.450	69.578	87.502
Receivables and other capital assets	1.706.197	1.556.630	1.765.054	1.972.324	1.842.063	2.058.026	1.936.726	1.799.715	1.466.646	1.251.691
Commercial papers	47.537	54.241	87.138	161.080	165.367	301.037	329.615	223.816	246.834	260.022
Liquid assets	248.652	260.039	506.983	707.125	1.213.361	585.414	822.476	605.740	424.119	443.571
Deffered expenses and accrued income	**28.575**	**11.291**	**5.783**	**6.557**	**8.157**	**5.800**	**2.784**	**2.754**	**1.587**	**1.744**
Not with equity covered deficit	**0**	**838.504**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Amount of Assets	**3.874.457**	**4.769.376**	**4.590.361**	**5.337.955**	**6.418.877**	**6.107.034**	**5.391.353**	**4.465.459**	**3.912.519**	**3.682.530**

Liabilities	31.12.2000	31.12.1999	31.12.1998	31.12.1997	31.12.1996	31.12.1995	31.12.1994	31.12.1993	31.12.1992	31.12.1991
	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]
Equity	**126.190**	**0**	**528.457**	**374.901**	**808.381**	**835.741**	**1.094.653**	**682.263**	**518.264**	**482.293**
Issued capital	13.317	148.390	145.814	112.165	112.165	112.165	112.165	81.548	71.900	71.900
Reserves of the consolidated company										
... Capital reserves	149.725	352.102	337.357	199.723	633.665	659.459	735.412	367.765	251.597	251.597
... Retained earnings	0	0	0	0	8	531	158.484	167.255	143.027	116.958
Deferred item of the consolidation	22.091	21.545	16.495	16.933	19.215	16.108	17.522	16.321	8.923	4.184
Interests of other partners	22.999	23.806	28.791	46.080	43.328	47.479	40.787	27.356	25.562	21.836
Balance sheet profit / deficit	-81.943	-1.384.347	0	0	0	0	30.284	22.018	17.256	15.818
... Not with equity covered deficit	0	838.504	0	0	0	0	0	0	0	0
Special reserves with an equity portion	**0**	**0**	**0**	**0**	**80**	**13.921**	**9.648**	**6.227**	**8.151**	**28.646**
Accured liabilities	**1.083.128**	**1.264.421**	**847.232**	**1.322.405**	**1.190.687**	**1.171.350**	**1.067.680**	**1.069.770**	**869.744**	**745.881**
Liabilities	**2.664.989**	**3.504.479**	**3.213.722**	**3.638.919**	**4.416.415**	**4.084.707**	**3.219.081**	**2.706.966**	**2.516.258**	**2.425.581**
... Short term (< 1 year)	2.301.526	2.804.322	2.374.372	2.843.311	3.657.470	3.389.788	2.539.585	2.149.747	2.120.538	2.100.371
... Middle term (1 - 5 years)	221.835	559.552	777.330	685.476	676.831	562.238	568.035	460.702	341.523	276.280
... Long term (> 5 years)	141.628	140.605	62.020	110.132	82.113	132.680	111.462	96.518	54.197	48.931
Deferred income and accrued expenses	**150**	**476**	**950**	**1.730**	**3.315**	**1.316**	**290**	**233**	**103**	**129**
Amount of Liabilities	**3.874.457**	**4.769.376**	**4.590.361**	**5.337.955**	**6.418.877**	**6.107.034**	**5.391.353**	**4.465.459**	**3.912.519**	**3.682.530**

Figure 1: Balance Sheets of Philipp Holzmann

Balance sheets of Walter Bau

Assets	31.12.2003	31.12.2002	31.12.2001	31.12.2000	31.12.1999	31.12.1998	31.12.1997	31.12.1996	31.12.1995	31.12.1994
	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]
Fixed assets	**401.705**	**437.696**	**516.248**	**400.443**	**286.517**	**306.692**	**319.116**	**324.430**	**280.552**	**281.274**
Intangible fixed assets	17.251	17.427	31.422	20.549	16.778	18.362	20.505	21.962	923	1.195
Tangible assets	223.632	255.625	303.903	230.798	158.637	186.385	190.515	199.174	178.009	178.582
Financial assets	160.822	164.644	180.923	149.096	111.102	101.944	108.096	103.293	101.620	101.497
Current assets	**983.906**	**1.058.820**	**1.088.223**	**1.460.988**	**983.567**	**955.537**	**966.871**	**1.052.994**	**775.193**	**658.020**
Stocks	0	0	9.839	0	0	0	0	0	0	33.075
Other stocks	132.544	179.986	231.422	281.614	178.171	170.913	174.419	185.347	119.005	100.938
Receivables and other capital assets	629.352	643.559	586.948	610.986	366.854	349.690	321.584	337.719	313.443	232.162
Commercial papers	55	3.635	3.635	133.193	36.011	12.168	3.840	526	12.881	9.313
Liquid assets	221.955	231.640	256.379	435.195	402.531	422.766	467.029	529.402	329.865	282.533
Deffered expenses and accrued income	**6.978**	**7.679**	**5.246**	**3.068**	**1.728**	**2.348**	**4.366**	**4.399**	**1.412**	**1.404**
Amount of Assets	**1.392.589**	**1.504.195**	**1.609.717**	**1.864.499**	**1.271.812**	**1.264.577**	**1.290.354**	**1.381.823**	**1.057.157**	**940.698**

Liabilities	31.12.2003	31.12.2002	31.12.2001	31.12.2000	31.12.1999	31.12.1998	31.12.1997	31.12.1996	31.12.1995	31.12.1994
	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]	[T€]
Equity	**148.473**	**157.765**	**175.399**	**299.801**	**200.623**	**249.546**	**255.970**	**257.148**	**267.565**	**253.160**
Issued capital	154.251	154.251	154.251	84.801	50.000	38.347	38.347	38.347	38.347	38.347
Reserves of the consolidated company										
... Capital reserves	20.235	20.235	260.021	161.848	86.938	98.590	98.767	98.767	98.627	97.145
... Retained earnings	73.319	87.419	104.926	93.026	47.614	74.491	78.898	74.577	77.263	71.684
Balance sheet profit / deficit	-102.906	-106.589	-345.856	-101.885	-25.439	407	2.623	12.169	19.409	24.635
Minority interests	3.574	2.449	2.057	62.011	41.510	37.710	37.335	33.289	33.919	21.348
Special reserves with an equity portion	**1.880**	**186**	**64**	**0**	**5.854**	**12.052**	**12.396**	**12.740**	**13.004**	**13.546**
Accured liabilities	**503.687**	**538.974**	**649.850**	**625.570**	**318.667**	**306.477**	**288.706**	**292.828**	**292.001**	**277.277**
Liabilities	**737.426**	**806.449**	**784.076**	**938.877**	**746.425**	**696.444**	**733.171**	**818.992**	**484.427**	**396.649**
... Short term (< 1 year)	709.884	767.891	702.631	816.538	624.031	544.525	584.501	660.255	427.695	346.721
... Middle term (1 - 5 years)	24.551	29.043	68.990	114.296	120.137	144.262	141.966	149.393	48.161	36.162
... Long term (> 5 years)	2.991	9.515	12.455	8.043	2.258	7.658	6.703	9.344	8.571	13.766
Deferred income and accrued expenses	**1.123**	**821**	**328**	**251**	**243**	**59**	**111**	**115**	**160**	**67**
Amount of Liabilities	**1.392.589**	**1.504.195**	**1.609.717**	**1.864.499**	**1.271.812**	**1.264.577**	**1.290.354**	**1.381.823**	**1.057.157**	**940.698**

Figure 2: Balance Sheets of Walter Bau

BALANCE SHEET ANALYSIS AND KEY INDICATORS

Asset structure

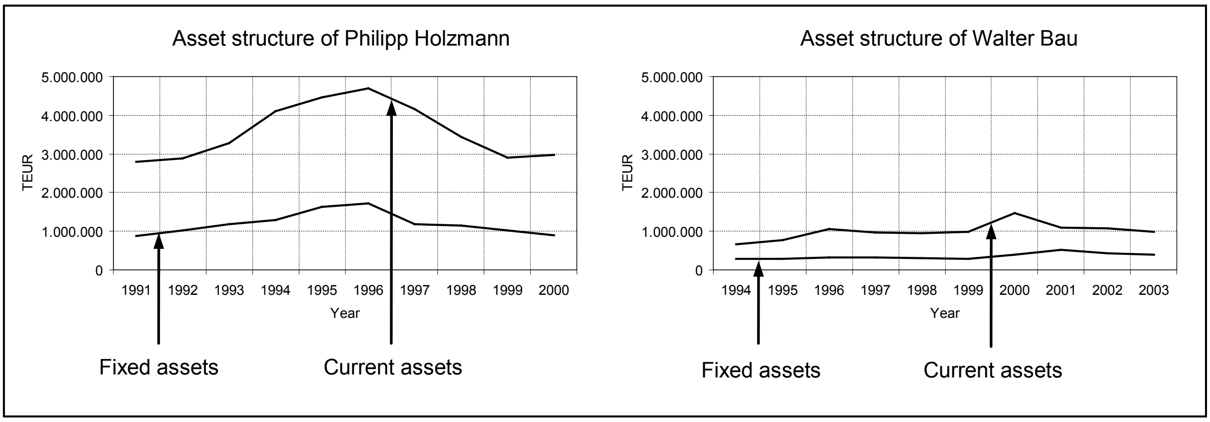


Figure 3: Asset structure of Philipp Holzmann and Walter Bau

In the description of the asset structure in both consolidated companies (figure 3) there can be recognized a peak of current assets four to five years before the consolidated companies had to declare their insolvency. Outstanding debits are not the reason for that. In both consolidated companies this items didn't skip strongly during the time of view. The Reason for the peaks are unsold stocks, because both consolidated companies show a marked increase of stocks (e.g. finished and non finished products) some years before their insolvency.

Capital structure

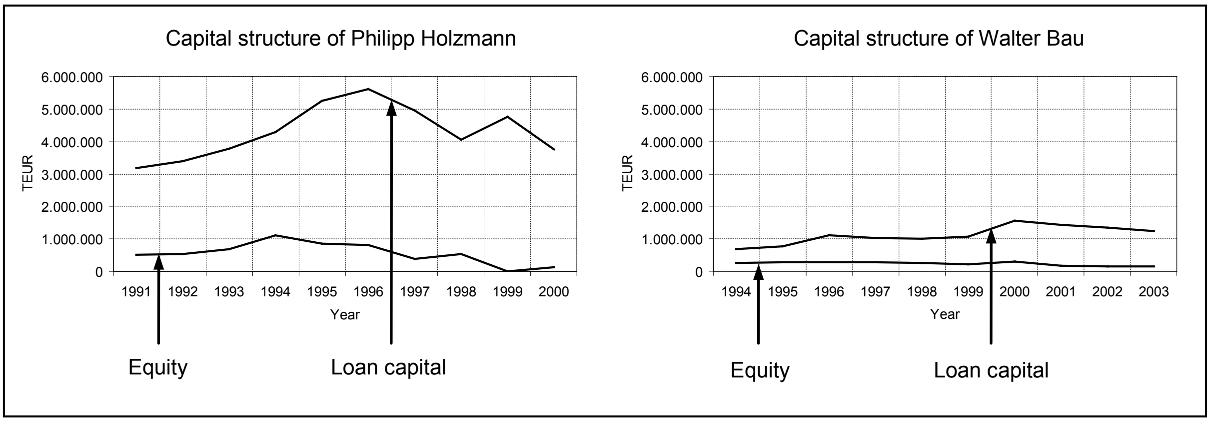


Figure 4: Capital structure of Philipp Holzmann and Walter Bau

Similar to the gradient of the asset structure their can be mentioned the capital structure. In the same time, when the assets rise up in the consolidated companies, the loan capital rises up too (figure 4). This is a typical combination because the increasing current assets are financed mainly with loan capital.

Leverage ratio

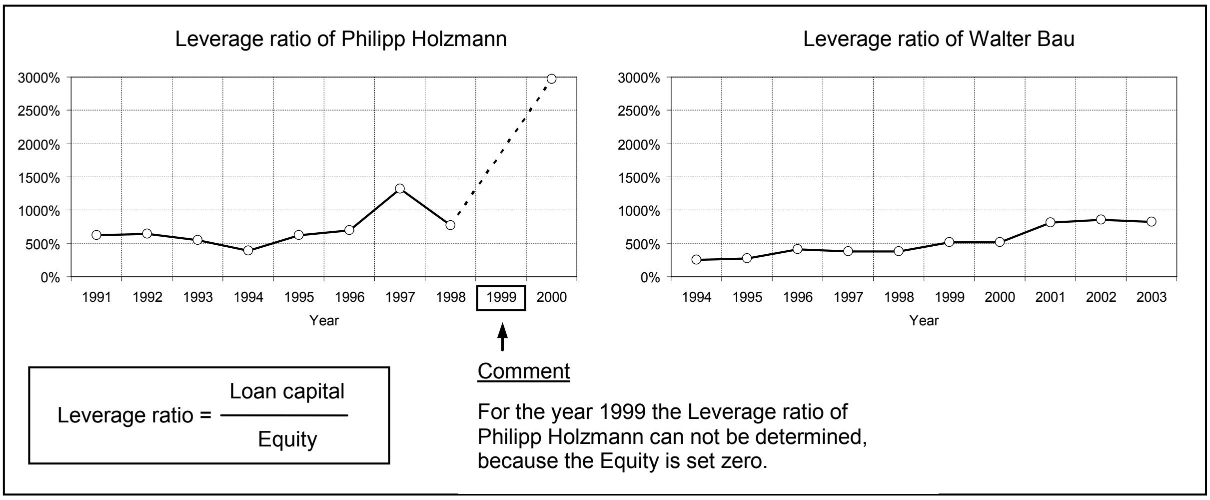


Figure 5: Leverage ratio of Philipp Holzmann and Walter Bau

Equity ratio

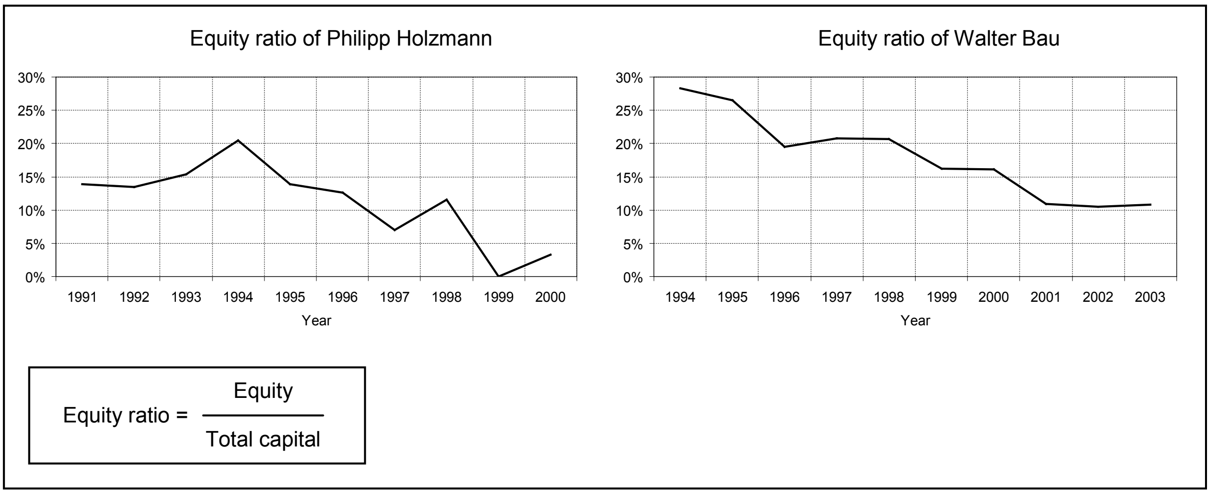


Figure 6: Equity ratio of Philipp Holzmann and Walter Bau

Normally companies shall have a leverage ratio of about 100 % so that the parts of equity and loan capital are nearly the same. But as it can be seen in figure 5, Philipp Holzmann as well as Walter Bau, didn't reach nearly that 100 %-range. Already four years before insolvency, Walter Bau had a leverage ratio of 522 % and Philipp Holzmann of 1.324 %! Also the equity ratio is significant. As the golden financing rule says, the equity ratio of companies in good shape shall be thirty or more percent; here the gradients show the big problems of both consolidated companies. During the whole time of view (ten years) none of them had reached the 30 %-range – not to mention more than this borderline.

Term time of liabilities

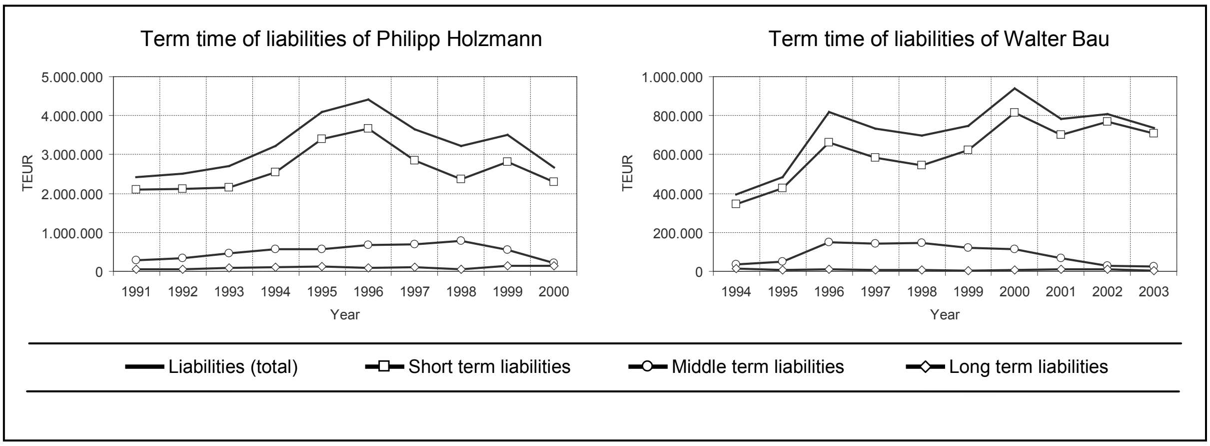
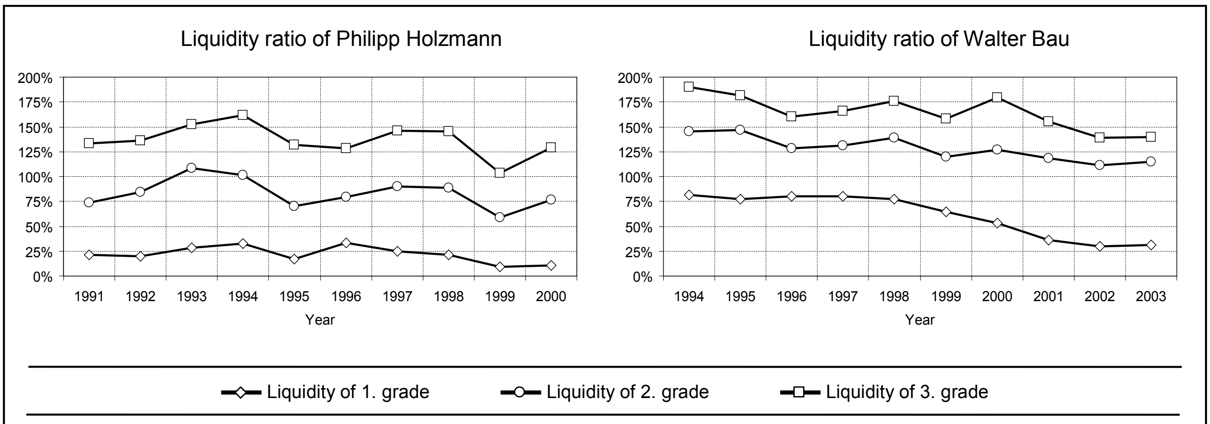


Figure 7: Term time of liabilities of Philipp Holzmann and Walter Bau

As already shown in figure 4 the loan capital increased in both consolidated companies four or five years before their insolvency. Figure 7 sows, how this loan capital is financed. Most part of it is financed by short term liabilities. That's a typical problem for companies going down to insolvency: On the one hand they need exactly in that time a lot of liquidity but on the other hand the financing institutes give mainly loans in those situations, anticipated as imminent insolvencies, only as short termed credits.

Liquidity ratio



$$\text{Liquidity ratio of 1. grade} = \frac{\text{Liquid assets}}{\text{Short term liabilities}}$$

$$\text{Liquidity ratio of 3. grade} = \frac{\text{Current assets}}{\text{Short term liabilities}}$$

$$\text{Liquidity ratio of 2. grade} = \frac{\text{Liquid assets + Short term receivables}}{\text{Short term liabilities}}$$

Figure 8: Liquidity ratio of Philipp Holzmann and Walter Bau

The liquidity ratio of both consolidated companies is also significant for companies being not in good shape. Normally the liquid ratio of 1. grade should be about 60 %. Approximately four to five years before insolvency, the 1. grade of liquidity falls bellow this marking in both consolidated companies.

Creation and dissolution of reserves

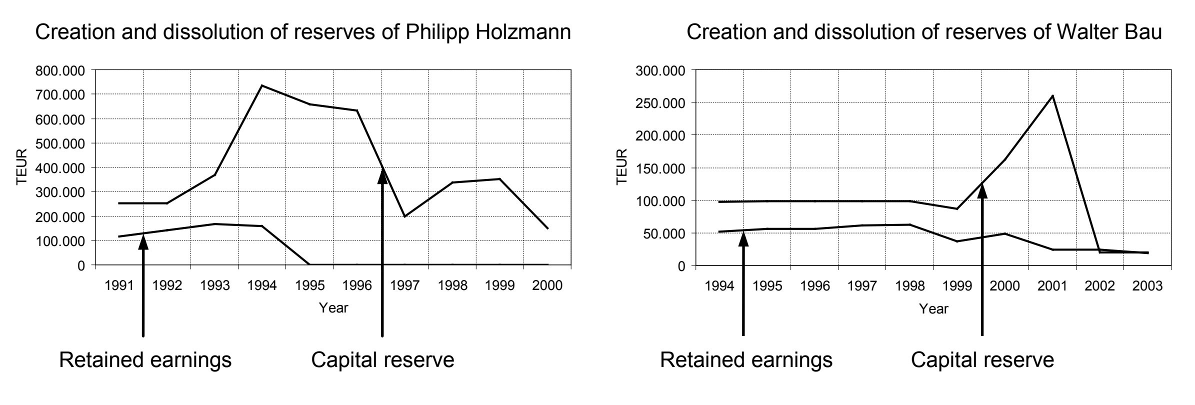
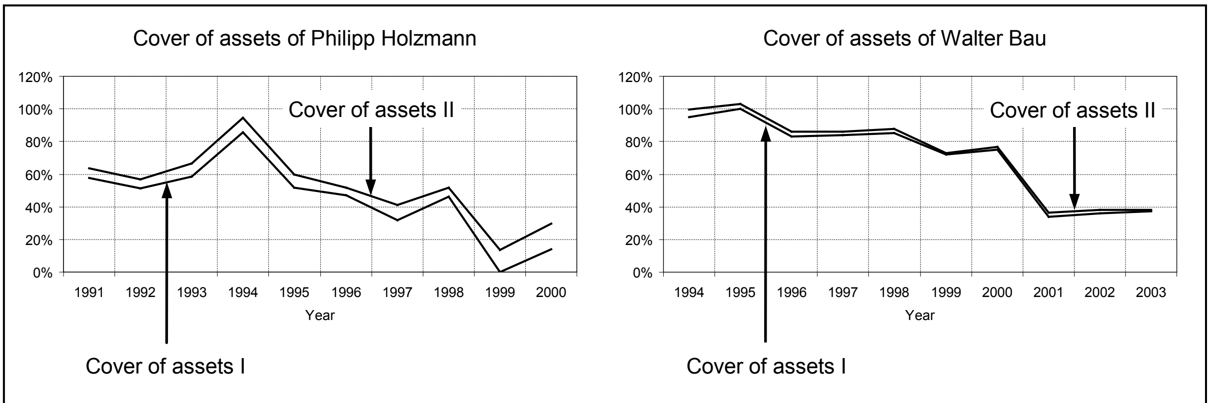


Figure 9: Creation and dissolution of reserves of Philipp Holzmann and Walter Bau

As figure 9 shows, there is no typical grade in creation and dissolution of reserves. Six years before insolvency Philipp Holzmann started to retain only marginal quantities of earnings. Four years before insolvency the consolidated company set the creation of retained earnings zero. In that time the balance sheet profit was also set zero. But that's not similar to Walter Bau. Here there were built reserves by retained earnings although a balance sheet deficit was stated. Altogether it is important to see, that the balance sheet profit is absolutely no key indicator, in anticipating an insolvency of a consolidated company. The balance sheet profit can be manipulated (on legal ways) during the consolidation of different companies so that this data is only a theoretical note.

Cover of assets



$$\text{Cover of assets I} = \frac{\text{Equity}}{\text{Fixed assets}} \qquad \text{Cover of assets II} = \frac{\text{Equity + Long term loan capital}}{\text{Fixed assets}}$$

Figure 10: Cover of assets of Philipp Holzmann and Walter Bau

Concluding the analysis there is the cover of assets. This key indicator should be 100 % in consolidated companies being in good shape. All the (long term time) assets should be financed by equity (also long term time). As figure 10 shows, this demand was only met one time by Walter Bau. In the building sector the cover of assets is frequently less than 100 %, so this can not be a significant point to anticipate insolvencies. But together with the knowledge that in about four to seven years before insolvency equity goes down (see figure 4), it is consequently that the grade of cover of assets goes downwards, too.

FUTURE PROSPECT

Structural balance sheet to optimise analysis

A problem of calculating key indicators is the not given absolute comparability of balance sheets from different consolidated companies (Küting 2006, p. 486 ff.). In order to optimise the results of such an analysis, it is advisable to transform all the balance sheets in a new structured sheet and to research the constitution of all the several balance sheet items in detail. Also financial and mathematical corrective actions on both sides of the balance sheets should be done. For example there can be mentioned the handling of outstanding capital contributions or the handling of balancing item for foreign currency translation. Following figure shows the necessary process.

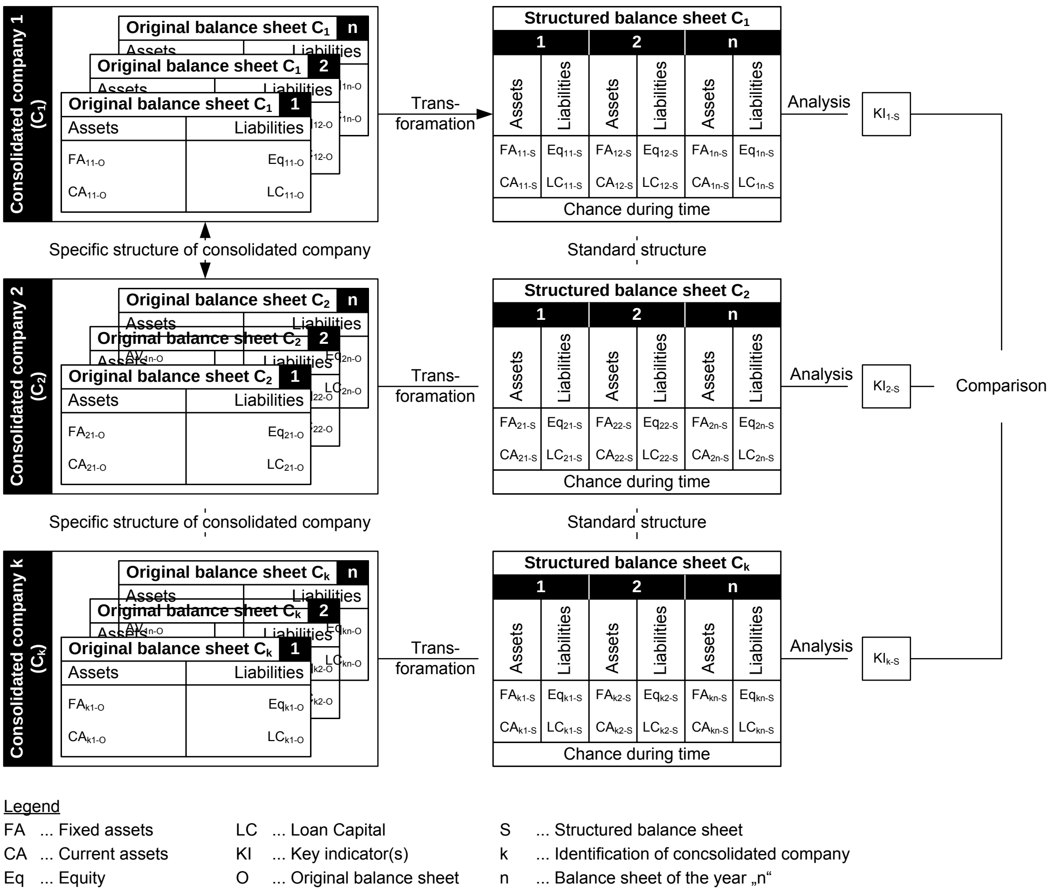


Figure 11: Optimisation of balance sheets analysis with structural balance sheets

CONCLUSION

In the time of an imminent insolvency a lot of key indicators show significant grades. Mostly there can be recognized a peak or a turn of the key indicators in the time between four or five years before the insolvency becomes reality. This is an interesting conclusion, because four or five years are enough time to manage the situation.

But of course it is not enough to have only one key indicator to anticipate an imminent insolvency. All key indicators together give the best overview of the situation in a consolidated company. But if there are several key indicators that show gradients like some of these, shown in this paper, there should be thought about reactive measures in the consolidated companies. The strategy of the consolidated company can be reconsidered; the activities in different markets can be challenged or other measures to rescue the consolidated company can be started.

REFERENCES

Books

Küting, K. and Weber, C.-P. (2006) Die Bilanzanalyse – Beurteilung von Abschlüssen nach HGB und IFRS, 8. Auflage, Stuttgart: Schäffer-Poeschel Verlag.

Annual reports

For the overview of annual reports, shown in figure 1 and figure 2, there are used following reports:

Philipp Holzmann: Annual reports of Philipp Holzmann AG – year 1991 to 2000, all published in Frankfurt am Main.

Walter Bau: Annual reports of Walter Bau AG – year 1994 to 2003, all published in Augsburg.

FAILURES AND DEFECTS IN THE BUILDING PROCESS – APPLYING THE BOW-TIE APPROACH

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Function failures, defects, mistakes and poor communication are major problems for the construction sector. A Danish research project focusing on failures and defects in building processes has been carried out over the last 2 years. As the empirical element in the research, a large construction site was observed from the very start to the very end and all failures and defects of a certain size were recorded and analysed. The methodological approach used in this analysis was the *bow-tie* model from the area of safety research. It combines critical-event analysis for both causes and effects with event-tree analysis. The paper describes this analytical approach as an introduction to a new concept for understanding failures and defects in construction. Analysing the many critical events in the building process with the *bow-tie* model visualises the complexity of causes. This visualisation offers the possibility for a much more direct and focused discussion of what needs doing, by whom and when – not only to avoid the number of defects in the final product, but also to make the building process flow much better and reduce the need for damage control.

KEYWORDS: **failures and defects, building process, cause-effect analysis.**

INTRODUCTION

It is always in the clear light of hindsight that one discovers what one should have done differently. The fact of the matter is that very often what one did was something one had done before (perhaps many times) and everything went well – so why not this time? Failure is seen in connection with an undesirable consequence – but what actually failed, what kind of failure was it, and why is it so difficult to recognise the causes of failure in a way that helps us see the danger signals and take preventive action? Failure in construction is generally related to defects and shortcomings in the finished building. Such defects and shortcomings are discovered either when the building is handed over – such as conditions that do not meet the owner's justified expectations on the basis of agreements and contracts – or a long time after the hand-over, such as problems of damp, cracks or, in the worst case, collapse. Quite a lot of research focuses on construction materials and methods; the aim is to find the right methods and the right materials. But despite a lot of knowledge about which materials are good and which methods work, a lot of defects and shortcomings still occur in building work (Danish Enterprise and Construction Authority 2009). The construction process itself is also the subject of extensive research and development aimed at improving the process and minimising losses, including defects and shortcomings, both during the construction process and in the finished building. Methods such as 'Construction Excellence' and other quality assurance systems were constructed. Over the past decade, concepts such as 'Partnering' and 'Lean Construction' have been in focus (Koskela 1999, Dahlgaard-Park et al 2007, Hellard 1993). Research into defects and shortcomings in finished buildings as well as during the construction process indicates that many of the causes lie in the project planning phase, in the co-ordination and communication during the building's construction, and in the lack of quality in the construction contractors' work (Henriksen et al 2006, Douglas et al 2008). Building and the construction process are described as a complex, stochastic process with many players. Every time it is a new product with new methods, new crew, new conditions, timeframe and finances, new suppliers, etc. that together make up the framework for the process that the construction runs through from idea to being taken into use (Kreiner 2005, Josephson et al 2005, Douglas et al 2008). In such a process, decisions will be made on an inadequate foundation and problems will arise that must be solved on the basis of the given situation and options. There will always be things that in one way or another can be called failures in relation to the given situation. But if such failures are discovered and corrected, i.e. solutions are found, it is more of an open question as to whether they are regarded as failures as such or 'merely' circumstances that reduce the efficiency of the construction process and cause quality and cost problems. This paper gives examples of how failures during the construction process can be revealed, and of the interdependence of such failures. For the purposes of this analysis, methods and conceptual understandings derived from accident research have been adapted to create a new way of mapping map failures in the process of construction. The intention is to provide a clear analysis of failures, including what happens, why it happens, and the ways matters can be improved in the individual construction phases.

WHAT IS FAILURE?

We should distinguish two definitions:

1. The way in which failure is understood by the formal system, which is set up to find out who is culpable in purely legal terms and who is liable in purely insurance terms. Failure in this connection is related to defects and shortcomings in the finished building and is a matter for the building owner and user.
2. The defects and their consequences that occur during the construction process from idea to handing over. The consequences of such defects can end up among the formal defects and shortcomings, but they can also be, and often are, resolved during construction, but with consequences for the project's budget, timetable and the construction crew, and with a waste of raw materials, etc.

A thorough examination of the literature about how the term 'failure' is understood and used shows that there is a very great variety of points of view. The term is often defined or explained using other terms, such as 'faults, mistakes, shortcomings, losses' etc.

Examples of how construction researchers describe or define the meaning of these terms include 'sudden situations or situations where new and unpleasant effects arise' (Kreiner 2005), 'that project materials, building materials, constructions or parts of buildings lack properties that have been agreed or are required by law' (Nielsen et al 2004), 'circumstances that prevent the builders carrying out their work efficiently' (Apelgren et al 2005). Accident research also defines faults as the causal explanation of accidents. In this branch of research, 'faults' are specified in various categories, such as 'faulty acts, functional faults, and faulty sources' (Reason 1990); 'omission, incorrect execution, irrelevant action, incorrect sequence, incorrect time' (Swain 1974); 'experience-based errors, rule-based errors, knowledge-based errors or deliberate errors' (Rasmussen 1997). If we look at the causal explanations in the various ways of looking at the term 'failure', we also get a number of different perspectives. Among building researchers, the causal explanations given are 'lack of communication and co-ordination, lack of knowledge and experience, stress and pressure of time' (Josephson 1994); 'lack of planning, lack of a strategy for quality' (Henriksen & Hansen 2006);

‘omissions and mistakes in project planning, omissions and mistakes by suppliers, omissions in the organisation of the work, handling of delays, etc.’ (Apelgren et al 2005, Josephson et al 2005, Nielsen et al 2004). In accident research, the categorisation of causal explanations leading to accidents is different. Here, for example, there are causes such as a chain of events including both immediate causes and underlying causes, and there is also the point of view that very rarely is there only one cause, but rather combinations of loosely related the causal explanations that in unusual combination result in an accident (Glendon et al 2006, Groeneweg 1996, Hale et al 1997). Here too causal factors are divided into a series of different types, e.g. ‘faulty equipment and materials, procedural problems, problems of design, mistakes in training, management problems, and external problems such as the weather, theft, vandalism, etc.’ (Jørgensen 2002, Glendon et al 2006, Groeneweg 1996). The same applies to the descriptions of consequences, which have been formulated as e.g. consequential effects, damage for which there is financial liability, undesirable effects, and situations leading to extra work. In accident research, the consequences would be described as injuries to people and/or damage to materials, accompanied by varying degrees of gravity (Jørgensen 2002). Common to both construction research and accident research is that we speak of ‘causes’ for what precedes an event and ‘consequences’ for what follows the event. This means that there is a big overlap in the way the terms ‘failure’ and ‘accident’ are understood.

A NEW WAY OF LOOKING AT FAILURE

Recognising the lack of clarity and conceptual confusion in the use of the term ‘failure’ in construction, let us look at the understanding of the term ‘accident’, which is a relatively well-established concept. To start with, let us look at Rasmussen’s model of the anatomy of accidents (Rasmussen 1997), in which the critical event is the point when it becomes clear that something has gone wrong. We can transfer this idea directly to the term ‘failure’, as illustrated in Figure 1, where the critical event is where a failure becomes visible and perhaps discovered.

Figure 1

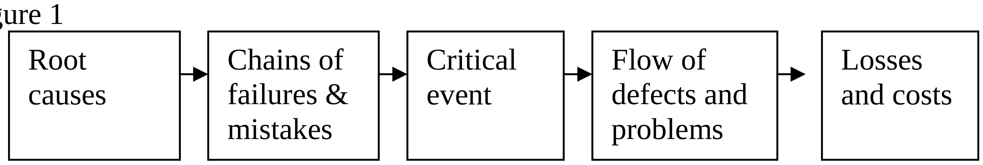

Figure 1 illustrates a model for the anatomy of failure.

A definition of the term ‘failure’ based on such a sequential model makes it possible to put the various other terms used into relationship with each other. The aim is to create a common language in which the terms can be used in a clearer way. This means that terms such as ‘faulty acts’, ‘functional faults’, ‘interruptions’, ‘delays’, ‘lack of precision’, etc. become causal explanations for the critical event, while ‘defects’, ‘damage’ and ‘losses’ become consequences. On the basis of this sequential model, we can look at the term ‘failure’ as something that covers causes, the critical event and consequences. In other words, ‘failure’ is defined as a series of relationships characterised by:

1. Being due to a number of defects and pre-conditions whose combination generates an undesired situation/critical event, and

2. Resulting in a number of consequences for the rest of the construction, which often create delays, increase costs, and require resources, and can also be factors in the occurrence of new failures later in the construction process.

This means that failure does indeed include faults, mistakes, shortcomings, damage, etc., but in a certain sequence. At the same time, it must be admitted that the term can be difficult to grasp unless you relate it to something definite, such as where the failure occurred or for whom it occurred. But making the term ‘failure’ relative it becomes possible both to make the term precise and to open it up to include all forms of inappropriate activity in the construction process. Precision can be gained by adding an adjective for the type of failure, e.g. design failure, process failure, communication failure, execution failure, materials failure, finishing failure, and so on. With this understanding, it will often be the case that one type of failure will be among the causes of another type of failure. In other words, in this sense failure can be something that goes wrong, something that is a cause, or something that is a consequence, entirely depending on your perspective. However, the advantage of this is that one can define the individual failure with precision, which means it also can be analysed with precision. At the same time, the number of failure analyses and the loosely coupled inter-relationships between them mean it is possible to ‘flow’ between them when analysing a failure process. The result is that it is possible to map what is generally described in construction as chaos and confused relationships, coincidences, etc. This will be illustrated later with a concrete example.

THE BOW TIE – AN ANALYTICAL METHOD

In accident research, especially in the high-risk area, fault tree analysis and event analysis are among the methods used to analyse the causes and consequences of accidents. One analytical method that combines these analysis forms is called the ‘bowtie’ because of its shape (Worm 2008). If this analytical method is used to model the term ‘failure’, a bow-tie analysis of failure will look like this:

Figure 2

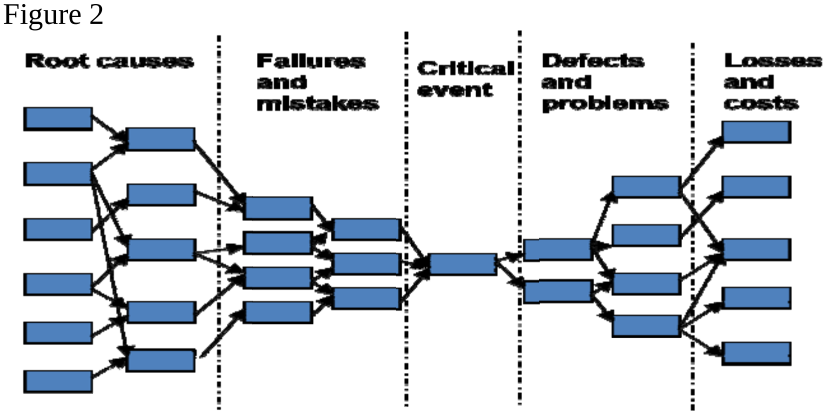

Figure 2 illustrates the bow-tie analysis of failure (ceasing to function).

Once the central or critical event has been observed, one can use the sequence of consequences to describe the right-hand side of the model. The principles are first to describe the immediate consequences of the critical event and then the following after-effects. The elements that make up the right-hand side are all the circumstances with the potential to exacerbate the consequences and their after-effects. The principles are first to find the immediate causes of the critical event and then to find the explanations for each of those immediate causes and proceed until you have a good view of the root causes also seen as the main circumstances for the critical event as a cause-consequence-tree analysis. In principle, the consequence side represents the effects that should be prevented or minimised. Similarly, the left-hand side represents circumstances that together generate the foundation for the occurrence of the critical event. Here too, there are many different circumstances and mistakes that, because of their synchrony, taken together explain the critical event. The model can also be used to illustrate where barriers can be raised either to prevent the critical event occurring or to minimise its potential consequences. The theory is that once an accident is analysed, the barriers that could affect the flow on both the left and the right-hand side of the critical event can be identified. For example, if one or more of the chains on the left-hand side can be prevented, the other circumstances will not result in a critical event. Similarly, a barrier on the right-hand side can limit the spread of consequences or minimise their gravity – e.g. if there is a fire, a sprinkler system would make it possible to extinguish it early or reduce its spread. So this model makes it possible to analyse loosely coupled causal relationships and consequences for specific critical events, and can therefore both describe and illustrate any kind of failure.

ANALYSIS OF FAILURE IN A BUILDING PROJECT

To verify the analytical method described above, a building project was monitored throughout the construction process; critical events were observed and both the circumstances preceding them and the resulting consequences were described.

The building project was a large housing project in which the principles of Lean Construction were followed and in which both the processes and collaboration partners were well under control. The final result was a very good construction job. Nevertheless, there were failures during construction and they affected the resources, time spent, and quality (Jørgensen 2008).

A total of 55 important critical events during the construction process were analysed. Each critical event was analysed separately with both a left and a right-hand side. Moreover, the use of the “bow tie” made it possible to link the individual critical events with each other and get an overview of all the processes and their mutual relationships. The red, blue and green used in Figures 3 to 7 are aimed at showing how almost all these critical events had an effect in terms of time, costs, and the use of resources of both materials and manpower.

To illustrate the use of the analytical method, examples are given in Figures 3 to 7 of the individual bow-tie analyses of failures identified, and in Figure 8 how the various critical events – and therefore failures – are inter-related. This figure also gives an overview of all 55 critical events. The construction processes analysed are shown given in Figures 3 to 7 below:

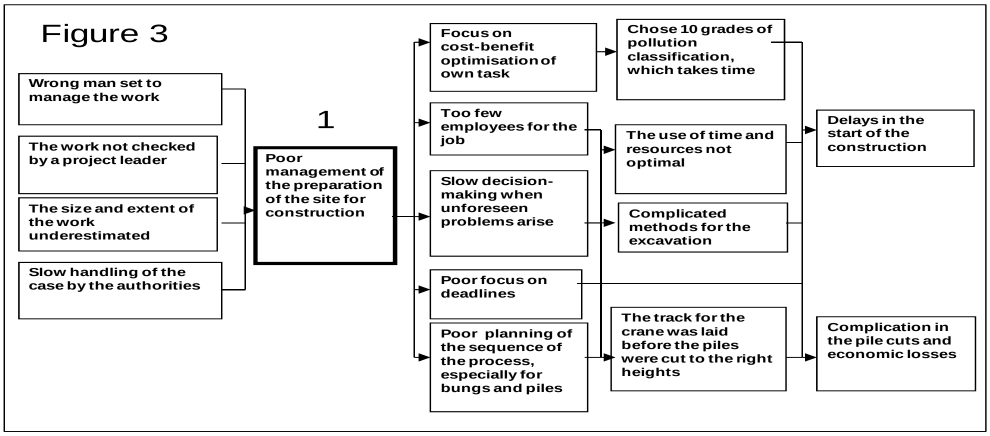

Figure 3 illustrates the bow-tie analysis of a critical event – the incompetent and inadequate management of the initial preparation of the construction site. The left-hand side shows the background for the poor management and the right-hand side shows its overall consequences.

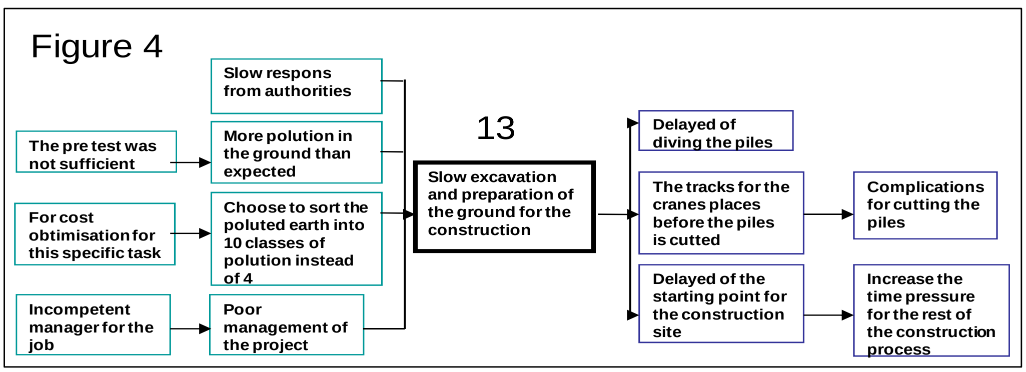

Figure 4 illustrates the bow-tie analysis of one of the consequences of the incompetent management of the preparation of the site –the project moves forward far too slowly in relation to the schedule. It can be seen that the incompetent manager was not the only reason for the slowness, and that the consequences of this critical event can also be clearly defined.

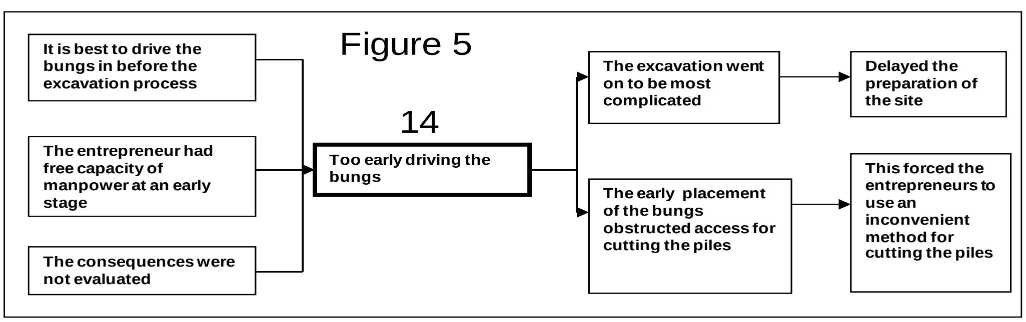

Figure 5 illustrates the bow-tie analysis of another consequence of the incompetent management – that the bungs were driven in too early in the process, which had serious consequences for later stages. This shows that the reason for driving the bungs early was quite reasonable – but also that there was no adequate process analysis.

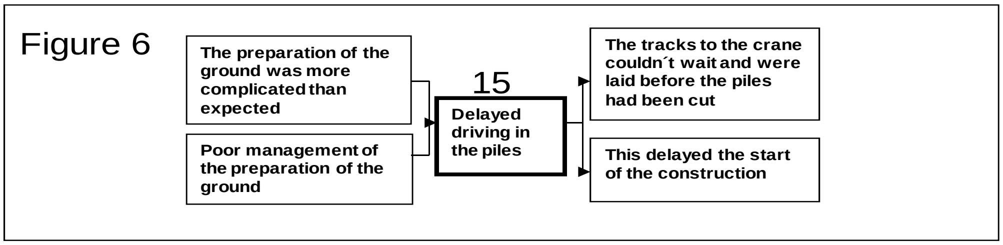

Figure 6

Figure 6 illustrates the bow-tie analysis of a thi rd consequence of the incompetent management – that pile driving came too late in the process, with the result that other process stages, e.g. laying the crane tracks, occurred before the piles were cut, with consequences for the pile cutting.

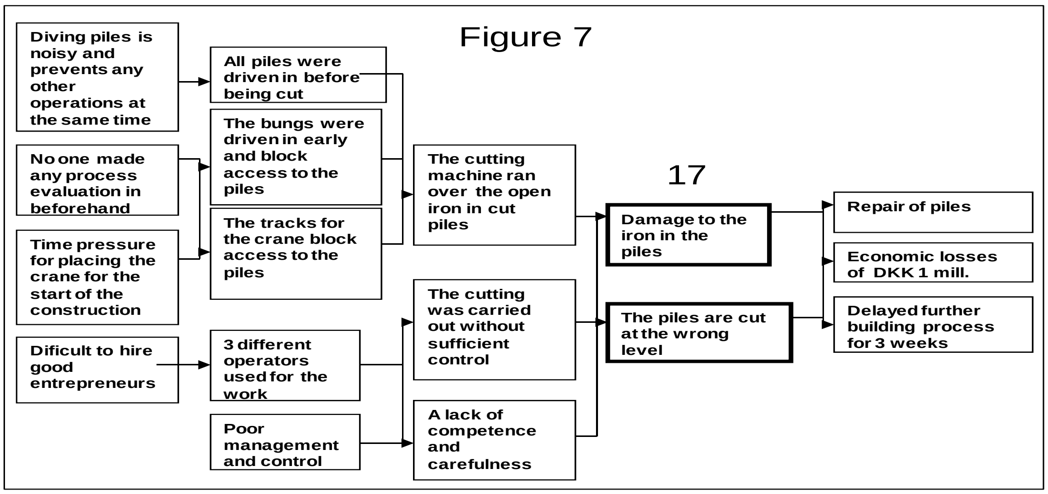

Figure 7

Figure 7 illustrates the bow-tie analysis of the unfortunate consequences for the pile cutting – that the exposed iron was damaged and that a number of piles were cut wrongly. Again we can see a number of clear causes for this, not just the incompetent management, and that the consequences affect the project’s timetable and cost.

This series of bow-tie analyses show how there can be a flow of inter-relationships between critical events in a process stage, leading to new critical events at later stages. On the other hand, they also illustrate how the relationships are not unambiguous and that at each stage there are other factors that so to speak support and aid the development of the individual critical events.

Figure 8

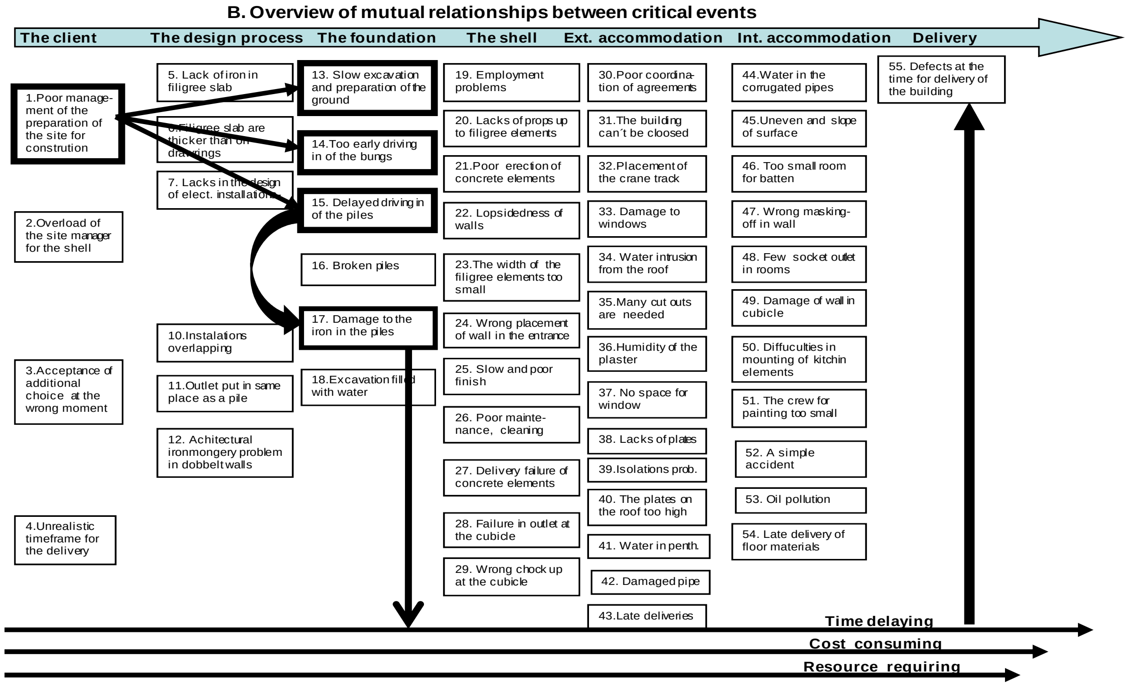

Figure 8 gives an overview of the 55 critical events in the construction project. The inter-relationships between the bow ties used in the examples are marked. Those examples are critical event number 1, 13, 14, 15 and 17. The marked arrows show how the consequences of one critical event do influence on a cause of another critical event. This kind of analysis, focusing on critical events in individual phases of the building project, makes it possible both to focus on critical events in the individual phases and at the same time put each critical event in relationship to others where such a relationship exists. In this way, it was also possible to show a connection between an inappropriate composition of the project management for the building shell and the quality of the construction of the shell, which later had consequences all the way through the rest of the construction process. It was also possible to clarify the link between deficient electrical planning and a number of critical events later in the construction phase during the internal fitting out.

RESULTS

The advantage of using this analytical method the way it sets focus on the failures that occur during a construction process and not just on those that end up being visible when construction has ended. There were a number of defects in the construction when it was handed over, but they were all minor defects that could be corrected in a few months. Moreover, they were the usual defects associated with the last phases of the construction process and most could be ascribed to lack of time for the work. This lack of time could be explained by a number of delaying failures throughout the whole project, and it can be far more useful to get an overview of these failures than just those visible at the end of the project.

The concept formulation that is presented here gives consistency to the way failures in construction processes can be seen and at the same time makes it possible to use analytical methods from accident research for mapping causal relationships in something that may otherwise be regarded as chaotic and incoherent.
The analytical method makes failures visible and creates an overview of their relationships at the same time as making it possible to bring to light both overall lines and the details.
So this systematic method provides Visibility, Overview and Connection, thereby making it possible to establish a number of targeted initiatives and define the barriers that can help prevent similar critical events from arising in another construction situation.
Examples of such barriers might be putting expertise managers in charge of the construction to a greater degree; always conducting a review of the planning material including those parts of the project planning that might seem less risky and more trivial; ensuring that the timeframes for the construction such that the sequence of the individual stages can actually be followed even in the event that an individual function is delayed; ensuring skilled craftsmen that know their trade and can also be involved in the planning of procedures.
Much of this is what is promoted as good practice in a construction project, including in descriptions of how Lean Construction should be implemented. But the problem is that the construction industry is a difficult industry to make changes in. Documenting failures in the building process, as in the examples given in this paper, makes visible how the individual players, especially in the first stages of the process, have quite a significant impact on the final result. This has probably been said on many occasions, but not documented as clearly. Perhaps this evidence can contribute to more people taking the planning stage preceding construction more seriously.

DISCUSSION

Research into failure, defects and shortcomings in construction is relatively new and as a result does not have basis in terms of theory and method. The aim is defined as being able to manage quality assurance, which is a difficult task in construction because of the many players, the highly fragmented responsibility, the unique technical design of every construction, variation in organisation and procedures, etc. The implementation in recent years of new methods such as Partnering, Lean Construction, etc. are examples of a more targeted way of making the construction process more effective, but experience shows very great variation with regard to the success rate of these ideas.
The recommendation therefore is that we need to start developing our knowledge with a focus on the underlying factors in the causes of defects and shortcomings. Here it will be possible to find inspiration in accident and risk research, which has undergone a development in research over the past century in which there has been continual extension of theories on causal relationships, explanatory models, and preventive methods. Part of this development has been to look at the experience of the general principles of quality assurance and their results, especially in industrial production.
Safety and risk show that explanations for the causes of accidents must be found in management concepts, organisation, production, expertise, culture, technology, etc. Similarly, causal relationships in this area are multi-functional and loosely related.
The latest development in this research has been aimed at finding out what makes a system resilient to errors, rather than finding causal explanations. The following argument is a quotation is taken from the book ‘Resilience Engineering’ (Hollnagel et al 2006): “To understand why mistakes sometimes happen, one must first understand how success is

achieved – how people learn and adapt to create safety in a world fraught with holes, hazards, trade-offs, and multiple goals" (Cook el al., 2000). The argument goes on to state that this thesis is based on a number research results that show that both individual mistakes and system failures represent a temporary inability to cope effectively with complexity. Success belongs to organisations, groups and individuals who are resilient in the sense that they recognise, adapt to, and absorb variations, changes, disruptions, and surprises – especially disruptions that fall outside of the set of disturbances the system is designed to handle.
In the end, it is a matter of making the construction process resilient in relation to the problems that will arise, and create the best possibilities for minimising the risk that they will arise. Resilience in this sense is related to best practice.
One obvious step would be to examine whether some of the results that have been found in safety research can be used as inspiration for mapping generic conditions in construction and can thus explain the existence of many or few defects and shortcomings, and thereby contribute to generating new theories in this special industry.

REFERENCES:

Apelgren S., Richter A., Koch C. (2005) Snublesten i byggeriet. Denmark: The Technical University of Denmark

Dahlgaard-Park S.M., Dahlgaard, J.J. (2007) Management Control Theories and the EFQM Excellence Model. Sweden: The University of Lund,

Douglas J., Ransom B. (2008) Understanding Building Failures. London: Taylor&Francis, Third Edition.

Erhvervs- og Byggestyrelsen (2009) Omfanget af svigt, fejl, mangler og skader i dansk byggeri, Denmark www.ebst.dk/file/25739/Omfanget_af_svigt_fejl_mangler_og_skader_i_dansk_byggeri.pdf

Glendon I.A., Clarke S.G., McKenna E.F. (2006) Human Safety and Risk Management. Taylor & Francis

Groeneweg J., (1996) Controlling the Controllable –The management of Safety. The Netherlands: Leiden University.

Hale A., Wilpert B., Freitag M., (1997), After the event – from Accident to Organisational Learning. Pergamon, Elsevier Science.

Hellard R.B. (1993) Total Quality in Construction Projects. London: Thomas Telford,

Henriksen K.R, Hansen E.J. (2006) Kvalitet og byggefejl. Denmark: The Institute of Construction Research.

Hollnagel E., Woods D.D., Leveson N., (2006) Resilience Engineering – Concepts and Precepts. Ashgate.

Josephson P.E. (1994) Orsaker till fel i byggandet. Sweden: Chalmers Universitet, Josephson P.E. Saukkoriipi L. (2005) Slöseri i byggprojekt. Sweden: Chalmers Universitet,

Jørgensen K. (2002) A Taxonomy for Causes of Occupational Accidents. Denmark: The Technical University of Denmark.

Jørgensen K. (2008) Svigt i byggeprocessen. Denmark: The Technical University of Denmark.

Koskela L. (1999) Management of Production in Construction: A theoretical view. IGLC 7th Annual Conference.

Kreiner K. (2005) Læringssvigt i byggeriet. Denmark: Copenhagen Business School.

Nielsen J., Hansen M.H., Pedersen C. (2004) Svigt i byggeriet. Denmark: The Institute of Construction Research.

Rasmussen J. (1997) Risk Management in a Dynamic Society- A modeling Problem. Safety Science, vol. 27, No 2/3, 183-213,

Reason R. (1990) Human Error. Cambridge University Press,

Swain A.D. (1974) The Human Element in Systems Safety. Industrial and Commercial Techniques Ltd,

WORM Metsmorphosis Consortium (2008) The Quantification of Occupational Risk – The development of a risk assessment model and software. The Netherlands: RIVM.

A NEW FRAMEWORK FOR DETERMINING PRODUCTIVITY FACTORS ON CONSTRUCTION SITES

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The productivity level within the construction industry is of direct interest to site managers and project management teams. Different researchers have tried to determine the factors that influence productivity but no general agreement could be made. The aim of this paper is to develop a conceptual framework on site productivity. Five major groups of independent variables, namely, project characteristics, labour characteristics, management system, resource management and the external environment are identified as crucial to site productivity. Based on these groupings, a conceptual model is to be developed to represent causal relationships. Once identified, this relationship is believed to be a useful piece of information to implement a project more productively.

KEYWORDS: resource management, productivity, project performance.

INTRODUCTION

It is axiomatic that the construction industry has a significant role to play in the economic growth of a nation. The industry employs a large number of skilled, semi-skilled and un-skilled workers and its activities provide work for the economic sector. The success or failure of the construction sector can therefore seriously influence the living standards of the population.

Site productivity is one of the most difficult factors to measure because its determinants can vary significantly depending on size of site and place of measurement. The definition of productivity ranges from industry-wide economic parameters to the measurement of crews and individuals. For instance, Single-Factor productivity measures such as Average Labour Productivity (ALP) looks at the impact of one factor input (labour), whereas total (Multi-Factor) productivity measures take into account the impact of all inputs and output. Crawford et al. (2006) provided an overview of methods used to measure productivity in the construction industry. It was concluded that most existing work provides a partial modelling of the production process, potentially resulting in biased productivity estimates. Furthermore, the simple-to-calculate output/labour input ratios used in most studies do not enable the establishment of robust cause and effect relationships, leaving the reader largely in the dark about drivers of performance and their relative importance.

In a more technical approach to measuring labour productivity, Radosavljević et al. (2002) have examined the complex variability of 12 construction labour productivity data sets by analysing the central moments of tendency, and applying the Kolmogorov-Smirnov and Anderson-Darling tests of normality. The results consistently show that the productivity is not normally distributed. In addition, undefined variance causes a failure of the central limit theorem, thus indicating that some basic statistical diagnostics like correlation coefficients and t statistics may give misleading results and are not applicable. A brief comparison with volatility studies in econometrics has revealed surprising similarity with Pareto distributions, which can model undefined or infinite variance. Such distributions are typical of chaotic systems like the logistic equation, whose properties also are described briefly. Therefore, it is suggested that future research should be focused on studying the applicability of chaos theory to construction labour.

Within the context of such theories, Winch et al. (2001) made an attempt to benchmark the on-site productivity in France and the UK. They conducted an interesting detailed analysis of structural concrete operations to compare the productivity performance of these two countries using the activity sampling approach CALIBRE. The results showed that the UK productivity performance is poorer than that in France, which can be explained by the elaborate divisions of labour, lack of investment in plant, and less effective work organization. However, it was further argued that these differences cannot be understood without reference to the overall contracting system and the constraints upon action that it imposes.

According to an earlier report by the European Construction Industry Federation (ECIF, 1996) the construction industry in Europe is facing a difficult time and the signs are that this crisis is not coming to an end in the near future. In the UK alone, between 1990-1996, 480,000-construction worker have lost their jobs. A subsequent survey by Arditi et al. (2000) of the top 400 US contractors were conducted in 1979, 1983 and 1993 indicated that cost control, scheduling, design practices, labour training, and quality control are the functions that consistently over the years are perceived as having considerable room for productivity improvement, whereas materials packaging and foreign developments in construction technologies are perceived consistently as functions that do not have much effect on improving construction productivity. The functions that were identified as needing more *improvement in 1993 compared with the previous surveys were: prefabrication, new materials, value engineering, specifications, labour availability, labour training, and quality control, whereas those that were identified as needing less improvement than in the previous surveys were field inspection and labour contract agreements. Also, respondents indicated consistently over the years that they were willing to participate in activities related to improving construction productivity but were not interested in funding any such activities.

A more recent study by Clarke et al. (2004) into productivity in social housing construction in England, Scotland, Denmark and Germany was apposite in demonstrating structural differences in the organization of the construction process, their implications for efficiency and productivity, and their impact on employment and contract relations as well as innovation and skills. The effects of the overriding cost rationale of the British system are illustrated in terms of labour deployment and the efficiency and productivity of the site construction process. This paper showed the high labour intensity in the British case, with 39% more labour needed to produce one m^2 compared with Germany and 50% compared with Denmark.

At the same time, the nature of labour deployment is qualitatively different being front-loaded in England, whilst in the other countries it is end-loaded in the sense that there is a gradual build-up of labour on site. It was also noted that the Danish building industry is facilitated by extensive prefabrication processes.

FACTORS AFFECTING SITE PRODUCTIVTY

In this paper, productivity factors are grouped under five main headings in an attempt to design a conceptual framework that links them together. These group headings are: project characteristics, labour characteristics, management system, resource management, internal and external environment. The purpose is to develop a conceptual framework that shows the interrelationship among these group factors.

Project characteristics

Type and size - Site productivity is determined by a number of factors, one of which is the type and size of the project including layout and complexity. Naturally, a large construction site requiring a large number of workers and will be relatively harder to manage than a smaller size. The difficulties in managing manpower on a large scale may result in productivity loss. A large proportion of high costs in construction works are as a result of excessive labour costs. These costs can be reduced if productivity on site is increased by improving labour efficiency. Thomas (1991) notes that work on a complex project such as the construction of a nuclear project becomes more difficult as the project advances. The construction method such as use of off-site pre-fabrication units will reduce the number of labour hours required. Other factors such as the level of skill amongst the workers and work practices and length of workday can affect productivity on construction site.

A further research by Proverbs et al. (1999) into construction resource and productivity level for high rise concrete construction was conducted among contractors across France, Germany and UK. For concrete placing productivity rates, none of the resource factors (material, plant or labour) when considered independently was found to be of significance. It was then concluded that international variations in concrete placing productivity rates were not connected directly to these individual factors. However, framework productivity rates were impacted by the type of framework utilized on column and beam work. The most unproductive rates were related to traditional timber solutions, while proprietary (for column work) and prefabricated (for beam work) solutions were associated with the most efficient (and hence most economic) productivity rates. Moreover, when working more than 5 days each week, the productivity of framework operations was found to decline.

Overcrowding – There is evidence to suggest that overcrowding leads to productivity loss. It has been suggested by Smith (1987) that a labour density greater than one man per 30 m^2 will lead to a decrease in productivity. According to Rad (1980) cited in Kaming et al. (1998), an average weekly loss of 5 hour per man resulting from congestion on nuclear power station sites. As working space deceases from 30 m^2 (standard working space) to 10 m^2 per operative, it incurs about a 40% productivity loss (Smith, 1987).

Thomas et al. (1985) conducted a comparative study in Europe to find out whether countries differ in their employment of sub-contractors. The result of their model based survey of contractors (planning engineers) in France, Germany and UK, indicated that the working schedule of UK and German contractors may be excessive, and can have an impact on construction productivity level. The survey also identified that the UK's labour force employed on site are 26% employed directly and 74% sub-contractors, but in France 93% of labour force on site are directly employed and only 7% are sub-contractors.

Factors related to Labour

Lack of measurement and benchmarking - Labour related factors affect the physical progress of any construction project. In order to improve labour productivity, site production should be measured on a regular basis, and then compared to an acceptable standard benchmarks. The management of each contracting company should maintain its own record which describing the baseline productivity in different previous projects with similar conditions. Enshassi et al. (2007) argues that such records can be used to help estimate labour productivity in future projects. For example, changes made to original scope of work are costly and have an effect on labour productivity and should be recorded. Although some changes are inevitable, the impact on site productivity is nonetheless significant. The impact of changes to original scope of work has been investigated by Thomas and Napolitan (1995). They studied the impact of changes in quantitative terms and discussed why change impacts on the labour forces efficiency. They also explored the relationship between changes and various types of disruption.

Labour efficiency - Efficiency is the relative loss of productivity compared with a benchmark setup in the original plan of work. The effect of changes on labour productivity was investigated by Leonard (1987). His study was based on a detailed review of 90 claim cases and the percentage loss of productivity was shown as a function of the total work hours spent on changes. The increase in the percentage of work hours spent on changes led to a 10-20% loss of productivity. Another study by Zink (1990) that dealt with labour efficiency and changes, suggested a measured mile method to quantify work hour overrun. Changes are considered as an indirect factor by many researches within the construction industry. However, it is also realised that changes themselves do not decrease productivity or efficiency, it is the manpower involved in the process. If a change occurs in the final stage of a construction project the crew must stop working until the changes are carried out first. Also the work method may require changes as well as more co-ordination being required. Once changes occur routine works will change, processes will slow and the total work hour will be several times greater. On average, there is a 30% loss of efficiency when changes are being performed, although it is possible to perform many changes without a loss of efficiency.

Skills and ability - Olomolaiye et al. (1998) explains that the personal attribution of workers contribute to the factors that directly affect productivity. He specifies these attributes as:

1. Worker's skills, experience, training and qualifications.
2. Innate physical and mental ability.
3. Intensity of the application of both skills and innate ability to the production process.

Management system

Decision support systems - Christian and Hachey (1995) found that delays and disruption within the construction site are created by idle and waiting times. An analysis and breakdown of delay would enable the management team to focus on this important and un-productive factor. The delays associated with waiting for supervisory instruction only occur when there are severe time constraints and problems with shortages of on-site managerial staff. In this context, the Construction Decision Support System for delay analysis [Delay Analysis System (DAS)] was developed by Yates (1993) to assist managers in decision-making process. The DAS brings together traditional project control techniques with interactive methods to produce a programme that can both monitor progress towards achieving project milestones and simultaneously it highlights the causes for deviations from established baselines. It also provides recommendations on how the management team can eliminate or minimize delay during construction periods.

Management influence - Thomas (1992) investigated the level of labour productivity for masonry activities from seven countries by selecting case study projects. Statistical analyses showed little difference in productivity amongst the seven countries, despite major differences in labour practice. The aim of this investigation was to show that productivity in Australia, Canada, England, Finland, Scotland, Sweden and the United States is similar but the principle difference was management influence. The site with the highest level of disruption had the worse productivity level on site. Other objectives of the investigation were to test the validation of factor model, the management influence on labour productivity and the level of control contractor has over labour productivity. Other investigations have shown that the labour disruption accounts for more than 50% of the variability in daily crew productivity (Sanders et al. 1989).

Variation orders - The variables affecting efficiency is believed to be the time of the change. Rework, disruption and presence of change work can lower labour performance (Thomas et al., 1995). Hanna et al. (1999) have identified the impact of changes on construction site and described that disputes are common between the client and contractors when these changes occur. Their study used data from 43 projects and a linear regression model was developed that predicted the impact of changes on labour efficiency. The model allows labour efficiency loss to be calculated in a particular project enabling both the client and the contractor to understand the impact such changes will have on labour productivity. However, this study is limited to mechanical trade with some specific plumbing, fire protection, and process piping. From a study carried out by Thomas and Napolitan (1995) over a period of 4 years, based on 3 projects, an equation was derived to calculate the efficiency loses from the impact of change order. Efficiency was defined as actual productivity ratio to baseline productivity. Baseline productivity was also measured for this survey. Efficiency was determined by dividing the performance ratio equation value on a normal day by the performance ratio equation when change order had occurred. The survey result showed an average loss efficiency of 30%. Change order impact on a project lowers labour efficiency and productivity. The result of a survey by Hanna et al. (1999) indicated that labour efficiency on a job that is not impacted by change has a higher level of efficiency. Disruption which was also found to cause changes in the original plan of work increased the project cost through re-work and decreased labour efficiency for the main contractors and sub-contractors.

Factors related to resource management

Material - Ferguson et al. (1995) suggest that 50% of the waste deposited in disposal sites in the UK is construction waste. In order to reduce waste and increase productivity Just-In-Time (JIT) has been introduced on construction sites. Pheng and Tan (1998) investigated whether the introduction of JIT can reduce the level of wastage on site. Their investigation showed that wastage of materials could be kept to a minimum and consequently productivity improved. From the result of the survey, both project and site managers did not regard wastage on site as an important factor in improving construction productivity. Faniran and Caban (1998) suggested that wastage on site could be reduced if design changes were kept to a minimum during the construction work. The respondents also identified leftover material scraps, waste from packaging and unreclaimable non-consumables, design/detailing errors, and poor weather as being important sources of construction waste.

Material management is a worldwide problem and ongoing researches have been conducted to highlight its effect on site productivity. Abdul Kadir et al. (2005) in their research into factors affecting construction labour productivity for Malaysian residential projects, found that material shortage at site as well as non-payment to suppliers causing the shortage of material delivery to site as highly important. Other factors that can cause time and cost overrun and subsequently affect productivity are change order by consultants; late issuance of construction drawing by consultants; and incapability of contractors' site management to organize site activities.

Waiting time - Christian and Hachey (1995) found that delays and disruption are created by idle and waiting time. Hester et al (1987) in his study into interruption time, found that the level of productivity for pipe work installation can be reduced by 70% when installation work was interrupted by more than one interruption per section of pipe work. Interruption lasting longer than a half hour was found to cause productivity loss of about 35% during a working day. Thomas et al. (1992) also found that disruption has a major effect on labour productivity. The average daily productivity for non-disrupted days was 0.44 work hours / m^2. Disrupted days had an average productivity of 2.16 work hours / m^2, an average increase of 388%. The respondents identified that ‘delays and disruption caused by design team mistakes’, can have a negative impact on productivity levels. Project managers identified ‘delay and disruption caused by late arrival of materials’, as a determinant that can reduce the level of productivity ranking this factor as the fourth most important determinant of productivity. Site managers ranked this factor as the seventh most important determinants of productivity.

Leadership - The construction process is a collective effort involving a team of specialists from different organizations. The leader of the team may affect the productivity of the design and construction. The person who leads the team varies dependent upon the contractual arrangement adopted for the project. A number of studies have been conducted to investigate the relationship between leadership styles and productivity rate. For example, Cheung et al. (2001) carried out an empirical survey that aimed to establish the relationship between leadership behaviours of design team leaders and the satisfaction of the design team members. The results indicate that charismatic and participative leadership behaviours primarily determine the satisfaction of the team members.

Motivating factors - Motivation is a prime determinant of worker performance. As far as known, researchers have failed to develop a commonly agreed theory that addresses worker motivation that is valid and relevant to the construction industry. A key motivator for one worker compared with another worker in a certain situation may differ. Individuals tend to seek a job, which will satisfy personal needs. Key motivators may be one or a combination of the following: high achievement, recognition, the nature of the work itself, responsibility and personal advancement and growth. In the view of some researchers, it appears that there are differences in opinion whether workers motivation contributes positively or at all to the level of productivity on construction sites.

A number of behavioural and psychological researchers have argued that the expenditure of effort by a worker is the physical manifestation of motivation. The greater worker motivation is, the greater the worker motivation becomes. For example, Kazaz et al. (2007) showed that monetary factors in Turkey remain pre-eminent in influencing productivity, but that the socio-psychological factors such as giving responsibility and taking account of cultural differences appear to be increasingly importance in a developing economy.

On the other hand, ranking on questions related to motivation showed that there is little support for the suggested motivating factors on construction site. For instance, Olomolaiye (1990) used a model to define how a bricklayer spent a working day on site. With the help of a computer aided activity-sampling package, his investigation showed that motivational issues did not influence the rate of work.

Others researchers argued that other independent factors such as lack of tools, shortage of materials, delays in decision-making by management, change order, late forwarding of information etc, can all have an indirect impact on worker satisfaction and therefore affect productivity on site.

Ranking of questions related to the hygiene factors on productivity showed that, in the view of the project or site managers, there was no strong correlation between: company policy, relationship with equals, relationship with sub-ordinates, status, and personal factors on the level of productivity on construction site. The only factors that seem to be of importance to the respondents are salary and supervision.

Other factors such as high salary and job security are other factors for high productivity among firms. Training is also considered to be an influential factor in high productivity on construction sites. In recent years the growth in labour only sub-contracting on sub-employment bases in UK construction sector and the level and quality of training within the industry is a source of concern. Productivity within the UK construction industry compared with West Germany and France is partly the result of low levels of training labour force receive in UK (Prais and Steedman 1986). In this context, UK government policy has emphasized the role of skills development and training as a means of improving productivity performance across all sectors of the economy. According to Abdel-Wahab et al. (2008), there is inconsistency in the industry's productivity performance, despite the overall increase in qualification attainment levels and participation rates in training over the same period. However, the year-by-year change in the participation rate of training was not consistently associated with an improvement in productivity performance. Therefore, there is an urgent need to consider skills development and training within the context of construction businesses in relation to other factors in order to unpack how skills can bring about improvement in productivity performance.

Resource planning – Many researchers have cited ineffective resource management as the primary cause of poor productivity rather than an unmotivated and unskilled workforce. For example, Allmon et al. (2000) revealed four primary ways of increasing productivity through management, namely planning, resource supply and control, supply of information and feedback, and selection of the right people to control certain factors.

The result of a model based survey by Proverbs et al. (1996) of contractors planning engineer in France and UK suggested that planned construction time for an identical high rise in-situ concrete framed structure in France is 9 weeks faster than UK. It takes French contractors 13 weeks where the average of 22 weeks is recorded for UK firms. French firms work less hours per week but are more productive when compared with UK firms. Since planned construction periods reflect past experience, French contractors appear to achieve superior levels of productivity on site, because they utilize directly employed workers and have less supervisors on site. The causes of high productivity amongst French contractors are:

- Scheduled overtime is avoided.
- Labour force is directly employed.
- They are main skilled work force.
- The maximum of 40 hour per week is the norm rather than the exception.

Naoum (1996) conducted a survey into productivity factors in construction to find out, first, whether there are significant differences in opinions between head office personnel and site managers on factors that influence construction productivity and, second, to determine groups of factors that mostly influence site productivity. A critical discussion was structured under three general headings: (1) management factors; (2) employee motivation; and (3) experience and training. Twenty-nine factors were extracted from the above headings and were assessed by 19 head office personnel and 17 site managers. The survey indicated that both samples regard 'ineffective project planning' and 'constraints on a worker's performance' as the most crucial factors influencing productivity. Other highly ranked factors by both samples are 'difficulties with material procurement', 'lack of integration of project information', 'disruption of site programme', 'lack of experience and training' and 'exclusion of site management from contract meetings'. Ultimately, when the factor analysis technique was applied on the 29 factors, the result shows that Resource Management Effectiveness appeared to be the most dominant group of factors influencing construction productivity.

This was later confirmed by Doloi (2008) in a research into the application of Analytical Hierarchy Process (AHP) in improving construction productivity from a management perspective. Anecdotal evidence suggests that workers' attitude towards high productivity may not be limited to purely financial rewards, but inherently linked to many other latent factors. This research shows that the biggest influences on productivity are planning and programming.

Impact of external environment

Technology - Technology has had a great effect on productivity output within the construction industry. Technological advancement has resulted in considerable changes to most tasks on construction sites. Machinery has become more powerful and complex. This new technological advancement requires new manpower skills to ensure proper and full use is made. It is becoming increasingly problematic to separate the contribution made by management, labour and machinery, to productivity. Innovation within the construction industry faces many barriers such as diversity of standards, fragmentation, business cycles, risk aversion and other factors, which all produce a complex and unfavourable climate, in which to work. High labour costs within the construction industry is a strong reason for this industry to move towards new technology. One of the reasons that many construction firms are reluctant to move towards new technology is the risk it carries if the new technology proves to be ineffective. The cost of changes may prove to be too high for the firms and may put their future in jeopardy. Heap (1987) argued that productivity could be improved if manpower is replaced by modern high capacity plant and equipment. In most developing countries with limited capital, mechanization may increase the unemployment. Other problems associated with introducing modern machines and equipments include costly and complicated maintenance, with machine downtime contributes towards a fall in productivity. Baldwin (1990) believed information technology would revolutionise management information systems and help management obtain accurate information that leads to faster and more accurate decisions on site. So far many productivity studies tend to concentrate on improving the technology related to the construction site. Rapid mechanisation within the industry has resulted in increasing productivity by the introduction of structural steel, system form work, pre-casting techniques, pre-fabrication and component manufacture, but the construction industry requires more innovation to remain competitive among other sectors.

Weather - The factor model by Thomas (1987) evaluated the effect of temperature and relative humidity on productivity. Multiple regression techniques were used to explain approximately 40% of the variability in the daily productivity data. Other statistical parameters are also described. The results of the weather model are compared to similar relationships reported by other researchers. The relationship developed by the writers is consistent with those reported in the literature. The factor model and the methods used to develop the weather model appear to be valid because the discounted productivity curve has less variability than the original productivity data. Lastly, an example is presented that illustrates the way in which impact of weather on productivity can be evaluated.

THE CONCEPTUAL FRAMEWORK

The model in Figure 1 shows the interrelationship between the factors that can affect productivity on a construction site (Naoum 2001). The purpose of the model is to represent or explain the phenomenon of the productivity issue. In this way, managers can assess and predict what needs changing to improve the productivity level on a construction site as well as for developing a strategy for achieving the change.

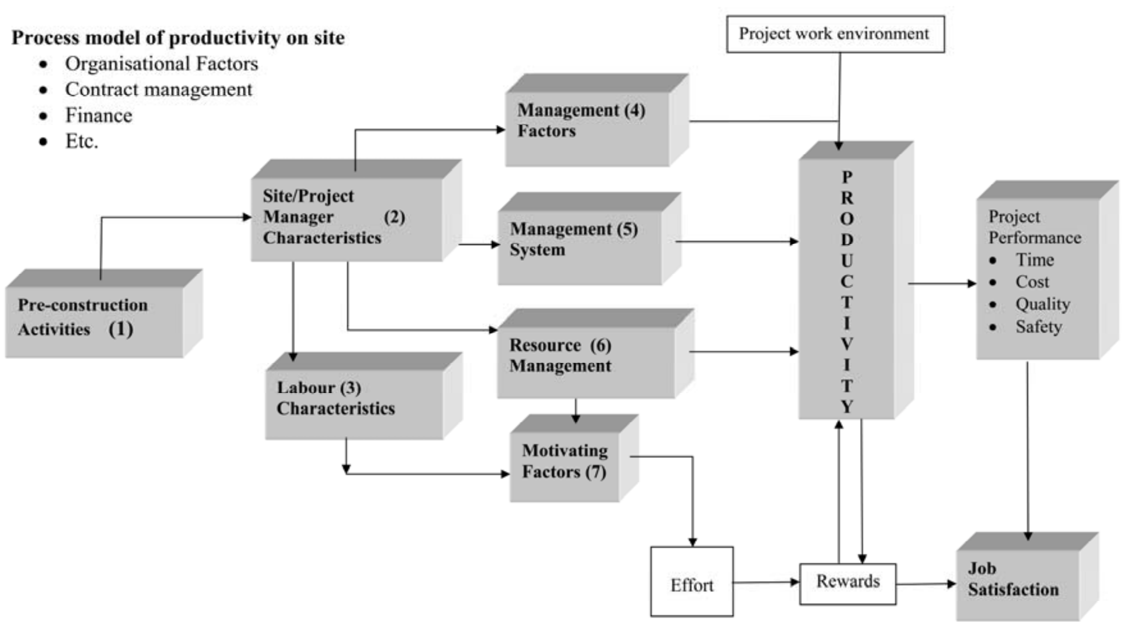

Figure 1: Factors affecting productivity on construction sites

Executive manager's responses can either reinforce and identify the productivity problem, or create pressures to change it. Much depends upon how sophisticated a diagnostic model the manager's use. For instance, one of the factors that can influence productivity is motivation of the workforce. Achieving high motivation depends on the working environment where financial or physical rewards can be regarded as an incentive for the efforts needed in achieving high productivity. In order to assure a good working environment, the management of resources needs to be highly effective, as recommended by previous research.

CONCLUSION

This paper reports on past and recent literature available into productivity in the construction industry. It has presented a conceptual framework that includes and groups the identified variables affecting site productivity. This framework is currently being used by the authors as a base model to test these proposed causal relationships. The term productivity has been defined by Naoum (2001) as the number of units (output) to be produced in a spell of time, utilizing an optimum number of human and non-human resources (inputs) in a safe and efficient manner. A high rate of productivity level can be achieved by eliminating the unnecessary wasteful resources from the construction operation by means of the following:

- using the Socio-Techno-Managerial approach,
- technically by an efficient planning and scheduling of the resources,
- socially, by creating the work environment that can motivate and lead the people effectively,
- managerially, by designing an efficient management system to communicate, co-ordinate and control the work activities.

The main hypothesis of the model shown in Figure 1 is that "site productivity is a function of pre-construction activities, the characteristics of the project manager/site manager, labour characteristics, management activities, the management system adopted, efficient management of the resource and the motivation of employees". These variables are both interrelated and intra-related. Once identified, this relationship is believed to be a useful piece of information to implement a project more productively.

REFERENCES

Abdel-Wahab, M. S., Dainty, A. R. J., Ison, S. G., Bowen, P., and Hazlehurst, G. (2008) Trends of skills and productivity in the UK construction Industry. Engineering, Construction and Architectural Management, 15(4), 372-382.

Abdul Kadir, M. R., Lee, W. P., Jaafar, M. S., Sapuan, S. M., and Ali, A. A. A. (2005) Factors affecting construction labour productivity for Malaysian residential projects. Structural Survey, 23(1), 42-54.

Allmon, E., Hass, C. T., Borcherding, J. D., and Goodrum, P. M. (2000) US construction labour productivity trends 1970-1998. Journal of Construction Engineering and Management, ASCE, 126(2), 97-104.

Arditi, D., and Mochtar, K. (2000) Trends in productivity improvement in the US construction industry. Journal of Construction management and economics, 18(1), 15-27.

Baldwin, A., (1990) Why an IT strategy is important?. Chartered Builder, July/August.

Cheung, S. O., Ng, S. T., Lam, K. C., and Yue, W. M. (2001) A satisfying leadership behaviour model for design consultants. International Journal of Project Management, 19(7), 421-429.

Christian, J., and Hachey, D. (1995) Effects of delay times on production rates in construction. Journal of Construction Engineering and Management, ASCE, 121(1), 20-26.

Clarke, L., and Herrmann, G. (2004) Cost vs. production: labour deployment and productivity in social construction in England, Scotland, Denmark and Germany. Journal of Construction Management and Economics, 22(10), 1057-1066.

Crawford, P., and Vogl, B. (2006) Measuring productivity in the construction industry. Building Research and Information, 34(3), 208-219.

Doloi, H. (2008) Application of AHP in improving construction productivity from a management perspective. Journal of Construction Management and Economics, 26(8), 839-852.

Enshassi, A., Mohamed, S., Mayer, P., and Abed, K. (2007) Benchmarking Masonry Labor Productivity. Journal of Productivity and Performance Management, 56(4), 358-368.

European Construction Industry Federation, (1996). Annual Report.

Faniran, O. O., and Caban, G. (1998) Minimizing waste on construction project sites. Engineering, Construction and Architectural Management, 5(2), 182-188.

Ferguson, J., Kermode, N., Nash, C. L., Sketch, W. A. J., and Huxford, R. P. (1995) Managing and minimizing construction waste – A practical guide. Institute of Civil Engineers, London.

Hanna, A. S., Russell, J. S., and Vandenberg, P. J. (1999) The impact of change orders on mechanical construction labour efficiency. Construction Management & Economics, 17(6), 711-720.

Heap, A. (1987) Improving site productivity in the construction industry**.** International Labour Office.

Hester, W., and Kuprenas, J. (1987) The productivity of insulation installation.

Kaming, P. F, Holt, G. D., Kometa, S. T., Olomolaiye, P. O., (1998) Severity diagnosis of productivity problems – a reliability analysis. International Journal of Project Management, 16(2), 107-113.

Kazaz, A., and Ulubeyli, S. (2007) Drivers of productivity among construction workers: a study in a developing country. Building and Environment, 42(5), 2132-2140.

Leonard, C. A. (1987) The effect of change orders on productivity. Revay and Acssociates ltd, Canada 6(2), 1-3.

Naoum, S., (2001) People and organizational management in construction. Thomas Telford

Naoum, S., and Hackman, J., (1996) Do site managers and the head office perceive productivity factors differently? Journal of Engineering, Construction and Architectural Management, 3(1&2), 147-160.

Olomolaiye, P. (1990) An evaluation of the relationships between bricklayers' motivation and productivity. Journal of Construction Management and Economics, 8(3), 301-313.

Olomolaiye, P., Jayawardane, A., and Harris, F. (1998) Construction productivity management. Chartered Institute of Building, Englemere, Ascot, UK.

Prais, S. J., and Steedman, H. (1986) Vocation training in France and Britain: the building trades. National Institute Economic Review, 116(1), 45-55.

Pheng, L. S., and Tan, S. K. L. (1998) How 'just-in-time' wastages can be quantified: case study of a private condominium project. Construction Management and Economics, 16(6), 621-635.

Proverbs, D. G., Holt, G. D., and Olomolaiya, P. O. (1999) Construction resource/method factors influencing productivity for high rise concrete construction. Journal of Construction Management and Economics, 17(5), 577-587.

Rad, P. F. (1980) Analysis of working space congestion from scheduling data. Transactions of the American Association of cost Engineers, 24th Annual Meeting, Washington, July, pp. F4.1-F4.5.

Radosavljević, R., and Horner, R. M. W. (2002) The evidence of complex variability in construction labour productivity. Journal of Construction Management and Economics, 20(1), 3-12.

Sanders, S. R., and Thomas, H. R. (1991) Factors affecting masonry–labor productivity. Journal of Construction Engineering and Management, ASCE, 117(4), 626-644.

Smith, A. D. (1987) Measuring on-site production. Transactions of the American Association of Cost Engineers, 31st Annual Meeting, Atlanta.

Thomas, H. R., and Jansma, G. L. (1985) Quantifying construction productivity losses associated with an accelerated schedule. Final Report for Burns and Roe.

Thomas, H. R. (1991) Labor productivity and work sampling: the bottom line. Journal of Construction Engineering and Management, ASCE, 117(3), 423-444.

Thomas, H. R. (1992) Effects of scheduled overtime on labor productivity. Journal of Construction Engineering and Management, ASCE, 118(1), 60-76.

Thomas, H. R., and Napolitan, C. L. (1995) Quantitative effects of organizational changes on labor productivity. Journal of Construction Engineering and Management, ASCE, 121(3), 290-296.

Thomas, R., (1987) Factor model of construction productivity. Journal of Construction Engineering and Management. ASCE, 113(4), 623-639.

Winch, G., and Carr, B. (2001) Benchmarking on-site productivity in France and the UK: a CALIBRE approach. Journal Construction Management and Economics, 19(6), 577-590.

Yates, J. (1993) Construction decision support system for delay analysis. Journal of Construction Engineering and Management. ASCE, 119(2), 226-244.

Zink, D. A. (1990) Impacts and construction inefficiency. Cost Engineering, 32(11), 21–23.

GLOBAL CRISIS: THE EFFECT ON THE MIDDLE EAST CONSTRUCTION SECTOR

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This paper looks to identify the effects of the global crisis on the Middle East construction sector. It draws mainly from personal experience, management of both public and private projects as well as interaction with key people from the Middle East construction industry. The major findings that emerged were as follows: a) The adverse effects of the ongoing crisis can differ significantly throughout the Middle East countries. b) The work culture is changing on a daily basis. c) How hidden opportunities exist even during these challenging times. This paper will provide valuable information to construction related companies for the current situation in the Middle East and solutions for moving ahead in the best possible ways will be revealed and discussed.

KEYWORDS: crisis, construction, effects, opportunities.

INTRODUCTION

The global economic crisis has seriously affected the Middle East construction sector. The “Mecca” of the construction world is now facing its toughest ever challenge and companies are worried on how their future will shape up in the region. The answer is not easy and in certain cases merely speculations can be made. The crisis has definitely heavily and unexpectedly affected the majority of construction related companies.

2010 is expected to be even more challenging than 2009 as numerous companies are still going through this year based on existing contracts. This can also be predicted by the fact that foundation contractors are now facing a huge crisis. Many ongoing projects face uncertainty due to important liquidity problems. Material prices have been reduced in some cases by as much as 70%. This resulted in projects being retendered, even in cases where contractors had already mobilized on site. The sudden change in finance availability and end-user demand are the two main factors responsible for this slowdown.

Each country in the Middle East region has developed over the years in different ways, under its own pace, standards, setting different goals and hence the effects of the crisis can significantly differ. Figure 1 presents the percentage of projects on hold in each country of the Gulf co-operation council (GCC). We can see that the U.A.E. is responsible for an impressive 91% which is mainly due to Dubai´s heavier development and investment compared to the rest of the GCC. The total value of projects either on hold or that have been cancelled in the GCC at the moment is estimated to be approximately $249 billion.

Table 1: Percentage of projects on hold/cancelled in the GCC

Location	Percentage (%)
Dubai	81
Abu Dhabi	10
Rest	9

The following sections present an overview of the most important countries in the GCC in terms of construction. By using personal experience as a basis, their current and future situation is analyzed and discussed.

U.A.E.

The two major cities of U.A.E., Dubai and Abu Dhabi will be dealt with independently as they were found to have fundamental differences.

Dubai

The construction industry in Dubai is facing a sharp slowdown as a result of the economic crisis. Property prices fall, jobs are cut and projects are axed. Dubai is the Middle East city which is feeling the crisis at its hardest, mainly because everything was developing at a blistering pace. Huge residential and commercial projects have been either put on hold with a tentative starting date in most cases not announced or significantly scaled down. By extending construction schedules clients are given more time to observe and assess the overall market situation.

More than half of the construction projects have been put on hold, with more expected to be deferred in 2009 and 2010. Huge residential projects, one alone designed to be twice the size of Hong Kong, have been put on hold as well as a series of artificial islands. While the real estate sector is being hit hard this is not the case with infrastructure. Although delays in payments from pubic authorities have created a major concern, the Dubai government recently launched a second $10bn sovereign bond programme to ease tight liquidity conditions which is slowly bringing back optimism to construction companies.

It is interesting to point out that the number of arbitrations has dramatically increased the last few months because of clients cancelling, postponing projects or just holding payments.

Abu Dhabi

Abu Dhabi saw its major boom starting 2 years ago and predictions are still talking about a city which could even surpass Dubai in the years to come by experiencing only minor effects due to the crisis. The U.A.E. capital is currently in the advantageous position of having a financial surplus and the possibility of carefully choosing the correct projects to initiate.

Till date, only a few commercial buildings have been postponed for 6 to 12 months while infrastructure projects are still going ahead. Abu Dhabi has been facing for the last years a major problem in housing availability for expatriates. An average of 2 months is needed for an expatriate to find suitable accommodation. The shortage of housing units reached 7,500 units in 2007 and 20,000 in 2008. Hence, a slowdown in this area is considered highly unlikely.

The Abu Dhabi government considers infrastructure as a key for its economic development as well as the success of the Abu Dhabi 2030 plan which is intended to increase the city´s population by 35% in 21 years and transform the capital into a global center. Already, big steps are taken into that direction and bids have been recently received for the consultancy services of the upcoming 130km metro.

Bahrain

Bahrain is a small country and always considered to have a stable economy. In fact, the Bahrain Stock Exchange has been the least affected among the key Gulf bourses. There are not too many huge projects and the end-user demand is still high. Bahrain has been trying to promote itself as a business friendly country and at the same time also making steps to increase its tourist numbers. Since August 2006, there is a Bahrain-U.S.A. free trade agreement which significantly contributed to the growth of the country.

The construction slowdown can be easily spotted in the foundations contracting business. Prior to the crisis non-availability of foundations contractors would even lead to delays in projects while this is clearly no longer the case. Bahrain's real estate market is feeling the effects of the global financial crisis, but its modest growth rate should prevent it from seeing a sharp decline. There are a few projects being put on hold but this is mainly the case with mega-projects which are now deemed too ambitious for such a small country. One of the exceptions seems to be the $3 billion Bahrain-Qatar causeway which due to significant funding from Qatar could commence at the end of this year. In that case, Bahrain which already has road access to Saudi Arabia since 1986 would heavily reinforce its already geographically strategic position in the GCC.

Qatar

Qatar continues to be the fastest growing economy in the GCC, with one of the largest per capita incomes in the world. By not focusing on real estate and tourism the country seems to have been only slightly affected by the ongoing crisis.

Infrastructure works however are not following last year´s pace and the public works authority is currently restructuring. There is a major focus on health and business related construction where funds are already secured. Public works in Qatar appear to have more obstacles than any other GCC country and there have been cases where major international contractors stopped bidding for government projects. However, due to the existing opportunities that will be disregarded attracting the interest of all major contractors. Large real estate projects are currently being redesigned, nevertheless projects of such nature had never been a real focus in Qatar and this policy is definitely not going to change now.

The Qatari government seems optimistic about the future stating that increase in the oil and gas production will compensate the fall in their prices. In any case, the monetary reserve will help satisfy the needs of the country if necessary.

Oman

Oman has never been at the same level of development as the previous described countries. Nevertheless, it has had an interesting amount of building projects going on in order to enhance its popularity as a traditional tourist destination in the Middle East. Progress in big real estate projects is still doubtful but certain developers seem to be determined to go ahead. Moreover following Bahrain´s example, on 1 January 2009 Oman signed a free trade agreement with the U.S.A. lifting all tariff barriers to consumer and industrial products.

Oman at the moment is surprisingly issuing several infrastructure tenders including numerous bridgeworks, with the new Muscat and Salalah International Airports in particular attracting the interest of contractors worldwide. Prior to the outbreak of the crisis, only 6 or 7 contractors would usually compete for public works in Oman whereas nowadays this number has risen to approximately 25. Another fact that makes the country so appealing is that the government has all project funds secured and no significant payment delays have been reported from contractors in 2009.

Saudi Arabia

Saudi Arabia is a market attracting a lot of attention lately. However, people are doubtful even at these challenging times if development can easily take place. One of the most encouraging facts about Saudi Arabia is that its population is characterized by rapid growth and that at least 60% is under 20 years old.

Several Dubai based companies are now focusing their efforts in this country where mega projects are planned. Up to now, one of the major drawbacks of Saudi Arabia was the low living quality level offered to expatriates as opposed to U.A.E. or Bahrain. The heavy development in the nearby countries never created the need for major contractors to focus in Saudi Arabia. However, things have changed in Saudi Arabia´s favor and contractors are concentrating their efforts in what is now considered the biggest market in the region. Impressive projects are being awarded such as the new railway system that will link the Kingdom's Holy cities with a total cost of $1.78bn and completion due for Hajj 2012.

Summarizing the comparison between GCC countries, table 2 shows the value of ongoing projects in the area.

Table 2: Value of ongoing projects in the GCC

Location	Ongoing (US $bn)
Dubai	698
Abu Dhabi	270
Saudi Arabia	210
Qatar	220
Oman	104
Bahrain	140

Changes in work culture and positive effects

As a result of the ongoing crisis, radical changes are taking place in the work culture.

It is easily noticeable that consultants are going into much more detail regarding quality and structural calculations than before. This is mainly due to the reduction in workload and time pressure allowing them to address issues which they did not before. Although contractors might argue that this is simply done for impressions, a more thorough check from consultants enhances quality and safety. Numerous articles were written in the past years pointing out the lack of quality and major errors in projects in the Middle East and particularly Dubai as a result of unreasonable time pressure on site and in the design offices.

Value engineering is finally coming into place as clients are looking to cut down on costs. New technologies will be introduced. Even though Dubai and generally the Middle East was the center of construction throughout the last decade it is surprising how old methods of construction were still being implemented.

Reduced workload will allow local authorities to focus on items such as unified building codes. It is surprising that the UAE for example does not have one and it is said that government approval on this subject has been pending for more than two years. Besides, the country lacks a proper classification of contractors. Each emirate has its own building code and classification system that varies in criteria. Working on the above areas can only ease operations in the near future.

End users are finding this a right time to buy property as prices have dramatically fallen. Moreover, due to the fact that sales are no longer flourishing owners are putting their properties in the rental market creating more supply that demand as opposed to seven months ago. Rental rates have fallen up to 40% in certain regions creating a necessary correction in the market.

New competition

It is obvious that companies throughout the world eye Middle East construction market in a bid to escape global economic crisis. Even though the slowdown in the region is significant, the number of ongoing and future projects is still enough to attract major attention. A lot of importance has to be given to companies coming from Spain. Till now few Spanish companies and especially infrastructure contractors had a presence in the region as work was booming both in Spain and South America. This is rapidly changing and it will be interesting to see how the likes of big Spanish contractors will shape up the market.

In Spain, the financial crisis is also seriously affecting the real estate market. Lack of liquidity not only has an impact on households as many people cannot get mortgage loans, but also on companies who cannot find financial support for their construction projects. Housing projects in Spain throughout the last years were equal in number to the ones in UK, Germany and France together. It is expected that many contractors involved in such projects will be extremely eager to enter the Middle East market.

Emerging markets

Need for projects is naturally creating new markets. It is said that several companies are performing feasibility studies in Iraq for real estate works. In fact there are projects worth of US $2.18 billion on the table. Already major contractors are under negotiations for jobs in Iraq as the country is due to spend $15 billion during 2009 on repairs to its infrastructure, oil and energy facilities. This figure represents 25% of the country´s draft 2009 budget.

Recently two major Middle East based developers announced a $15 billion development in Kurdistan and a $10 billion project in Baghdad.

It seems that Middle East developers have found a "safe haven" during the crisis as Northern Africa and especially Morocco properties are considered to be the best investment opportunity at this given moment. A real estate project worth $1,3 billion was recently completed and all main Middle East developers are heavily trying to promote their Moroccan projects. With the likes of projects aimed to dramatically increase the number of tourists in the coming years it is clear that there is a lot of room for infrastructure and hotel property market improvements.

Keys for success and opportunities

In this section an attempt is made to identify which are the key factors for moving ahead as a company during the crisis while maintaining one´s capabilities to the maximum and possible damages to the minimum. Also, ways on how to explore potential opportunities are discussed.

Closeness to the customer is a success factor nowadays. Helping clients in issues such as deadline pressure, safety and quality will give a company the edge. There are price-sensitive customers and also cost-conscious ones. It´s important to make sure that the customers look at one product from a total cost point of view and not just the purchase or rental price. Items such as formwork which represent a small amount of the total investment can have a huge impact on daily progress as well as safety, quality and hence total project budget.

The numerous lay-offs seem to imply that human capital is only considered as a cost element in a company´s balance sheet, decreasing in hard times and increasing in booming periods. Smart companies know that human talent is what will make the difference between success and failure especially when things are gloomy and uncertain. Companies with a visionary strategic plan should now invest on human capital considering this period as a tremendous opportunity for building on future growth. The pool of possible applicants has never been bigger.

Instead of brutally reducing personnel a company should indentify major risks, calculate all the direct and indirect costs associated with alternative strategies and policies, and evaluate necessary steps which could reduce the need for layoffs. Examples would include retraining and transferring redundant employees, freezing or reducing hiring and changing pay and working hours.

Moreover, opportunities should be explored to increase the volume of work. An example is in sourcing work that might have been outsourced earlier. Diversification can also give a new motivation to employees. Cross-functional teams can be created to develop these plans and implement them. Employees working in companies following steps such as the above will feel much more connected to their employer and a team feeling will be cultivated which can make a huge difference in the output.

This is the time for companies to invest in programs that create diverse skill sets. By maintaining a strong talent pool, firms will have people with the necessary skills when the markets pick up again. Companies heavily affected by the crisis have come to recognize the importance of effective senior executive planning and resourcing. Firing employees should be the last resort.

Moreover, as workload is being reduced in most cases it would be wise for companies to resolve outstanding internal problems. Now is time to reflect on past mistakes and see how these can be improved in the future.

The nature of this sudden crisis proved the vast importance of carefully choosing financial terms in construction contracts. Although this statement might sound simplistic, several cases have been found where subcontractors engaged in the same field and country have significantly different payment terms in their subcontract agreements. Mislead by the non-stop financing of recent years, numerous companies found themselves not worrying too much about payment terms in contracts and not covering their interests with the use of letter of credits for example. Hence, many of their ongoing projects are now facing problems due to unpaid invoices creating huge cash flow problems. A major advantage of companies which correctly used letter of credits is the option of stopping site works in case of not getting paid. The last resort would be to demobilize from the project which would still not have very important cost implications for them. Their clients knowing that will probably give priority in being punctual to their payments.

Companies with a background in public works have obviously an important advantage at the moment. However, with the likes of small companies dropping prices below cost just in order to ensure some continuity throughout the crisis period makes things difficult. There is no doubt that contractors are heavily competing for projects. And that competition is bringing a wider range of bids for public projects and potential for big savings. Clients however should be very prudent when awarding projects. Receiving offers under the estimated budget might be very attractive but the client should have very reliable information on the contractor´s financial situation. A contractor attempting to get jobs at under-cost prices might be a dangerous option as at any given moment could go out of business.

CONCLUSIONS

Times are for sure challenging and big changes have been made in a very short period. Future projects will focus much more on real needs of the region and we will be seeing a lot less of super-expensive and luxurious projects. It is clear that till now infrastructure works are less affected than real estate.

As a result of the slowdown, competition is now fiercer not only by already settled companies decreasing their prices but with new companies coming into the region. At the moment big industry players seems to be focusing in Abu Dhabi, Qatar and Saudi Arabia. Bahrain and Oman still have opportunities but in smaller scale while countries such as Iraq and Kurdistan are suddenly attracting much more attention and are considered to be emerging markets. Further investigation and discussion can be done on the Kuwaiti construction market which was not described in this paper due to lack of personal experience. Yemen which belongs to the GCC was also not included due to its currently small contribution in the construction industry. However, this might drastically change if plans for a Middle East-Africa bridge linking Yemen to Djibouti go ahead. In such an event it would be very interesting to study the trade effects of possible good importations from Russia, India and China to Africa.

It is time for companies to brainstorm about how they will go through the crisis. Layoffs should only be used as a last resort. Quality and value engineering are now more important than ever. A tough combination of quality, low price and meeting client demands should be the vision.

There are still opportunities during these difficult times but not as obvious as before. People will see this as a huge challenge, shall be more motivated and this will bring out the best of them. Companies will be tested and truly skilled people will have a chance to prove their worth.

REFERENCES

Orr, R., and J. Kennedy (2008) Highlights of Recent Trends in Global Infrastructure: New Players and Revised Game Rules. Transnational Corporations, Vol 17, No 1, 2008, 95-130.

Yanosek, Kassia, Gregory Keever, and Ryan J.Orr (2007) Emerging-Market Infrastructure Investores: New Trends for a New Era? The Journal of Structured Finance, Winter, 2007.

Benjamin Sovacool and Saul Halfon (2007) Reconstructing Iraq: merging discourses of security and development. Cambridge University Press, 33:223-243.

George Soros (2009) The crash of 2008 and what it means: the new paradigm for financial markets. New York: Public Affairs.

DEVELOPING A MODEL TO EVALUATE PROJECT PERFORMANCE: CONTRACTOR COMPANY'S VIEWPOINT

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Project success is one of the most important concepts and goals in project management, for which it seems to be difficult to give an exact definition. In this paper, the authors used a comprehensive definition of project success consisting of two components: product success and project management success. Due to the insufficient attention given to the study of project management performance in contracting companies, while merely considering the consequences of the final product, in this paper the level of project management performance from a contracting company's point of view was evaluated by developing a novel model. Critical and effective indices were defined for this component and used to develop a model, by which the project management performance can be evaluated.

KEYWORDS: project management performance, critical performance indices, contractor company.

INTRODUCTION

A review of the project management literature provides no consistent interpretation of the term "project success". McCoy (1986) observed that a standardized definition of project success does not exist nor does an accepted methodology of measuring it. Likewise Wateridge (1998) noted that very few people in the past have thought seriously about the success criteria. Similarly, Wells (1998) laments the lack of attention given to defining success except in quite general terms. Furthermore, one of the most important efforts for quantifying the project performance is "The Practice Standard for Earned Value Management" (EVM) which has been developed as a supplement to "A Guide to the Project Management Body of Knowledge" (PMBOK). This standard focuses only on cost and schedule performance. Moreover, Kamil Nassar (2005) developed a model to evaluate project performance. His model consists of 8 indices which try to evaluate project performance but this model does not separate indices considering the difference between product success and project management success and does not focus on the project processes.

Also, since the definition of project success is directly related to the stakeholders' various goals and benefits, which are sometimes in contrast with each other, the first step in defining project success is identifying whose point of view should be considered. In this paper, project performance based on the point of view of the contractor and project executing company is studied.

Baccarini (1999) emphasized that project success consists of two components, as follows:

- Product success deals with the effect of the project's final product.
- Project management success focuses upon the project process and, in particular, the successful accomplishment of cost, time, and quality objectives. It also considers the manner in which the project management process was conducted.

Nevertheless the long-term success of a contractor company depends on its performance in project management, lots of contractors consider only product success and its consequences. Consequently many of the long-term goals of a contractor organization and also its condition in competitive markets are endangered. Obviously if a contractor repeats its mistake in other projects, this means it has a serious problem in its project management system, even though it may have many successful projects products.

Considering the lack of a mathematical and quantitative model for measuring the project management performance based on the Baccarini's definition, focusing on the project processes, a need to develop such a model exists. Thus in this paper, by developing a novel model, the level of project management performance from a contractor company's point of view is evaluated. Moreover some critical and effective indices are defined which, by calculating and substituting them in the developed evaluation performance function, the value of performance is measured. Furthermore, sub-indices of performance will be introduced which can specify the strong and weak points in project management success.

PROJECT MANAGEMENT INDICES

As mentioned above, project management performance indices concerned with the successful accomplishment of the project's cost, time, and quality objectives and consist of the six following indices:

Cost Performance Index (CPI)

The Cost Performance Index (CPI) is a measure of the cost efficiency of the project. The CPI is determined by dividing the earned value by the actual costs incurred. This index is one of the indices of "The Practice Standard for Earned Value Management" (EVM).

CPI = (BCWP) / (ACWP)

Where BCWP is the Budgeted Cost of Work Performed and ACWP is the Actual Cost of Work Performed.

The category limits of the performance for each index is determined by the contractor organization's manager's expert opinion of contractor organization, regarding the index definition, contractor's strategies, market rivals, etc. These category limits can be modified for every project. The limit values determined in this paper are only for the present case study. Table 1 shows the limits for the CPI index.

Table 1: Cost Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	$CPI \geq 1.15$
2	Exceeds Target	$1.05 \leq CPI < 1.15$
3	Within Target	$0.95 \leq CPI < 1.05$
4	Below Target	$0.85 \leq CPI < 0.95$
5	Poor Performance	$CPI < 0.85$

Billing Performance Index (BPI)

The billing or cash flow performance index shows the contracting company's ability and performance in receiving claims and demands and it is defined as follows:

BPI = (CRWP)/(PRWP)

Where PRWP is the Potential Revenue of Work Performed and CRWP is the Cash Revenue of Work Performed.

Table 2: Billing Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	$BPI \geq 0.98$
2	Exceeds Target	$0.95 \leq BPI < 0.98$
3	Within Target	$0.90 \leq BPI < 0.95$
4	Below Target	$0.80 \leq BPI < 0.90$
5	Poor Performance	$BPI < 0.80$

If the BPI index indicates an undesirable situation, the contractor's lack of financial security may be the result inappropriate cord codifying by the contractor or the client's neglect of his financial commitment to the project.

This issue is considers by the BPI_{client} and $BPI_{contractor}$ sub-indices. The former considers the client's influence and the latter considers the contractor's influence in financial issues of the project.

BPI_{Client} = (CRWP)/(BRWP)

$BPI_{Contractor}$ = (BRWP)/(PRWP)

Where BRWP is the Billed Revenue of Work Performed.

Schedule Performance Index (SPI)

The Schedule Performance Index (SPI) is a measure of the schedule efficiency of the project. Similar to the Cost Performance Index (CPI), SPI is one of the indices of "The Practice Standard for Earned Value Management" (EVM).

SPI = (BCWP)/(BCWS)

Where BCWP is the Budgeted Cost of Work Performed and BCWS is the Budgeted Cost of Work Scheduled.

Table 3: Schedule Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	$SPI \geq 1.15$
2	Exceeds Target	$1.05 \leq SPI < 1.15$
3	Within Target	$0.95 \leq SPI < 1.05$
4	Below Target	$0.85 \leq SPI < 0.95$
5	Poor Performance	$SPI < 0.85$

Safety Performance Index (SFI)

The index considers issues about safety observation and increasing safety in executive project outcome. The SFI index is the sum of two weighted sub-indices as follows:

SFI_C = (ELSO)/(TECP)

Where SFI_C is the safety performance index of the project outcome in terms of expenses, ELSO is the Expenses arise from damages of the lack of safety observance and TECP is the Total expenses of project construct phases

SFI_S = (IDWH)/(TIWH)

Where SFI_S is the safety performance index of the project outcome in terms of scheduling, IDWH is the Number of individual - dismissed working hours because of lack of safety observance and TIWH is the Total number of individuals–working hours in construction phase.
Obviously the SFI_C and SFI_S must be normalized before calculation of SFI, so:

$SFI = x_1 \times SFI_c + x_2 \times SFI_s$

$\Sigma x_i = 1$

Where X_i is the weighting factor of sub-Indices

Table 4: Safety Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	$SFI \geq 1.15$
2	Exceeds Target	$1.05 \leq SFI < 1.15$
3	Within Target	$0.95 \leq SFI < 1.05$
4	Below Target	$0.85 \leq SFI < 0.95$
5	Poor Performance	$SFI < 0.85$

Quality Performance Index (QPI)

This index considers the quality of the project outcome based on the expenses resulting from the lack of quality, the expenses of redoing part of the work, fines, etc.

$QPI = (SELQ)/(TECP)$

Where SELQ is the sums of direct and indirect expenses arise from lack of quality in project outcome and TECP is the total expenses of project construct phases.

Table 5: Quality Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	$QPI \leq 0.005$
2	Exceeds Target	$0.005 < QPI \leq 0.01$
3	Within Target	$0.01 < QPI \leq 0.02$
4	Below Target	$0.02 < QPI \leq 0.03$
5	Poor Performance	$QPI > 0.04$

Environment Performance Index (EPI)

This index considers the contractor's performance regarding environmental issues and expenses arising from the lack of observance of environment consideration during the project.

EPI = (SELE)/(TECP)

Where SELE is the sum of the direct and indirect expenses arising from the lack of attention to the environmental issues and TECP is the total expenses of project construct phases.

Table 6: Environment Performance Rating

Condition	Rating	Index Range
1	Outstanding Performance	EPI ≤ 0.002
2	Exceeds Target	0.002 < EPI ≤ 0.005
3	Within Target	0.005 < EPI ≤ 0.01
4	Below Target	0.01 < EPI ≤ 0.015
5	Poor Performance	EPI > 0.015

PROJECT MANAGEMENT PERFORMANCE MODEL

The function of project management which considers the manner of management of the project's outcome is defined as follows, by combining the six critical performance indices:

$$PMPI = u_1 \times CPI + u_2 \times BPI + u_3 \times SPI + u_4 \times SFI + u_5 \times QPI + u_6 \times EPI$$

$$\Sigma\, u_i = 1$$

Where u_i is the weighting factor for each of the critical indices of project management success.

It is necessary to mention that weighting factors for each of the indices are determined by AHP and consistency measurement in order to make sure of the reasonability of the results. Moreover the values of the critical index and sub-index must be normalized in order to be used in the project management performance function.

Normalization of Performance Indices

As the first step in normalization of the indices, the success borders for the CPI index as the base borders are determined. On the basis of the base borders and by using the ratio of the success border of each index and the basis success borders (or by using a diagram as shown in figure 1), the normal amount of each performance index is calculated. As an example, the diagram for calculating the normal amount of BPI according to the CPI category limits, is shown in Figure 1.

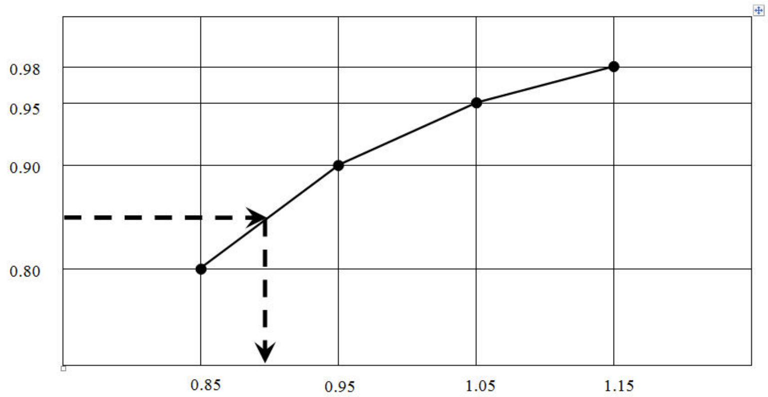

Figure 1: The Typical Diagram for Calculating Normal Amount of BPI According to the Limits of CPI.

CASE STUDY

In this section, the developed performance evaluation model will be applied for the case of a real project which is being executed in Iran. The scope of the project is the construction of a power transmission line (consisting of 176 telescopic towers), 22 Km long.

By studying the monthly documents of this project which were recorded at the end of the 4th month (January, 2009) of the project's timetable, the following information was extracted:

- Budgeted Cost of Work Performed (BCWP): 2,600,000$
- Actual Cost of Work Performed (ACWP): 3,100,000$
- Budgeted Cost of Work Scheduled (BCWS): 2,550,000$
- Cash Revenue of Work Performed (CRWP): 2,822,000$
- Billed Revenue of Work Performed (BRWP): 3,180,000$
- Potential Revenue of Work Performed (PRWP): 3,300,000$
- Earned Profit of Work Performed (EPWP): 525,000$
- Expenses arise from damages of the lack of security observation (ELSO): 0 $
- Total expenses of project construct phases (TECP): 4,800,000$
- Number of individual - dismissed working hours because of lack of security observation (IDWH): 1920 Individual-Hour (The project had been placed on hold for 8 days because of safety problems)
- Total number of individuals - working hours in construction phase (TIWH): about 72,000 Individual-Hour
- The sums of direct and indirect expenses arise from lack of quality in project outcome (SELQ): 12,000$
- The sums of direct and indirect expenses arise from lack of attention to the environmental issues (SELE): 0$

Using the above information, the critical indices and their normal amounts ware calculated and the results presented in table 7.

Table 7: The Amount of Critical Performance Indices for the Power Transmission Line

Index	Amount of Index	Condition	Normal Amount
CPI	0.84	5	0.84
BPI	0.85	4	0.90
SPI	1.02	3	1.02
SFI	1.12	2	1.12
QPI	0.002	1	1.19
EPI	0	1	1.15

The BPI sub-indices are calculated as follows:

$BPI_{Client} = 0.89$ and $BPI_{Contractor} = 0.96$

And the calculated SFI sub-indices are as follows:

$SFI_C = 0.00$ (Normal value = 1.15) and $SFI_S = 0.03$ (Normal value = 1.05)

Where, the weighting factors of the SFI_C and SFI_S are 0.7 and 0.3, respectively.

Project Management Performance Evaluation

As mentioned in the previous section, the weighting factors of critical performance indices are determined by AHP. As a result the weighting factors for this project are shown in table 8 (the consistency is 0.063, so the weight factors are reasonable and acceptable).

Table 8: The Weighting Factors of the Critical Performance Indices for the Power Transmission Line

Index	CPI	BPI	SPI	SFI	QPI	EPI
Weighting Factor	0.26	0.20	0.19	0.13	0.15	0.07

On the basis of the above weighting factors, the amount of the project management performance function for this project is derived as follows:

$$PMPI= 0.26\times CPI+0.20\times BPI+0.19\times SPI+0.13\times SFI+0.15\times QPI+0.07\times EPI$$

PMPI= 0.26×0.84+0.20×0.90+0.19×1.02+0.13×1.12+0.15×1.19+0.07×1.15

PMPI= 0.997

Finally, the value of the project management performance of this project is determined to be 0.997. Regarding the category limits of the base border, the performance condition of this project is within the target range (condition 3).

Analysis of the Results

The results of this case study show that the weakest performance of the contractor is the cost performance which is in the 5th condition (poor performance). This poor cost performance may be the consequence of a mistake in cost forecasting before the beginning of the project or the poor cost performance of the contractor along with the project. For a more precise evaluation, CPI can be divided into the sub-indices such as Indirect Cost Performance Index (CPI_I), Labor Cost Performance Index (CPI_L), Material Cost Performance Index (CPI_M).

The best performance of the contractor is QPI, which is in the 1st condition (outstanding performance) showing that the contractor has an excellent performance quality. The EPI index is also in the 1st condition, but because of its weak weighting factor it is not very effective on the project management performance of contractor.

Sensitivity Analysis

The project management performance can change as the value each index changes. If the contractor wants to conduct corrective actions to improve its project management performance, it is necessary to recognize the most important indices. Figure 2 shows the change in the project management performance due to changes of each index as the other indices remain unchanged. Sensitivity analysis shows that the CPI, having the maximum slope, is the most effective index, and the EPI which has the minimum slope has the least effect on project performance.

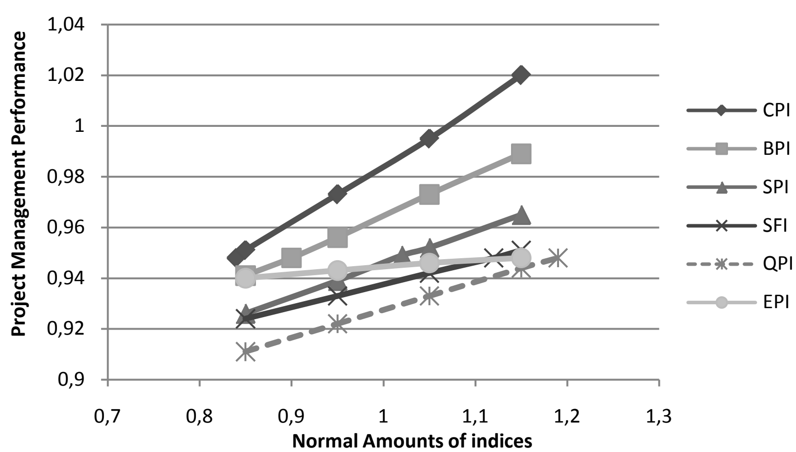

Figure 2: T he Sensitivity A nalysis Diagram o f the Project Man agement Performance in Respect of the Normal Amount of Indices

CONCLUSIONS

In this paper, project management performance was studied based on an index-based model. For the project management performance, the six critical performance indices consisting of: Cost Performance Index, Billing Performance Index, Schedule Performance Index, Safety Performance Index, Quality Performance Index, and Environment Performance Index, were defined. As mentioned before, due to the conflict of interest between the contractor and the other stakeholders, the point of view of the contractor was considered in this paper. Thus all of the indices were measured by considering the profits and damages of the contractor. It is necessary to mention that Billing Performance Index is only defined for contractors. Furthermore the function for project management performance which considers the manner of management of the project's outcome in terms of introduced critical performance indices was defined. Finally, by application of the developed model for a real project, performance indices, weighting factors and project management performance of a contractor company were evaluated and by analyzing the results of the model, the weak and strong points of the contractor's project management were specified. The results show that this model can measure project performance with suitable accuracy and can be used as a reliable tool for measuring the project management performance of contractors.

REFERENCES

Baccarini, D. (1999) The Logical Framework Method for Defining Project Success, Project Management Journal; Dec 1999; 30, 4; ABI/INFORM Global pg. 25

Nassar, N.K., An integrated framework for evaluation, forecasting, optimization of construction projects, The thesis for PhD degree, University of Alberta, 2005.

McCoy, F.A. (1986). Measuring success: Establishing and maintaining a baseline, PMI Annual Seminar & Symposium Montreal.

PMI (Project Management Institute), (2005). Practice Standard for Earned Value Management

Wateridge, J. (1998). How can IT/IS projects be measured for success? International Journal of Project Management Journal, 16(1), 59-63.

Wells, W.G. (1998). From the editor. Project Management Journal, 29 (4), 4-6.

DISCUSSION OF IC EFFICIENCY AND ORGANIZATIONAL CHARACTERISTICS IN CONSTRUCTION INDUSTRY

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Intellectual capital (IC), a sole source of competitive advantage today, was examined intensively in knowledge intensive industries. On the other hand, construction industry, more precisely contracting sector is characterized as labour intensive. Although labour intensive, knowledge and IC still are a factor of competitiveness on the market. A question is weather IC influence can be estimated. Among numerous methods of measurement of IC, intellectual capital efficiency index was chosen as most suitable. After data gathering and calculation it was confronted with qualitative survey results that focuses on organizational effort to measure, manage and optimize organizational IC.

KEYWORDS: intellectual capital, construction industry, effectiveness, organisation.

INTRODUCTION

In todays business, knowledge is considered as the most effective tool for achieving competitive advantage. However, knowledge, commonly called intellectual capital(IC), is immaterial by nature and therefore is hard to define and quantify (Grossman and McCarthy, 2005). A term is best defined by its use, and therefore it is probably still correct to regard Intellectual Capital (IC) and Knowledge Management (KM) as twins - two branches of the same tree (Sveiby, 1998). Intellectual capital was recognized through the market to book value difference (Edvinsson&Malone, 1997, Svibey, 1997). This difference emerges when intangible elements exist in organisation that is not encompassed in classical accounting. First IC reporting was done by Skandia Company in 1994 in their yearly report using their IC management system Navigator. Among other methodologies for measuring and managing IC, Balanced Scorecard, developed by Kaplan and Norton in 1992 and Intangible Asset Monitor, developed by Sveiby in 1997 are most notable(Bismuth and Yoshiaki, 2008). Importance of IC is recognized in practice in the last two decades (Serenko i Bontis, 2004). Again, numerous authors are pointing at IC as most important source of competitiveness in contemporary business (Nonaka and Takeuchi, 1995, Bontis, 1996; Sveiby 1997, Egbu 2004). According Henricsson and Ericsson, indicators of competitiveness in construction industry are profitability, productivity, time and cost management, client satisfaction, wage level, working conditions, attractiveness of profession, business ethics, green conscious (ecology) and innovativeness. According to Egbu(2004) the real backbone of business success are innovativeness and dynamic strategy.

Internationalization of engineering is based on big companies whose services are not locked to geographical regions. They provide space flexible services such as planning, management, financing, highly specialized technology and skills (tunnelling, bridges, green technology) etc. while basic, manual labour on the other hand stays local or regional an therefore is not embraced by global market demands (Eurofound, 2005).

Although construction industry is dominantly labour intensive, these services are defined as knowledge intensive services. Companies that provide such services source competitiveness solely from firms IC. . Such firm uses two kinds of intellectual capital, Management and engineering knowledge on one hand and labour skills on other hand. Both of these influence productivity and performance of the firm. Although the border between one and the other IC logic is rather pale, and both sections are in constant interaction is obvious that basic IC management approach still focuses on labour skills

Therefore is easy to conclude that IC or knowledge is major influence on competitiveness on global construction market. In its fragmented environment, that construction market is recognized for, knowledge demands for projects are rapidly increasing. Firms are motivated to learn, to gather and absorb knowledge. Gathering and keeping various knowledge and competences in the company becomes expensive. Efficiency of such knowledge depends on cost of acquisition, frequency of use, sophistication etc. Therefore it would be interesting to further examine IC efficiency in construction.

Contemporary efforts in IC management are focusing on IC or knowledge measurement. In general, there is plenty of theoretical background on IC measurement, but empirical use is lacking. Numerical methods that exist are not precise and insufficiently demonstrate actual benefits of IC to the firm. Numerous methodologies of IC measurement are trying to describe IC through sole IC index. Today, measurement methods are in process of consolidation and there is still no general consensus on IC measurement (Grossman and McCarthy, 2005). It is our opinion that qualitative methods are more precise in IC measurement but they make benchmarking rather complex.

RESEARCH

Objectives

Objective of this research is to examine relationship between Intellectual capital efficiency and organisational performance in contracting industry. Due to numerous factors that influence overall company performance, e.g. market conditions, weather, megaprojects etc., we have concluded that only IC efficiency could take us to conclusion rather than usual business performance indicators. In fact, the main question is weather measuring and managing IC actually influences ICE index in contracting sector. It is logical to expect that organizations that are more oriented toward IC exploitation do have higher IC efficiency.

Contracting industry is chosen as it employs a dominant number in overall construction industry and is characterized as labour intensive industry (Bureau of Labour statistics, 2009). In such industry, orientation on IC should provide wide range of organisational IC management variants.

Constructs and hypothesis

Numerous author have has shown in their research that IC has, in general, dominant impact of business performance and competitiveness. As, last two named are further influenced by numerous external and internal factors, using classical business indexes as comparison wouldn't be correct. Therefore a quantitative IC measurement method will be used to describe trends and IC environment. General idea of this paper is to examine weather awareness of KM and IC and use of IC and KM management methodology can be seen on quantitative indicator such as is VAIC methodology. A data collection will be made for three last years that will enable interpretation regardless of momentary market conditions. In light of all said previously a following hypothesis will be tested: IC awareness, measurement and management leverages IC effectiveness in contracting enterprises. Level of IC will be indicated through a VAIC method index called Intellectual Capital Efficiency index (ICE).

Strategic relevance

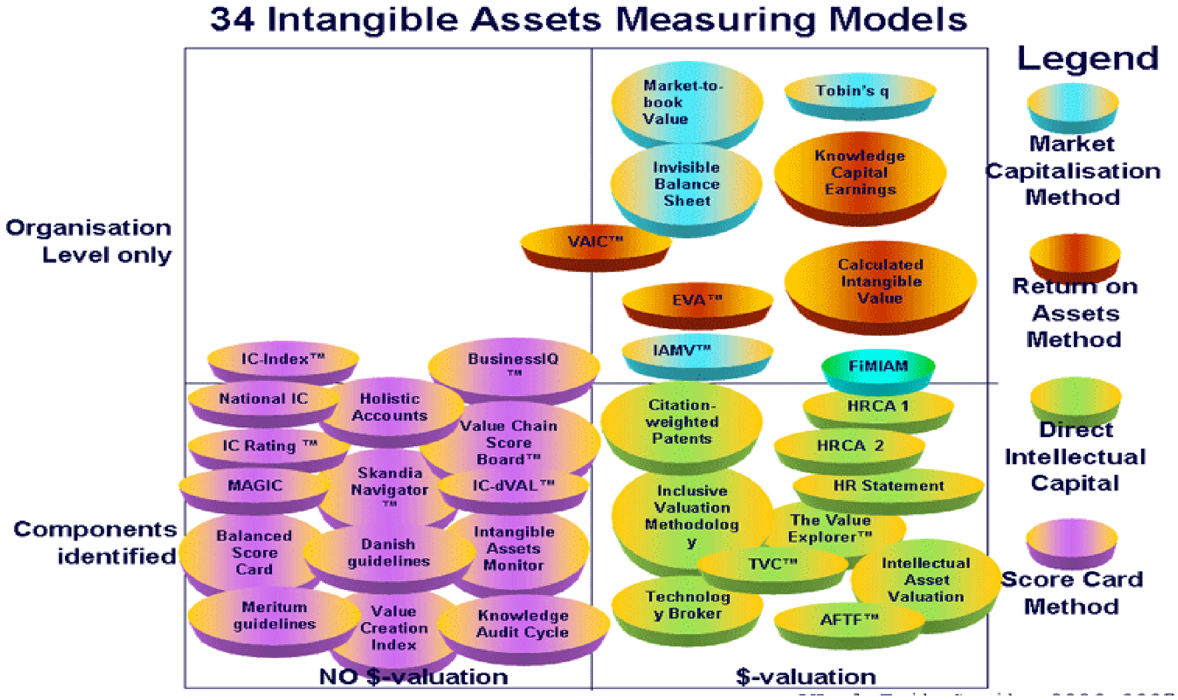
IC management and KM methodologies are widely accepted in business. Big firms in construction industry are first to use modern management tools and methodologies in search of competitiveness. Medium contracting enterprises still source their competitiveness through regional dominance and are usually characterized as followers rather than leaders in management change (Eurofound, 2005). Medium enterprises, on the other hand, are carriers of regional management practice change and are therefore dominant factor in management practices spreading over to SME’s. Therefore and examination of IC management practice on regional level is of importance.

SAMPLE AND DATA COLLECTION

ICE Index measurement

There are numerous quantitative and qualitative methods of measurement of intellectual capital. Some of them are listed in figure 1 below.

Figure 1: IC measurement methods according to IC level and weather they are quantitative or qualitative nature (Sveiby, 2002-2007)



All above mentioned methods of IC measurement have they advantages and disadvantages due to reason and time of their development. Among those methods, for this research I find VAIC method as most suitable as it focuses solely on IC efficiency and due to its simplicity. VAIC indicator ICE (Intellectual Capital Efficiency Index) will be confronted with level of organisational orientation towards IC management.

Value added can be calculated from existing information in annual reports as follows: where OP is operating profit, EC is employee costs, D is depreciation, and A is amortization. Consistent with the literature, the value added would be the sum of labour expenses, corporate taxes, dividend, interest expenses, amortization and depreciation, minority shareholders, and retained earnings. VAIC calculates the efficiency of both intellectual capital and financial capital. Partially based on the Skandia Navigator intellectual capital measurement model, VAIC is composed of human capital and structural capital. Based on the theories of compensation and an efficient labour market, the VAIC uses total the compensation paid to employees as the proxy to assess the value of human capital. VAIC does not consider expenditures on employees as a part of input. This denotes that expenses related to employees are not treated as cost but represent an investment. As a result, sum of Human Capital efficiency and Structural Capital efficiency is ICE or Intellectual Capital Efficiency Index.

As construction is dependant on market cycles a longer time period was observed. Data was collected for 2005 – 2008 year period. A mean was used as relevant input for calculation of ICE.

Qualitative survey

For inspection of organizational orientation on IC we have developed a framework that consists of a categorization and a questionnaire. Categorization was done according to IC management practice and its goal is to make distinction between companies according to their IC management. The methodology adopted is based on a review of the literature and a case study approach. The literature review provides the platform for developing specific themes for the case study investigations. This included the motivation for intellectual capital, choice of models and performance measures, knowledge management, which is central to innovation, and other factors associated with competitiveness. Following are 4 ways of understanding IC: Asset, Benefits, Baseline and Action (Sveiby, web). Questionnaire is made after categorisation and dispatched to ten relevant firms in Croatia that are according to statistical standards medium to large firms.

Table 1: Five categories of corporate attitude towards IC

ADVANCED IC MANAGEMENT – creating competitive advantage on basis of strategically managed IC obtained through practice and learning	IC importance for company is declared in its mission and vision. Competitiveness advantage is strictly based on IC management. IT tools for IC management are used. Referential IC database exists and is used by medium and high management for its allocation. Employee career management is defined through firms protocols with goal to maximise his/hers IC efficiency. Constant monitoring of individual and overall employee IC with profitability maximization goal. Defined policy for IC absorption, creation and measurement. Contract management also considers IC. Internal and external knowledge transfer processes am onitored and supported. Recruiting policy based on IC acquisition strategy. Dealing with IC security issues
SUCCESSFUL IC MANAGEMENT PRACTICE – creating competitive advantage through IC obtained through practice	IC importance is common fact through organization. Competitive advantage is based on IC gained through practice. Referential IC database exists and is used by medium and high management for its allocation. Internal certification for certain knowledge or skill. Employee revenues levelling with their competences progress and their IC efficiency. Interdisciplinary services that demand solid IC management.
BASIC IC MANAGEMENT	Basic understanding of IC management. HR dept. takes in consideration employee competences when recruiting or dispatching employees through organization. There is an institution of mentorship for unexperienced employees. Motivation programmes for employees to acquire knowledge and experience are active although on basic level of complexity. Knowledge is dominantly gained through practice. Internal certification for certain knowledge or skill.
AWARENESS OF IC IN ORGANIZATION	There is awareness about IC but there is no defined approach how to deal with it. HR dept. collects only basic data on employees who exclude competences and individual progress. Sometimes, employees attend lectures, only due to legal requirements.
WHAT IS IC? SORRY, NEVER HEARD OF	IC value is not recognized in the firm. Competitiveness is sought in other way.

RESULTS

Among 10 companies that have received the survey, we have had four respondents. Those respondents will be called as following: Company A, B, C, and D

Table 2: Four tables depicting four companies business performance in period 2005 - 2008

FIRM B (millions HRK)	*Operational profit*	*Employee expenses (salaries + other expenses)*	*Amortization*
2005	51,7	46.04	22.53

2006	-17,71	54.23	19.08
2007	33,5	67.48	30.53
2008	3,1	75.43	29.27
Mean	17,65	60,80	25,35

FIRM A (millions HRK)	*Operational profit*	*Employee expenses (salaries + other expenses)*	*Amortization*
2005	35.31	145.19	14.57
2006	56.09	165.18	16.32
2007	55.31	177.03	16.82
2008	30.29	196.78	20.09
Mean	44,25	171,045	16,95

FIRM D (millions HRK)	*Operational profit*	*Employee expenses (salaries + other expenses)*	*Amortization*
2005	3.43	161.87	16.04
2006	17.23	187.29	15.26
2007	11.98	195.85	15.60
2008	26.56	224.06	17.01
Mean	14,80	192,27	63,91

FIRM C (millions HRK)	*Operational profit*	*Employee expenses (salaries + other expenses)*	*Amortization*
2005	10	56	11
2006	36	63	12
2007	45	73	17
2008	45	82	20
Mean	34	68,5	15

Table 3: Calculation of Intellectual Capital Efficiency Index (ICE) according to VAIC methodology

	Operational profit	*Employee expenses*	*Amortization*	*Value Added (VA)*	*HCE = VA/HC*	*SC = VA - HC*	*SCE = SC/VA*	*ICE = HCE + SCE*
FIRM B	17	60	25	103	1,707	43	0,414	2,121
FIRM A	44	171	16	231	1,355	60,75	0,262	1,617
FIRM D	14	192	63	270	1,409	78,7	0,290	1,699
FIRM C	34	68	15	117	1,715	49	0,417	2,132

Qualitative survey has provided us an insight in firm's attitude and towards IC. Firm B is a major firm and as a consortium it has developed specific protocols for their IC management of certain aspects. Other methods they use depend on regional office although methodologies and protocols are adapted through the concern. Their approach to IC management was recognized as most developed one. On the other hand, rather developed but completely different was an IC management system developed by A. This system was developed in different environment and it provides good service to the firm and its management but due to lack of connection on today IC management practice its sustainability and evolution is questionable. Third firm in a row is rather young system that has experienced tremendous growth due to market demand. This company is still developing their IC system and for now it is only on declarative stage of IC management. Fourth firm manages it IC with basic HR tools and hasn't yet recognized intellectual potential to the full.

Table 4: Comparation of two research approaches

ICE	*ICE index grading*	*Qualitative grading*	*Qualitative survey*
1.	C	B	SUCCESSFUL IC MANAGEMENT PRACTICE
2.	B	A	
3.	D	C	BASIC IC MANAGEMENT
4.	A	D	AWARENESS OF IC IN ORGANIZATION

CONCLUSION

Findings and limitations

This research explores correlation between quantitative IC measurement method and qualitative IC management survey. A numerical method was used to evaluate IC efficiency in the firms. In above mentioned survey, companies have expressed their attitude towards IC and the way they manage it. A comparison has been done between these two surveys and a positive correlation among two is visible. Although data collection methods are different in nature a conclusion can be made that IC efficiency is higher in firms that are aware of their IC and are strategically and practically managing it. Also survey results point out that leveraging IC demands organizational orientation towards IC and common effort of employees. Research limitations are recognized in rather low number of examined enterprises due to fact that substantial number of contracting firms still does not recognize IC management as crucial for their sustainability due to favourable market conditions. Another limitation to the research is that examined firms all operate on same market; therefore research depicts single market conditions. Research was conducted in limited period of time. Authors consider that further research, with broader number of firms examined, could provide more balanced results.

REFERENCES

Edvinsson, L. And Malone, M.S. (1997), Intellectual capital – Realizing your Company's True Value by Finding its Hidden Brainpower, Harper Collins, New York, NY

Sveiby, K.E. (1997), The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets, Berrett-Koehler, San Francisco, CA

Skandia (1994), Visualising Intellectual Capital, Annual Report, Skandia

Bismuth, A., Yoshiaki T., (2008), Creating value from intellectual assets, Journal of Intellectual Capital Vol. 9 No. 2, 2008 pp. 228-245

Serenko A., Bontis N. (2004), „Meta-review of knowledge management and intellectual capital literature: citation impact and research productivity rankings" Knowledge and Process Management, Vol. 11 No 3, pp 185-98

Bontis, N. (19960), „There's a price on your head: managing intellectual capital strategically", Business Quaterly, Vol 60 No 4, pp 40-7

Sveiby, K.E. (1997), „The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets, Berrett-Koehler, Sna Francisco, CA

Sveiby Knowledge Associates web site

Egbu C.O. (2004), „Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: an examination of critical success factors", Engineering, Construction and Architectural Management, Volume 11, Nr. 5, pp. 301-315

Nonaka I. And Takeuchi, H. (1995), The knowledge Creating Company, Oxford University Press, Oxford

European Foundation for the Improvement of Living and Working Conditions (2005) „Trends and drivers of change in the European construction sector:Mapping report", EF/04/149/EN **h**ttp://www.eurofound.europa.eu/emcc/publications/2005/ef04149en.pdf,

Karl-Erik Sveiby 9 April 1998, updated April 2001.
http://www.sveiby.com/articles/IntellectualCapital.html

EMCC – European Monitoring Centre on Change (2004) Sector Futures – The knowledge-intensive business services sector

Grossman, M; McCarthy R.V.(2005);Qualitative approaches to knowledge management assessment, Issues in Information Systems, Vol VI, No 2.

Robinson H. S.;Anumba C. J.; Carillo P.M.; Al-Ghassani A.M.; (2005) Insight from research – Business performance measurement practices in construction engineering organizations, Measuring business exellence, Vol. 9 No.1pp 13-22

Nazri, J.A., Herremans, I.M. (2007) Extended VAIC model: measuring intellectual capital components. Journal of Intellectual Capital, 8(4), 595-609

Roos, J., Roos, G., Edvinsson, L., Dragonetti, N.C. (1997), *Intellectual Capital: Navigating in the New Business Landscape*, Macmillan, London., .

David O'Donnell, Philip O'Regan, Brian Coates Intellectual capital: a Habermasian introduction, Journal of Intellectual Capital Vol.1Nr. 2, 2000, pp 187-200

Bureau of Labor Statistics , United States Department of Labor - Publicatications – Construction;2009.; http://www.bls.gov/oco/cg/cgs003.htm

MODELING OF RISK FACTOR INFLUENCE ON CONSTRUCTION TIME OVERRUN BY APPLYING MULTIVARIANT REGRESSION ANALYSIS

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This paper analyses the problem of quantifying the significant risk factor influence on contracted construction time extension by applying the mathematical method of multivariant regression analysis. It can be said that the Bromilow „time-cost“ model significantly simplifies the problem, even to the extent which sometimes can not be considered as satisfying because it does not take into consideration the number of circumstances which lead to the event realization in the specific way. Under series of circumstances which lead to the specific event occurence those that are of the greatest significance must be proven in the exact way. The appropriate mathematical procedure is the multivariant regression analysis. This paper analyses 28 hydraulic engineering structures (water supply structures) in the context of modeling the significant risk factor influence on the construction time overrun. By applying the SPSS9 software the regression equation is to be obtained and the joint influence of risks on construction time overrun is then defined. However, it must be pointed out that the obtained equation is applicable to the research area only because the risk factors are specific in natural, economic and other circumstances for each research area.

KEYWORDS: multivariant regression analysis, construction target date, overrun, risk factors.

INTRODUCTION

Although the construction target date planning is a complex, demanding and a very important project management task, it is often paid insufficient attention in construction practice. The experience has shown that the construction date is more often the result of the client's wish rather than of the contractor's objective and previously verified capacities of completing the construction in time.

The early planning stage during which the construction time is mostly determined by a flat-rate estimation without the detailed planning technique application is of major importance.

Some countries, such as Australia, Great Britain, China, Texas, Malaysia and Croatia, have their own quick construction time assessment models which are recommendable for the early planning stages (Bromilow, 1969; Kaka and Price, 1991; Chan and Kumaraswamy, 1995; Choudhry and Rajan; Chan, 1999; Car-Pušić, 2004a) where the construction time is expressed solely in construction cost function. Those are the so called „time-cost“ models created by the Australian Bromilow. One of their main characteristics is their limited applicability to the research area due to economic and other differences. The research conducted on hydraulic engineering structures, water supply systems, built from 2001 to 2006, resulted in establishing the following model for Federation of Bosnia and Herzegovina (Žujo, 2008a):

$$T = 75 \times C^{0,56}$$

C being the construction price expressed in 100.000 KM (KM is the convertible mark, state currency of Bosnia and Herzegovina, 1 KM = 1 BAM = 0.51129 Euro).

Under conditions of expected increased risks the „time-cost“ model is not sufficient for an effective time assessment. Other than the construction price, which is the most influential factor of all, there are other factors, risk factors which are subject of research shown in this paper.

Research

The conducted survey has provided data about the constructed time overrun causes for 28 hydraulic engineering structures – water supply systems in Federation of Bosnia and Herzegovina from 2001 to 2006 (see Table 1). The data have been collected through interview and inquiry methods.

Risk factors which influence the construction time overrun are classified as (Car-Pušić, 2004b; Radujović, 1997; Radujković, 1993):

a. legal ones (local regulations, consents and permits, changes in law, standards)
b. political ones (political changes, elections, war, the existing agreements)
c. economical ones (regulations, rise in prices, currency rate, conditions of financing)
d. social ones (education, culture, seasonal work, strike, labor turnover)
e. natural ones (climate, soil, ground waters, natural disasters)
f. contracting (unrealistic due date, unrealistic price)
g. technical documentation (delays, incompleteness, inaccuracy, new solutions)
h. organization (poor management, poor organization)
i. technology (poor technological solutions, out-of-date technology)
j. resources (deficiency of labourers, deficiency of machines, mechanical failures, delays in delivery of materials)
k. human factor (productivity, sick-leaves, motivation, mistakes and oversights).

Table 1: Data base from the field

Structure	**Construction time [in days]**			**Risk sources**			
	Contracted	**Effectuated**	**Difference**	**Factor**	**P_V [in days]**	**P_V [%]**	**P_V^I [%]**
1	2	3	4	5	6	7	8
1	120	238	118	c	6	5,00	5,08
				e	78	65,00	66,10
				a	34	28,33	28,81
2	90	210	120	a	80	88,89	66,67

				g	40	44,44	33,33
3	240	330	90	j	18	7,50	20,00
				e	45	18,75	50,00
				a	27	11,25	30,00
4	15	15	0	-	0	0,00	0,00
5	60	80	20	g	15	25,00	75,00
				e	5	8,33	25,00
6	90	105	15	g	10	11,11	66,67
				a	5	5,56	33,33
7	90	100	10	e	10	11,11	100,00
8	60	80	20	a	20	33,33	100,00
9	225	300	75	j	20	8,89	26,67
				a	25	11,11	33,33
				g	30	13,33	40,00
10	220	220	0	-	0	0,00	0,00
11	180	180	0	-	0	0,00	0,00
12	96	96	0	-	0	0,00	0,00
13	145	325	180	a	60	41,38	33,33
				g	120	82,76	66,67
14	20	20	0	-	0	0,00	0,00
15	60	150	90	e	50	83,33	55,56
				g	40	66,67	44,44
16	225	240	15	j	8	3,56	53,33
				g	7	3,11	46,67
17	225	240	15	j	8	3,56	53,33
				g	7	3,11	46,67
18	60	67	7	e	7	11,67	100,00
19	60	75	15	a	15	25,00	100,00
20	90	90	0	-	0	0,00	0,00
21	180	?	?	?	?	?	?
22	60	120	60	e	30	50,00	50,00
				g	30	50,00	50,00
23	180	200	20	a	20	11,11	100,00
24	180	180	0	-	0	0,00	0,00
25	180	240	60	g	60	33,33	100,00
26	180	180	0	-	0	0,00	0,00
27	180	240	60	g	60	33,33	100,00
28	180	180	0	-	0	0,00	0,00

P_v – contracted time overrun regarding risk factors
P_{v^1} - single risk factor share in total time overrun

Out of 28 structures, the contracted time overrun occurred at 18 structures. The structure under ordinal number 21 was excluded from the data base from the start because it has never been wholly completed. The maximum due date overrun is 150% while at average the contracted due date was overrun for 33.29%. A total of five different risk factors occurs:
a – the legal one (at 9 structures)
e – the natural one (at 7 structures)
g – technical documentation (at 11 structures)
j – resources (at 4 structures)
c – the economical one (at 1 structure).

No case of construction completion before due date was noted. By its intensity, the strongest factor is the risk factor g, technical documentation, which reaches summarily 366.19%. This is actually the total amount of percentage overruns of single contracted due dates. The weakest in intensity is the risk factor, “resources” which is 23.51%. The average overrun is 90.39%.

Basic Model Theses

Proceeding from the hypothesis that the main risk factors such as technical documentation, natural risk factors, legal risk factors, etc., are of crucial significance and that the total planned time overrun can be expressed in dependence to those factors, it is assumed that there is a linear dependence between the chosen variables. Therefore a multi-variant linear regression is used for assessment.

The multivariant regression analysis is a mathematical procedure of discovering the joint influence of several independent variables on the one dependent variable in which process the number of measurements is significantly larger than the participating variables (Ivanović, 1994). This method is adequate for analyizing those occurrences whose main event can be explained as “coincidental“.

The following regression equation is assumed in the analyzed problem:

$$Y = a_1 x_1 + a_2 x_2 + \ldots + a_n x_n$$

$Y = \Delta T$	being the difference between the effectuated x and the contracted x construction time (that is, the construction due date overrun) expressed in percentage in relation to the contracted due date
$a_0, a_1, \ldots, a_n$	being regression coefficients
$x_1, x_2, \ldots, x_n$	being risk factors which influence the contracted due date change and are expressed in time change percentages in relation to the contracted due date

The final result of the multi-variant regression analyisis are the assessed regression coefficients (a_1, a_2,...a_3) which indicate the single changing influence of each independent variable (x_1, x_2,.....x_3) on the dependent variable (y). The complete regression equation indicates the effects of the joint simultaneous influence of all the independent variables on the dependent one.

Multi-variant Linear Regression Application on Data Base

Model creation is carried out in following phases:

- creation of a basic – input regression matrix,
- computer calculation of correlation matrix,
- elimination of those independent variables which insufficiently influence the due date overrun occurrence,

- creation of a new – reduced regression matrix which is composed of those independent variables whose influence is significant for the occurrence,
- computer calculation of correlation coefficient, determination coefficient, corrected determination coefficients, standard assessment error, regression coefficient for a 95% confidence interval,
- drawing of a “estimated values y – residuals” diagram in order to additionally check the results. The scattered diagram points point out accidental mistakes,
- drawing of a “estimated values y – effectuated values” diagram in order to additionally check the results.

By implementation of the stated phases the required regression coefficient values are obtained and the regression equation is adopted. The SPSS9 computer program was used in this paper.
After the initial regression matrix has been created, those independent variables which have the largest influence on the dependent variable are determined by correlation matrix computer calculation. See Table 2. Those are the variables whose correlation coefficients R are larger than or approximately 0.50 because the correlation coefficient by which the relation strength between the dependent and the group of independent variables is expressed ranges from 0 to 1. Therefore the independent variables *c* and *j* are ignored and the variables *e*, *g* and *a* are analyzed further. Based on those data a reduced regression matrix is created (see Table 3).

Table 2: Correlation Matrix

Correlations

		Y	C	J	E	A	G
Y	Pearson Correlation	1,000	,286	-,057	,664**	,600**	,830**
	Sig. (2-tailed)	,	,148	,776	,000	,001	,000
	N	27	27	27	27	27	27
C	Pearson Correlation	,286	1,000	-,075	,500**	,191	-,117
	Sig. (2-tailed)	,148	,	,710	,008	,340	,561
	N	27	27	27	27	27	27
J	Pearson Correlation	-,057	-,075	1,000	-,060	-,033	-,127
	Sig. (2-tailed)	,776	,710	,	,768	,869	,527
	N	27	27	27	27	27	27
E	Pearson Correlation	,664**	,500**	-,060	1,000	-,031	,386*
	Sig. (2-tailed)	,000	,008	,768	,	,880	,047
	N	27	27	27	27	27	27
A	Pearson Correlation	,600**	,191	-,033	-,031	1,000	,346
	Sig. (2-tailed)	,001	,340	,869	,880	,	,077
	N	27	27	27	27	27	27
G	Pearson Correlation	,830**	-,117	-,127	,386*	,346	1,000
	Sig. (2-tailed)	,000	,561	,527	,047	,077	,
	N	27	27	27	27	27	27

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

y being a dependent regression variable which represents the total due date overrun percentage

e being an independent regression variable which represents the due date overrun percentage caused by risk factor influence – the natural one

g being an independent regression variable which represents the due date overrun percentage caused by risk factor influence – technical documentation a being an independent regression variable which represents the due date overrun percentage caused by risk factor influence – the legal one

c being an independent regression variable which represents the due date overrun percentage caused by risk factor influence – the economical one

j being an independent regression variable which represents the due date overrun percentage caused by risk factor influence – resources

Table 3: Reduced Regression Matrix

y	e	a	g
98,33	65,00	28,33	0,00
133,33	0,00	88,89	44,44
37,50	18,75	11,25	0,00
0,00	0,00	0,00	0,00
33,33	8,33	0,00	25,00
16,67	0,00	5,56	11,11
11,11	11,11	0,00	0,00
33,33	0,00	33,33	0,00
33,33	0,00	11,11	13,33
0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00
0,00	0,00	0,00	0,00
124,14	0,00	41,38	82,76
0,0	0,00	0,00	0,00
150,00	88,33	0,00	66,67
6,67	0,00	0,00	3,11
6,67	0,00	0,00	3,11
11,67	11,67	0,00	0,00
25,00	0,00	25,00	0,00
0,00	0,00	0,00	0,00
100,00	50,00	0,00	50,00
11,11	0,00	11,11	0,00
0,00	0,00	0,00	0,00
33,33	0,00	0,00	33,33
0,00	0,00	0,00	0,00
33,33	0,00	0,00	33,33
0,00	0,00	0,00	0,00

Computer calculations of multi-variant linear regression parameters are shown in Table 4.

The regression model representative quality is expressed by a determination coefficient R^2 whose value ranges from 0 to 1. The larger value indicates that the chosen model has explained the larger part of dependent variable variations. The representative quality of the model is also expressed by a corrected determination coefficient AR^2 whose value is the same or less than the determination coefficient value.

The standard assessment error (Std. Error) is an inclination indicator of the real from the regression values from the statistical point of view. (Johnson and Bhattacharyya, 2001; Marić, Dukič, Dukić; Pauše, 1993).

Apart from the stated ones, several other basic indicators of multi-variant linear regression have been presented such as:

- Non-standardized regression coefficients B with their standard assessment errors. Should an independent variable increase for a unit and all the others remain unchanged, the coefficient B indicates what the expected change of average independent variable value is.
- The standardized regression coefficients β are actually the transformed regression coefficients expressed in a standard form.
- The test values t with their pertaining significance (Sig.) which is used for testing the hypothesis about the single independent variable significance. Based on their significance, that is, p – value the hypothesis about the observed regression coefficient significance is either accepted or rejected.
- The bounds of 95% confidence interval of non-standardized regression coefficients B (lower bound, upper bound).

Table 4: Regression results

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,998[a]	,997	,997	2,6709

a. Predictors: (Constant), G, A, E

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53604,571	3	17868,190	2504,711	,000[a]
	Residual	164,078	23	7,134		
	Total	53768,649	26			

a. Predictors: (Constant), G, A, E

b. Dependent Variable: Y

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1,188	,635		1,872	,074	-,125	2,501
	E	1,004	,026	,491	38,592	,000	,950	1,058
	A	1,029	,029	,447	35,734	,000	,970	1,089
	G	,953	,027	,486	35,874	,000	,898	1,008

a. Dependent Variable: Y

Regression Analysis Results

According to the results shown in Table 4 the following regression equation is obtained:

$$y = 1{,}188 + 1{,}004e + 0{,}953g + 1{,}029a \qquad (3)$$
$$R^2 = 0{,}997$$
$$R = 0{,}998$$

y	being the dependent regression variable which represents the total due date overrun percentage
e, g, a	being the independent regression variables
R	being the correlation coefficient
R^2	being the determination coefficient

Analysis of the Obtained Results

$$y = 1{,}188 + 1{,}004e + 0{,}953g + 1{,}029a \qquad (4)$$

The conducted regression analysis has shown that the risk factors which have the largest influence on the due date overrun are: the natural ones (unfavorable climate), technical documentation (incomplete and inaccurate) and different consents and permits.

The constant in the equation has the value of 1.188. That means that if there were no realistic estimation for risk factor occurrence, the due date overrun would be 1.188%. The possible assumption is that this constant is redundant in the model and that such form is the result of including those structures in the analyzed specimen which had no due date overrun (there are no less than 33% of such structures in the specimen).

The regression coefficient of 1.004 which stands by the risk factor e (the natural one – the climate) indicates that the due date overrun increases in average for 1.004% if the risk factor – the climate increases for 1% providing that the independent variables g (technical documentation) and a (the legal one) remain unchanged. There is an analog explanation for the regression coefficient of 0.953 which stands by the risk factor g (technical documentation) and the regression coefficient of 1.029 which stands by the risk factor a (the legal one).

The test values F and t as well as the empirical significance values indicate that all the previously described independent variables (influential values) have a significant influence on the due date overrun.

The correlation coefficient values (0.997) and determination coefficient values (0.998) are close and their values indicate a high percentage of mathematical description of construction time overrun with help of the mentioned influencing values.

Practical Application of the Obtained Results

By applying the proposed methodology what must be assessed is the construction time overrun for a water supply system whose construction time according to the "time-cost" model is 60 days (for estimated costs of 294.663 Euro). The construction is planned for the beginning of the winter period. Changes in technical documentation are expected which possibly imply issuing of additional consents by the competent authorities.

The total construction time will be determined as a total of "time-cost" model values (Žujo, 2008b) and construction time overrun according to the model offered in this paper.

$$T_{UK} = T + \Delta T \text{ (in days)} \tag{5}$$

T_{UK} being the total planned construction time
T being the planned construction time according to the "time-cost" model
ΔT being the planned construction time overrun due to risk factors.

Since there is a real assumption of risk factor occurrence and their influence on the planned construction due date, the team of experts composed of experienced professionals from the construction operation field assesses the risk factor influence amount:

- The works are to start in November when the meteorological conditions are unfavourable, so that the value e = 15% is assessed for the e factor.
- Changes of technical documentation are expected, so that the value g = 4% is assessed for the factor g.
- Because of a possible interruption of works due to delays in issuing permits and consents regarding the changes in technical documentation, the factor a is assessed to be 2%.

The formula $\Delta T = 1{,}188 + 1{,}004e + 0{,}953g + 1{,}029a$ will be applied,

$\Delta T = 1{,}188 + 1{,}004 \times 15 + 0{,}953 \times 4 + 1{,}029 \times 2$
$\Delta T = 22{,}118\%$
$\Delta T = 13 \text{ days}$

The construction time overrun for a water supply system whose estimated costs are 294.663 Euro is assumed to be 13 days. The total construction time is therefore estimated at 73 days.

CONCLUSION

The conducted research leads to the conclusion that the contracted construction time overrun of water engineering structures, water supply systems, is mostly influenced by risk factors relating to the incompleteness of the technical documentation, poor climate and consents and permits.

The discussed methodology is adequate when the influence of single risk factors is assumed to be strongly manifested and when the extent of their influence on construction time overrun which was determined by the "time-cost" model can be reliably estimated.

Extremely high correlation coefficient and determination coefficient as well as the prominent significancy obtained through multiple linear regression indicate that the proven hypothesis was set within the frames of research program and that the obtained results have their value when making decisions related to the water supply system construction. On the other hand, there is space for further research with classification of risk factors differing from the proposed one and with analyses of the structures regarding the type of contract, technical characteristics, etc.

REFERENCES

Bromilow, F.J. (1969) Contract Time Performance Expectations and the Reality, Building Forum 1(3), 70-80

Car – Pušić, D., (2004) Methodology of Anticipating Sustainable Construction Time, doctoral thesis, Faculty of Civil Engineering, Zagreb

Chan, D.W.M. and Kumaraswamy, M.M. (1995) A Study of the Factors Affecting Construction Duration in Hong Kong. Construction Management and Economics, 13(4), 319-333

Chan, A. P.C. (1999) Time–cost Relationiship of Public Sector Projects in Malaysia. International Journal of Project Management, 19, 223-229

Choudhry, I., and Rajan, S.S.., Time–cost Relationiship for Residential Construction in Texas, Texas A$M University, College Station

Ivanović, M., (1994) Research by Multi-variant Regression, Faculty of Civil Engineering, Sarajevo

Johnson, A., Bhattacharyya, G.K., (2001) Statistics: Principles and Methods, University of Wisconsin at Madison

Kaka, A., and Price, A.D.F. (1991) Realitionship between Value and Duration of Construction Projects. Construction Management and Economics, 9, 383-400

Marić, T., Dukić, D., Dukić, G., Mathematical Model of Determination as Cost, Time, and Quality Management Support by Regression Analysis Application, Hrvatske vode – časopis za vodno gospodarstvo br. 60, (Croatian Waters – Water Management Sector Magazine)

Pauše, Ž., (1993) Introduction to Mathematical Statistics, Školska knjiga Zagreb

Radujković, M., (1997) Risk Management at Construction Projects, Građevinar 49 (5), 247-255

Radujković, M., (1993) Influential Factor Analysis at Construction Due Date Optimalisation, doctoral thesis, Faculty of Civil Engineering, University of Zagreb, Zagreb

Žujo, V., (2008) Construction Project Management through Construction Time Planning, doctoral thesis, Faculty of Civil Engineering, Mostar

RISK ASSESSMENT IN CONSTRUCTION INDUSTRY

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Construction industry is a highly risky process mostly because of its long life duration and unique product as a result of construction, and also many different professions are involved in one project. Generally, risks in construction industry should be controlled and reduced during design, procurement and construction phase, and the most important activities are define risk management plan from the very beginning and to assign risks to different project members and to manage their execution. In this paper risks on a project in initial phase will be presented, cost and duration risks and complete contingency for the previously defined budget will be described. Statistical data for one project in design phase will be analyzed and general comments and recommendations will be proposed. Also, general method for calculating risks will be presented.

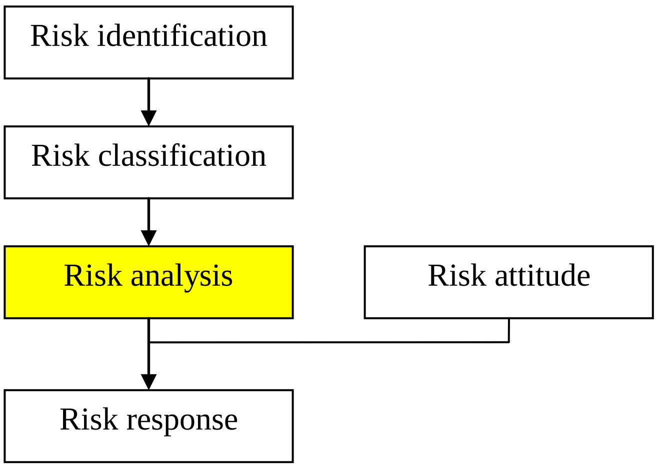
KEYWORDS: construction, risk management, forecasting.

INTRODUCTION

Project management in the construction industry is mostly risk management oriented, and the main goal is to achieve risk control in all project phases. Great and long-lasting construction projects are exposed to many different risks, so the most important is to define risks at the very beginning of the project and to control and reduce them during the project execution. Risk management is a very important segment of project management, and generally the main target on a construction projects is to manage cost and time since quality is very often defined in an agreement. In order to systematize risk overview management it is necessary to carry out risk analysis. Risk Analysis is a systematic approach to understanding these risks and their impact so that the decision makers can account for them in contingency planning, as well as plan for risk mitigation. The project risk can be in many areas, such as traffic estimation, product pricing, host country's fiscal policy or political uncertainty, EHS risk, etc.

RISK ANALYSIS

Risk assessment should be the process which passes through few phases, and during risk generation assessor should overview all risks on the project and their changes. Generally, the risk management framework is [1]:



There are four objectives of doing risk analysis:

- to set the project's funding requirement during Budget or Authorization for Expenditure
- to assess the highest risk items at different project stages so that mitigation can be planned
- to return any excess contingency fund during project execution, so that the fund can be used more profitably in other areas
- to set Stretch Target as a challenge to the Project Team

The most frequent risks on the construction projects are related to:

- land and property
- design
- politics and technique / technology
- infrastructure
- business and commerce
- pre-construction
- site establishment
- procurement
- construction

During the initial phase risks are not completely defined, so it is very difficult to make decision about future project strategy. As an example, one big marina and residential project was in danger with many general risks, and the main risks were identified as in the following table. Also, the in the table is presented description and management action for all identified risks.

Reference No	Heading	Description of Risk	Management Action
1.0 General			
1.1	Local market	Projects in the Kotor area create high demand for construction resources	Plan and secure commitment for human and material resources
1.2	Montenegrin legislation	Mis-understanding of Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team
1.3	Montenegrin legislation	Change in Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team
1.4	Montenegrin legislation	Montenegrin approvals take longer than planned	Build in contingencies in master programme ; Keep close to Montenegrin and municipal authorities ; Monitor progress
1.5	Local infrastructure	Local infrastructure cannot support the development	Early contact with local authorities and utility companies ; Allowance in cost plan
1.6	Utility companies	Poor performance by utility companies for infrastructure provision	Agree scope, deliverables and programme with utilities companies
1.7	Utility companies	Change in previously agreed plans by utility companies/municipality	Agree scope, deliverables and programme with utilities companies ; Regular liaison with utility companies/municipal authorities ; Monitor progress
1.8	Local market	Unfamiliarity with Montenegro	Early meetings and regular contact with Montenegrin authorities, utility companies, etc. ; Identify good local partners and maintain regular contact with them ; Identify other International companies active in Montenegro and seek
1.12	Wastewater solution	Currently assuming connection to new regional strategy main sewers, which should be in place by summer 2009	Monitor progress of regional strategy implementation ; Identify contingency plans
1.13	Storm water solution	Existing combined discharges from Tivat cross site. These must be intercepted and not allowed through development to contaminate marina/ bay	Review results of Ehting survey ; Monitor programme for local infrastructure implementation ; Identify contingency plans
1.14	Potable water supplies	New regional supply to be available 2010. Also supply from Herceg Novi is possible solution.	Identify contingency in liaison with local authorities. ; Monitor Regional supply scheme implementation ; Ensure design features incorporate measures to reduce consumption
1.15	Power supplies	Solution will require off-site works – new distribution lines and sub-stations. Possible 3rd party land issues.	Develop robust strategy for power supplies ; Confirm off-site routes and requirements ; Add works to Tivat regional strategy ; Procure via local distribution co as necessary
1.16	Land permit and Building permit	Land Permit and Building Permit applications – possible delay if documentation is not full and complete. Time for approval by Ministry is not	Use local advisors/consultants to define exact scope of information to be produced at each stage

At the planning phase of that project with very strict time frame and very big penalties management decided to proceed risk analysis and to define time and cost contingencies. The result was very interesting:

Cost risk	320,000 Euro	/	Time risk	120 days
	260,000 Euro	/		195 days
	275,000 Euro	/		150 days

As the penalties were 500 Euro per day third combination was optimal. That project was managed with additional specialist, and more consultants during the design phase, so the risk management plan defined at the initial stage helped the project finished successfully.

General risks during design and procurement (tender) stages are how to coordinate design and to estimate cost, as well as to prepare cost plan in a realistic boundaries. Cost and programme is very difficult to estimate. Thus, during the pre-construction phase it is very important to manage all design risks and to organize design according to design brief as well as to minimize budget increase.

After risk elements identification, possible scenarios for all risk elements should be evaluated. The worst case or the most pessimistic scenario and the best case or the most optimistic scenario should be considered as the maximum and minimum impacts of risk elements.

Not all risk elements will impact all cost items. For example, labor productivity will impact only labor cost items and not the material cost items. Also a risk item, if it impacts on several areas, may not impact on them equally. For example, if major equipment scope changes, it will affect the equipment cost significantly, but it will also affect the corresponding bulk material and labor cost by a lesser amount.

For the risk calculation the key factors are the variation from initially defined value (cost or programme) and the probability that the variation can occur. For example, the estimated foundation cost is 1,000,000 £ and the maximum expected variation is 200,000 £, with the probability of 30 %. The expected cost is:

1,000,000 £ + 0,30 x 200,000 £ = 1,060,000 £

The following matrix is an example how to categorize risks according to cost and time variation and probability percentage.

%Probability / (€) Cost / Time	100%	80%	60%	40%	20%
Greater than 3,000,001 max 5,000,000 / Greater than 90 days max 180 days	25	20	15	10	5
Up to 3,000,000 / Up to 90 days	20	16	12	8	4
Up to 1,000,000 / Up to 30 days	15	12	9	6	3
Up to 500,000 / Up to 14 days	10	8	6	4	2
Up to 100,000 / Up to 7 days	5	4	3	2	1

This matrix presents the guideline for assigning the risk categories of importance 1,2,3,4 or 5 and is based on a combination of (€) Cost / Time and Probability Percentage. The color indication presents proposal how to categorize risks as a low (green), middle (orange) and red (high) risk.

RISK CALCULATION AND OVERVIEW

Risk register is a document which should be updated regularly and it is one of the key documents on the project. All risks and all risks management actions for risk reducement or control should be described in the document. For all the risks a response could be to accept, reduce, transfer or avoid them. It is very important to propose management action based on current situation on the project. Every risk should be assigned to the specific owner and close out date for every risk should be defined.

Since the cost and duration and cost of the project are in an interrelation and the changes of cost very often cause changes in duration or vice versa, the risk calculation is mostly related to the cost and duration.

Cost of Risk Occurrence (€K) Raw Information			Duration of Risk Occurrence (Weeks) Raw Information				Cost of Risk Occurrence (€K) With Probability Factor					
Min Likely	Most Likely	Max Likely	Min Likely	Most Likely	Max Likely	Probability of Occurrence (%)	Min Likely	Most Likely	Max Likely	Expected Exposure to Risk	Category of Risk A, B or C	Risk Response

				Cost Rating	Duration Rating	Highest Rating
Risk Ref	Risk Title	Description of Risk	Management Action	0 - 5	0 - 5	
1.0 General						
1.1	Local market	Projects in the Kotor area create high demand for construction resources	Plan and secure commitment for human and material resources	3	4	4
1.3	Montenegrin legislation	Change in Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team	3	3	3
1.5	Local infrastructure	Local infrastructure cannot support the development	Early contact with local authorities and utility companies ; Allowance in cost plan	5	4	5
1.6	Utility companies	Poor performance by utility companies for infrastructure provision	TC to be provided from utility companies after full submission of required capacities from the Client	2	4	4
1.12	Wastewater solution	Currently assuming connection to new regional strategy main sewers, which should be in place by summer 2009.	Monitor progress of regional strategy implementation ; Identify contingency plans	1	1	1
1.13	Storm water solution	Existing combined discharges from Tivat cross site. These must be intercepted and not allowed through development to contaminate marina/ bay	Review results of Ehting survey ; Monitor programme for local infrastructure implementation ; Identify contingency plans	1	1	1
1.14	Potable water supplies	New regional supply to be available 2010. Also supply from Budva is possible solution.	Client instruction is to considerate water supply from Budva. Regulary check the progress of that project.	3	4	4
1.15	Power supplies	Solution will require off-site works – new distribution lines and sub-stations which may have possible 3rd party land issues.	Coordinate with electrical utility company, and together with them find best solution to speed up the process.	1	4	4
1.16	Land permit and Building permit	Land Permit and Building Permit applications – possible delay if documentation is not full and complete. Time for approval by Ministry is not predictable	Use local advisors/consultants to define exact scope of information to be produced at each stage	5	4	5

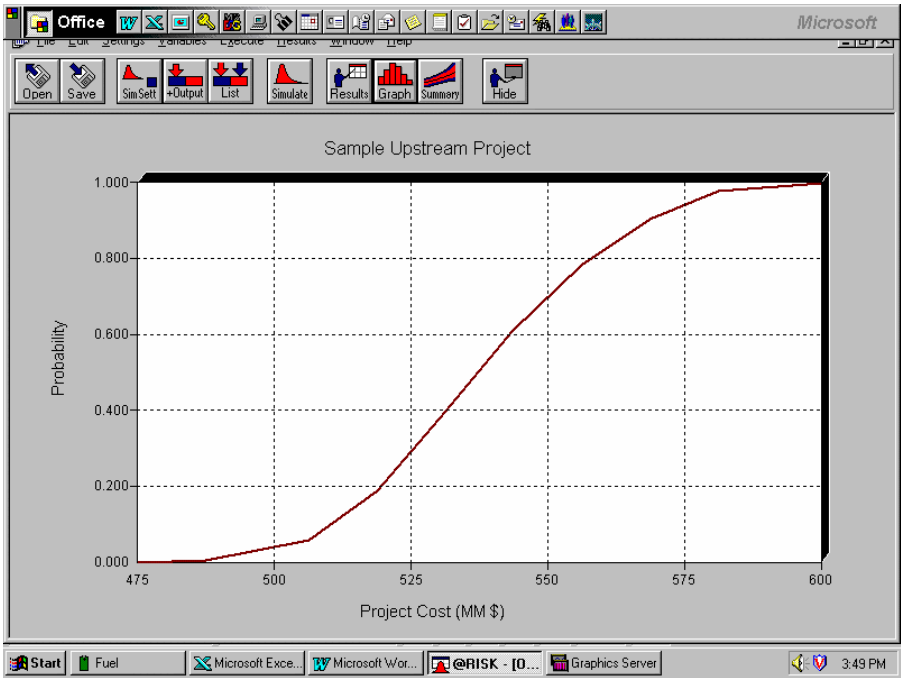
Cost Risk			Duration Risk			Probability Rating	Probability %	Risk Rating Number	Factored Risk Cost	Factored Risk Duration
Min €	Max €	Ave. Cost	Min days	Max days	Ave. Duration	0 - 5				
500,001	1,000,000	750,001	31	90	60.5	1	20%	4	150,000.10	12.10
500,001	1,000,000	750,001	15	30	22.5	1	20%	3	150,000.10	4.50
3,000,001	5,000,000	4,000,001	31	90	60.5	4	80%	20	3,200,000.40	48.40
100,001	500,000	300,001	31	90	60.5	2	40%	8	120,000.20	24.20
0	100,000	50,000	0	7	3.5	1	20%	1		
0	100,000	50,000	0	7	3.5	1	20%	1	10,000.00	0.70
500,001	1,000,000	750,001	31	90	60.5	2	40%	8	300,000.20	24.20
0	100,000	50,000	31	90	60.5	4	80%	16	40,000.00	48.40
3,000,001	5,000,000	4,000,001	31	90	60.5	4	80%	20	3,200,000.40	48.40

The tables above show a real example of risk calculating at a great construction project. It is very important to describe the risk and management action in order to keep it on an acceptable level or possibly to eliminate it. This method is applied to determine the impact of risk on costs and project duration in the range 1 - 5, where each value presents our assessment how much a certain risk can affect cost increase and project delay. Besides these values, the assessor should also determine the probability of risk occurrence during the project completion. Through a calculation determined in advance factual costs and time risks are obtained.

This calculation functions based on the principle of fuzzy logic as it should be taken into account that it is difficult to determine how much a certain risk can affect the project, so the values are kept within specific limits. It is very important to determine how much all the risks can increase the project value and duration, however, it should be taken into consideration that many risks are overlapped, so that through this calculation a great reserve or contingency is very frequently obtained.

The following diagram presents the curve that actually shows the probability in which range the project costs can vary. Considering that costs are generally estimated as a fixed value, by this approach the probability of completing the project for this value would be added to the value. For example, it can be seen from this graph that the project can be completed for $ 550 million with the probability of 68%.

These values have been gained in such a way that some items from the bill of quantities were given the value with definite probability, and thus these cost values of a complete project have been gained from the analyzed project.



CONCLUSION

The principal objective of risk analysis and calculation is to offer the decision maker more variants of cost and project duration, perceiving the probability to complete the project within this range. It is also essential to forecast reserves, with which the risk from budget exceeding is reduced. The decision maker makes the decision with what risk level the project will be completed based on the data at his disposal. During the project completion all these values must be controlled and corrective actions must be proposed.

REFERENCES:

Flanagan R., Norman G., "Risk Management and Construction", Blackwell Science, 2003.

Ivković B., Popović Ž., (2005). "Construction Project management", Građevinska knjiga, Beograd (in Serbian)

Brook M., (2008) "Estimating and tendering for construction work", Oxford : Butterworth-Heinemann

Hinze J.W., (2004) "Construction Planning and Scheduling", Pearson Prentice Hall

Jamadi O.A., Almishari S., "Risk assessment in construction", Journal Construction Engineering Management, Vol 129, No 1, 2003, p. 492-500

Edwards L., (2008) "Practical risk management in the construction industry"

Koller G.R., (2007) "Risk assessment and decision making in business and industry"

OPTIMIZATION OF STEEL PLANE TRUSS MEMBERS CROSS SECTIONS WITH SIMULATED ANNEALING METHOD

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This paper presents an optimal design problem analysis, with the Simulated Annealing method. The main algorithm represents seeking for the solution in the search space with the aim to minimize a value of the subject function. A stochastic procedure has been proposed to determine organization rule analog to atomic organization with minimum energy. The strategy which avoids getting trapped at a local minimum point is the main preference of this method over others. A simple and significant tool considering optimal cross sections of plane truss members has been ensured by this method. Also, this work proposes a comparison of our results with the results obtained in other methods application. In addition, the advantage of this method over others has been established.

KEYWORDS: simulated annealing, optimization, total weight, steel truss.

INTRODUCTION

Despite its name, Simulated Annealing has nothing identical either with simulation or with annealing. Simulated Annealing is a technique of problem solving based on analogy with the method of annealing metal in order to increase its strength. When a heated metal cools off very slowly, it forms its structure in the shape of simple (minimal energy) crystal lattice – thermo-dynamic equilibrium in compliance with Boltzman's factor of probability e^{-E/k_BT} for atom configuration during metal melting. In physics, every set of all system atoms is valued by Boltzman's probability factor, where E is configuration energy, T is temperature expressed in ^{0}C or K, and kB is Boltzman's constant equals kB=1,380650524 * 10^{-23}J/K. When a metal is forcibly cooled, atoms will form metastable system, non-crystal lattice, irregular and weak structure, with high energy as a consequence of internal forces.

For the first time the method of Simulated Annealing was applied in 1953 (Metropolis, 1953) to solve non-linear optimization problems. In his work, Metropolis with his associates developed Monte Carlo method of "calculating characteristics of any substance that can be considered as a compound of mutually dependent molecules". This inspired Kirkpatrick (Kirkpatric et al, 1983) to develop an algorithm of Simulated Annealing (SA) that can be applied to solving various optimization problems. The „Metropolis" procedure is an exact copy of this physical process, which can be used in atom configuration simulating in termo-dynamic equilibrium at a given temperature. New geometry has been designed as a random atom disposition in each iteration. Energy generated in every new generation is being calculated, as well as the probability that exactly such a geometry will be generated.

In the analogy between a combinatorial optimization problem and the process of annealing, the states of bodies represent possible solutions of optimization problems, the states of energy correspond to the value of the concerned functions, the state of minimal energy corresponds to optimal problem solution, and accelerated cooling can be observed as local optimum. Customary, the algorithm consists of iterative steps. Every iteration consists of random change of instantaneous solution in order to create a new solution in its neighborhood. The neighborhood is defined by the selection of generational mechanism.

The ideas of function and solution are defined in the same way as in Genetic Algorithm methods. From the same method various mechanisms can be developed, like, for example, mutations and convergence. General algorithm consists of solution searching within solution area that minimizes the value of a given function, namely annealing can be considered as a stochastic procedure in defining the organization of atoms with minimal energy. The advantage of this method over others is that there is no probability of „getting the solution stuck“ in the local minimum area. The probability that the value of the requested considered function will be increased can be expressed according to Boltzman-Gibbs' disposition:

p=exp ($-\Delta f\, k_B/ T$)...(1)
where Δ is a value change of the considered function f, k_B is Boltzman's constant, and T is a control parameter called *temperature.* The counter of random numbers then makes numbers evenly arranged in the interval (0, 1), and if the sample is smaller than p, the step is accepted.

Analogous to physical process, temperature T is initially high. That is why the probability referring to acceptance of the step that increases the considered function is also initially high. The temperature is being significantly reduced as the process continues, i.e. the system is *cooling* slowly. Eventually, the acceptance of the step that increases the considered function becomes exceptionally small. Generally, the temperature is being reduced in compliance with *annealing scheduling*. When defining annealing scheduling for annealing simulation algorithm four parameters must be defined. These are: the initial temperature, the rule of changing temperature, the number of iterations at each temperature step and the termination criterion. Several different annealing dispositions have been presented in bibliography. Continual and non-monotonous schemes temperature reduction involve very simple annealing strategies (geometric annealing scheme etc).

Most frequently applied annealing disposition is *exponential cooling*. It begins at some initial temperature, T_o, and it is being reduced in temperature steps in compliance with $T_{k+1}=\alpha T_k$; where $0<\alpha<1$. Certainly, a fixed number of steps at each temperature must be adopted before the calculation is continued. The algorithm is terminated either when the temperature achieves certain final value, T_f, or when some other termination criterion is met.

The value selection of α, T_o and T_f is completely dependent on the type of problem. Empirical records show that it is most convenient to adopt value 0.95 for a, and the initial probability 0.8.

The initial generation is usually adopted by the principle of coincidence. The algorithm presented below is based on application in bibliography (Huang and Arora, 1997):

Step 1: Select initial temperature T_0 (the expected global minimum of function) and a visible point $x(0)$. Calculate $f(x(0))$. Select the integer value L (e.g. the limit of iterations in order to obtain the expected minimal value). Set the iterative counter as K=0 and other counter k=1.

Step 2: Create a new point *x(k)* in the neighborhood of the current point. If the point is within the area of the impossible, create a new point until the probability of existence is satisfied. Create the random number *z* evenly disposed in the interval [0,1]. Calculate $f(x(k))$ and $\Delta f = f(x(k)) - f(x(0))$.

Step 3: If $\Delta f < 0$, as a new best point *x(0)* arose, set $f(x(0)) = f(x(k))$ and move to step 4. Invasively, calculate the disposition of probability function (equation 1). If $z < p(\Delta f)$, then *x(k)*is treated as a new best point and go to step 4. Invasively, return to step 2.

Step 4: If k < L, then set k=k+1 and go to step 2. If k > L and if any other termination criterion is satisfied, then stop. Invasively, go to step 5.

Step 5: Set K = K+1, k =1; set TK = rTK-1; move to step 2.

The authors Huang and Arora then suggest:

- L has the value of 100, and r= 0,9.
- In step 2 only one point is generated in the neighborhood in a period of time. Namely, although Simulated Annealing (SA) usually creates project points without the need for information on function or gradients, the matter is not in a mere research of coincidence in the whole research area. In an early stage, a new point can be located distantly from the current point in order to accelerate the process and to avoid „drawing into" local minimum. After the temperature is lowered, the new point is usually generated in the immediate vicinity with the aim to focus onto the local area. This is controlled by defining the procedure about the size of the steps.
- In step 2, the newly created point must be possible. To achieve this, some other method can be applied, e.g. the *method of penalty functions*.
- The process is done until "freezing point" is reached. In step 4, the following has been suggested: a) the programme is terminated if the value changes are less than 0.0001 for four successive iterations. B) The programme comes to a hault if I/L < 0.05, where L is a limit, i.e. the number of the possible created points in one iteration, and I is the number of points that satisfy the condition Δ f <0 (see Step 3). C) The programme stops if K achieved the supposed value.

The algorithm in the form of a tree is presented, which represents the structure of Simulated Annealing (See Figure 1).

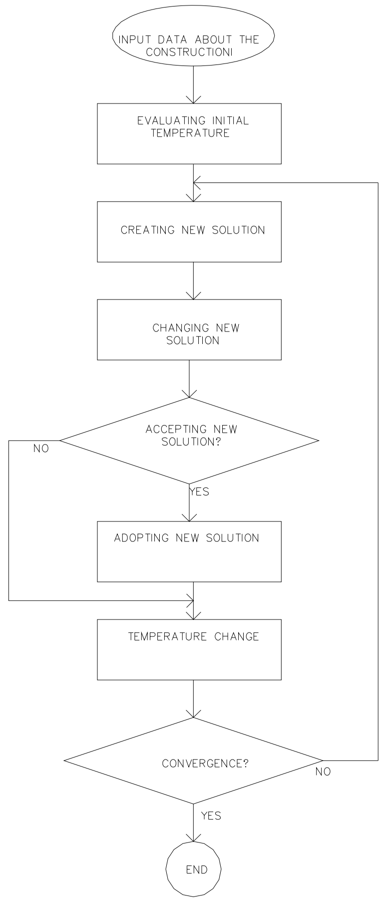

Figure 1: The structure of Simulated Annealing algorithm

PRACTICAL IMPLEMENTATION OF SIMULATED ANNEALING (SA)

The solution for the problems with continual project variables should be created in compliance with the formula:

$x_{i+1}=x_i+\mathbf{Q_u}$..(2)

where $\boldsymbol{n}$ is a vector of random variables within the interval $(-\sqrt{3}, +\sqrt{3})$, so that each has a median and the unit variance equal to zero, and $\boldsymbol{Q}$ is a matrix which regulates the disposition size by steps. Aimed at making steps with the co-variance matrix $\boldsymbol{S}$, $\boldsymbol{Q}$ can be found by solving:

$\boldsymbol{S}=\boldsymbol{QQ^T}$..(3)

according to Cholesky decomposition, for example. $\boldsymbol{S}$ should be changed as the research proceeds in order to involve information about local topography:

$\boldsymbol{S_{i+1}}=(1-\alpha)\,\boldsymbol{S_i} + \alpha\omega\mathbf{X}$...(4)

where matrix X is a measure of the next step co-variance and α dumping constant which controls the rate of information transfer from X to S with weight coefficient ω. The disadvantage of this scheme is that the solution of the equation (3), which must be obtained each time when S is changed, is rather robust.

There is an alternative strategy for solution making according to the formula:

$x_{i+1}=x_i+\mathbf{D_u}$..(5)
where ***n*** is now a vector of random numbers within the interval (-1, 1), and **D** is the diagonal matrix that defines maximal permitted changes of each variable. After accepting the solution change, **D** can be defined as:

$\boldsymbol{D_{i+1}}=(1-\alpha)\ \boldsymbol{D_i} + \alpha\omega\mathbf{R}$..(6)
where **R** is a diagonal matrix of elements that consists of magnitudes of successful changes over each control variable. The change of probability value defined in equation (1) is:

$p=\exp\ (-\delta f/\ Td)$..(7)
where d is an average size of streps, and $-\delta f/Td$ is the measure of change efficiency. Since the size of the steps is considered at value calculating p, **D** need not be ajusted when calculating T.

The development of a solution

SA algorithm neither requires nor creates some deduced information, it is only necessary to be provided with the considered function for every solution it produces. It is important that problem function evaluation is carried out efficiently. In most cases the procedure can be simply programmed to reject any offered opportunities resulting in constraint violation. Namely, there are two significant circumstances in which this approach cannot be carried out (Busetti, 2002.):

- If there is any constraint at the system
- If the possible area defined by constraints is such that it is not possible to connect all the possible solutions without passing through the above mentioned „impossible“ area.

In any case, the problem should be transformed into a problem without constrains by designing magnifying considered functions, so that constraints are incorporated into penalty function:

$f_A(x) = f(x) + 1/T\ w^T\ c_V(x)$..(8)
where w is the vector of non-negative weight coefficients and the vector c_V designates magnitudes of any constraint violation. Penalty inversive dependence on temperature is largely directed towards the possible research area as it progresses.

Through equations from (1) to (7), *annealing scheduling* determines the degree of progress. Initial temperature should be high enough to „grind“ completely the system and it should be lowered to the „freezing point“ during algorithm solving.

OPTIMAL CONSTRUCTION DESIGNING

The construction analysis and designing usually involve highly complex procedures and a great number of variables. As a result, the solution is found through iterative procedure, while initial values are set in the form of variables. Also, the number of analysis steps grows significantly if optimal values are set among all possible alternatives. Describing physical behavior of a construction through mathematic functions, the aim of optimization techniques is achieved, namely, the extreme values of these functions. The studies of axial loaded constructions optimization can be classified in three main categories: a) optimization of member sizes, b) optimization of configuration or geometry and c) optimization of topology or connectivity. Simultaneous optimizations of topology and geometry may be referred to as layout optimizations. Optimization of member sizes is adjusted to optimization of construction weight (mass), where the areas of cross-sections of all elements are considered as project variables and coordinates of nodes and lengths of members as fixed.

Generally, minimizational problem can be expressed as:

$min\ f(x_i)$ $\quad i=1,...n$ ....(9)

in compliance with $\quad g_j(x_i) \leq 0 \quad j=1,...m$ ....(10)

$\quad h_k(x_i) = 0 \quad k=1,...l$ ....(11)

$\quad x_i^l \leq x_i \leq x_i^u$ ....(12)

where f designates the considered function and $X=(x_1,x_2,...,x_n)^T$ the vector of design variables. The remaining functions are constrained functions that correspond to inequations with constraints (g), equations with constraints (h) and limit constraints with lower and upper limits designated with l and u, respectively. These functions, which can be solved analytically or numerically, can be linear or nonlinear and can include project variables in explicit or inexplicit form.

A very wide range of solutions can be obtained for the problems with continual design variables mathematically defined through equations from (2) to (7), irrespective of whether they are "small" construction problems or not. In the text below an example of optimization technique with SA for steel plane truss optimization will be presented (See Figure 2), an example where cross sections are discrete variables that make the solution possible not only from mathematical, but also from practical point of view. Although only a reduced number of accurate cross sections are considered because of economical and aesthetic reasons, the number of combinations is very large (Kripka, 2004). This indicates, if a construction has a certain degree of vagueness, stresses can be redistributed through alteration of relative stiffness of members when the cross section of only one member is altered.

Nomenclature:

A – cross section area, m^2
E – elasticity module, KN/m^2
W – the objective function, weight in KN
L – member length, in m
F – the objective function with penalty, in KN
f – the objective function, in KN
K_B – Boltzman's constant
T – body temperature

Greek symbols:
σ – stresses, in MPa
ρ – specific mass, in KN/m^3
δ – displacing of supports, m

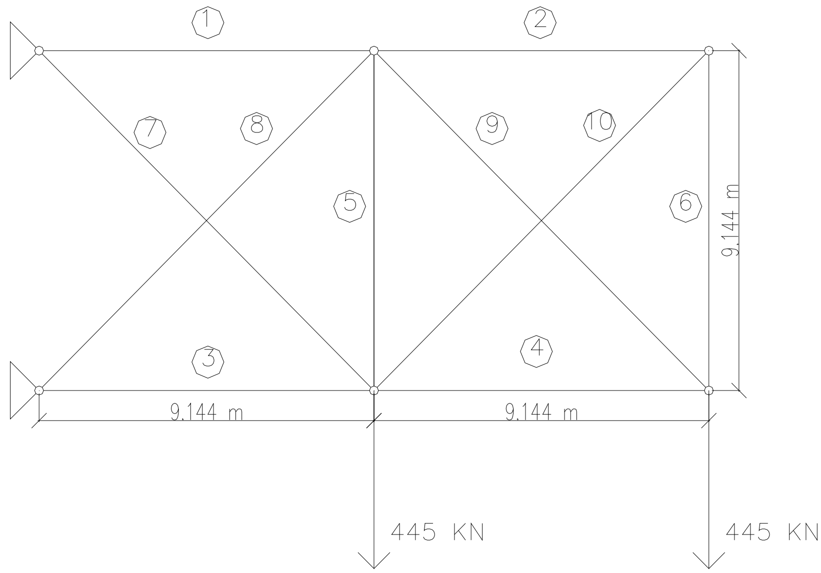

Figure 2: Plain truss with 10 elements

This example of plane truss, which is frequently described in bibliography (e.g. Rajeev, Krishnamoorthy, 1992), has been deliberately chosen because its optimization has been carried out in a large number of ways, so that the obtained results can be easily compared. Also, to process this example, namely its optimization, a great number of easily available commercial and free software is at our disposal.

42 commercially available W cross sections collected from the American Steel Construction Institute have been adopted for design variables in order to compare the results (See Table 1). The procedure is also identical with the data that would be collected from a domestic and European standard (I, U, HEA,...).

Table 1: Available cross sections areas in cm^2

10,45	11,61	12,84	13,74	15,35
16,90	16,97	18,58	18,90	19,94
20,19	21,81	22,39	22,90	23,42
24,77	24,97	25,03	26,97	27,23
28,97	29,61	30,97	32,06	33,03
37,03	46,58	51,42	74,19	87,10
89,68	91,61	100,00	103,23	109,03
121,29	128,39	141,94	147,74	170,97
193,55	216,13			

The above mentioned constructions optimization problem can also be solved successfully through application of algorithm that supports the previous idea of Simulated Annealing method.

$$min\ f(x) = W = \sum_{i=1}^{n} \rho A_i L_i + \sum \left(\frac{1}{2T} \right) g(x)^2 \quad \text{..} (13)$$

in compliance with

$$\frac{\sigma_i}{\sigma_{dop.}} - 1 \leq 0 \qquad \qquad (14)$$

$$\frac{\delta_i}{\delta_{dop.}} - 1 \leq 0$$

Much more complicated constraint conditions can be conducted upon the concerned function. For example, temperature changes, temperature variations, residual stresses in material, stresses generated at the joint of elements... Analogy can also be applied to constructions loaded to bending.

Aimed at computer application, constraints are considered with the support of dynamic penalty technique known as *annealing penalty* (Michalewicz, Schoennauer, 1996). Similar to optimization techniques, penalty factor has a relatively small initial value, which is significantly increased as the temperature is lowered.

Thus, even when a problem starts with impossible solutions, small constraint violation is initially permitted. Input constants are identical as in every other analysis of this example in order to compare the results. Owing to its heuristic nature, the initial point is less significant than in other methods. Output programme results are given comparing the results with other optimization techniques for the same example of the plane truss.

THE RESULTS OF THE ANALYSIS AND FINAL CONSIDERATIONS

The results are obtained applying software package of *Simanneal*–Simulated Annealing code. The final solution is obtained through 1200 iterations in the process which remind as climbing on a local hill to avoid drawing into local minimum (See Figure 3).

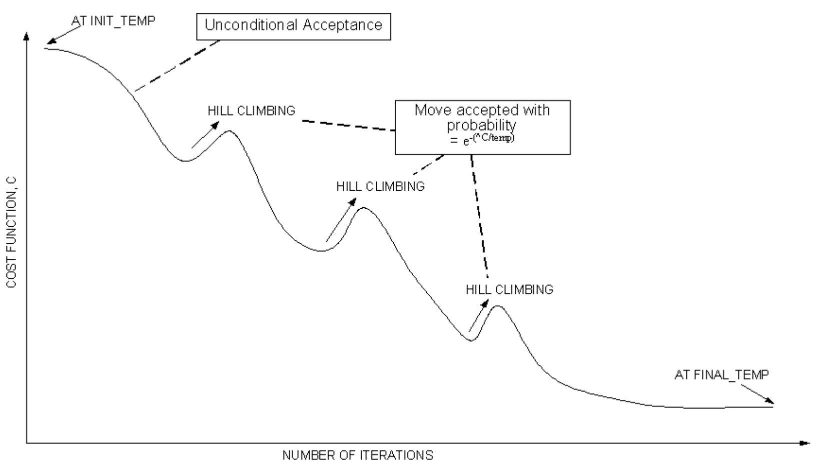

Figure 3: Convergence of Simulated Annealing

The results are remarkably similar to the results obtained by Kripka in 2004, applying some other computer code for an almost identical problem assumption, but with a little differently adopted parameters (See Table 2). It can be concluded that insignificantly better results are obtained by applying Simulated Annealing algorithm than the results obtained by Simple Genetic Algorithm. Furthermore, this would be reflected on construction cost. Similarly, methods that do not treat constraint in cross sections give seemingly better results. It is dealt with seemingly better results because it could be established by a more detailed analysis that construction cost price is significantly increased through the increase of cross sections varieties, especially introducing those that are not commercially available.

Table 2: The comparison of plane truss optimization results

Author	W[kg]	A1[cm^2]	A2	A3	A4	A5	A6	A7	A8	A9	A10
Previous study	2491,00	216,13	10,45	147,74	100	10,45	10,45	51,42	141,93	141,93	10,45
Kripka (2004)	2490,00	216,13	10,45	147,74	90,07	10,45	10,45	51,42	147,74	141,93	10,45
Improved method of penalty function (Cai, Theireu, 1993)	2491,00	216,13	10,45	147,74	100	10,45	10,45	51,42	141,93	141,93	10,45
Genetic algorithm (Rajeev at al, 1992)	2546,00	216,13	10,45	147,74	100	10,45	10,45	91,61	128,39	128,39	10,45
Genetic algorithm (Coelo, 1994)	2534,10	193,55	10,45	147,74	87,10	10,45	10,45	89,69	141,93	141,93	10,45
Genetic algorithm (Togan, Daloglu 2006) MATLAB	2564,10	216,13	16,91	141,94	103,23	10,45	10,45	30,96	193,55	128,38	10,45
WITHOUT CONSTRAINTS IN CROSS SECTIONS											
Penalty function of double linear segments (Pezeshk, Camp, Chen, 2000)FEAP-GEN	2258,0	186,59	0,65	155,30	90,07	0,65	0,65	49,62	142,52	141,62	3,61
GA with method of Lagrange's multipliers (Bieniawski, Kroo, Wolpert,2004)	2332,24	200,00	3,23	158,06	93,55	0,65	0,65	54,84	135,48	132,26	6,45

REFERENCES

Bieniawski S.R., Kroo I.M., Wolpert, D.H. (2004.) Discrete, Continuous, and Constrained Optimization Using Collectives, 10th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Albany, New York

Busetti, F. (2002.) Testing for (common) stochastic trends in the presence of structural breaks, Journal of Forecasting

Cai, J.B., Thiereut, G. (1993) Discrete optimization of structures using an improved penalty function method, Engineering. Optimization, 21.

Coello, C.A. (1994) Discrete Optimization of Trusses using Genetic Algorithm', Expert Systems Applications and Artificial Intelligence

Huang, M. W., Arora, J. S. (1997) Optimal Design with Discrete Variables: Some Numerical Experiments, International J. for Numerical Methods in Engineering, 40.

Kirkpatrick, S., Gelatt C.D., Vecchi, M.P. (1983) Optimization by Simulated Annealing, Science 220, 4598.

Kripka, M. (2004) Discrete optimization of trusses by simulated annealing, Journal of the Brazilian Society of Mechanical Sciences and Engineering.

Metropolis, N., Rosenbluth, A., Rosenbluth, M., Teller, A. Teller, E. (1953) Equation of State Calculations by Fast Computing Machines, J. Chem. Phys. 21.

Michalewicz, Z., Schoennauer, M. (1996) Evolutionary Algorithms for Constrained Parameter Optimization Problems, Evolutionary Computation (MIT Press), 4(1).

Pezeshk, S., Camp, C.V., Chen, D. (2000) Design of Nonlinear Framed Structures Using Genetic Optimization, ASCE J. Struct. Engineering.

Rajeev, S. and Krishnamoorthy, C.S., (1992) Discrete Optimization of Structures Using Genetic Algorithms", Journal of Structural Engineering, 118, 5.

Togan, V., Daloglu, A., (2006) Optimization of 3D Trusses with Adaptive Approach in Genetic Algortihms, Engineering Structures, 28.

ORGANIZATION AND TECHNOLOGY DURING CONSTRUCTION OF CEMENT SILO

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This paper describes main project references during construction of a cement silo that should provide continuous and economic storage of up to 7 types of cement in eight chambers with the total capacity of 20.000 tons. The paper describes organizational issues occurring during construction with application of sliding formwork technology. The need for a detailed planning phase in project is pointed out as well as possible risks during the project. The paper discusses the need for additional human resources and equipment during the application of sliding formwork technology.

KEWWORDS: cement silo, sliding formwork, resources, risk.

INTRODUCTION

One of the major investment projects within Nexe Group Inc. Našice, whose implementation began in 2007 and is still ongoing, is the construction of a silo for storage of cement within the Našicecement Inc. factory in Našice. The need for the new cement silo occurred because of inadequacies of existing storage capacity that did not entirely satisfy the needs of the technological production process. The main objective was to build a facility according to the provisions of the adopted strategy of Našicecement Inc. Našice.

Silo capacity, technical infrastructure, building specifications and project organization have put it in the group of the most challenging construction projects in the wider region. Sliding formwork technology was applied for the construction of silo. The last time this technology was applied in the Slavonia-Baranya region was more than seven years ago, on a smaller project.

Construction of the *Cement Silo No. 6-13* involved two reinforced concrete silos, each with 4 cells, the total capacity of approximately 20,000 tons and the area between the silos for loading bulk cement.

Application of sliding formwork technology demanded implementation of best practices in management of this construction project (Woodward, 1997):

- management of scope - construction project is unique and purpose-made, therefore it has to be fully briefed and designed
- procurement
- planning and progress – analysing the project, setting a plan of action and progress control
- time management
- cost management
- quality management – determination of standards and their observance
- human resources management
- risk management – determination what are the risks, who carry them and how can they be avoided or minimised
- zero accidents techniques.

Construction system - sliding formwork

Sliding formwork sets were developed for high buildings, with closed layout without horizontal structures, with the same or uniformly variable wall thickness by height (tall factory chimneys, grain silos, liquids containers, high columns of bridges, cement silos). Sliding formwork is continuously vertically shifting formwork. This formwork is lifted using special cranes or hydraulic presses (Chudley, 2006).

Continuous movement of the formwork during casting of concrete avoids the adhesion between the surface and the concrete. Casting the concrete is done in layers throughout the volume of the building. At the moment when the coupling of concrete occurs, or when concrete reaches initial strength, formwork is erected to stop the connection between the formwork and concrete.

Assembly of sliding formwork consists of (Lončarić, 1995):
- formwork surfaces - steel sheet metal surfaces on steel substructure, height 1.5-2.0 m, width 1.2 - 2.4 m
- yokes - which accept the load of formwork, materials and labor and transfer its to the hoists
- load-bearing pipes - on which the cranes slide
- slip-pipes - used as protection of load-bearing pipes from concrete and for hardening the load-bearing pipes. Sliding tube is an integral part of the crane.
- measuring equipment - which monitors the height and levels the sliding formwork
- working area - located on the upper edge of formwork
- hanging working scaffolding - which is used for repairs of finished walls and concrete care during the sliding.
- lifting device - self propelled hydraulic cranes, speed range 5-20 cm.

Application of this technology requires a special organization of the building site:
- continuous monitoring of formwork and presses
- continuous work during sliding
- discipline in the work.

In addition to these organizational particularities, application of sliding formwork technology requires continuous work of the laboratory for testing the properties of fresh concrete on the construction site during the sliding process in order to achieve uniform quality of concrete.

Work of the laboratory on the construction site must be coordinated with the work of the laboratory of concrete producers.

Planning the construction of the cement silo

Based on the documentation submitted by the investor, company Našicecement Inc. Našice, contractor approached to the analysis of costs and the bidding process for the execution of construction works on silo. Specified reinforced construction of cement silo required a large engagement of human and material resources, procurement of additional equipment and subcontracting companies specialized for each phase of works.

Next to the target date and the period of realization of the project this required special attention during planning phase of the project. Based on the project documentation and cost estimates detailed financial and operational plans were made (Figure 1).

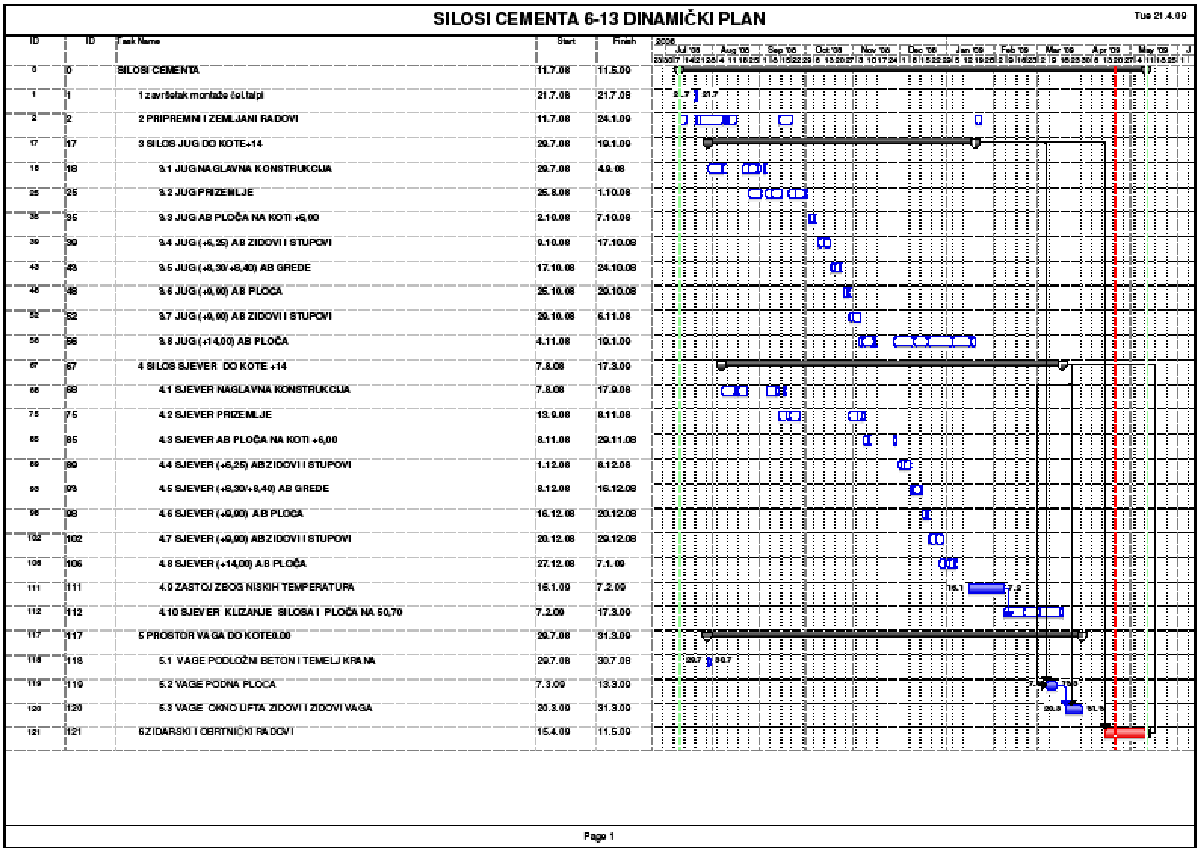

Figure 1: Dynamic Plan

On the basis of detailed financial and operational plans, an analysis of required use of labor and materials was conducted, together with all other necessary resources with the aim of obtaining an economically acceptable offer. Bid had to be in accordance with the approved financial plan of the Investor for realization of the entire project. During the selection and subcontracting of the companies special attention was on skills, expertise and equipment for performing the requested work. Reference to previously delivered objects and client satisfaction with the previous works were requested from subcontractors.

During the planning phase of the project possible risks in construction were defined:
- to ensure continuous performance of works
- to ensure continuous delivery of concrete during the sliding of silo
- to reduce the negative impacts of low temperature.

In order to minimize and control the risks during the planning stage responses to the risk were outlined. In order to ensure continuous performance, contractor had additional equipment and human resources in reserve. Spare concrete factories were provided (from the same manufacturer) with an obligation to be available 24 hours every day during the execution of works, in order to be able to provide the delivery of concrete to the site at any moment. The emergency service was secured with additional equipment in case of accidents or failures. Impact of the weather, impact of the risk which could not be reduced or avoided was the weather conditions. Response to risk was the concrete enhancements for winter casting and monitoring of the weather at the beginning of sliding so that the sliding would start in as favorable weather conditions as possible.

Building the cement silo at the factory Našicecement Inc.

The construction of *Cement Silo No. 6-13* consists of following units (Figure 2):
- system for cement transport and filling the silo chambers
    - air-handling troughs
    - elevators
    - line flows
- system for out-dusting chamber silo and transport of cement for filling and discharging silo
- reinforced cement silo consisting of
    - two times four (4) separated chambers (two batteries) (Figure 3)
    - roof eaves made of the load-bearing steel sections and coverings of trapezium steel sheet
    - supporting cone in the bottom of each chamber
- system for emptying silo and cement transport
    - system for loosening at the bottom of each chamber
    - bolt under each chamber
    - alligator lump under each chamber
    - distribution boxes below each chamber
    - electromotive dosing rollers
    - air-transport beds
    - transportation system of packed cement
- bridge between an exsisting cement silo and elevated tower made of bearing steel sections and coverings of trapezium steel plates (at the height of roof slabs)
- elevated tower made of bearing steel sections and coverings of trapezium steel plates
- area of charging trucks derived from the load-bearing steel sections and coverings of trapezium steel plates,
- area for bulk loading of trucks in four bands with mobile unit for the filling and the corresponding dust control system
- balances
- freight elevator for transport to the silo roof set in elevated tower
- reliable measurement of the cement level in all silo chambers

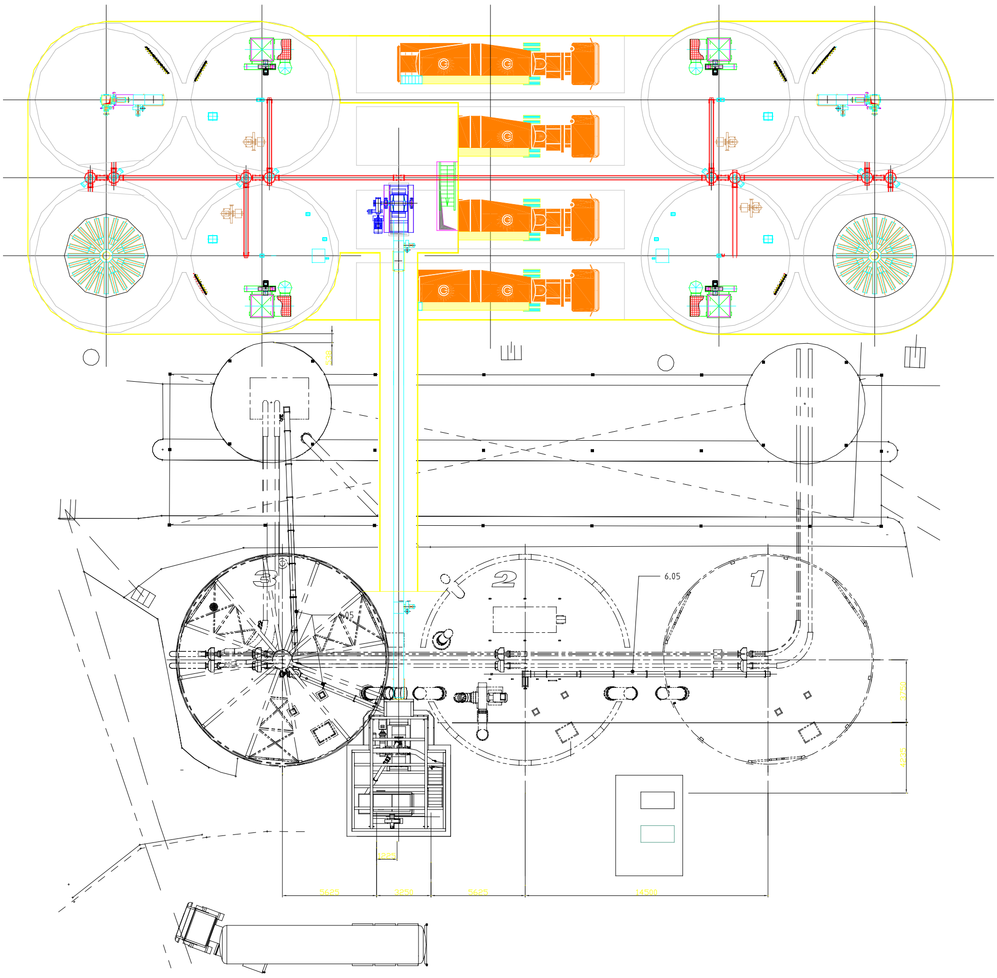

Figure 2: Cement Silo No. 6-13

Figure 3: Chambers of the cement silo

- marking the silo with different types of cement and the loading schedule
- horizontal and vertical signaling of access roads
- system of electrical power supply

- management system of the production process
- software system for loading cement that works in the dosing regime on loading line and workstation for closing the weights and print weight calculations
- software for the dispatching position.

Foundations of the cement silo were done with 93 reinforced concrete pilots with the diameter Ø 150 and Ø 120 cm (Figure 4). On these pilots, reinforced concrete core slabs were constructed with the thickness of 2,00 meters. Bearing structure consists of reinforced concrete columns and walls which are connected by beams and plates. Reinforced-concrete slabs are located on three floors: on 6,00 m, 9,90 and 14,90 m. From the plate, set on level of 14,70 m, sliding for circular chamber silo is continued at the height of 50,70 m. The wall thickness of silo chambers is 25 cm continuously through the entire height of the silo. At the top of the chambers semi-assembled reinforced concrete plate is built leaning on the chamber walls. At the outer-ring beam steel bearings are made for the roof construction.

Figure 4: Reinforced concrete pilots

Construction of monolithic reinforced-concrete structures (up to the level of +14,90 m) required the involvement of 25 workers (carpenters, concrete workers, reinforcement workers and co-workers) with 8-hours working time in three shifts. For the purposes of meeting the deadlines and execution in accordance with the approved dynamic plan during the construction phase, two tower cranes are installed on the building site. DOKA formwork system was used during the construction of monolithic reinforced concrete structure.
The construction to the hight of +14,90 m of the two silos included:

- 4,350 m³ of concrete
- 690 tons of reinforcement
- 3,900 m² of formwork for columns and walls
- 10,350 m³ of heavy load-bearing scaffolding.

Upon the completion of works on the first silo, up to height of +14.90 m sliding formwork was set and the first battery of silo was constructed. Work on the sliding of silo requested continuous engagement and great discipline of all employees at the building site during 24 hours. The work of employees is organized in two shifts, each 12 hours. In one shift 41 additional workers were hired: 16 bar-benders, 8 concretors, 9 bricklayers, 1 leader, 1 manager, 2 crane operators, 3 engineers (hydraulic pumps), thus the number of employees engaged on the construction site during one day climbed to approximately 150. Work on the sliding at the first battery started on 12th December 2008 and it was finished on 24th December 2009. Work on the sliding at the second battery started on 27th February 2009 and it was finished on 9th March 2009. On both batteries the sliding speed was 2 meters per day.

For vertical transport of concrete and reinforcement to the working platform and into the silo walls tower cranes were used. Concrete was produced in the concrete factory, Nexe Concrete Ltd., Production plant, Našice which is located 8 kilometers from the place of installation. To ensure continuous concrete delivery backup concrete mixing plants in Osijek and Djakovo were provided.

During the execution of works and concrete casting, according to the *Quality performance plan of concrete structures*, constructor continuously carried out quality control of fresh and hardened concrete. Before the installation testing of fresh concrete, namely the consistency of concrete according to the standard HRN EN 12350-2 Testing fresh concrete - Part 2: Slump test was conducted, and the temperature of concrete was measured. Concrete samples were also taken every day for attesting the concrete compressive strength and they matched the class C25/30 of the compressive strength.

CONCLUSIONS

This paper was created in reference to the planning and performance of reinforced concrete works at the cement silo. Project construction was optimally planned out, and plans were realized within a reasonable time-deadline. Good and high-quality organization of human resources and equipment, subcontracting of high-quality and reliable suppliers and contractors ensured the construction of the cement silo in the set conditions so that the construction price, contract terms of performance and proven quality meet the project's set boundaries.

REFERENCES

Cement silos - Tender for basic design and supplying of equipment, Nasice, 2006

Chudley, R., Greeno, R. (2006) Advanced Construction Technology. Prentice Hall (UK), 2006

Lončarić, R. (1995) Organizacija izvedbe graditeljskih projekata. Zagreb: HDGI

Technical description for project Nasicecement new cement silos 20.000 t, Nasice, 2006

Woodward, J. (1997) Construction project management, London: Tomas Telford

PROBLEMS IN LARGE SCALE PRECAST CONSTRUCTION PROJECTS

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In touch with large scale projects all types of occurrences can be seen. Such large scale projects should present a great composition of first class organization in every part of project stages. In architectural design, structural analysis, production, building site organization, transportation, etc. The choice of the construction system to satisfy all the wanted outcomes is tough. Wrong choice and combination of construction systems can result with complication of building process, overrunning of time limits, which all result with multiple rise of building costs. This article is orientated on showing the occurring problems if a project is not planed properly and directs a reader or a potential project manager to choose a proper choice of combining several building systems.

KEYWORDS: precast, large scale, problems.

INTRODUCTION

Each project is induced for answering problems and satisfying needs. While answering to the project's problems responsibility of each engineer is to choose the right construction design. Chosen construction design needs to be able to satisfy several factors, like:

- set the right answer to the project's problem
- adequately accommodate needs of esthetics
- satisfy building codes and regulations

Each engineer, after deciding to build and form his construction using precast building system, has to follow some rules of precast building. Tendency to standardize dimensions and qualities of element is a must. Limiting numbers of different type cannot be avoided. With those limitations, an engineer is forming or choosing a precast elements assortment that provides flexibility of building and architectural unity of an object.

Large scale construction projects usually have several common critical requirements that need to be fulfilled. Time limitation and high architectural and esthetic requirements are the most propounded ones. In order to satisfy both of these aspects, it is not rare that engineers decide to use a combination of several different construction systems. Either concrete precast, steel, reinforced concrete, or steel – concrete composite systems are used. By using precast concrete, speed of production and quality of produced elements is gained. On site production is characterized by reduced number of workers and material. To achieve the complex architectural design, the usage of steel – concrete composite building system is needed.

LARGE SCALE PROJECTS PROBLEMS

As mentioned previously, in order to fulfill requested speed of building and yet to keep the esthetical qualities of these projects, solution of the problem is usually attained by combining several construction systems.

By deciding to use a combination of construction systems, a group of problems appears. The actual problem is how to chose and combine those systems optimally. Poor solution of structure organization can result with complex building process, organization and planning of the site, and reduce ability to respect time limitations.

Table 1: Percentage ratio of precast construction in whole project

		Construction system					
Dilatation	Level	Precast area [m2]	Monolith area [m2]	Steel area [m2]	Composite area [m2]	Sum area [m2]	% (precast / sum)
A	1	3657,3	2741,5	0	0	12797,6	57,2
A	2	3657,3	2741,5	0	0		
B	1	2260,3	693,8	0	2622,8	11305,7	20,0
B	2	2263,1	693,8	371,9	2400		
C	1	2374,3	1276,8	0	1122,5	9791,7	24,2
C	2	3111,5	532,7	1373,9	0		
D	1	3567,1	1010,8	0	1011,6	11885,9	30,0
D	2	3567,1	1010,8	1718,5	0		
E	1	2225	1123,3	0	3182,9	13242,9	16,8
E	2	2397,1	656	740,4	2918,2		
F	1	2475,3	436,5	0	0	5823,6	42,5
F	2	2475,3	436,5	0	0		
G	1	3564,1	1659,9	0	1742,5	14198,7	25,1
G	2	3789,4	1336,2	2106,6	0		
H	1	1988,8	687,6	0	1509,1	9135,2	21,8
H	2	2273	1065,3	679,3	932,1		
I	1	3786,5	875	0	627,5	11116,7	34,1
I	2	4100,8	958	0	768,9		
J	1	1476,2	966,2	0	2937,7	10760,2	13,7
J	2	1476,2	966,2	0	2937,7		
K	1	2776,9	1793,2	0	1574,8	12210	22,7
K	2	2887,5	1000,6	1840,9	336,1		

From the precast to sum area ratio can be concluded that this kind of building is not specific for precast building system. Such combining of systems cause problems in execution of projects in each aspect.

BUILDING PROCESS COMPLICATIONS

In order to prevent time delays, when merging construction systems, it is of essential importance to have highly organized production program with two way information flow between building site and production site. If necessities are not considered production halts with high expenses.

Time delays usually occur when poor planning is done. Poor planning in precast construction system usually means that time for monolith concrete construction to obtain its bearing capacity is not taken in account. Although this may seem as basic civil engineering knowledge it is not rare that those facts are left out while planning time schedule.

Figure 1: Completion of the precast construction depends on the completion of the monolith construction

Figure 2: Completion of the stair case dictates the precast construction completion

BUILDING SITE AND PROJECT PROBLEMS

Delays and problems can be evoked with non synchronized project documentation (e.g. scaffolding plans and precast mounting plans), by poor on site coordination, or poor on site control.

Figure 3: Due to poorly perfected project documentation mounting of monolith beam was impossible without additional processing of the precast element

Figure 4: Poorly perfected project documentation resulted with a need to additionally process the precast element

PRICE PROBLEMS

The most common result of problems during construction is a price increase. But in concrete precast construction, price of the construction raises potentially by producing specific precast element types that are used only once or twice during the whole building process.

Table 1: Concrete precast elements to positions ratio

Dilatation	Colum			Beam			Plate		
	pcs	pos	pcs/pos	pcs	pos	pcs/pos	pcs	pos	pcs/pos
A	45	18	2,50	89	21	4,24	177	34	5,21
B	35	22	1,59	55	38	1,45	118	55	2,15
C	36	28	1,29	65	38	1,71	141	59	2,39
D	42	31	1,35	65	59	1,10	176	66	2,67
E	49	42	1,17	64	56	1,14	116	46	2,52
F	28	16	1,75	45	24	1,88	132	55	2,40
G	55	46	1,20	79	49	1,61	191	70	2,73
H	44	40	1,10	73	61	1,20	143	87	1,64
I	39	32	1,22	65	53	1,23	212	90	2,36
J	32	27	1,19	44	36	1,22	72	38	1,89
K	39	31	1,26	70	62	1,13	151	84	1,80
Sum	444	333	1,33	714	497	1,44	1629	684	2,38

By observing number of elements and element position ratio, it is obvious that decision of using precast concrete building system was not used correctly. The advantage in price and speed of building in precast system did not get used as planned.

As can be seen from the **Table 1** the number of elements to element position ratio is mostly about 2, where the expected ratio for would be at least 30%-40% of the number of elements. With that ratio the production and the choice of precast building system would have been reasonable.

TIME LIMITATIONS PROBLEMS

Table 2: Building time table

Construction part	Dilatation	Height (from - to)	Planed Start	Planed end
Single foundations	H		02.09.'08.	08.09.'08.
Precast columns	H	0 - +12,75	28.08.'08.	09.09.'08.
Bearing construction	H	0 - +5,85	05.09.'08.	17.09.'08.
Precast beams	H	+5,85	09.09.'08.	18.09.'08.
Precast plates	H	+5,85	06.10.'08	14.10.'08.
Bearing construction	H	5,85 - +12,75	17.09.'08.	29.09.'08.
Precast beams	H	+12,75	18.09.'08.	27.09.'08.
Precast plates	H	+12,75	27.09.'08.	06.10.'08.

As can be seen in **Table 2** for the same dilatation the works are not planned properly, nor can they be synchronized by this plan. For instance single foundations are supposed to be finished for erecting columns, while production of single foundations has not even started. In order to mount beams and plates all the bearing parts of monolith construction are supposed to be finished and ready to take over the weight of precast structure. This is impossible due the fact that those parts have been finished the day before.

By taking these facts in account while planning, time schedule is less endangered.

CONCLUSION

Precast concrete construction system use is reasonable when composing any type of building construction, when architecture is characterized with typical construction spans and larger number of same construction element types. In such constructions, the industrialized production of elements is preferred with all the positive effects of industrial production: series production don by educated and specialized staff, high quality products, and minimal usage of scaffolding.

By observing number of precast elements and element type ratio in any project, we can easily conclude if a precast concrete building system is used correctly and optimal.

Simple tasks can result with immense problems if a project is not planned and controlled properly. Also costs reduction is achieved by understanding advantages of building system that is used. This way simple mistake like e.g. tendency to reduce costs by reinforcing each precast element differently can be avoided.

According to data collected from a project inevitable question can be answered: Is the usage of precast elements and building system reasonable for this project?

By deciding which building system should be used, one should be aware the system advantages and disadvantages. Also one should be aware of requirements for a system to be rentable.

Precast concrete building system use requires developed information flow for decision making in each production point: production, transportation, temporary storage, and assembling of elements.

In order to justify the choice of using the precast concrete building system some sacrifices are needed, so that all benefits of precast building system can be used, and thereby reduce building costs.

REFERENCES

Kovač, B.; Brana P.; Vidaković, D. (2006) Tehnologija građenja – handbook. Osijek: Faculty of Civil Engineering

Lončarić, R. (1995) Organizacija izvedbe graditeljskih projekata. Zagreb: Univesity of Zagreb

Arizanović, D.B. (1997) Tehnologija građevinskih radova. Beograd: Uinversity of Beograd

Ivković, B.; Arizanović, D. (1990) Organizacija i tehnologija građevinskih radova. Beograd: Uinversity of Beograd

Trivunić, M.R. (2000) Montaža betonskih konstrukcija zgrada. Novi Sad: University of Novi Sad

Ćirović, G.; Mitrović, S. (2007) Tehnologija građenja. Beograd: Civil Engineering and Geodesy academy

CONSTRUCTIVE CONFUSION OR PARADIGM PROLIFERATION: COMPETING EXPLANATIONS FOR LOW CONSTRUCTION PRODUCTIVITY GROWTH

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The objective of this paper is to develop a system to categorise the explanations found in previous research and thus improve our understanding of the analysis of construction productivity. Despite the efforts made by governments, industry organisations and firms in many countries, the rate of growth in construction productivity as measured by national statistical agencies has consistently been low compared to many other industries. Research into explanations for low construction productivity growth has found a wide range of factors and possible causes that may be at work, and there is no agreement on the most important of these. Explanations include: the methodology of productivity analysis and measurement; regional and sectoral effects on industry productivity; the project-based nature of the industry and the role of project management; procurement and delivery systems and the effectiveness of construction industry policy and intervention; and the contribution of research and development and innovation to construction industry productivity growth. By categorising this research the differences, commonalities and linking factors can be identified and the various analytical paradigms evaluated. The competing explanations of the causes of low construction productivity growth are then assessed in terms of their completeness (whole of industry or part), applicability (time, place and circumstance) and generality (a data artefact or not).

KEYWORDS: construction productivity, explanatory categories, paradigms.

INTRODUCTION

The rate of growth of productivity in Australia, the UK, US and other major economies in the OECD become an issue in the late 1960s, when declining output per hour worked and output per person employed became the focus of a large research program that sought to interpret and analyse the causes of what became known as the productivity slowdown. At this time the construction industry's low productivity growth attracted attention. The rate of growth of productivity of the construction industry has been poor since the 1960s, even by comparison with a long-run overall industry average in the order of two to three percent a year.

Despite the efforts made by governments, industry organisations and firms over the past few decades, the rate of measured growth of construction productivity has remained low compared to many other industries. The answers typically offered in explanation of construction productivity cover a wide range of factors and possible causes that may be at work. The approach taken in this paper is to review previous research across five areas that have been suggested as important influences on construction productivity.

Industry, Projects and Institutions

The different aspects of construction productivity measurement and performance reviewed above apply at three distinct levels. Which of these three levels is the most appropriate for productivity analysis of construction will depend on the purpose of the analysis. At the industry level the focus is on the measurement of output within the national accounting framework, so the paper firstly looks at the measurement of rates of productivity growth. This is a large topic and incorporates a rage of issues relevant to the topics that follow.

The second topic is the heterogeneous nature of construction products, both by type and location, At the project level, to a great extent each project in each of its categories is designed and built to serve a special need. Although specific design skills are needed over and over again, the outputs differ in size, configuration, location and complexity. Such uniqueness impacts substantially on construction productivity and the construction process. Thirdly, the site-based methods of project management used are discussed. As a subset of these factors the work sampling studies carried out on specific tasks, processes or teams should be included.

Finally, there is also another set of factors that can be called institutional, and these include procurement methods, R&D and innovation, technological progress, regulation and the legal framework. The paper collects the limited research on the effects of location and the project based nature of the industry. The last two topics addressed are procurement and delivery systems and construction industry policy, and R&D and innovation.

METHODOLOGY OF PRODUCTIVITY MEASUREMENT

The measured rate of construction productivity growth may be low because of the measurement of output as value added, the total value of goods and services produced after deducting the cost of goods and services used in the process of production, adjusted for movements in prices and changes in quality. The construction deflator may not fully take these movements into account, and therefore real output is underestimated. Also, the significant role of changes in the quality of construction has not, so far, been rigorously measured.

Output of the building and construction industry is estimated by deflating current price figures by input price indexes. A number of researchers have criticized the use of input price indexes for deflating construction expenditure, for being unrepresentative of the inputs priced and geographical coverage, and being based on inaccurate weights. The Stigler Report (1961: 29) recommended a significant increase in research on construction deflation, and suggested a residential deflator based on the price per square foot of a range of categories of new homes. This led to the adoption by the BEA in 1968 of a new, hedonic price index for housing.

A number of alternative deflator have been developed. Allen (1985) used a price per square foot index for deflating non-residential building, assuming that this is a good proxy for output. According to Allen's (1985) estimates about half the decline in construction productivity during the 1960s and 1970s was due to the overdeflation of construction output. Cassimatis found that price indexes cannot provide adequate deflators for construction: "the feeling persists that construction productivity is greater than the measurements show ...

largely due to the fact that there are no adequate price indexes that can be used as deflators of the gross product" (Cassimatis 1969: 79-80).

Table 1. Representative Papers: Methodology of productivity analysis and measurement

Stigler Report (1961)	Recommended a significant increase in research on construction deflation
Cassimatis (1969)	Argued that price indexes for construction based on unit numbers at market prices cannot provide adequate deflators for construction
Stokes (1981)	Found no conclusive evidence that real output was understated
Allen (1985)	Used a price per square foot index for deflating non-residential building
Bowlby and Schriver (1986)	Developed a hedonic price index for construction as an alternative to the existing US deflators
Pieper (1990)	Also argued that deflation by input price indexes does not produce suitable estimates of output at constant prices
Chau and Lai (1994)	Measured the relative labour productivity of construction from Hong Kong national accounts data
Lowe (1995)	Describes the estimation indexes of Statistics Canada
Allmon et. al. (2000)	Means's cost manuals) were used to trace benchmark values for construction tasks
Goodrum, Haas, and Glover (2002)	Developed an alternative productivity measure based on individual work activities
Ive et. al. (2004)	International comparison that addressed statistical data issues on definition and labour force numbers
Briscoe (2006)	Identifies a range of problems with reliable and accurate data collection and statistical analysis
Crawford and Vogel (2006)	Data constraints limit the ability to identify drivers of construction productivity
Yu and Ive (2008).	Finds that British indices measure the price movement of traditional building trades but almost completely ignore mechanical and electrical services

Pieper (1990) also argued that deflation by input price indexes does not produce suitable estimates of output at constant prices and, given the extensive use of input price indexes as deflators in estimating the constant price of output for the construction industry, productivity measurement for this industry is problematic, to say the least. Pieper concludes that, for the US, "evidence indicates an overdeflation of construction of at least 0.5% per year between 1963 and 1982."

Chau and Lai (1994) developed a system for measuring the relative labour productivity of the Hong Kong construction industry. Their approach used a method of measuring the relative labour productivity of the industry, from national accounts data, and then derives the trend of construction labour productivity. This discussion of relative rates of growth of labour productivity uses an implicit price deflator for net output of the construction industry obtained through double deflation, but does not discuss the nature of the price indexes used or their applicability. The price indexes are based on a construction output price index and a material cost index using the methodology developed by Chau and Walker (1988).

Lowe (1995) describes the use of estimation indexes by Statistics Canada, using surveys sent to subcontractors. Around 100 different items are priced for five building types and each of five elements has its own index. A recent analysis of British building price indices by Yu and Ive (2008) found that these indices measure the price movement of the traditional building trades but almost completely ignore mechanical and electrical services.

Cannon (1994) questioned the accuracy of contractor statistics and Briscoe (2006) asked "How useful and reliable are construction statistics?" These papers identify a range of problems with data collection and analysis, including defining the scope and coverage of the industry; measuring outputs across different types of activity; identifying construction firms; measuring capital formation and capital stock, and inconsistent employment statistics. Crawford and Vogel (2006) also draw attention to data limitations for productivity analysis.

REGIONAL AND SECTORAL EFFECTS ON IPRODUCTIVITY

Other hypotheses for the decline in construction productivity are a decline in the capital-labour ratio (Blake et al. 2004), changes in the age-sex composition of the labour force (Cremeans 1981), a shift towards non-union construction (Allen 1984), an increase in government regulation (Tucker 1986) or cyclical and business cycle effects. Project characteristics such as the increased size and complexity of projects, resulting communication difficulties, and fast-tracking projects where design and construction phases overlap also affect coordination. There have been a few papers that address the effects of these on productivity.

Cremeans (1981) discussed a number of hypotheses that had been proposed to explain the significant decline in construction industry labour productivity in the 1970's.Only one of the hypotheses, the increased proportion of younger, less experienced workers, was supported by the available data. Bowlby and Schriver's (1986) analysis of US productivity data indicated seven compositional changes in building, and they suggested that these would account for much of the productivity slowdown.

Table 2. Representative Papers: Regional and sectoral effects on industry productivity

Cremeans (1981)	Found younger, less experienced workers the main cause
Bowlby and Schriver (1986)	Identified seven compositional changes in building, and these account for much of the productivity slowdown
Tucker (1986)	The increased size and complexity of construction projects
Ive et al. (2004)	The output-structure of a country's construction industry will influence average labour productivity
Blake et al. (2004)	UK construction has lower capital per worker than France, Germany and the US

PROJECT-BASED NATURE OF THE INDUSTRY AND THE ROLE OF PROJECT MANAGEMENT

A large number of papers have recommended that construction productivity could be improved through the use of flexible organisation structures, favourable union attitudes, higher workmen motivation, and improved overtime and change order strategies. Most of these surveys found cost control, scheduling, design practices, labour training, and quality control are the functions that are consistently seen as having room for improvement. Often the fragmented nature of the industry is seen a hindrance to improving productivity (Ganesan 1984). However, Chau and Lai (1994) suggest that productive efficiency is increased by the division of labour.

Borcherding (1976) identified the factors having an adverse effect on construction productivity as union attitudes, workman selection practices and motivation, inflexible bureaucratic organisation structures, overtime; and change orders. Using these factors, Herbsman and Ellis (1990) developed a statistical model of the quantitative relationships between influence factors and productivity rates.

Table 3. Representative Papers: Project-based nature of the industry and the role of project management

Borcherding and Oglesby (1974)	Concluded well organised construction jobs which permit workers to be productive lead directly to job satisfaction
Borcherding (1976)	Identified six factors having adverse effects on construction productivity
Kellog et. al. (1981)	Argued that the fragmented nature of the industry impedes productivity growth
Ganesan (1984)	Also argued fragmentation affects productivity
Hague (1985)	Found financial incentives and any other method for encouraging productivity has had arguments for and against
Koehn and Caplan (1987)	Productivity improvement efforts should be concentrated on planning, scheduling, supervision, and labour
Briscoe (1988)	The quality of construction management is an important factor which helps to explain low productivity
McFillen and Maloney (1988)	Found contractors did little to encourage good performance, so workers reported little incentive to be highly productive
Herbsman and Ellis (1990)	Developed of a statistical model of quantitative relationships between influence factors and productivity rates
Chau and Lai (1994)	Argue the fragmented nature of the industry is often seen a hindrance to improving productivity
Dai, Goodrum, and Maloney (2007).	Foremen reported project management factors having more impact on their productivity, and craft workers reported factors related to construction materials having more impact

Koehn and Brown (1986) argued that construction productivity is affected by a wider range of variables which they divided into the six areas of management, labour, government, contracts, owner characteristics and financing. Koehn and Caplan (1987) but focused on small to medium size construction firms rather than large construction firms. The study concluded that productivity improvement efforts should be concentrated in planning, scheduling, site and labour management functions. Jenkins and Laufer (1982) also focus on the management issues, and discuss them in the context of motivation of workers. They suggested that while motivation does not directly influence the rate of working, motivation directly impacts upon the percentage of working time spent productively.

Arditi and Mochtar's surveys of the top 400 US contractors in 1979, 1983 and 1993 identified areas with potential for productivity improvement. The functions needing more improvement in 1993 compared with the previous survey were prefabrication, new materials, value engineering, specifications, labour availability, labour training, and quality control, whereas those that were identified as needing less improvement were field inspection and labour contract agreements (Arditi and Mochtar 2000).

Allmon et al. (2000) presented an approach to long-term productivity trends in the US construction industry over the past 25–30 years. Means's cost manuals (the main US source of estimating data) were used to trace the values for these tasks, and changes in these values were taken as productivity trends. Unit labour costs in constant dollars and daily output factors were compared over decades for each task. Direct work rate data from 72 projects in Austin, Texas over the last 25 years were also examined. The combined data indicated that productivity had increased in the 1980s and 1990s. Depressed real wages and technological advances appear to be the two biggest reasons for this increase. Their data also indicated that management practices were not a leading contributor to construction productivity changes over time.

PROCUREMENT SYSTEMS AND THE EFFECTIVENESS OF CONSTRUCTION INDUSTRY POLICY AND INTERVENTION

Some researchers have and identified institutional factors responsible for construction productivity levels. Labour issues include organised labour, the competency of project participants, the tendency of site management to spend more time providing information and writing reports than actually managing the project, and the inadequacies of an educational system which produces graduates with excellent skills in analysis and design but with little knowledge of methods to turn designs into realities (Tucker 1986). Other institutional issues are the tendency of construction firms to become larger and more specialised, legal restrictions on the management of construction projects and the complex regulatory regimes the industry works under.

Table 4. Representative Papers: Procurement and delivery systems and the effectiveness of construction industry policy

Cassimatis (1969)	The major factors affecting the efficiency of organisation in construction are institutional
Tucker (1986)	Institutional issues were the tendency of construction firms to become larger and more specialised, legal restrictions on the management of construction projects and insufficient research in construction and project management methods
Sidwell (1987)	Described the Australian construction industry as thoroughly conservative and slow to change in any fundamental way
Cox and Townsend (1998).	Construction has not developed the supply chains and procurement methods like other industries
Craig (2000)	Compared traditional and D&B procurement for innovation
Dubois and Gadde (2002)	The separation of design and construction creates inefficiencies

The limitations of the traditional procurement method have contributed to the poor performance of the construction industry and have prompted the development of alternative procurement strategies designed to facilitate improvements in the way buildings and structures are delivered (Cox and Townsend 1998). Craig (2000) concludes that the traditional tendering process for building works does not encourage design innovation by tenderers, because tendering rules produce direct price competition for a specified product.

R&D, INNOVATION AND PRODUCTIVITY

The construction industry has not established an impressive track record in innovation or technical advancement. The main effort in industry development has been concentrated in procurement, planning, management and design improvements. Nevertheless, there have been some significant advances in construction technology over the last two decades in both the materials used and the application of new construction methods (Fairclough 2002).

Gann (2003: 554) cites Bowley (1960) as showing that construction is an adopter of innovations from other industries, rather than a source of innovation. Bowley's work "shows that demand for new types of buildings is usually more important in stimulating radical technical and organizational innovation than the need to erect better and cheaper buildings to accommodate existing functions." Cassimatis (1969) concluded his study with a chapter on institutional factors, because "once the contract is awarded, competitive forces do not always prevail" (Cassimatis 1969: 118). Institutional factors that affect the performance of the industry are its openness to innovation and capturing of economies of scale.

Koch and Moavenzadeh (1979) focused on the role of technology in highway construction, and found there had been substantial gains in both labour and capital productivity over the previous 50 years in the US. They concluded that future gains in efficiency can be expected to be less than the previous gains, so new means of accomplishing technological change in the construction industry are needed. Arditi (1985) conducted a study of large construction firms to determine potential areas for construction productivity improvement. One of the study's conclusions was that more productive construction technology such as industrialised building processes are important in achieving higher levels of construction productivity.

Hobday (2000) and Gann and Salter (2000) argue that the construction industry can, and should be, more innovative. Many papers follow Tatum's (1986) analysis of the industry in terms of advantages and constraints to innovation, and despite the Tatum model of construction innovation being two decades old it still captures many of the key features of the discussion raised by more recent efforts such as Reichstein et al. (2005), Fairclough (2002) or Slaughter (1998). Ivory (2005) suggested that client will not be prepared to pay for innovation.

Table 5. Representative Papers: Contribution of research and development and innovation

Rosefielde and Mills (1979)	Argue the rate of technological progress in the construction industry may be slow because buildings are heterogeneous
Koch and Moavenzadeh (1979)	Focused on the role of technology in highway construction and concluded new means of accomplishing technological change are needed
Arditi (1985)	Recommended areas that research should concentrate on
Tatum (1986)	Construction has many features that favour innovation
Gann (1997)	Discusses the role of government funded R&D
Gann and Salter (2000)	Construction has the potential to be more innovative
Fairclough (2002)	Construction lags in R&D and innovation
Hobday (2000)	Argues that the nature of construction projects and teams creates opportunities for innovation
Zhi, Hua, Wang and Ofori (2003)	Seven factors influencing TFP growth in the construction industry of Singapore over 1984–1997 were identified
Ivory (2005)	Argued clients will avoid risk associated with innovation

CONCLUSION

Construction productivity is an important topic, and an issue both for the industry and its clients. The rate of growth of productivity in the industry in OECD countries has lagged that of other industries for at least five decades, and the earliest studies that identified a problem date from the late 1960s in the US with Cassimatis' (1969) analysis of labour productivity growth in construction between 1947 and 1967.

This paper has collected a wide range of previous research addressing a range of factors that could affect productivity. The bringing together of these different literatures on productivity analysis and measurement, project procurement and delivery systems, construction industry policy and intervention, and R&D and innovation allows a broader perspective on the construction industry's productivity performance.

These competing explanations of the causes of low construction productivity growth can be assessed in three ways: their completeness (whole of industry or part); their applicability (time, place and circumstance); and their generality (a data artefact or not). Clearly, no single explanation is complete, because each one focuses on a specific issue. The diversity of products and fragmented nature of the production process makes this perhaps inevitable, however measurement issues are both prevalent and relavent accross all sectors of the industry.

In terms of applicability, the breadth of management issues raised by researchers points to some possible serious problems with both the management of projects and management of workers. After several decades of development of project management techniques the average performance of projects does not appear to have improved greatly, with the more recent research finding similar problems as those found in the early work.

Lastly, it is possible that the R&D profile of the industry is as much an artefact of the data as a real problem. Construction is an industry that readily adopts research developments in other industries, the use of computers and the constant flow of new products from manufacturers supplying materials and equipment being good examples. R&D expenditure within the industry will not be very high in this case.

While this review of the construction productivity literature is not complete, because this is a very large field indeed, it has highlighted two key characteristics. The first is the importance of measurement and data to the research. More papers have been published on these issues than any other and they continue to be central to the discussion about the industry's productivity performance. This belongs to a broader set of issues about the structure and use of price indexes in the national accounting framework, an area where construction economists might have an opportunity to make a contribution. Recently there has been a shift from the use of deflators and their effects on measured output (or more precisely the ratio of output to labour input) to concern over the boundaries of the production system and more accurate measurement of specific factors such as capital inputs adjusted for quality and employment adjusted for firm size.

The second is the diversity of other issues raised that are suggested as affecting productivity. Influences on productivity growth in the construction industry, apart from the nature of the product, can be traced to the nature of the methods used in delivering and managing the processes involved. Construction is a labour intensive industry in comparison with manufacturing industries, but there has been a significant increase in the prefabricated component of construction, which could have been expected to lead to productivity growth. Also, construction methods have tended to become more capital intensive as the number of cranes and the variety of equipment and hand tools used has increased. However the productivity growth that one would expect to observe as a result of these trends has not occurred, according to measurements of productivity growth by the major national statistical agencies and reports like the UK studies by Ive et al. (2004) and Blake et al. (2004).

REFERENCES

Allen, S.G. (1985) Why Construction Productivity is Declining. Review of Economics and Statistics, (67), pp. 661-69.

Arditi, D. and Mochtar, K. (2000) Trends in productivity improvement in the US construction industry. Construction Management and Economics 18(1), pp. 15-27.

Allmon, E., Haas, C., Borcherding, J. and Goodrum, P. (2000) US Construction Labor Productivity Trends 1970-1998. Journal of Construction Engineering and Management ASCE, 126 (2), pp. 97-104.

Blake, N., Croot, J. and Hastings, J. (2004) Measuring the Competitiveness of the UK Construction Industry, Vol. 2: Industry Economics and Statistics, DTI, London

Bowlby, R. L. and Schriver, W. R. (1986) Observations on Productivity and Composition of Building Output in the United States, 1972-82. Construction Management and Economics, 4(1), p. 1-18.

Bowley, M. (1960) Innovation in Building Materials, London, Gerald Duckworth.
Briscoe, G. (2006) How useful and reliable are construction statistics? Building Research & Information, 34(3), 220-229.

Cannon, J. (1994) Lies and Construction Statistics. Construction Management and Economics, Vol. 12, No. 4, pp. 307-312.

Cassimatis, P. J. (1969) Economics of the Construction Industry. Studies in Business Economics No.111, New York: National Industrial Conference Board, Inc.

Chau, K. W. (1993) Estimating Industry-Level Productivity Trends in the Building Industry from Building Cost and Price Data. Construction Management and Economics, 11: 370-383.

Chau, K. W. and Lai, L. W. C. (1994) A Comparison Between Growth in Labour Productivity in the Construction Industry and the Economy. Construction Management and Economics, 12, pp. 183-185.

Chau, K. W. and Walker, A. (1988) The Measurement of Total Factor Productivity of the Hong Kong Construction Industry. Construction Management and Economics, 6 (3): 209-224.

Cox, A. and Townsend, M. (1998) Strategic Procurement in Construction. London: Thomas Telford Publishing.

Craig, R. (2000) Competitive Advantage through Tendering Innovation. Australian Construction Law Newsletter, 70: March, UTS Design, Architecture and Building.
Cremeans, J. E. (1981) Productivity in the Construction Industry. Construction Review, 27 (5), pp. 4-6.

Dai, J., Goodrum, P. M. and Maloney, W. F. (2007) Analysis of craft workers' and foremen's perceptions of the factors affecting construction labour productivity. Construction Management and Economics, 25:11, 1139-1152.

Dubois, A. & Gadde, L.-E. (2002) The Construction Industry as a Loosely Coupled System: Implications for Productivity and Innovation. Construction Management and Economics, 20 (7)**,** 621-632.Fairclough, J., (2002). Innovation in the Construction Industry – a Review of Government R&D Policies and Practices. Department of Trade and Industry, London.

Ganesan, S. (1984) Construction Productivity. Habitat International, 8 (3), 29-42.

Gann, D. M. (2003) Guest editorial: innovation in the built environment, Construction Management and Economics, 21, 553–5.

Gann, D.M. (1997) Should governments fund construction research? Building Research and Information, 25, 257-267.

Gann, D.M. and Salter, A.J. (2000). Innovation in project-based, service enhanced firms: the construction of complex products and systems. Research Policy, 29, 955-972.

Goodrum, P.M., Haas, C.T. and Glover, R.W. (2002) The divergence in aggregate and activity estimates of US construction productivity, Construction M anagement and Economics, 20, 415–423

Hague, D. J. (1985) Incentives and Motivation in the Construction Industry: A Critique. Construction Management and Economics, 1985 3(2) 163-170

Herbsman, Z. and Ellis, R. (1990) Research of Factors Influencing Construction Productivity. Construction Management and Economics, 8(1), pp. 49-61.

Hobday, M. (1998) Product complexity, innovation and industrial organisation. Research Policy 26, 689–710.

Ivory, C. (2005) The cult of customer responsiveness: is design innovation the price of a client-focused construction industry? Construction Management and Economics, 23, 861–870.

Ive, G., Gruneberg, S., Meikle, J. and Crosthwaite, D. (2004). Measuring the Competitiveness of the UK Construction Industry, Dept. of Trade and Industry, London.

Koch, J. A. and Moavenzadeh, F. (1979) Productivity and Technology in Construction. Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, 105 (C04), December, pp. 351-366.

Koehn E. and Caplan, S. B. (1987) Work Improvement Data for Small and Medium Size Contractors. Journal of Construction Engineering and Management, Vol. 113, No. 2, pp. 327-339.

Lowe, P. (1995) Labour-Productivity Growth and Relative Wages: 1978-1994”, in Andersen, P., Dwyer, J. and Gruen, D. (Eds.) Productivity and Growth: Proceedings of a Conference, Reserve Bank of Australia, Sydney.

Peiper, P.E. (1990) The Measurement of Construction Prices: Retrospect and Prospect, in Fifty Years of Economic Measurement (ed. E.R. Berndt and J.E. Triplett), National Bureau of Economic Research, University of Chicago Press, Chicago. pp. 239-72.

Reichstein, T., Salter, A. J. and Gann, D. M. (2005) Last among equals: a comparison of innovation in construction, services and manufacturing in the UK. Construction Management and Economics, 23, 631–644

Rosefielde, S. and Mills, D. Q. (1979) Is Construction Technologically Stagnant?", in Lange, J. E. and Quinn, D., (Eds) The Construction Industry: The Balance Wheel of the Economy. Lexington Books, D.C. Heath and Co., Lexington, MA, pp. 83-111.

Sidwell, A. C. (1987). The Future For Building Education, Occasional Paper No. 3, The Australian Institute of Building.

Slaughter, S. (1993) Builders as sources of construction innovation. Journal of Construction Engineering and Management, 119(3), 532–49.

Slaughter, S. (1998) Models of construction innovation. Journal of Construction Engineering and Management, 124(30), 226–31.

Stigler Report (1961) Price Statistics of the Federal Government: Review, Appraisal and Recommendations, Price Statistics Review Committee, NBER, New York.

Stokes, Junior, H. K. (1981) An Examination of the Productivity Decline in the Construction Industry. The Review of Economics and Statistics, 63 (4), pp. 495-502.

Tatum, C.B. (1986) Potential Mechanisms for Construction Innovation, Journal of Construction Engineering and Management, ASCE, Vol. 112, No. 2.

Yu, M. K. W. and Ive, G. (2008). The compilation methods of building price indices in Britain: a critical review. Construction Management and Economics, 26:7, 693-705.

Zhi, M., Hua, G. B., Wang, S. Q. and Ofori, G. (2003) Total factor productivity growth accounting in the construction industry of Singapore. Construction Management and Economics, 21:7,707 — 718.

GLOBALISATION IN CONSTRUCTION

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A number of factors have been driving globalisation in the construction industry over the last two decades, and there is now a substantial body of research into firm strategy, determinants and the relationship between factors. The development of the concept of globalisation in construction is divided into three chronological periods. The first starts with the work of Strassman and Wells (1988) and includes Hawk on the formation of the new construction industry (1991) and Abdul-Aziz's (1994) comparison of Japanese and American international construction firms. These writers document the change from the transnational firm discussed by Strassman and Wells within a conventional trade theory to the mega-firm operating in a globalised market, and the works by Hawk and Abdul-Aziz together represent a quite definitive statement of the characteristics of globalisation. The second period runs from 1994 to about 2007 and the review identifies issues thought to be important in international construction by the writers at the time: competitiveness, technology and technology transfer, procurement and mergers and acquisitions. They draw surprisingly little from the previous discussion within the industry or in the general community, on globalisation, treating each issue in isolation. The third period starts about 2008 and brings together the different strands of thinking into a new, more mature, but equally footloose concept of globalisation. The review finds that there has been little progress in the appreciation of the effects of globalisation on the construction industry, which is surprising given the importance of the topic. The review concludes that there is little evidence of a global industry operating in a global market in competition against each other. There is, however, a number of mega projects that call for firms with global outlooks, capabilities and strategies. It is not a global market in the sense of global manufacturing firms, but it is the development of a new industry that has changed our concept of construction.

Keywords: Construction, international contractors, globalisation, markets, strategy

INTRODUCTION

The concept of globalisation does not strictly apply to the construction industry, as construction is not a commodity that can be traded across international markets. Nor does it extend itself to internationally integrated production, as production in the construction industry takes place on site, within any number of countries (Strassman and Wells, 1988). However, there is no doubt that construction has changed in response to globalisation, and the aim of this paper is to trace these changes and the implications they have had and will have on the future of construction.

The Development of Globalisation

In a discussion about strategies Ridderstrale and Nordstrom (2007) suggest that globalisation is an ongoing revolution. Success in revolutions, they say, is not about following the rules. Success is about breaking old rules and making new ones. At times of radical change, nuances are usually notable by their absence. Nowhere is this more obvious than in the very beginning of a period of rapid change, when initially there is no agreement about where the change is leading us, or if it is leading us or, indeed, if there actually is any change. To try to trace the developing concept of globalisation, this review will be divided into three chronological periods. The first starts when the old order was beginning to break down, with the works of Strassman and Wells (1988), including also Hippo and Tamura (1900) and Hawk on the formation of the new construction industry (1991), and finally Abdul-Aziz's (1994) comparison of Japanese and American international construction firms. Written just before and after the collapse of the Soviet Union as the process of globalisation developed, they trace the change from the transnational firm discussed by Strassman and Wells within a conventional 2x2x2 trade model to the mega-firm operating in a globalised market, and the works by Hawk and Abdul-Aziz together represent a quite definitive statement of the characteristics of globalisation.

The second period takes us from 1994 to about 2007, reviewing the issues that were identified as being important in international construction by the writers at the time. The papers draw surprisingly little from the previous discussion on globalisation, within the industry or in the general community, treating each issue in isolation. The third period starts about 2008 and brings together the different strands of thinking into a new, more mature, but equally footloose and ignored concept of globalisation.

EARLY HISTORY

The first wave of international contracting came when European firms started building abroad. Initially, they capitalised on new technology developed in the industrial revolution and followed the expansion of the British Empire in the nineteenth century. Other countries soon followed, with the French building the Suez Canal, the German's constructing the Ankara to Bagdad railway and the American's undertaking the construction of a number of hydro electric power stations and petroleum refineries around the world (Strassmann and Wells 1988). At the beginning of the 20th century, there were free flows of world trade and investment, but this was brought to a halt by the onset of World War 1, which prompted protectionism and ultimately the Great Depression in the 1930s, followed by World War II. The end of the Second World War could be taken as a possible beginning of modern internationalisation, with renewed interest in trade and investment leading to the development of multinational companies producing and selling in domestic markets around the world.

Strassman and Wells (1988) is the earliest of the works we look at in this paper, and it serves to some extent as a benchmark against which we can see where we were and how far we have moved. Globalisation was a new concept, and there are few signs of it emerging in their work. There was international construction, but for few large firms, maybe 10 or so, did overseas projects predominate. Most firms used overseas activity to bolster home country earnings. The issues the authors discuss have a distinct similarity to the general writings on foreign direct investment in economic development theory and could apply equally well to any production overseas. They centre around comparative and absolute advantage and include discussions firstly on the encouragement of the investors in the form of government financial support and willingness to transfer resources abroad and secondly on the contribution of technology transfer to the host country. The capacity and willingness of the contractor to transfer site know-how and design-construct skills, possibly in the form of joint ventures, is a major issue. The authors also ask if competition is as fierce as it is said to be, when some contractors could exploit technological and economic leadership positions or if their dominance encouraged bidding rings, bribes or inside deals. Little evidence is offered in support of this proposition, which also seems to be a carry-over from the general debate.

The authors define two different approaches or models to international contracting. One we may call the US model a group which also includes UK, Canada and Australia, and the second the Japanese model, which in less extreme forms also includes most of Europe and a number of developing countries like Korea and Turkey. The difference is most noticeable in the extent of government support to the international contractors. In US, there is a generic support for the removal of barriers to trade, but little direct assistance. In the second group, there is not only a high level of direct government support, but also a highly co-ordinated approach by the construction industry and the governments.

Five years after the publication of Strassman and Wells, globalisation had become a more accepted concept and Abdul-Aziz compares the same two models as different forms of global strategies, rather than their approach as two different ways of creating competitive advantage in a conventional international trade model. Abdul-Aziz stated the difference between an international and a global approach: while contractors generally search for overseas opportunities when certain conditions prevail, the global builders, with global perspectives have additional motives which fundamentally are similar to those of global manufacturers. This means first and foremost the willingness to make farsighted commitments: “Instead of evaluating opportunities on a country by country basis these companies daringly took integrative actions for the sake of long term prosperity even though the immediate costs were high.”

The competitive advantages Strassman and Wells saw for US firms were typically technological or organising skills, including the use of computers and CM or design and construct contracts. The direct investment part was normally restricted to about ten or less subsidiaries: “one in Saudi Arabia and the rest divided equally between industralised and developing countries.” The government offered very limited support but Strassman notes that “most countries protect their construction industries, not through tariffs but with other preferences and discriminatory measures.” and that the US government was heavily involved in bilateral and multilateral negotiations to reduce these trade barriers. This protection seems to have been a two-way street as US firms received preferential treatment for US installations and government foreign aid projects overseas.

The Japanese strategy was quite different. After the Second World war Japan like Europe started from a very low base. Where American firms aimed to defend their supremacy, the Japanese corporations’ medium term aim was to become major players in international construction. This included a very deliberate policy of avoiding the perception of themselves as outsiders in the new markets by entrenching locally established corporations within local business communities where they were active, and maximising the use of local resources. Some also supported popular causes like environmental protection or by giving funds to universities.

The American contractors derived their competitive advantage from expertise in construction management, but also from construction technologies that allowed them to establish dominant positions in niche, for instance one half of the world’s nuclear reactors were built by Bechtel. The Japanese tended to develop innovative construction methods and related specialised equipment that enabled them to establish proprietary positions across major sectors of the industry. During the 1980s, project finance became a competitive tool and here too the strategies differed, with US depending on its international banking sector while Japan could draw on their government’s comprehensive export credit system. The American technological lead was also under threat. Abdul-Aziz suggests that while the leading American firms spent 0.5 per cent of revenues on research, the corresponding figure for Japan was 3 per cent and if all sources of research are included, in some instances it reached 10 per cent.

While these differences were to become important, at the time the similarities between American, Japanese and European firms were more evident. Unable or unwilling to compete on price in the 1980s recession, the firms from developed countries marketed a “total” service, including not only CM, finance and design, but also services such as site selection, feasibility study, design engineering, procurement of materials and equipment, commissioning, staff training and post-construction maintenance. The “complete solutions” implied proposing more cost-effective alternatives where possible, resuscitating abandoned projects or stimulating demand. This enabled the global firm to add value before and beyond the construction activity.

In this context, Abdul-Aziz suggests a theoretical framework proposed by Porter, who recognises competitive advantages based on both country and firm specific advantages. The national advantages are derived from factor and demand conditions as well as from the state of related and supporting industries. While the firm can only accept the country specific advantages, it can create specific advantages or disadvantages in the form of firm strategy, structure and rivalry. There is little to separate America and Japan in terms of demand conditions, while Japan is judged to have advantages in factor conditions and related and supporting industries. However, at the firm level the ownership structure of Japanese industry conveys a real advantage. Ownership, by and large, by institutions concerned with long term appreciation makes it possible for Japanese corporations to take a long term perspective of business development, a strategy by and large not available to the US firms. The patient capturing of market share and investment for research for sustained competitive lead fits in with the global mentality and makes Japan a good breeding ground for global industry.

Written prior to Abdul-Aziz, David Hawk’s 1991 paper accepts as given Abdul-Aziz’s major assumption, that competitive advantage on a national basis is not important, rather globalisation is based on the strategies of the firm. Discussing “Conditions of success” in international construction, Hawk does not mention globalisation, but implicitly, the whole paper is about how to be a successful participant in a “new”, global construction industry, where the industry is not confined to activities on the site, but covers everything from design to material to construction to finance. The themes around which the successful firms are responding to industry changes (developed from discussions and interviews with 60 of the largest participants) span not only new technology and organisation, but most of all, changes in the products and services they deliver that expand and create new markets. More specifically, the themes include innovation in identifying and responding to changing consumer expectation such as higher quality, lower costs and improved environmental sensitivity and finding new business ideas and customers by providing, among others, environmental sustainability, one-stop shopping, intelligent buildings, PPPs and innovative linkages to other industries. The over-riding theme is to add value through integration of the total process and respond to the advantages opened up by the globalisation of the world economy. This means that the firms accept higher levels of diversity in what they do and how they do it. The alternative to stagnant markets is to generalise with many specialties, including one-stop shopping.

In terms of the process of construction, the themes emphasised industrialisation by replacing the crafts tradition and organisation by industrial concepts and investing in a scientific-technical base for continual improvements. This would create the preconditions for replacing the traditional hierarchy system with a system based on decentralised decision making. The organisation of the firm needs to allow small autonomous groups to efficiently function within large companies to link the operational advantages of smallness to the symbiotic advantages of integration. Finally, there was the one theme that made all of this possible, adopting an attitude of learning to learn.

In Hawk's vision, international construction was entering a new stage that was more mature than the conventional multinational firm and less dependent on isolated and transient stockpiles of money. The global construction firm is closer to global business as developed in other industries than it is to the traditional, small scale, low technology service industry which it has left behind. This fairly small group of global firms is what Hawk, provocatively but justifiably, refers to as the new construction industry.

THE MIDDLE PERIOD

Globalisation has been one of the major issues that have defined the economic and political debate for two decades, but as suggested in the introduction, there is no general agreement on the most basic issues. Indeed, defining globalisation is an issue in its own right. Even more prolific and diverse has been the debate regarding the significance of globalisation. Writings in construction and construction management have not, with a couple of notable exceptions (Lewis, 2007and to some extent Raftery et al. 1998) participated in these debates, nor have they built on the foundations discussed above. Rather, the construction debate has been limited to individual papers on individual aspects of the industry, scattered without any clear pattern across a number of issues. While the term "globalisation" is used, there appears to be no implicit or explicit difference between globalisation and internationalisation or between the global and the multinational firm. A number of papers have dealt with competitiveness but these papers contribute little to the globalisation debate and will not be discussed here.

Halpin and Hoang (1995) summarised responses from interviews with representatives of international corporations into a set of recurrent themes. While the terminology is different there are similarities between this set of themes and that developed by Hawke: customer focus, integrated perspective, environmental sensitivity, flexibility, improvements in management with less emphasis on hierarchies, the image of the client, and, most of all, add value to the development. Their conclusion, however, follows the American model: provide a service, concentrate on niche markets, focus on core competencies and ensure flexibility through loosely defined alliances with small and flexible specialty firms.

Raftery et al. (1998) breaks the mould by touching on the impact of globalisation on income distribution in the region, and in a Heckser-Ohlin framework sees mutual benefits for exporter and importer, but does this without any empirical analysis. However, as has been pointed out, reality does not satisfy many of the very restrictive assumptions in the 2x2x2 trade model. In particular capital is becoming more mobile and is often supplied by the importer rather than the exporter. Without entering the debate on who benefits most from globalisation, the buyer or the seller, there are strong reasons to believe that there are more complex relationships than assumed in conventional trade models. The rest of their paper discusses policies for deregulation, rational taxation and increasing involvement of the private sector in provision of infrastructure. The only country in the region already part of the global market, Japan, is examined and the major reason for its success is seen as advanced technology. This is supported by a large domestic market that provides experience, access to finance and a supportive government. The importance of the strategy of the firm aiming to participate in the global market, stressed by Hawk and Abdul-Aziz, is somehow subsumed under generalised national competitive advantages, bringing us back to the analysis of Strassman and Wells a decade earlier.

Globalisation has demonstrated the importance of means other than international trade for winning markets, notably mergers and acquisitions (M&A) and takeovers, leading toward a small, global, "super league" of contractors who are seeking to widen their expertise, enter new markets and get closer to their international clients. There is an extensive literature on the performance of firms that have merged or taken over another firm, but very little in the construction context. One exception is Choi and Russell (1994). In their sample the acquiring firm typically had four previous experiences. Most of the transactions were cooperative and in about half the cases the target firms were classified as construction. As in many other studies, the shareholders of the merging firms did not realise significant gains around M&A transactions.. Not too much should be made of the explanatory variables tested. In regression equations, their R^2 were between 0.10 and 0.16.

Whatever the profitability or otherwise Runeson and de Valence (2009) traced the growth of some of the top ten Australian construction firms as they went through stage after stage of M&A until most of them emerged as part of the top European firms, which have inputs of literally hundreds of firms from a range of countries. .

Among the most active writers on internationalisation of construction firms have been the staff at SNU and in particular George Ofori, starting from 1992 and covering a range of issues over the following decade. The first paper discussed here is Betts and Ofori (1992), which deals with the importance of strategic planning in creating competitive advantage. While the paper itself doesn't deal specifically with globalisation, many of its examples draw on studies of the

Japanese (Hasegawa 1988) and UK (Cannon and Hildebrandt, 1990) globalised industries, as well as companies like Bechtel which have embraced globalisation. There are discussions of the major aspects of strategies such as backward and forward integration towards the one-stop-shop and investments in technology which have become central to the debate but no corresponding conclusions. Ofori (1994) also discussed the broad issue of technology transfer with international construction. Joint ventures and PPPs are singled out as potential ways to facilitate technology transfer.

In a 2003 paper, Ofori recognises an “international construction system” comprising firms operating throughout the world. The firms chose markets where they have a competitive advantage, based on firm and national competitive advantages. In reconsidering Porter’s model, Ofori rejects factor conditions, demand conditions related and supporting industries and government support as irrelevant on the grounds that the international operation of the global firm offers alternative sources for these supports which leaves firm strategy, rivalry and chance. The conclusion is a model based on multiple linked diamonds.

Cuervo and Low (2005) report on a study of the reasons for internalising various factors in transnational construction that also demonstrates the problem of using a model developed for manufacturing for analysing construction. The importance of the various factors is determined without consideration to the motives for initiating transnational construction, although there are very strong a priori reasons to believe that the considerations of a contractor doing work overseas for a local client (twenty per cent of the firms) would be vastly different to these of the contractor making a deliberate decision to establish themselves in an overseas market (less than half of the firms). This, of course is not a problem in manufacturing where production overseas means a deliberate decision to be active in the market, requiring FDI.

The differences between firms that have made a decision to aim for a presence in the global market and firms that engage in international contracting on an opportunistic basis is illustrated in a study of British construction firms by Whitula et al (2006). Using Yip’s (2003) framework of four global drivers: costs, market, government and competitive which makes it profitable to make more or less use of five levers: participation, products and services, location of activities and competitive moves. The strength of the global drivers varies by industry and firms are expected to globalise activities and operations such that strategy levers align with relevant industry levers. In a sample of eight, where six firms are involved in international contracting on a substantial but opportunistic basis and two are by most definitions global firms, there is virtually no overlap between the two groups in terms of use of the levers. The authors found the global drivers were relatively weak, which suggested the use of global levers would also be low. While this was true in aggregate, the two global firms made significantly more use of each lever than the remaining six, suggesting that globalisation is an attitude rather than a classification based extensively on degree of internationalisation.

The future of construction: a critical review of construction future studies (Hartey et al. 2007) offers some interesting insights into current thinking. When aggregating 13 reports on the future of construction, three issues dominate the discussion: ICT, Sustainability and Globalisation and the authors present the conclusions in the form of two extreme scenarios of the future 20 years on. In scenario 1, increased legislation and regulation of both construction and building performance at national, international and global levels as well as common standards has allowed expansion of the national sector into an international market. The work has shifted from short term construction to long term service provision with forward and backward integration, as new materials allow a shift from site to factory. Scenario 2 is different mostly in the consequences of a more regulated and standardised market. In this scenario national markets are opened up to global firms and in the end, only a few large firms has survived and operate in a global market. As in scenario 1, the surviving firms deliver a holistic, lifecycle based service integrating design, construction and facilities management, but like manufacturing, the products are standardised.

COMPETITION FOR GLOBAL CONTRACTORS

Brockman (2009) paints a rather sobering picture of the current state of globalisation that may in parts explain the limited interest demonstrated in the construction literature. First of all, he differentiates between international, multinational and global markets and firms. If the activities in more than ten foreign countries contribute a larger share to a company's revenues, then the company can be called multinational. A multinational company normally has foreign subsidiaries and much of the firm's foreign revenue is produced locally by these subsidiaries. The projects are won, managed and constructed locally with local material and equipment, with no foreign influence except the transfer of profits and an occasional meeting of top representatives. Global companies, on the other hand, operate a network spanning the globe. Managers come from countries around the globe, products are bought where cheapest, and production is set up where labour costs are low. The orientation of the company is not tied to any one national culture. The headquarters coordinate the activities of affiliated and owned companies around the world.

Brockman uses the total value of construction spending, estimated to be around US$3.9 trillion for the year 2002 (Tulacz, 2000), when the top 225 international contractors had revenue from overseas operations equivalent to 3.4 per cent of total construction spending, which means that the whole international market is roughly the same size as the market in Germany. Therefore about 95 per cent of the global construction spending is allocated in local markets to local and national contractors. It definitely shows that the construction market is not a global market. Further, the international revenue of the ten most active international companies amounts to 44 per cent of the worldwide international revenue, meaning that the market shares held by these ten companies of all national markets is merely 2.5 per cent. This would suggest that there are no global players in construction holding a recognizable market share.

To find out the strength of competition, we can look at the revenue in the six largest markets and the different types of project that generate the international revenue. There are clear indications that, except for the markets in Europe and the US, the direct competition among the big multinational companies is rather limited geographically and for types of construction with the exception of buildings. In each market the multinational firms compete only against a small subset of similar firms. The conclusion is that there is no global construction market, where companies compare themselves with the global leaders. On the demand side, in 2000 Engineering News Record listed 147 international projects with an average size of about US$400 million, including a small number of Megaprojects, a special subgroup of projects of extreme complexity and size that require cutting-edge technology and include hydroelectric, thermal and nuclear power, urban transport, roads, tunnels, bridges, tunnels, oil and technology projects.

Construction companies offer their potential in markets and sellers look for the potential their projects require. While on the supply side, we may not have a global market where global firms compete against each other, there is a global demand for construction potential to deal with international megaprojects: “There is a select group of companies engaged in global projects around the world. They standardize across cultures and organizations what they offer on this market, their potential to execute megaprojects. Such companies are the global players in construction” (Brockman 2009, p 195).

CONCLUSION

Brockmann identifies what characterizes global construction firms: a global contractor understands megaprojects and knows how to deal with the complexity, is neither ethnocentric nor polycentric but transcentric, must have experience with international joint ventures, and have the ability to organize and manage an international network. The international contractor must offer the client a worldwide reputation as hostage against his possibilities to resort to opportunism and provide cutting-edge technology and possess sufficient financial resources for the tendering, negotiation and the start-up of the project. A global player does not standardize output but standardizes input in order to deliver projects around the world.

Brockmann’s findings are consistent with Hawk’s (1992) and also with Male and Mitrovic, (1999) and Halpin and Hoang (1995) and also with Runeson and de Valence (2009) who have looked at how social, political and technological developments have encouraged the development of very large firms with global potential. In a number of ways, these papers and that by Abdul-Aziz, have arrived at basically identical conclusions. Comparative advantages based on country of origin are not important. Conventional trade models offer little in the form of explanation of why or how global construction. Rather, we have a small number of firms, maybe 20 or so, that have developed strategies and responded to changing social, economic and technological developments in such a way that they have acquired the potential to handle global construction and have become part of the global market.

This paper has divided the development of the concept of globalisation in construction into three periods. The first started with Strassman and Wells (1988) and included Hawk (1991) and Abdul-Aziz (1994). In the second period from 1994 to about 2007 issues thought to be important were competitiveness, technology and technology transfer, procurement and mergers and acquisitions. The third period from 2008 has more mature concept of globalisation. The review finds that there has been little progress in the appreciation of the effects of globalisation on the construction industry, which is surprising given the importance of the topic.

REFERENCES

Abdul-Aziz, A. (1994) Global strategies: a comparison between Japanese and American construction firms. Construction Management and Economics, Vol 12 no 3, 473 – 84

Betts, M. and Ofori, G. (1992) Strategic planning for competitive advantage in construction. Construction Management and Economics, Vol 10, pp 511 - 32

Brockman, C. (2009) Global construction markets and contractors, in Ruddock, L. (ed.) Economics for the Modern Built Environment, Taylor and Francis, Oxford.

Cannon, J. and Hildebrandt, P. (1990) Diversification, in The Management of Construction Firms: Aspects of Theory. (Eds Hildebrandt P and Cannon, J) Macmillan, London.

Choi, J., Russell, J. (2004) Economic gains around mergers and acquisitions in the construction industry of the United States of America. Canadian Jnl of Civil Engineering, Vol 31, pp 513-25.

Cuervo J. and Low S.P. (2005) Significance of internalization factors for Singapore transnational construction corporations. Construction Management and Economics, 23:2, 147 - 162

Halpin, D and Hoang, R-H. (1995) Competition and future needs of international clients. Journal of Professional Issues in Engineering Education and Practice, July, pp 191-96

Hartey, C, Goodier, C, Soetanto, R, Austin, S, Dainty, A and Price, A, (2007) The futures of construction: a critical review of construction future studies. Construction Management and Economics, Vol 25, pp 477 - 93

Hasegawa, F. (1988) Built in Japan. Wiley, NY.

Hawk D. (2006) Conditions of success: a platform for international construction development, Construction Management and Economics, vol 24 pp 735 – 42

Hawk, D. (1992) Forming a new industry – International building production. Document D11. Stockholm: Swedish Council for Building Research.

Hippo, Y. and Tamura, S. (1988) Japan, in Strassman and Wells (1988).

Lewis, T. M. (2007) Impact of globalization on the construction sector in developing countries. Construction Management and Economics, 25:1, 7 — 23.

Male, S. and Mitrovic, D. (1999)Trends in world markets and the LSE industry, Engineering Construction and Architectural Management, Vol 6, no 1, pp 7 – 20

Ofori, G. (1994) Construction industry development: role of technology transfer. Construction Management and Economics, Vol 12, pp 379 – 92

Ofori, G. (2000) Globalisation and construction industry development: research opportunities. Construction Management and Economics, Vol 18, pp 257 - 52

Ofori, G. (2003) Frameworks for analysing international construction. Construction Management and Economics, 21:4, 379 — 391.

Porter, M. (1985) Competitive advantage, Free Press, New York

Raftery, J., Pasadilla, B., Chiang, Y.H., Hui, E.C.M. and Tang, B.S. (1998) Globalization and construction industry development: Implications of recent developments in the construction sector in Asia. Construction Management and Economics, 16:6, pp. 729-737.

Ridderstrale, J and Nordstrom, K (2007) Funky Business Forever, 3rd Ed Blackwell, London

Runeson, G. and de Valence, G. (2009) The new construction industry, in Ruddock, L. (ed.) Economics for the Modern Built Environment, Taylor and Francis, Oxford.

Strassman, P and Wells, J (eds) (1988) Global Construction Industry,.Croom Helm, London.

Tulacz G.J. (2000) A look at a $3.4 trillion market. Engineering News Report, Dec. 4, 30–43.

Whitla, P., Walters, P. and Davies, H. (2006) The use of global strategies by British construction firms. Construction Management and Economics, 24:9, 945 — 954.

Yip, G.S. (2003) Total Global Strategy II, Prentice Hall, Englewood Cliffs, NJ.

THE MECHANICS OF COLLUSION

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The construction industry is according to the bribe payers index from Transparency International the most corrupt industry, well ahead of the defense sector. Corruption and collusion are closely interrelated in the public sector, they nurture each other. However, collusion does not depend on corruption, it can thrive by itself.
A basic question is whether collusion is mostly a moral or an institutional issue. Using the title "mechanics of collusion" and proving the implied automatic reactions clearly strengthens the argument for an institutional view. There is no freedom of choice in mechanics and accordingly there are no moral issues. The predominant antecedents of the construction industry (sealed-bid auctions, competitive environment, large contract volumes) are setting incentives for collusive cooperation. Such a behavior can even be morally defended. Since it is illegal (while extant) in most countries, it cannot be encouraged. However, it is worthwhile to discuss changes to the procurement process that will set incentives to discourage collusion.

KEYWORDS: collusion, game theory, institutions, monopsony.

INTRODUCTION

The practice of collusion is illegal. Most capitalist countries have laws safeguarding competition. In the USA, anti-trust legislation prohibits monopolization, restraints of trade, and collusion among firms. The base of this legislation was laid 120 years ago with the Sherman Antitrust Act (1890), the Clayton Antitrust Act, and the Federal Trade Commission Act (both 1914). The fundamental idea behind this legislation is that free competition serves the general welfare best by limiting the power of any one party when determining price and quantity through the interaction of supply and demand (Samuelson / Nordhaus 1989). The idea is to protect the weaker market side (the buyer in general or the client in construction) and therefore to enable a competitive market to develop that is sustainable.

Competitive markets are perceived as maximizing the welfare of society (composed of all buyers and all suppliers) since in them long-run economic profit is zero. Economic profit is the difference between total revenue and total cost. The economic concept of total cost takes into consideration the opportunity cost of any activity, i.e. the value of the best forgone alternative. In other words, total cost includes all self-supplied services priced at the value of the best forgone alternative (Hirshleifer / Hirshleifer 1998). In construction, this is especially the income of the owner and interest on equity. Accounting profit does not consider opportunity cost.

Collusion in duopolies

Collusion in duopolies is the typical case used in textbooks to introduce this practice. While duopolies are practically non-existent in the construction industry, a duopoly allows to understand the basic mechanics of the process. The following example is from Taylor (1995) and uses game theory for analysis.

Two companies called Bageldum and Bageldee produce rather homogenous products, bagels. They have a choice of charging the competitive price where they will earn no economic profit as marginal cost equals price or they could collude, charge the monopoly price and make a profit of 2 mill. dollars each. There is also an incentive to defect from the collusion by undercutting the monopoly price just slightly (thus becoming competitive with a price above marginal cost) and by selling a large volume of bagels with a comfortable profit (4 mill. dollars in the example). The other company then will make a loss equal to fixed cost (-1 mill. dollars). The payoff matrix shown in table 1 resembles that of the well known prisoner's dilemma.

Choices		**Bageldee (A)**			
		Competitive Price		Monopoly Price	
Bageldum (B)	Competitive Price	A: $0	B: $0	A: -$1 mill.	B: $4 mill.
	Monopoly Price	A: $4 mill.	B: -$1 mill.	A: $2 mill.	B: $2 mill.

Table 1: Payoff matrix for the bagel duopoly

In the prisoner's dilemma, communication is physically impossible while in the case of a duopoly price communication is illegal but possible. The incentive to defect is large and an innocent Bageldum might choose this option. Bageldee has no other choice but to follow in reducing the price, otherwise it will be wiped out. Thus, both arrive at the competitive price. Bagels are sold continuously and the game is repeated over and over again contrary to the prisoner's dilemma which is played just once. Bageldum and Bageldee will get the idea sooner or later and collude again to charge the monopoly price. If the game is played often enough, there is not even need for explicit collusion. Understanding the mechanics, both companies will converge towards the monopoly price by tacit collusion which is not illegal. It is well established that the results of monopoly pricing are quantities supplied below equilibrium quantity Q_o and prices charged above equilibrium price P_o, definitely a suboptimal outcome with regard to overall welfare (Varian 2001).

The difference between the prisoner's dilemma and duopolistic collusion is due to two facts: communication is possible and the game is repeated in the case of duopolies. As a duopoly is highly unlikely to be found in the construction industry, we need a model of market structures for the construction industry to advance the argument.

Market structure of the construction industry

Three different levels of market structure can be discerned in the construction industry (Brockmann 2009):

1. Macro-level or national construction market: In all capitalist countries the number of construction companies competing for jobs is very large. Construction investment is high and the average job size is small relative to the overall investment (while still being a large sum per se). Both facts mean that there are many suppliers and buyers: The market is in perfect competition.
2. Mezzo-level or regional construction market: In most cases and dependant on the business cycle both, supply and demand, are characterized by a large number of players. The market is in perfect competition, except for a few abnormalities.
3. Micro-level or construction project market: The structure depends on the choice of the client (demand-side). In the most common case of sealed-bid auctions, the structure can be characterized as a monopsony where the client has complete price information and companies are ignorant except with regard to their own offer. The client has considerable market power on this level. After signing of contract this structure will shift into a two-sided monopoly, but this is irrelevant for collusive behavior because this ends latest with the signature.

Competitive markets on the macro- and mezzo-level deny each single construction company to have an influence on quantity or price, they act as quantity and price takers. Anything close to a duopoly with its influence on pricing might be found in specific and few niches, otherwise it is of no importance.

Course of the argument

This introduction is followed by a short description of the research methodology. We accept the idea of competitive markets maximizing welfare for the following discussions. However, there remains the question whether construction markets are organized in a way to produce the equilibrium quantity Q_o at the equilibrium price P_o. This question will be researched in the chapter on pricing in the construction industry. The results of the discussion on pricing are then introduced as incentives for playing and organizing strategic games in the chapter on collusion in construction. A summary of the results and an overall interpretation are given in the conclusions.

RESEARCH METHODOLOGY

Economic theory, game theory, and archival data are used to develop the argument by logical deduction. Three research questions are driving the argument:

1. Why does collusion exist in construction?
2. How are collusive games played?
3. How can collusion be prevented?

These research questions can also be formulated as two hypotheses: (1) There are strong economic incentives for contractors in the construction industry to engage in collusion. (2) Collusive games in construction do not necessarily decrease social welfare.

PRICING IN THE CONSTRUCTION INDUSTRY

Pricing in construction depends on the procurement method chosen by the client as buyer. There is a large number of different procurement methods. To simplify the discussion, we will concentrate on the most common one, the conventional method (Masterman 2002) in the form of a sealed-bid auction and award to the low bidder. In many counties this is the prescribed procurement method for public clients. Sealed-bid auctions with award to the low bidder are characterized by a price bias, an information bias, and an uncertainty bias. The first two are a result of the monopsonistic power of the client, the last one is an estimating bias for complex contract goods.

Price bias in sealed-bid auctions

In general, pricing in construction could follow the laws of supply and demand, if procurement would not make use of sealed-bid auctions. The result of sealed-bid auctions is the monopsony market structure for any given project. The expectancy value of a bid E(b) from a number of contractors (n) depends on this number and is in all cases except for n = 1 below the price resulting from the equilibrium price P_o in competitive markets (Leitzinger 1988). The larger the number of bidders, the smaller are the chances to win an auction by submitting the equilibrium price. Winners are faced with a price below equilibrium in competitive markets assuming a normal distribution of the bids (see table 2). Price bias can be explained by estimating errors or by technology advance.

Number of contractors	1	2	3	4	5	6	7	8	9	10
Expectancy value E(b)	±0,00	-0,564	-0,846	-1,029	-1,162	-1,266	-1,351	-1,423	-1,484	-1,537

Table 2: Expectancy values for bids in sealed-bid auctions

Estimating bias for complex contract goods in sealed-bid auctions

Contract goods are very different from exchange goods, they are fabricated after signing a contract, they are most often single units and of considerable complexity. Milgrom (1989) discusses two premises in conjunction with pricing in sealed-bid auctions of contract goods: the private and the common values assumption. The private values assumption states that contractors can determine their cost (labor, materials, equipment, subcontractors, indirect cost) and Milgrom does not accept this assumption to hold. He assumes estimating errors by all bidders (ε_i) with a normal distribution about the mean (i.e. no bias). All detailed analyses of single estimates and the bid-spread of submissions support the statement. The estimating approach takes this into consideration and deals with the problem by detailing a structure into a comprehensive work breakdown schedule. Judgment mistakes occur for most items, however, they are not systematic. Over a large amount of items these cancel each other out and there is a tendency towards a mean value. In an example of a post-construction analysis of a structure, the differences in single items reached almost 100% while the overall difference between planned and actual cost was only 3%. The contractor was lucky, he had overestimated the total cost (Birol 2009).

The second assumption is accepted by Milgrom: all companies face approximately the same cost (C), the common values assumption holds. In different segments of the market companies of equal size tend to compete against each other, therefore the purchasing power of the companies is the same. Short-term advantages of one competitor (i.e. use of cheap foreign labor) must be imitated by the others due to the competitiveness of the market.

With these considerations Milgrom can formulate $X_i = C + \varepsilon_i$. While the estimating error is unbiased, this does not hold true for the successful bid. The lowest bid lies below the mean value and therefore below equilibrium price P_0.

Technology advance in sealed-bid auctions

It is not necessary to make use of Milgrom's equation to explain the values of table 2. The same argument can be made for companies with different degrees of competitiveness. Assume some companies to be technologically advanced and others to be lagging behind.

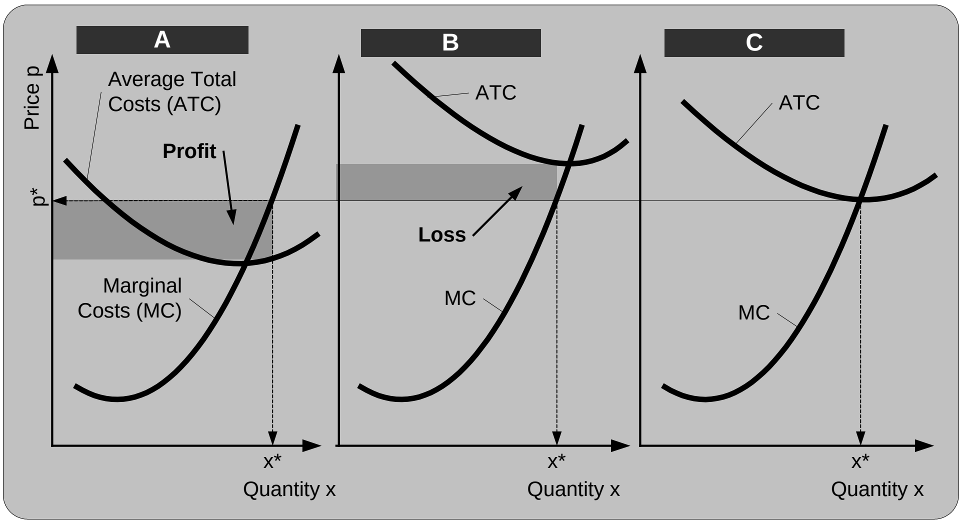

Figure 1: Average total cost, marginal cost, profits and losses

According to economic theory companies stop producing once marginal cost (MC) equals market price. Average total cost (ATC) for each company now depends on technology and these differ between contractors. The ATC of contractor A of fig. 1 with an advanced technology are below market price resulting in a profit. For contractor B who is lagging behind on technology, the inverse is true and the contractor will lose money. Case C shows the average contractor who does neither achieve an economic profit nor suffer a loss.

It can be assumed that the cost are normally distributed around a mean determined by the intersection of marginal and average total cost. There are some companies with high, some with low cost and most are found close to the mean (Heuß 1965). This allows us to draw a theoretical curve of the planned cost. All companies want to cover at least the average variable cost, this sets the lower boundary of the normal distribution (see fig. 2).

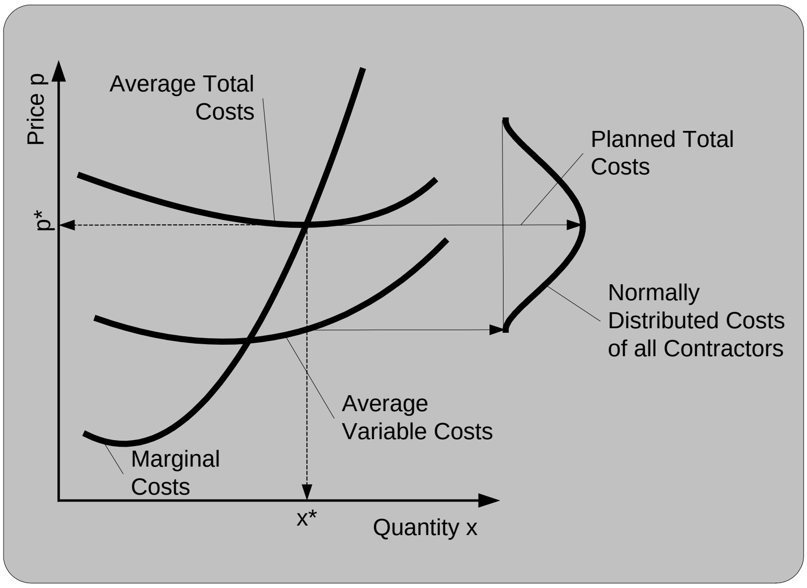

Figure 2: Normally distributed cost of all contractors in a bid

Whether we assume estimating errors or technology differences, the result is the same: There is a normal distribution around a mean value. When the low bidder is being awarded the contract, then the auction results are biased. In one case we have the winner's curse, in the other case wins the technologically most advanced company. However, this company cannot reap profits from its advance but must hand over most of it to the client. This does not only decrease the incentives to innovate it also takes away the necessary means.

Information bias in sealed-bid auctions

In many cases, private clients use their complete information of all unit prices of all the different bidders to negotiate the price further. The asymmetric information allows the client to play one bidder against the next. False information about the price of one bidder given to another one cannot be detected by either bidder during a simultaneous negotiation round. Only at the end of the negotiation the bidders can exchange and check the client's information. This strategy by the client is legal, yet the consequences of the monopsony are as detrimental to the overall welfare as it is perceived to be true for monopolies.

In general fashion results of information asymmetry are shown in fig. 3 (Prognos 1977). Depending on which side is in possession of privy information, there will be a shift of the mean price in that direction. It is for this reason that in many countries public clients are not allowed to negotiate the price after opening the sealed bids.

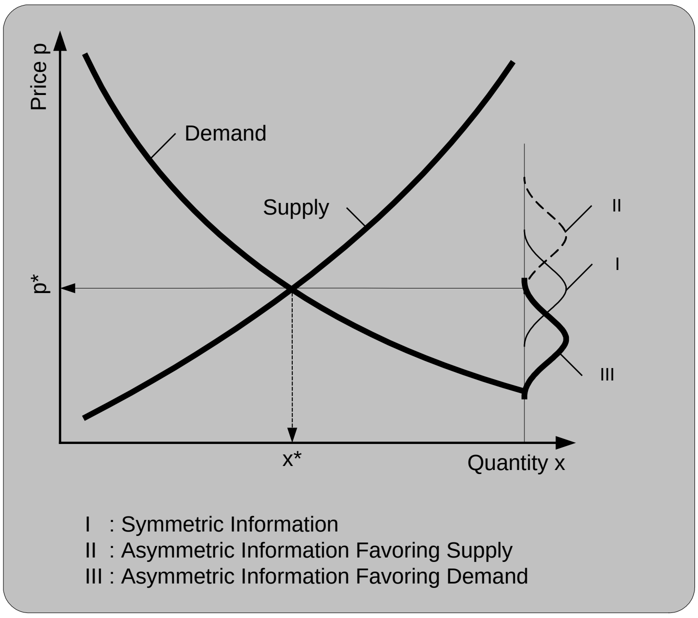

Figure 3: Influence of asymmetric information on price

Effects of sealed-bid auctions

Perfect competition in construction markets combined with sealed-bid auctions and followed by a monopsony situation assures the market power of the client. The contractor is confronted with four factors:

1. Sealed-bid auctions as institutions are biased with regard to estimating errors, driving the low-bid award price below equilibrium price.
2. Sealed-bid auctions as institutions are biased with regard to technology, driving the low-bid award price below equilibrium price.
3. Both effects will overlap and aggregate, driving the award price further below equilibrium price. In the worst case, the technologically most advanced contractor commits the biggest estimating error.
4. Sealed-bid auctions as institutions are biased with regard to information, driving the low-bid award price below equilibrium price. This holds especially true in a two-phase award process, when the auction is followed by price negotiations.

Accordingly, contractors feel to be continuously pressed into an unfair pricing system in comparison to competitive market structures. Their only chance to counter the asymmetric information advantage of the client is through collusive cooperation. In terms of game theory it can be stated that the payoffs for a non-collusive outcome of a sealed-bid auction are negative in comparison with the often as fair perceived equilibrium price.

The incentives in the auction game are not set in a way to keep the contractors interested in keeping the rules. Anti-trust laws are required to keep them in line. However they are not always successful.

THE GAME OF COLLUSION

The game of collusion being played by contractors wrests the information edge away from the client and transfers it to the contractors. There are two possible environments where collusion can thrive. On the one hand (naturally caused collusion) there are natural niches where the players are limited setting up an oligopoly or even a duopoly as in the introductory example. On the other hand (artificially caused collusion) information from the client is required and bribery is used to get the information.

Bribery is rather widespread in construction. The construction industry is according to Transparency International (Bribe Payers Index 2008) the most corrupt industry, easily outpacing notorious sectors like defense (see table 3). The lower the index number, the more corrupt is a sector.

Table 3: Bribery in industry sectors

Sector	Index
Public works contracts & construction	5,6
Oil & gas	5,7
Mining	5,8
Real estate & property development	5,9
Heavy manufacturing	6,1
Pharmaceutical & medical care	6,2
Civilian aerospace	6,3
Arms & defense	6,4

Corruption is also a cultural problem, there are significant differences between countries. A cluster analysis of some industrialized and some newly developed countries by Transparency International yields the results of table 4. In this case, cluster 1 contains the least and cluster 4 the most corrupt countries.

Table 4: Cluster analysis of corruption in selected countries

Cluster 1	Australia, Belgium, Canada, Germany, Japan, Netherlands, Switzerland, United Kingdom
Cluster 2	France, Singapore, Spain, United States
Cluster 3	Brazil, Hong Kong, Italy, South Africa, South Korea and Taiwan.
Cluster 4	China, India, Mexico and Russia

Benchmarks of the data can be found by interpreting additional survey results. Belgium belongs to the cleanest cluster and still 16 percent of the respondents believe that Belgian companies use familiar or personal relationships “often” or “ almost always” to win public contracts.

Bribery as a basic ingredient that can be employed towards collusion is more or less common in the construction sector. Having won this pennant is a doubtful honor for any sector.

Naturally caused collusion

Oligopolies exist because there are some factors limiting competition. One possibility is a limited regional oligopoly, another is a long-term monopoly in a niche of the construction sector. Deep-water dredging is one example for the latter. Dredgers are undoubtedly required resources, they are visible and the whole interested world knows who owns them. Competitors for large deep-water dredging contracts are thus known and they form a naturally caused oligopoly. Market entry is limited by the high investment for dredgers.

Tacit collusion is not possible because there is not a large quantity of goods being supplied to the market as it is the case for bagels or refinery products etc. Instead, the goods traded are defined by large single-unit contracts that are often awarded by sealed-bid auctions. These games are not repeated often enough to establish a market equilibrium at monopoly prices. In addition the size of a single contract offers considerable incentives to defect from collusion and this is facilitated because the contract prices are always publicized. Except for abstaining from collusion altogether and accepting the biased sealed-bid auction price, the competitors can only engage in explicit collusion.

The mechanics of the ensuing process are driven by two mechanisms. Firstly the colluding contractors must agree on a selection mechanism and secondly they must decide on a price setting mechanism. Thirdly – but not necessarily – a profit distribution mechanism needs to be established. Bribery is not required to gain information, the competitors are known by possession of the limiting factor (in the case above, by the dredgers).

The selection mechanism must allow to determine whose term it is. This can either be based on statistical data, such as market share at the beginning of collusion, or on argumentation where a bundle of criteria might be considered.

The price setting mechanism again depends on two options: Companies can either generate their own profits once they have been chosen or the profit of each company can be distributed to all colluding contractors. The first case sets the stage for a two-phase game that is cooperative in the first phase and competitive in the second. Here, the chosen contractor wants to establish the highest reasonable price possible while all the others want to limit his profits since he will still be a competitor in other areas or at other times. The price will shift from below equilibrium price upward. How much upward depends on the price effect of the collusion. In an older study (Prognos 1977), the price effect was found to amount to 2,5% as part of return on turnover for all projects (competitively and collusively bid). Since the total return on turnover during the same period was smaller than 2,5%, there would have been prices below equilibrium without collusion.

The second case brings also a two-phase game about, but both phases are cooperative. Since all companies are interested in the profit from the focal transaction they have a tendency to charge the highest price possible which is the monopoly price. The monopoly price decreases welfare due to the overall deadweight loss, it is not a desirable result (Varian 1999).

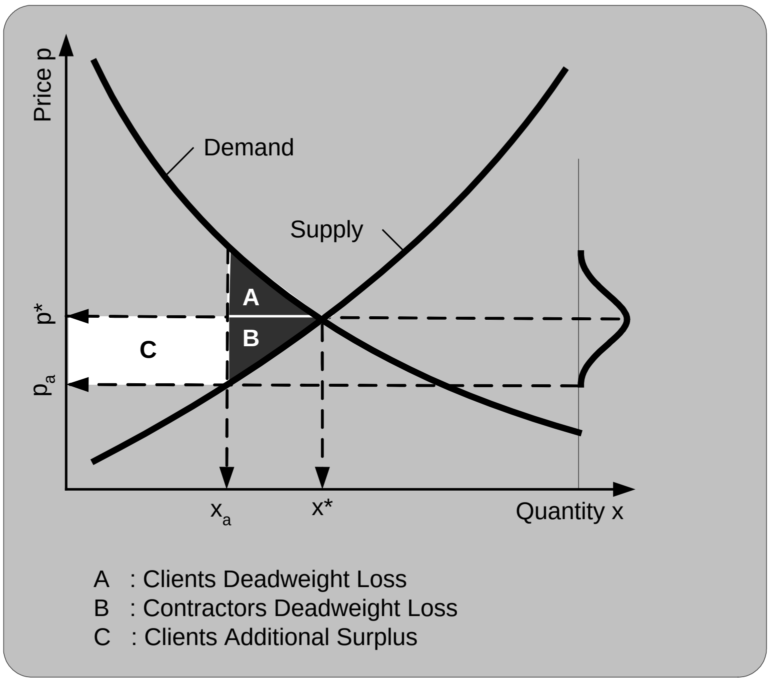

Figure 4: Deadweight loss due to sealed-bid auctions

For considerations about the collusive outcome on social welfare, this distinction is of utmost importance. The argument on pricing was that sealed-bid auctions force the contractors to except prices below equilibrium and this lowers overall welfare. The effect is shown in fig. 4. The auction price is below the equilibrium price and this has two results: (1) It augments the clients' surplus (C) by the same amount that it reduces the contractors' surplus. (2) In addition there is a decrease in both surpluses (A +B), a deadweight loss. This deadweight loss measures the reduction of social welfare. Since only the quantity x_a is produced, there still remains a willingness to pay from the clients' side that will not be served by the contractors since they will not provide the additional quantity at price p_a.

Artificially caused collusion

Clients basically have three options in arranging a market through procurement:

1. A perfect competition / monopsony by letting all interested contractors submit a bid. The number (and names) of players in the game is large and unknown to everybody.
2. A perfect competition / limited monopsony by preparing a bidders list. The client knows the number and names of the bidders.
3. A perfect competition / two-sided monopoly by negotiating with just one contractor. In this case knowledge is symmetric.

Case 1 does not provide enough information for collusion. In order to enter the game, there must not only be an incentive but also the knowledge of all participants.

Case 2 is the classical set-up for collusion in a market that is generally in perfect competition. In order to get the information contained in the bidders list, contractors must bribe someone in the organization of the client. A principal-agent relationship is an absolute prerequisite for bribery. The agent in such relationships can profit at the expense of the principal. In a private company, the owners are the principals and all employees are agents. Accordingly all employees with knowledge of the bidders list are possible targets for bribery. The taxpayer is the principal in public companies, all employees are agents and therefore all of them are possible addressees of bribes.

Case 3 does not lend itself to collusion because of lack of players. Bribery is still a possibility to get access to information for the negotiation process and to create an asymmetric information situation.

Bribery in construction is facilitated by the large contract sums and the imprecise knowledge of prices. One million dollars more for a contract of 10 million dollars cannot be easily detected as being excessive. A bribe of 100.000 dollars out of the extra million is in most cases enough to convince a morally weak agent.

For a collusion scheme to work, there must be repeated tenders, preferably an infinity. Then and only then the contractors can play repeated collusive games among themselves. It is not necessary that all contractors are always invited. The group playing the repeated games can be larger than the bidders for one contract. The collusive arrangement must, however, include all contractors that have been or will be invited.

CONCLUSION

The line of the complete argument can be found in a condensed form in fig. 5. There are strong incentives in the construction sector to engage in collusion. The main argument is that widely used sealed-bid auctions with award to the low bidder produce outcomes below equilibrium price. This is unacceptable to the bidders and economically undesirable since it produces an overall deadweight loss to society.

Depending on the mechanisms chosen in collusive games, the result will be monopoly pricing (economically undesirable) or a price not far away from the equilibrium price (economically desirable). The first will be produced by structures that include repeated games by a group, cooperative behavior when predetermining the winner of the bid, and cooperative behavior when setting the price because all players participate in the profit. The latter depends on repeated games and cooperation predetermining the winner. The price is restrained by a competitive phase when agreeing on the profit that accrues only to the winner.

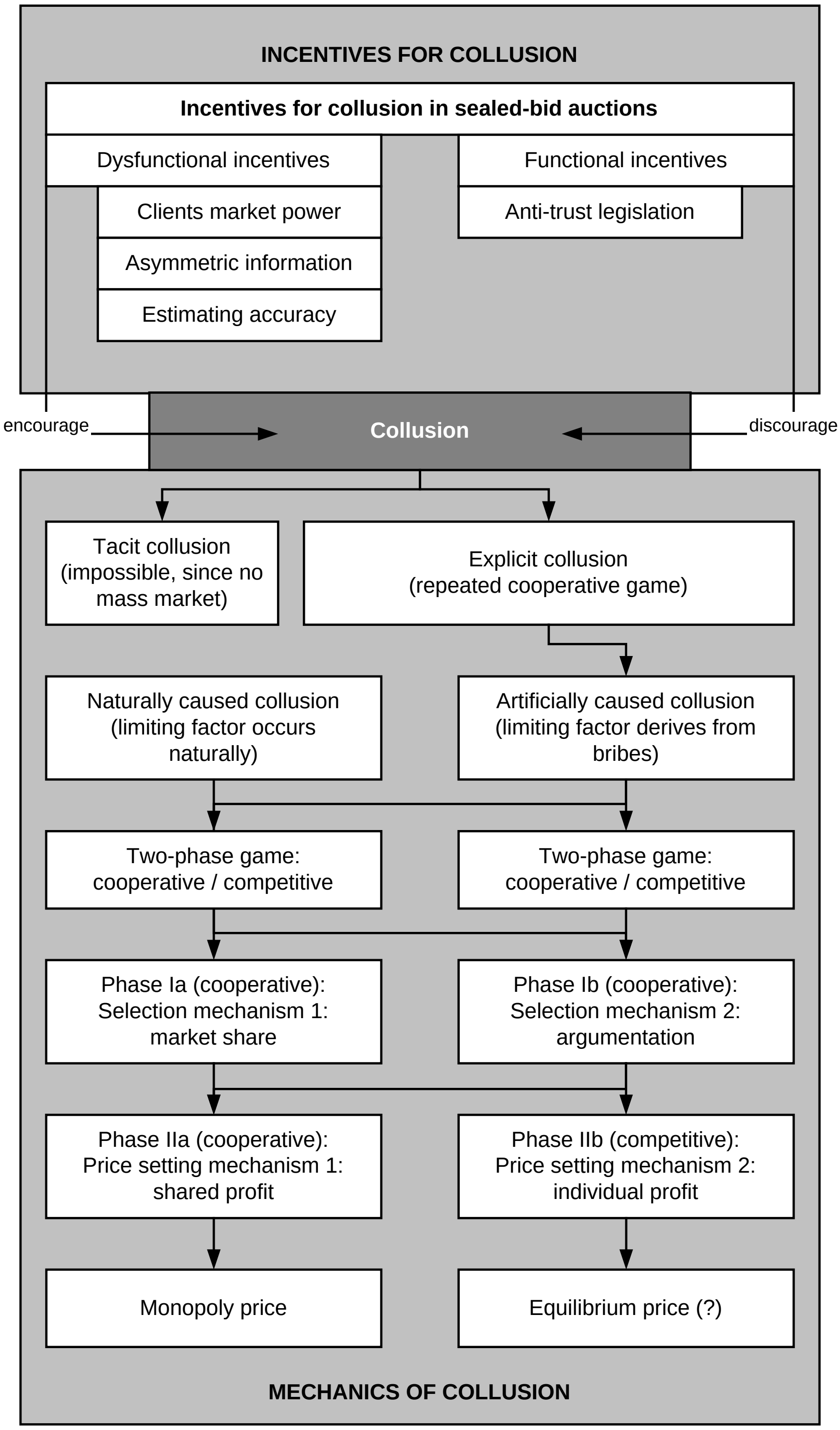

Figure 5: Incentives for and mechanics of collusion

A change of the institutional arrangements of procurement processes is required if collusion is to be avoided, legislation is not sufficient. Both hypotheses can be answered positively: (1) There are indeed strong incentives to enter into collusive games. In the long run economical survival is at stake. (2) The outcomes of collusive games need not be detrimental to social welfare of an economy.

A word of warning is warranted at the end. Putting aside all arguments, collusion is an illegal practice. Prison sentences are not uncommon when collusion is uncovered.

REFERENCES

Birol, F. (2008). Nachkalkulation – dargestellt am Beispiel einer Industriehalle. Bremen, Germany: Unpublished Thesis at the University of Applied Sciences Bremen

Brockmann, C. (2009). Global Construction Markets and Contractors. (Hrsg.): Economics for the Modern Built Environment ed. by L. Ruddock, London, UK: Taylor & Spons, 168 - 198

Bülow, H.; Zubeil, G.; Schröder, D. (1977). Gutachten der Prognos AG zur Wettbewerbsordnung und Wettbewerbsrealität am Baumarkt, Forschungsreihe der Bauindustrie, Bd. 39, Basel, Schweiz: Prognos

Heuß, E. (1965). Allgemeine Markttheorie. Tübingen, Germany: Mohr-Siebeck

Hirshleifer, J. ; Hirshleifer, D. (1998). Price Theory and Applications. Upper Saddle River, USA: Prentice Hall

Leitzinger, H. (1988). Submission und Preisbildung: Mechanik und ökonomische Effekte der Preisbildung bei Bietverfahren. Köln; Germany: Carl Heymanns

Masterman, J. (2002). Introduction to Building Procurement Systems. London, UK: Spon

Milgrom, P. (1989). “Auctions and Bidding: A Primer”. Journal of Economic Perspectives 3 (3), 3-22.

Samuelson, P. ; Nordhaus, W. (1989). Economics. New York, USA: McGraw-Hill

Taylor, J. (1995). Economics. Boston, USA: Houghton Mifflin

Transparency International (2008). Bribe Payers Index. Berlin, Germany: Transparency International

Varian, H. (1999). Intermediate Microeconomics: A Modern Approach. New York, USA: Norton

SOURCES OF CONSTRUCTION GROWTH IN SELECTED OECD COUNTRIES

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Construction is believed to be less dynamic than other major economic sectors. Over the very long term this industry displays a bell shaped share in GNP by following the pattern of manufacturing, as labor moves towards services and construction employment share declines. This pattern has important policy implications since construction is a growth engine at lower development stages. This issue is addressed by using Growth and Productivity Accounts that include measures of output growth, employment and skill creation, capital formation and total-factor productivity (TFP) for selected OECD countries. Input measures include various categories of capital (K), labour (L), energy (E), material (M) and service inputs (S). The methodology builds upon the well known total-factor productivity (TFP) analysis. Growth accounting allows one to assess the relative importance of labour, capital and intermediate inputs to growth, and to derive measures of total-factor productivity (TFP) growth. TFP indicates the efficiency with which inputs are being used in the production process and is an important indicator of technological change. This framework can complement standard Input-Output analysis to assess the significant role played by the construction industry in the economic growth of any country.

KEYWORDS: total factor productivity, growth accounting, construction industry.

INTRODUCTION

The issues of why the construction industry grew phenomenally in some countries while it has stagnated or even regressed in others over the same time period and of why construction output per worker has been declining or not increasing as in other economic sectors go to the very heart of construction economics. One explanation relies on the well known U inverted curve put forward by Bon (1992). In less developed countries construction output is low, but as soon as industrialization develops, houses and infrastructure are required and building output grows significantly (Lewis, 2009). This view is consistent with past studies of developing countries that differentiate economic development from economic growth. The former is characterized by structural transformations such as industrialization, migration from rural areas and urbanization, while the latter by accumulation and technical change (Lewis, 1954, Rostow, 1956). Technical progress occurs in an economy that is already developed when the production of buildings tapers off, because house shortages are lessened or eliminated. In advanced countries construction valued added share in GDP declines, as the infrastructure and housing demand is stable while endogenous growth can even push the output per worker ratio further (Mankiw *et al.* 1992). However as human capital grows and knowledge spreads in the economy we would expect productivity gains in the construction industry too. Past evidence is questioning such a view. The sources of long-term construction output growth in selected OECD countries are addressed and compared in this paper. The study builds upon the use of the growth accounting framework which is preferred to partial measures, such as labor productivity, since the latter are potentially misleading, as output changes are often due to all input changes rather a single one. Growth accounting can be derived from a simple value added production function where output depends only on capital, labor and technical changes (Solow, 1957). Such a framework can be expanded to take into account working capital too. Hence technical change growth, or Total Factor Productivity (TFP), is the residual which records the variation that is left unexplained by all factor inputs. TFP, introduced by Jorgenson, Gollop and Fraumeni (1987), can be estimated by using linear or frontier regressions and direct accounting frameworks. Early studies of construction productivity had been published by Dacy (1965), Koch and Maovenzadeh (1979), Allen (1985), Schriver and Bowley (1985). Dacy (1965) estimated total factor productivity by using hourly wages, indexes of building and material prices and output per worker. Koch and Maovenzadeh (1979) used the production approach to derive productivity changes in the highway sector, while Schriver and Bowley (1985) considered changes in cost per square foot of building. Chau and Walker (1988) introduced an indirect approach to address total factor productivity in the Hong Kong construction industry due to problems of measurement and lack of data. More recently Tan (2000) and Sharpe (2001) analyzed the Singapore and Canadian construction industries respectively. Their findings are strikingly different. The study of Tan showed a negative TFP. The main contribution to real construction output resulted from capital accumulation. Differently Sharp noted that "despite an increased capital-labour ratio and higher levels of educational attainment in the workforce, labor productivity in the construction sector in Canada at the end of the 1990s was lower (in absolute terms) than that in the early 1980s. Among all other industries this sector was almost unique in experiencing such negative productivity developments over the examined period. The main reason for such a disappointing performance was due to lagging technical progress, i.e., TFP. Therefore, Sharp argued that many construction activities are not "amenable to productivity advances, despite increased capital per worker and higher education levels for the workforce". These limited findings suggest additional analysis of TFP indices in other countries. In the past lack of data prevented such a type of study, but currently it is no longer a problem. Since the early 1980s major statistical agencies, such as OECD, began publishing TFP indices at both national and industry levels. The OECD data do not have a very detailed sectoral classification nor address construction until the 1990s. More recently, the European Commission has financed a research project called KLEMS (Timmer *et al.* 2007) for analyzing productivity in the European Union and supporting research on the relationship among technical change, skill formation and innovation. Recently the scope of this ongoing project has been expanded with the inclusion of non European countries. In the following section a brief overview of the project and the growth accounting framework are provided. Then stylized facts related to construction value added and gross output volume indexes in selected countries are addressed. Very different patterns call for disentangling the sources of growth that are analyzed in the last section of the paper.

METHODOLOGY AND DATA

The study addresses a small set of developed countries included in the EU KLEMS Growth and Productivity Accounts (Timmer, *et al*., 2007). This data set contains indicators of output growth, employment and skill creation, capital formation and multi-factor productivity (i.e., TFP) at the industry level for the European Union member states, from 1970 onward, and some other selected countries such as the USA, Japan and Australia. Unfortunately data coverage differs across countries, industries and indicators. Hence for the sake of comparison with previous studies based on I/O accounts five countries, Finland, Germany, Italy, UK and the USA are considered (Bon and Pietroforte, 1990, Pietroforte and Gregori, 2003). The data set includes several input measures of capital (K), labor (L), energy (E), material (M) and service inputs (S) that make up the so called KLEMS model. For instance, labor takes into account changes in the composition of the labor force, while capital reflects the rapid investment shift towards Information and Communications Technology (ICT) goods in recent years. At the lowest level of aggregation, data were collected for 71 industries classified according to the European NACE revision 1 classification. In this study the construction sector is considered as a whole with no further subdivisions. Details about data measurement and harmonization can be found in Timmer *et al*. (2007). Growth accounts have the major advantage of being embedded in a clear analytical framework, rooted in production functions and theory of economic growth, that allows the analysis of the interaction among variables. This advantage is of fundamental importance in policy evaluation. Solow's classic 1957 paper provided a convenient context for introducing the basics of growth accounting. This study also influenced many of the subsequent growth accounting analyses. Solow begins by introducing a value added production function:

$$VA_t = f(K_t, L_t, t) \tag{1}$$

Where *VA* denotes value added, *K* and *L* are aggregate measures for the capital and labor inputs respectively, and *t* denotes time. Solow stated that the variable *t* "for time" appears in the production function to allow for technical change. However, he observed that this operational definition does not capture the adoption of new production technologies at all. Indeed, Solow noted that "slowdowns, speed-ups, improvements in the education of the labor force, and all sorts of things will appear as a 'technical change." In specifying the true production function, Solow assumed that technical change can be represented as shifts of the underlying true production function that leave unchanged all the marginal rates of substitution and that are associated with time, but not with expenditures on physical capital or labor. Under these assumptions, the production function can be rewritten as:

$$VA_t = A(t)f(K_t, L_t, t) \tag{2}$$

This function can be decomposed into a time varying multiplicative technical change factor and an a-temporal production function. The multiplicative factor, *A*(*t*) represents the effects of shifts over time. following the growth of capital and labor. This approach can be expanded by introducing a Cobb Douglas production function with constant returns to scale and disembodied exogenous Hicks neutral technical change, which increases the efficiency of both capital (K) and labor (L):

$$VA_t = A_t K_t^{\beta} L_t^{1-\beta} \tag{3}$$

Where β is equal to the capital share in total revenues and its complement (1- β) is the labor share. At this point it is possible to show that the percentage growth rate of value added is given by:

$$\frac{\dot{VA}}{VA} = \frac{\dot{A}}{A} + \beta\frac{\dot{K}}{K} + \frac{(1-\beta)\dot{L}}{L} \tag{4}$$

If companies are cost minimizing and operate in competitive markets and capital and labor are paid their marginal product then total revenues equal the sum of all factor costs. This set up provides an easy accounting procedure to figure out the deterministic equation for TFP growth rate:

$$\frac{\dot{TFP}}{TFP} = \frac{\dot{VA}}{VA} - \beta\frac{\dot{K}}{K} - \frac{(1-\beta)\dot{L}}{L}. \tag{5}$$

This approach can be extended in several directions. We can assume that an industry owns a well behaved production function that is defined over a complete set of both primary and intermediate production inputs. This function can be expressed as:

$$Y_t = f(K_t, L_t, E_t, M_t, S_t, t) \tag{6}$$

where Y is gross output that depends on capital, labor, while working capital has been divided into energy, material and service inputs. Under the assumption of constant return to scale, cost minimizing behavior and competitive input markets, the output value is still equal to the value of all the inputs valued at purchasers' prices. Hence TFP growth in discrete time is given by:

$$\mathbf{\Delta}lnTFP = \mathbf{\Delta}lnY - \alpha\mathbf{\Delta}lnK - \gamma\mathbf{\Delta}lnL - \delta\mathbf{\Delta}lnE - \eta\mathbf{\Delta}lnM - (1-\alpha-\gamma-\delta-\eta)\mathbf{\Delta}lnS \tag{7}$$

where α, γ, δ and η are respectively the share of capital, labor, energy and material in gross output value. In the following section we will address basic stylized facts such as value added and output volume indexes and sources of growth in the construction industry of the selected countries. Eq. (7) should be computed at sectoral level excluding construction intra-sectoral deliveries. By the same token, aggregate measures must exclude internal flows. For this reason aggregate decompositions, such as total manufacturing or total industry production, are to be considered for value added only.

STYLIZED FACTS IN THE SELECTED ECONOMIES

Figures 1 and 2 show the GDP and total manufacturing value added volume indexes, respectively. The GDP volume index of all considered countries doubled in the 1970-2005 period. The USA and Finland are characterized by the largest increase with an average annual growth rate of 2.9% and 2.7% respectively. The UK and Germany show the relative lowest rate (about 2%), immediately followed by that of Italy (2.3%). Despite business cycles, long term growth has been almost steady in all the countries, except in Finland that suffered a strong recession in early '90s. As shown in Figure 2, the recovery of this country was led by manufacturing that is also an important growth pillar in the USA. Differently the tertiary sector (the other main contributor to GDP) has been the growth engine in the UK, Italy and Germany since the '90s.

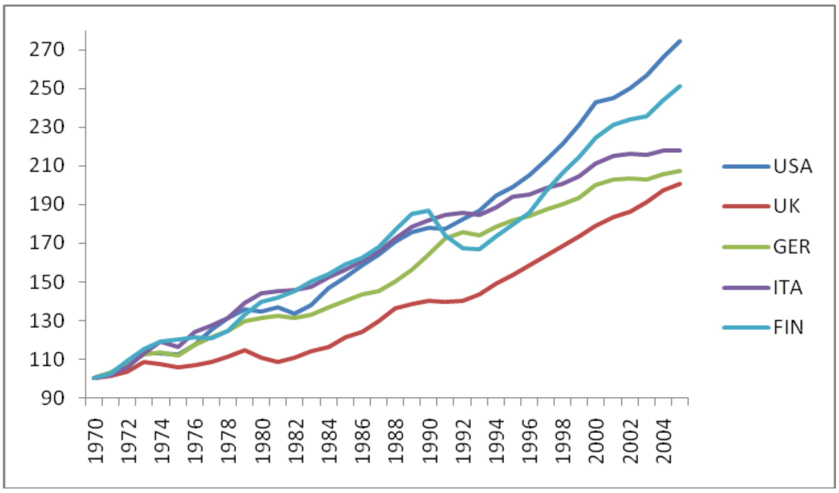

Figure 1: GDP volumes indexes

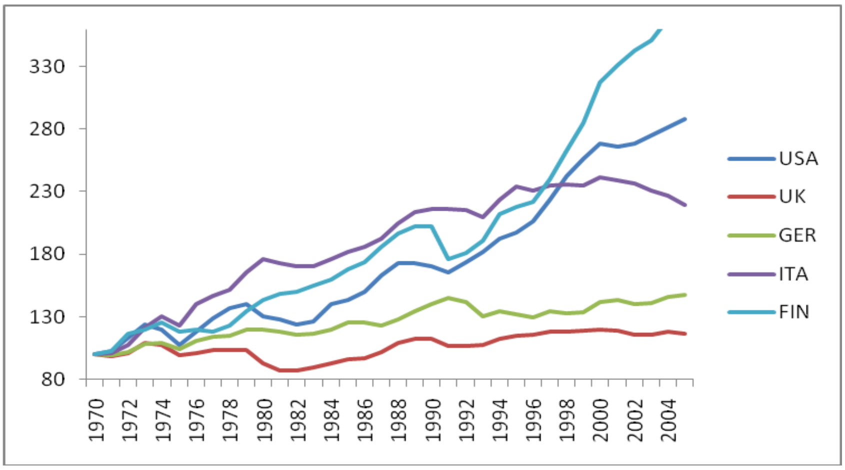

Figure 2: Total manufacturing value added volume indexes

As shown in Figure 3, the performance of the construction industries differs. Fluctuations are pretty wide in some countries, such as Italy and Finland.

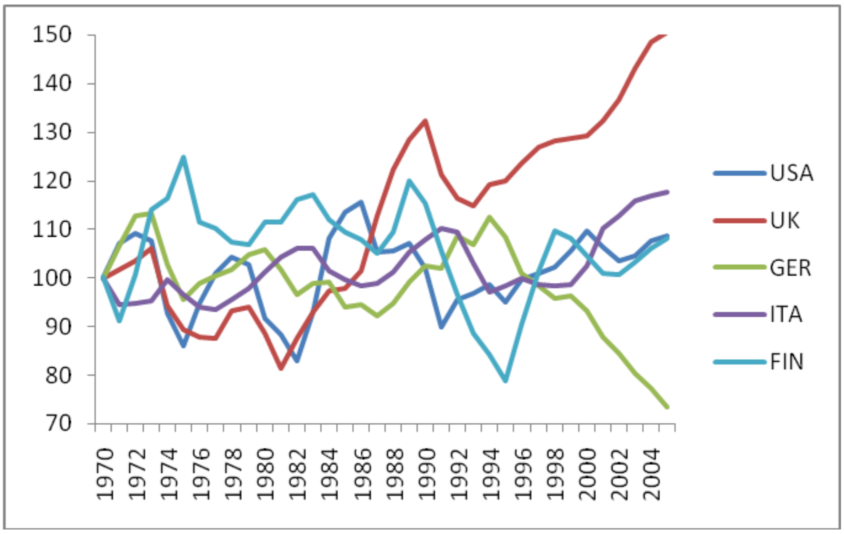

Figure 3: Construction value added volume indexes

In this last case, post crisis (1992) construction recovery lags behind that of GDP and total manufacturing. Construction value added growth, in addition, does not reach the levels of previous years. In the UK value added increased since the early '80s, with a downswing from 1991 to 1993. Nonetheless its volume grew by 50% at the end of the observed period, the largest growth in considered sample. Differently the performance of German construction is disappointing. After some cycles, value added started decreasing even after the reunification in 1990. In 2005 its volume is only 73% of the initial value. Finally the small increase (8%) of the USA and Finland should be compared with that (17%) of Italy. By including only primary factor payments, value added is not a reliable index of total output performance. Gross output should be preferred as a measure of production because it includes working capital too. Figure 4 shows the construction gross output volume indexes.

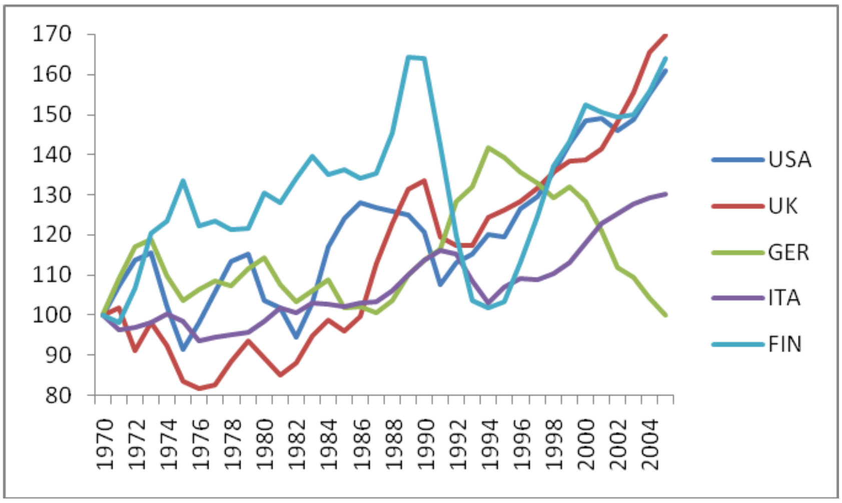

Figure 4: Construction gross output volume indexes

The correlation between these values and those of value added is strong. It ranges from roughly 0.82 in the UK and Italy to about 0.93 in the USA and Germany. Some patterns are different, for example, the drop of the Finnish total output index is larger than that of value added. The decrease preceded the 1992 recession, as construction slowdown started in 1990 and the recovery in 1996. The total downfall of the overall volume reached about 60% in only four years and ten years were needed to go back to the previous peak. German gross output pattern mirrors that of the value added one, while the growth of the USA (Figure 4) appears to be mainly driven by working capital in the last decade as production rapidly increases while value added is flat. Gross output growth is more robust when it includes materials and energy, as in the case of Italy. Hence a complete analysis of the sources of output growth with a KLEMS approach is needed.

SOURCES OF GROWTH

This section address the sources of change in the value added (VA) and gross output (GO) growth in the selected countries. As addressed in Eq. (5), VA growth is affected by the following factors:

1) Hours of work (VAConH),
2) Labor composition change (VAConLC),
3) ICT capital services (VAConKIT),

4) non-ICT capital services (VAConKNIT),
5) TFP (VAConTFP).

Table 1 shows the average annual growth rate of construction valued added (VA) and the sources of its growth, e.g., VAConH is the contribution of work hours to VA.

Table 1: Average growth rate in construction value added and its sources

	USA	UK	GER	ITA	FIN
VA	0.45%	1.29%	-0.79%	0.51%	0.43%
VAConH	1.89%	-0.20%	-1.31%	-0.03%	-0.66%
VAConLC	0.15%	0.23%	0.11%	0.05%	0.47%
VAConKIT	0.09%	0.08%	0.09%	0.15%	0.06%
VAConKNIT	0.28%	0.37%	-0.04%	1.15%	0.14%
VAConTFP	-1.96%	0.81%	0.36%	-0.80%	0.42%

Figure 3 shows that the German VA is smaller in 2005 than in 1970. This pattern is mirrored by the negative average growth rate of about 0.8% (Table 1). On the contrary, the UK displays the largest average VA growth rate. Two thirds of this sizeable increase is driven mostly by TFP, or technical change. This factor is also called the “measure of our ignorance” (Abramovitz, 1956), because it contains not only the impact of omitted variables, but also the errors arising from erroneous measurements or violations of assumptions, such as a constant return to scale. TFP rates are pretty large if compared to those of VA. Table 1 also shows the importance of other contributors such as labour and capital. For instance, the US growth rate of VA has a positive value because labour input has been growing. Work hours are the largest contributor, while the impact of labour composition is much smaller. The positive push of new IT capital investments is rather small, while standard contributors, such as machinery and fixed capital, are still effective as their push is about 2.8%, half of the overall VA growth in the USA. What is striking is the large negative effect of TFP that offsets the very positive contribution of work hours. These data confirm past studies about the decreasing value of productivity and capital/labour ratio in the American construction industry (Allen, 1985), but further analysis is needed. In this regard, we can observe the different behaviour of the US and European industries of the selected sample. The impact of work hours decreases in all European countries, particularly in Germany. The KLEMS database addresses labor according to nine dimensions. The most significant are age, gender and educational attainment. Hence it is also possible to measure the impact of workforce structure. Labour composition (VAConLC) is positive everywhere, particularly in Finland where its value is larger then that of VA growth. Differently, it is quite small in Italy. As far as ICT capital services (VAConKIT, i.e., office and computing equipment) are concerned, their contribution is low everywhere. Standard fixed capital, (VAConKNIT, i.e., machinery and gross capital fixed investments), is the largest contributor of the Italian VA with a value of 1.15%. Differently this source of contribution reaches far lower values in the other considered countries. What is left unexplained is an important factor in all considered countries. TFP, the so called measure of our ignorance, is offsetting most of the other positive sources of growth in the USA and Italy. In the UK, TFP shows a different pattern, as two thirds of VA growth is due to unexplained components, such as disembodied technical change. In Finland and Germany exogenous progress is the only growth engine, while other possible sources cancel out each other and cannot compensate for the negative contribution of work hours in these countries.

The emerging overall picture of VA growth sources is quite interesting. First of all it is not easy to find a common pattern. These sources differ not only in terms of magnitude but also of value, as in the case of TFP and work hours. Furthermore in all considered countries at least one source has a negative value that counterbalances the positive one of the other sources. The only exception is the UK with its growing construction industry. To shed light on this issue, the data presented in Table 1 are compared with the average growth of all other industries and with that of manufacturing alone, as shown in Tables 2 and 3 respectively. A clear pattern emerges. First of all the sluggish performance of construction is confirmed. Only in the UK this industry performs better than manufacturing. Second a negative source of growth always exists in manufacturing too. Actually work hours give a negative contribution in all the countries, including the USA. Factory workers slowdown VA growth considerably, particularly in the UK and Germany. When service sectors come to play and the economy as a whole is considered, only in Germany and Finland work hours worked give a negative contribution, while very positive values emerge in the USA and Italy. Labor market and industrial relations appear to have influenced VA growth significantly in the secondary sectors and construction.

Table 2: Average growth rate in total value added and its sources

	USA	UK	GER	ITA	FIN
VA	2.95%	2.03%	2.12%	2.27%	2.70%
VAConH	0.84%	0.08%	-0.30%	0.38%	-0.24%
VAConLC	0.17%	0.31%	0.12%	0.34%	0.74%
VAConKIT	0.43%	0.55%	0.30%	0.26%	0.42%
VAConKNIT	0.84%	0.76%	0.81%	0.84%	0.89%
VAConTFP	0.67%	0.33%	1.19%	0.45%	0.88%

Table 3: Average growth rate in manufacturing value added and its sources

	USA	UK	GER	ITA	FIN
VA	3.18%	0.50%	1.16%	2.35%	4.04%
VAConH	-0.44%	-2.03%	-1.52%	-0.35%	-0.69%
VAConLC	0.32%	0.35%	0.31%	0.09%	0.52%
VAConKIT	0.35%	0.38%	0.16%	0.22%	0.44%
VAConKNIT	0.51%	0.20%	0.50%	1.01%	0.97%
VAConTFP	2.44%	1.60%	1.71%	1.38%	2.80%

Gross output growth is also driven by changes in primary and intermediate inputs. The former are the same as those considered for VA, while the latter are classified according to the following factors:

6) Energy inputs (GOConIIE),
7) Material inputs (GOConIIM),
8) Services inputs (GOConIIS).

Table 4 shows the complete set of gross output growth rates and their sources in the construction industry. Quite surprisingly the negative value of the German VA (observed in Table 1) disappears when intermediate inputs (GOConII) are considered in the case of gross output growth, even if this positive value is very small, the lowest among the considered countries. The growth rate of the UK is still the highest, followed by those of Finland and USA.

Table 4: Average growth rate in construction gross output and its sources

	USA	UK	GER	ITA	FIN
GO	1.55%	1.67%	0.10%	0.79%	1.66%
GOConII	1.34%	1.18%	0.43%	0.58%	1.42%
GOConIIE	0.01%	0.02%	-0.18%	-0.02%	0.05%
GOConIIM	0.76%	0.82%	2.31%	0.38%	1.26%
GOConIIS	0.58%	0.34%	0.20%	0.23%	0.11%
GOConH	0.84%	-0.09%	-0.61%	-0.04%	-0.30%
GOConLC	0.07%	0.09%	0.05%	0.02%	0.20%
GOConKIT	0.04%	0.03%	0.04%	0.06%	0.02%
GOConKNIT	0.12%	0.15%	-0.02%	0.51%	0.06%
GOConTFP	-0.86%	0.31%	0.21%	-0.34%	0.25%

As far as growth sources are concerned the negative values observed in VA are confirmed, although their magnitude differs. The values of work hours (GOConH) contribution, for example, are negative with the exception of the USA whose value is halved. This conformity is expected given the significant contribution of intermediate inputs (GOConII). It ranges from about half a percentage point a year in Germany and Italy to 1.42% in Finland. The USA and UK have sizeable values too. It is interesting to notice that most of this contribution consists of material inputs. This characteristics justifies the need for studies based on I/O tables. The contribution of services appears to be more important in the USA and UK than in other countries. Only energy inputs have a very small, if not negative, effect.

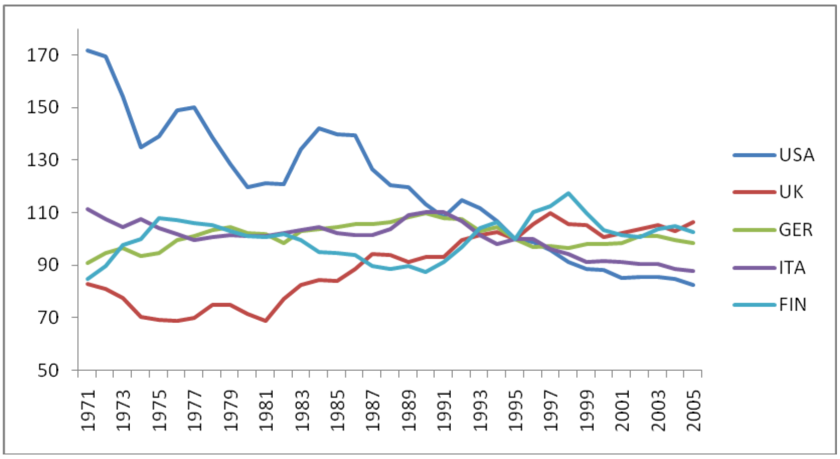

Figure. 5: –Value added TFP growth (1995 = 100)

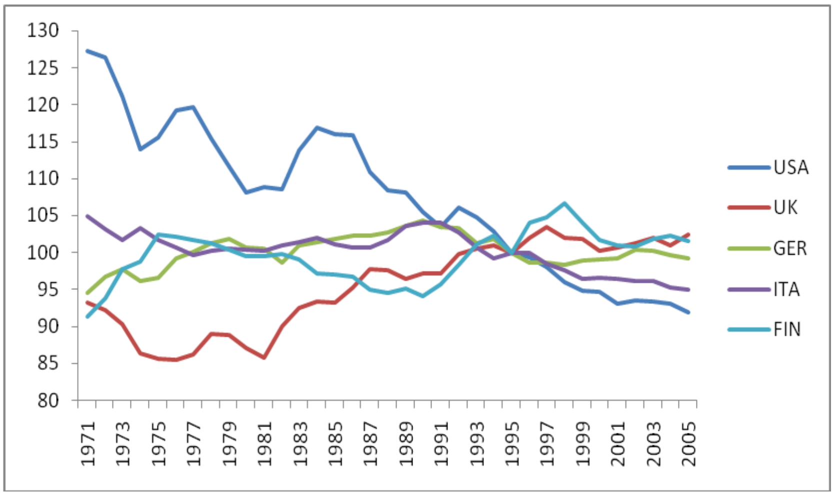

Figure 6: Gross output TFP growth (1995 = 100)

TFP patterns are confirmed with smaller magnitudes. Figures 5 and 6 TFP shows the contribution of TFP, or technical change, to VA and gross output growth. Time series have been normalized to 100 in 1995 in both charts. As far as VA is concerned (Figure 5), the decreasing contribution of TFP in the USA is steady from the second half of the eighties only, while in the first half and in the seventies there are several fluctuations linked with business cycles. Other emerging patterns are the constant increase of TFP in the UK from 1981 onward and its almost smooth decline in Italy after the 1993 recession. Figure 6 shows the contribution profile of TFP to gross output. Patterns are similar but their range is much smaller. Hence the qualitative analysis is the same as in the case of VA.

CONCLUSIONS

This study has addressed the growth of the construction output and productivity in some advanced economies, USA, UK, Germany, Italy and Finland, from 1970 to 2005. The KLEMS data base allows to compare the long-term patterns of GDP, total manufacturing and construction values. More specifically the determinants of growth have been illustrated by using proxies such as labor, capital and technical change, following Solow's model. Data confirm the lagging performance of the construction industry if compared to secondary sectors and the economy as a whole. The reasons of this pattern are country specific, but two facts emerge. First, apart from USA, work hours declined in all countries. Second, construction total factor productivity is lower than that of secondary sectors or entire economy. The only exception is the UK whose shift towards a service economy has been characterized by the significant growth of GDP as a whole, with the exception of manufacturing VA. We have also analyzed a more appropriate production function approach that allows for the consideration of intermediate inputs. As stated earlier, it is difficult to find a general pattern. The only common feature is that gross output growth is always larger than VA growth because intermediate inputs matter. This result is consistent with previous studies based on Input/Output models. Moreover TFP is still negative in the USA and Italy, while in the UK this factor has been losing its propulsive role in output growth. Construction productivity is an issue that cannot be neglected and deserves further analysis.

REFERENCES

Allen, S.G. (1985) Why construction industry productivity is declining. The Review of Economics and Statistics, 67, 661–669.

Bon, R. (1992) The future of international construction: secular patterns of growth and decline. Habitat International, 16, 119-128.

Bon, R. and Pietroforte, R. (1990) Historical comparison of construction sectors in the United States, Japan, Italy and Finland using input-output tables. Construction Management and Economics, 8, 233-247.

Chau, K W. (1993) Estimating industry-level productivity trends in the building industry from building cost and price data. Construction Management and Economics, 11, 370-383.

Chau, K W. and Walker, A. (1988) The measurement of total factor productivity of the Hong Kong construction industry. Construction Management and Economics, 6, 209-224.

Dacy, D.C. (1965) Productivity and price trends in construction since 1947. Review of Economics and Statistics, 47, 406-411.

Jorgenson, D., Gollup, F. And Fraumeni, B. (1987) Productivity and US economic growth, Amsterdam, North Holland.

Koch, J. A. and Maovenzaden (1979) Productivity and technology in construction. Journal of the Construction Division, ASCE, 105, co4.

Lewis, W. A. (1954) Economic development with unlimited supply of labor. The Manchester School, 22, 139-191.

Lewis, T. M. (2009) Quantifying the GDP-construction relationship. In Ruddock, L. Economics for the modern built environment, Chippenham, Taylor & Francis.

Maddison , A. (1987) Growth and slow down in advanced capitalist economies. Journal of Economic Literature, 25, 649-698.

Mankiw, G., Romer, D. and Weil, D. N. (1992) A contribution to the empirics of economic growth. Quarterly Journal of Economics, 107(2), 407-437.

Pietroforte, R. and Gregori, T. (2003) An input-output analysis of the construction sector in highly developed countries. Construction Management and Economics, 24, 711-715.

Rostow, W. W. (1956) The take-off into self-sustained growth. Economic Journal, 64, 25-48.

Schriver, W. R. And Bowley, R. L. (1985) Changes in productivity and composition of output in building construction, 1972-1982. Review of Economics and Statistics, 67, .

Sharpe A. (2001) Productivity trends in construction sector in Canada: a case of lagging technical progress. International Productivity Monitor, 3, 52-68.

Solow, R. M. (1957) Technical change and the aggregate production function. The Review of Economics and Statistics, 39, 312-320.

Tan W. (2000) Total factor productivity in Singapore construction. Engineering, Construction and Architectural Management, 7(2), 154-158.

Timmer, M. P., O'Mahoney, M. and van Ark, B. (2007) The EU KLEMS growth and productivity accounts. An overview, mimeo, University of Groningen & University of Birmingham, downloadable at: www.euklems.net.

Timmer, M. P., van Moergastel, M., Stuivenwold and Ypma, G. (2007) EU KLEMS growth and productivity accounts. Version 1.0, mimeo, University of Groningen & University of Birmingham, downloadable at: www.euklems.net.

Zhi, M., Hua, G. B., Wang, S. Q. And Ofori, G. (2002) Total factor productivity growth accounting in the construction industry of Singapore. Construction Management and Economics, 21, 707-718.

COST ESTIMATE FOR THE CONSTRUCTION OF RESIDENTIAL-COMMERCIAL BUILDINGS

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This paper analyzes a cost estimate for construction works within the scope of execution of investment projects, i.e. residential-commercial buildings. The proposed estimate is based on previous experience with the constructed residential-commercial buildings and it allows us to approximately estimate construction costs of future residential-commercial buildings. An estimate model consists of the cost analysis of completed construction projects, statistical data processing, and the definition of construction cost structure. The model can also be used in various phases of execution of other investment projects.

KEY WORDS: cost estimate, construction costs, bills of quantities, cost structure.

INTRODUCTION

High-rise buildings have always been very significant for the development of each community. When it comes to the construction of buildings, i.e. various projects, they accumulate good ideas, technologies and resources.

Based on one classification, buildings can be divided according to their purpose into public buildings (kindergartens, schools, gymnasiums, hospitals), infrastructure buildings (telephone exchanges, telecommunications, water storage facilities, industrial facilities), commercial buildings (for production, services, trade), and residential-commercial buildings (RCBs), Table 3). Accordingly, each such successfully completed project also generates a number of medium-sized and smaller projects, both on local and strategic national level, giving a development cycle an optimum impact. Construction of buildings represents an investment of own resources, but nowadays increasingly of foreign creditors' resources.

The Republic of Croatia experienced extensive construction activities with high investment values in the last few years.

The construction of motorways, which are of enormous strategic importance for the country, was accompanied by the construction of buildings, which is illustrated in Table 1. Buildings in the total value of HRK 35,861,146 were constructed in the period from 2004 to 2008.

Table 1: Value of executed works, in thousand kuna

YEAR	TOTAL [HRK]	BUILDINGS [%]	BUILDINGS [HRK]	OTHER FACILITIES [%]	OTHER FACILITIES [HRK]
DEC 2004	14,369,787	31.40	4,512,113	68.60	9,857,674
DEC 2005	14,996,797	35.70	5,353,857	64.30	9,642,940
DEC 2006	18,451,584	39.30	7,251,473	60.70	11,200,111
DEC 2007	19,663,275	41.50	8,160,259	58.50	11,503,016
DEC 2008	23,260,319	45.50	10,583,445	54.50	12,676,874
TOTAL	90,741,762		35,861,146		54,880,616

If we focus only on residential-commercial buildings (RCBs) quoted in areas, approvals were issued for construction of 14.506.648 m^2 in the same period, with an apparent annual growth trend (Croatian Central Bureau of Statistics, 2009).

Table 2: Area of residential-commercial buildings (RCBs) for which construction approvals were issued

YEAR	TOTAL [m^2]	RCBs [m^2]	NON-RESIDENTIAL BUILDINGS [m^2]
DEC 2004	4,202,942	2,434,488	1,768,454
DEC 2005	4,773,236	2,840,236	1,933,000
DEC 2006	5,155,445	3,167,992	1,987,453
DEC 2007	5,524,936	3,009,703	2,515,233
DEC 2008	5,156,169	3,054,229	2,101,940
TOTAL	24,812,728	14,506,648	10,306,080

The mentioned construction helped accumulate quite a lot of knowledge and experience through preparation, designing, execution, supervision etc. This will make an estimate of some future costs, in our case for residential-commercial buildings, easier and more accurate.

Cost estimate is a demanding task, which is especially true at the early stage of investment realization, when the technical documentation is at the level of conceptual design or the like. It is very important to make use of experience from the projects completed up to that point. According to the available references, a few cost estimate models are used around the world, such as: parametric models, element models, bills of quantities, etc., but the most frequently used model relies on a bill of quantities (Marenjak, El-Haram, Horner, 2002). The bill-of-quantity model is based on detailed descriptions of construction works and has to be structured so as to provide the contractors with a good and clear basis for bid preparation and execution of works, and an investor with a possibility of simple planning, analyzing and monitoring of construction costs.

The bill-of-quantity model has its advantages in the early phase of investment project realization because it allows one to apply previous experience from similar projects in the structure of construction works. It is important that the given structure always contains the same elements, to allow a comparison. This enables a cost estimate for certain facilities, buildings, groups of works, or simply types of works (Building Cost Information Service, 1999). The total construction costs can be quoted in various units, such as: pieces, km, m, m^2, m^3, etc. The very same approach was used in the cost estimate model below.

Cost estimate model

The theoretical model arises from an assumption that the construction costs of a certain building can be presented by the structure of construction works, which is a result of a familiar construction technology, and by certain groups of works making up the total costs of facility construction. Another significant element is description of works that have to be standardized in a way to make them comparable and unambiguous.

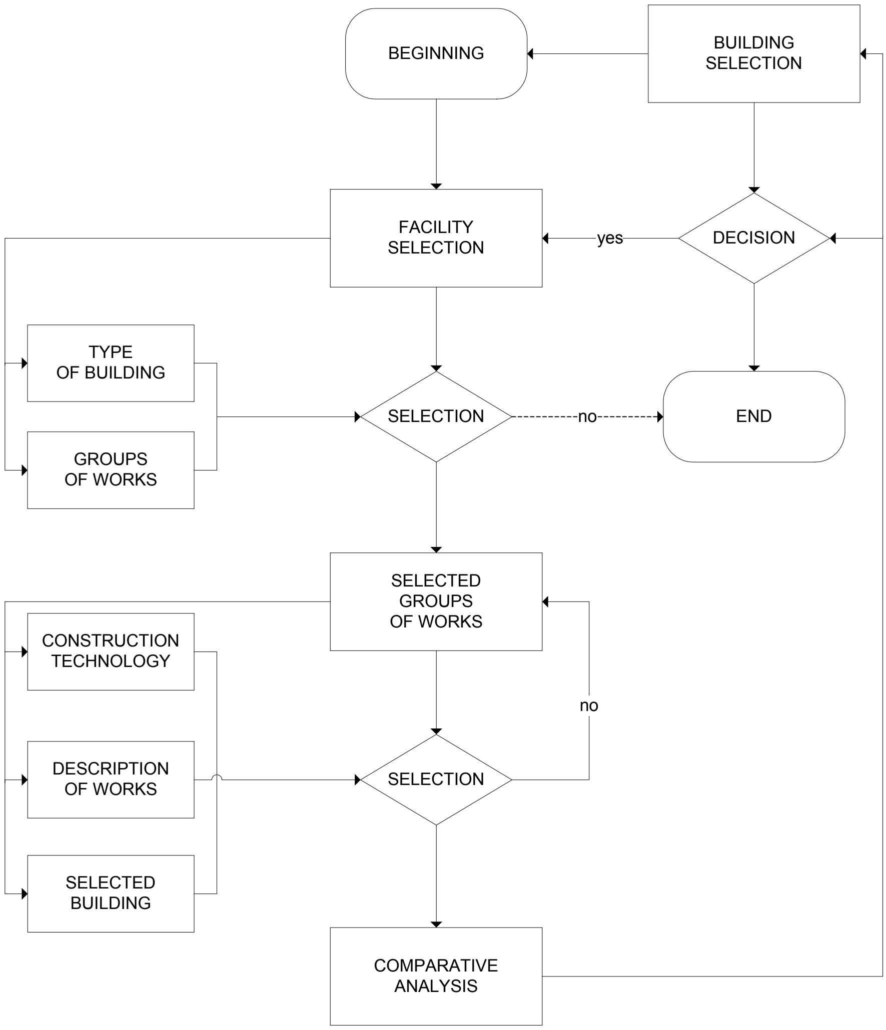

Figure 1: Flow chart of facility selection (Martinec, Bezak, Čaklović, 2004),(Martinec, Bezak, Linarić, 2006)

The flow chart in Figure 1 illustrates that the facility selection is connected with the selection of a building as a type of facility, in our case a residential-commercial building, or a group of works. The criterion for selection of a certain group of works is how they fit into the respective construction technology and their share in the total construction costs. Should the analyzed building prove not to possess the characteristic elements, according to the set criteria, the procedure should be terminated and repeated for another building from the selected facility or repeated for another one. Once we have chosen a group of works and construction technology, we analyze the selected building further through the descriptions of works, and we establish the quantities of works. A criterion for selection of the quantity of works is the existing documentation or previous experience with the same or similar types of buildings (Martinec, Bezak, Linarić, 2006).

Application of the model

The theoretical model of selecting a facility for which we want to estimate costs starts with the selection of building we want to build and ends with the comparative analysis. Accordingly, the research basis includes the construction costs, while the selection of building as a whole relies on the theoretical model. The building we chose is a residential-commercial building as a type of facility.

Table 3: Classification of facilities

No.	BUILDINGS
1.	PUBLIC BUILDINGS
	Kindergartens
	Schools
	Sports halls
	Hospitals
2.	INFRASTRUCTURE FACILITIES
	Telephone exchanges
	Telecommunications
	Water storage facilities
	Industrial buildings
3.	COMMERCIAL BUILDINGS
	Production facilities
	Service-providing facilities
	Shops
4.	RESIDENTIAL-COMMERCIAL BUILDINGS (RCBs)

The theoretical model was tested by analyzing the quantities of works from five bills of quantities for various residential-commercial buildings, approximately at the same locations and with the same geomorphological conditions in the north-west Croatia. The gross areas of selected residential-commercial buildings ranged from 6,741 to 15,000 m^2, number of storeys from 2 underground levels (UG2) to 5+loft, while their bearing structure was made of reinforced concrete.

Table 4: Overview of basic data of the analyzed residential-commercial buildings

BASIC DATA	RCB1	RCB2	RCB3	RCB4	RCB5
Load carrying structure	Reinforced-concrete structure	Reinforced-concrete structure	Reinforced-concrete structure	Reinforced-concrete structure	Reinforced-concrete structure
Storeys	UG+GF+4+loft	UG2+GF+5+ loft	UG2+GF+4+ loft	UG+GF+5+loft	UG+GF+5+loft
Gross area [m^2]	10,615	10,147	6,741	11,490	15,000

The analysis has shown that most bills of quantities had the same or very similar structure with average shares of specific groups of works in the total value (Đukan, 1986).

Table 5: Overview of the bills of quantities structure with averages shares

No.	STRUCTURE OF THE BILL OF QUANTITIES	AVERAGE SHARE [%]
1.	Construction works	52.36
2.	Craftworks	21.97
3.	Mechanical installations	8.80
4.	Electrical installations	6.68
5.	Water pipeline and sewage	6.40
6.	Sprinkler	0.70
7.	Elevators	3.09
	TOTAL	100.00

Table 5 also illustrates that construction works and craftworks together account for 75% of construction costs on average and are therefore most interesting to be considered further.

Comparing and analyzing the bills of quantities for the respective residential-commercial buildings, we discovered differences in the number, description, type and execution technology of residential-commercial buildings, their outfit and functionality, all this with respect to a unit of measure. We have extracted and presented the structure of construction works and craftworks as the most interesting. We have focused our further analysis on the processing of the construction work group because of its uniformity and comparability, and the share level. The structure of construction works was identical in all studied bills of quantities and it comprised eight groups of works, as presented in Table 6, which we called a typical structure.

The craftwork group is more extensive, diverse, and largely connected to the choice of finishing materials, which of course depends on the investor's wishes and buyers' needs. This, more complex group of works can be a subject of another analysis.

Table 6: Typical structure of construction works

No.	CONSTRUCTION WORKS
1.	Earthworks
2.	Concrete works
3.	Reinforced-concrete works
4.	Steel bending works
5.	Carpenter's works and scaffold
6.	Masonry works
7.	Miscellaneous construction works
8.	Insulation works
9.	External plastering

Comparative analysis

The studied typical structure of construction works has been broken down into groups of works in Table 7. It is obvious that the largest portion, as much as 60 %, refers to reinforced-concrete works, steel bending works and masonry work, which indicates that these three groups of construction works account for 32% of the total construction price. These groups of works contain most items constituting the largest share within the construction works group, and consequently of construction costs, with respect to the total value.

Different percentages of individual groups of works point out to differences in prices, which is understandable if we take into account various contractors, different terrain configuration, and construction technology applied.

Table 7: Comparative overview with shares of the group of works in the bills of quantities (Institut IGH)

TYPE OF WORK	RCB1 [%]	RCB2 [%]	RCB3 [%]	RCB4 [%]	RCB5 [%]	AVERAGE [%]
Earthworks	1.98	6.16	1.68	3.98	2.00	3.16
Concrete works	2.17	0.99	2.67	0.85	1.22	1.58
Reinforced-concrete works	15.69	16.10	20.19	18.05	22.45	18.50
Steel bending works	26.02	17.89	20.06	19.52	18.37	20.37
Carpenter's work and scaffold	14.79	10.73	14.23	12.04	8.76	12.11
Masonry works	20.89	24.17	24.92	19.66	23.12	22.55
Miscellaneous construction works	5.14	10.51	3.92	16.84	14.35	10.15
Insulation works	5.66	6.17	6.49	4.77	3.28	5.27
External plastering	7.67	7.27	5.83	4.29	6.45	6.30
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

Values in Table 8 are classified according to the minimum, mean and maximum value. It is indicative that deviations from the average prices in all five bills of quantities toward the extreme values were almost completely identical, and they amounted to 6% maximum.

Differences in percentages among the bills of quantities regarding the share of work groups in the total value reached up to 8% for reinforced-concrete works and steel bending works, and the maximum of 13% for various construction works having a very small, negligible share in the total value. We can see that percentages of specific groups of works in the total value are very similar, if we disregard the minimum and maximum percentage.

Table 8: Overview of characteristic values

TYPE OF WORK	min [%]	average [%]	max [%]
Earthworks	1.68	3.16	6.16
Concrete works	0.85	1.58	2.67
Reinforced concrete works	15.69	18.50	22.45
Steel bending works	17.89	20.37	26.02
Carpenter’s work and scaffold	8.76	12.11	14.79
Masonry works	19.66	22.55	24.92
Miscellaneous construction works	3.92	10.15	16.84
Insulation works	3.28	5.27	6.49
External plastering	4.29	6.30	7.67
TOTAL		100.00	

Figure 2 comparatively shows the average and the five studied residential-commercial buildings according to a group of construction works. Findings of the analysis indicate to the biggest deviations in the reinforced concrete works, steel bending works and masonry works.

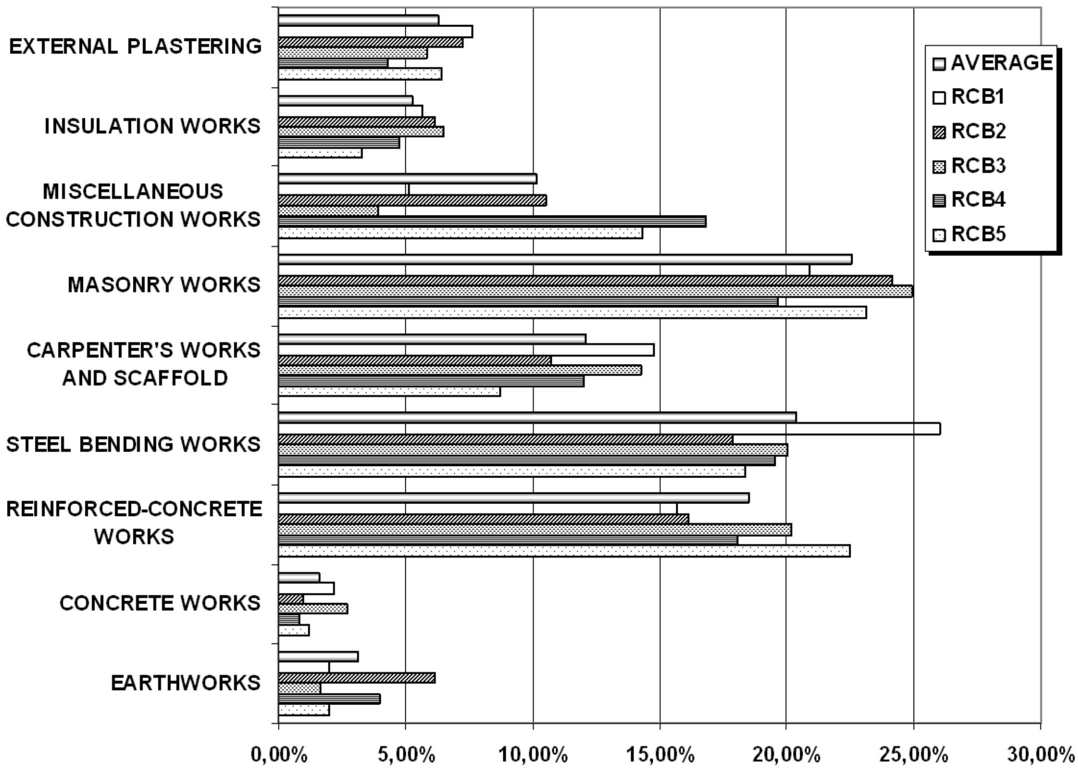

Figure 2: Overview of deviations of construction works from the average

As already mentioned, the group of construction works accounts for 52% of the total construction value, whereas reinforced-concrete works, steel bending works and masonry work account for 60% of construction works on average and 32 % of total construction costs of residential-commercial buildings.

If we want to get more accurate forecasts of future construction costs for residential-commercial buildings using a cost estimate, we definitely have to focus on the construction works group and the three above groups of works in the order of their appearance. Deviations among the considered residential-commercial buildings amount up to 10%, which seems acceptable for a cost estimate.

The presented cost estimate model for construction works, based on the average calculated for five considered residential-commercial buildings, can be relatively reliable for use in the early phases of estimating the costs of construction groups in the construction of residential-commercial buildings at similar locations and in similar geomorphological conditions.

CONCLUSION

Cost estimate is an extremely difficult and demanding task, particularly in the early phase of project realization, when the technical documentation is still a conceptual design. Awareness of the cost structure of construction works based on previously finished residential-commercial buildings is an important element of estimating and controlling the costs on similar future projects (Horner, 1991). The recognizable structure makes planning and monitoring of construction costs simpler. That way we can achieve the main purpose of cost estimate, which is a relative safety in planning the final costs for the whole project, or for a part of project.

REFERENCES

Building Cost Information Service: Standard Form of Cost Analysis, Principles, instruction and definition, The Building Cost Information Service, UK, 1999

Martinec, N., Bezak, S., Čaklović, A.(2004), Construction Works Cost Structure, 3rd SENET PM Conference, Project Management paving the way to European Union, pp 13-19, Bratislava, Slovakia

Horner, R.M.W.(1991), Control of Cost in Construction Projects, Građevinar 43 6, pp 289-293, Zagreb.

Marenjak, S., El-Haram, M.A., Malcolm, R., Horner, W.(2002), Analysis Of Overall Project Costs For The Building Industry, Građevinar 54 7, pp 393-401, Zagreb.

Martinec, N., Bezak, S., Linarić, Z.(2006), Cost Assessment Model Of Construction Works, p 47, Sarajevo, BIH

Državni zavod za statistiku RH (Croatian Central Bureau of Statistics), Mjesečno statističko izvješće (Monthly Statistical Report) 2/2009., 47-53, DZS RH

Đukan P. (1986), Standardna kalkulacija, Građevinski Institut-Zagreb, Građevinar, Zagreb

Institut IGH, d.d., expert data base

STEEL CONSTRUCTION COSTS IN EARLY PROJECT PHASES, GERMANY VS. FRANCE

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Construction costs are relevant success factors of building construction projects and most efficiently defined in early project phases. Thereby, reliable sources of cost indicators are required when analysing economic alternatives. With rising steel prices, the steel producing company ArcelorMittal together with UNTEC (French National Union of Construction Economists and Coordinators) developed a steel construction cost information and performance database for French planning institutions. After years, a similar product is about to be introduced to the German market in cooperation with CEEC (European Council of Construction Economists). As both countries work with different standards, however research on the German steel construction data was required to develop a similar database for the German market. In this field research, feedback from 100 institutions and companies (grouped into framework, floor, roofing, façade etc.) is statistically analysed and the results compared with the French data. This is the first study in a series to be carried out in the next few years around Europe.

KEYWORDS: steel, construction costs, early project phases, Germany.

INTRODUCTION

Cost planning is one of the main tasks for most participants involved in building construction projects today, as qualities, schedules and costs are relevant success factors. Compiling cost identifications in early project phases (budget and preliminary estimate) poses an considerable challenge onto architects, engineers and the awarding authority, as the base of information still is rather small at this time, although cost identifications are requested of a very precise quality (Ruf, 2003). Usually this first stage of cost planning is an early cost projection, based on single factor calculations using cost indicators (Stoy et al., 2008).

In this process, the qualities of both quantity determination (reference unit) and chosen cost indicator have the same importance for the final result, as normally the following type of equation is applied for cost identification:

Cost Indicator x Reference Unit = Cost Forecast (equation 1)

In the case of France and Germany, the exact determination of a project´s quantities is based on national standards that contain similarities, but also important differences in detail (Hagmann et al., 2008). These differences have a possible impact on both the development of cost indicators and their application in calculations of cost identification.

Furthermore, the contents of a cost indicator are related to material, labour time and specific coefficients. And these components again are partly based on national standards. In summary, a cost indicator may be based on a quite complex construction, always driven by different national standards.

For this reason decision was taken to realize the publication for the German market not by using the French cost indicators as they were. And not even by trying to localize them using a (to be found) French-German steel construction cost translation factor. But the approach agreed by all involved in the project was to carry out a survey on steel construction cost indicators in Germany, based on the French framework.

This paper describes the approach of the survey and the validation process, to end with the presentation of some exemplary German steel construction cost indicators compared to their French equivalents.

FRENCH BACKGROUND

In France, institutions have already elaborated and published a special data base for cost indicators of steel constructions some years ago (Les Carnets de l´acier, 2006). This tool enables to quickly estimate the construction cost of a building or part of the work, considering not a specific product but functions like structure, envelope, equipment, surface treatment or fire protection. The approach by function takes into account the type of building or system with weighted averages (in Parisian area) calculated and validated for areas from 300 to 1000 m². Based on enterprises´ bids analysis, these values integrate the different components, in order to obtain an estimation of the costs, which are directly and simply exploitable to get a spread of cost indicators. For example, the function "Façade" is composed of primary framework, accessories, insulation, aspects of the surface; including both material and labour costs.

After several years of successful experience in France, decision was made to prepare the introduction of a similar document on the German market. One of the main questions at that time was, whether the French data base could be translated into the neighbouring country for instance by simply adding a certain French-German coefficient to every existing French cost indicator. To get an answer to this question, the European Council of Construction Economists (CEEC) was asked to join and supervise the project by adding its international experience. And the final agreement of was to carry out a survey on the German market.

SURVEY

The field research by questionnaires was conducted to collect cost indicators for steel construction works and elements in Germany from the German planning und building industry. A total of over 600 of questionnaires has been sent to over 300 contacts, followed by uncounted phone calls. The collection of data was carried out from November 2007 to February 2008. In order to receive comparable prices, eight different questionnaires had been established to cover the different steel construction topics. Each of them asking for cost indicators valid for functions of the following type of building, inclusive supply (material) and laying (labour). All items are entirely based on German standards, mainly on DIN 276 (DIN 2006) and DIN 277 (DIN, 2005).

General specifications of our case study building as indicated on every questionnaire:

- Gross external floor area: 800 m² to 1400 m² BGF
- Snowload-zone: II
- Windload-zone: III
- Groundlevel: max. 500 m above sea level
- Compact building geometry

Further specifications are defined for every of the different topics of the questionnaires:

(1) Framework: the framework weights and prices including columns, connections and simple bracings or stiffings; the mixed construction takes into account the collaborating action studs shear connectors, but no slabs (see: (2) Floors).

(2) Floors: the indicated prices include complete placing with additional formwork, temporary propping, additional reinforcement and pouring of concrete; the prices include the data for fire resistance F90; a deduction in % is indicated for F30 construction.

(3) Fireprotection: massivity factor of about 140-180 which corresponds to the profile range of IPE 300 to 450 and the whole HEB range for example.

(4) Façade: secondary frameworks are included only if necessary; finish of elements in pale colours (class 1); no openings included; spans of 7.5 m.

(5) Roofing: are included if necessary; finish of elements in pale colours (class 1), no openings included; spans of 7.5 m.

(6) Doors & Windows: cost indicator takes no account of surface treatment (paint, galvanization, thermal lacquering); normal dimensions of glazing surfaces per element (1 m x 2 m for doors and 1 m x 1 m for windows); prices without specific metal fittings like door closer etc.; no special acoustic performance; fanlight excluded, specific ironmongery excluded.

(7) Metalworks: all stairs are standard with railing and handrails.

(8) Anticorrosion: the indicated prices include transportation up to an average distance from and to the workshop; costing modes are different from one industrialist to another, so in order to simplify, the mode "empty for full" in m² is asked.

VALIDATION

Despite the large number of questionnaires sent out and uncountable personal interviews, we received only about 100 with filled out cost indicators, that were all put in a data base.

In a first validation step, the data base provided a statistical overview of the survey results: lowest and highest value (and the fork between them), lower and upper quartile, median and average value (see Table 1). Finally, this method indicates outliers that you might want to discuss with its provider to avoid misunderstanding of item definitions.

In a second step, the upper and lower quartile was chosen in most cases to build the upper and lower value, as we agreed not to publish the cost indicator of an item as a single value only, but as a range (see Table 1).

Table 1: Validation step 1 and 2: descriptive statistics (extract from chapter: framework)

Tragwerk [Framework] {Ossature}		[Data Collection Results]							Publication Germany 2008			
		[Lowest value] {offre plus basse}	[Lower quartile] {quartile bas}	[Median] {médiane}	[Average value] {moyenne}	[Upper quartile] {quartile haut}	[Highest value] {offre plus haute}	[Fork between highest and lowest value]	**[Chosen lower value]**	**[Chosen average value]**	**[Chosen upper value]**	[Fork between highest and lowest value]
Durchschnittliche Tonnage [weighted tonnage], {tonnage pondéré}												
Integrierter Träger (IFB, SFB) [integrated floor beam (IFB/SFB)] {poutre intégrée dalle}	(€/kg)	€ 1,85	€ 1,98	€ 2,21	€ 2,27	€ 2,46	€ 2,54	30%	**2,00 €/kg**	*2,25 €/kg*	**2,50 €/kg**	22%
Walzprofile [solid web beam] {poutre à âme pleine}	(€/kg)	€ 1,92	€ 2,03	€ 2,14	€ 2,17	€ 2,27	€ 2,75	38%	**2,00 €/kg**	*2,15 €/kg*	**2,30 €/kg**	14%
Lochstegträger [cellular beams] {poutre alveolaire}	(€/kg)	€ 2,02	€ 2,09	€ 2,27	€ 2,37	€ 2,60	€ 2,80	33%	**2,10 €/kg**	*2,35 €/kg*	**2,60 €/kg**	21%

In a third step, the already published French data was integrated into the data base and each French item allocated to its German equivalent. As the latest French data available dated from December 2005, these cost indicators had to be updated by an index (in case of framework: 12%) provided by UNTEC, in order to be comparable to the German data, valid for the 1st quarter of 2008.

Whenever possible the data published by BKI (BKI, 2008) was used as an additional validation step to see the variation between the survey results based on a theoretical case study and the BKI data based on executed real life projects (see Table 2). Unfortunately, BKI has a large data base for many other areas than steel construction.

In case of particular variations between the German and the French indications, the data of this specific item was analysed into material costs, labour time and their coefficients, in order to understand where the difference comes from.

Every item was declared “validated as pre-result” only if both the French and the German side agreed to.

Table 2: Validation step 3: comparison to French data and BKI (continuation from Table 1)

Publication Germany 2008				Comparison: France						Comparison: BKI				
[Chosen lower value]	**[Chosen average value]**	**[Chosen upper value]**	[Fork between highest and lowest value]		[Chosen index] {index choisi}	[Lower value] {valeur basse}	[Average value] {valeur moyenne}	[Upper value] {valeur haute}	[Fork between highest and lowest value]		[Chosen index] {index choisi}	[Lower value] {valeur basse}	[Average value] {valeur moyenne}	[Upper value] {valeur haute}
				2005-12 (orig.):		€ 1,40		€ 2,00		yyyy-mm (orig.):				
2,00 €/kg	*2,25 €/kg*	**2,50 €/kg**	22%	2007-12:	12%	*€ 1,57*	*€ 1,90*	*€ 2,24*	35%	yyyy-mm:				
				Difference:		-28%	*-18%*	-12%		Difference:				
				2005-12 (orig.):		€ 1,40		€ 2,00		2007-02 (orig.):			€ 1,94	
2,00 €/kg	*2,15 €/kg*	**2,30 €/kg**	14%	2007-12:	12%	*€ 1,57*	*€ 1,90*	*€ 2,24*	35%	2007-11:	2%		*€ 1,98*	
				Difference:		-28%	*-13%*	-3%		Difference:			-9%	
				2005-12 (orig.):		€ 1,40		€ 2,00		yyyy-mm (orig.):				
2,10 €/kg	*2,35 €/kg*	**2,60 €/kg**	21%	2007-12:	12%	*€ 1,57*	*€ 1,90*	*€ 2,24*	35%	yyyy-mm:				
				Difference:		-34%	*-23%*	-16%		Difference:				

As the last step of validation, these pre-results were presented to all CEEC delegates and some chosen construction cost estimation professionals in Germany to get their comments on usability and quality of the cost indicators. And after their final agreement, nearly 300 items were "validated to be published".

RESULTS

The following three figures are comparing the results of the German survey after validation with the French data in the three exemplary chapters: façade (see Figure 1), framework (see Figure 2) and fire protection (see Figure 3).

To some extend, Figure 1 (façade) gives the impression that the consideration at the very beginning of this project, the idea of a French-German coefficient, seems to be quite likely.

But even if Figure 2 (framework) might nearly work with a coefficient, it would have to be a different, as the results comparing both countries are inverted.

And Figure 3 (fire protection) gives an example of a chapter, where the tendency is changing from one item to another.

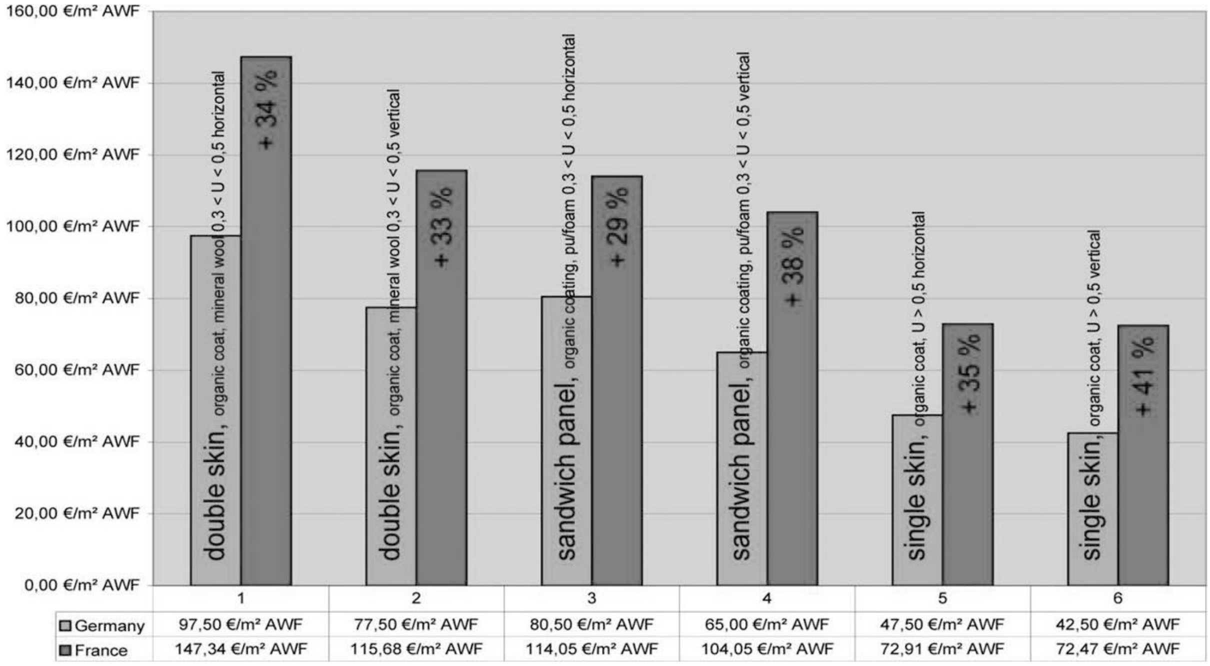


Figure 1: Comparison of results (extract of: façade)

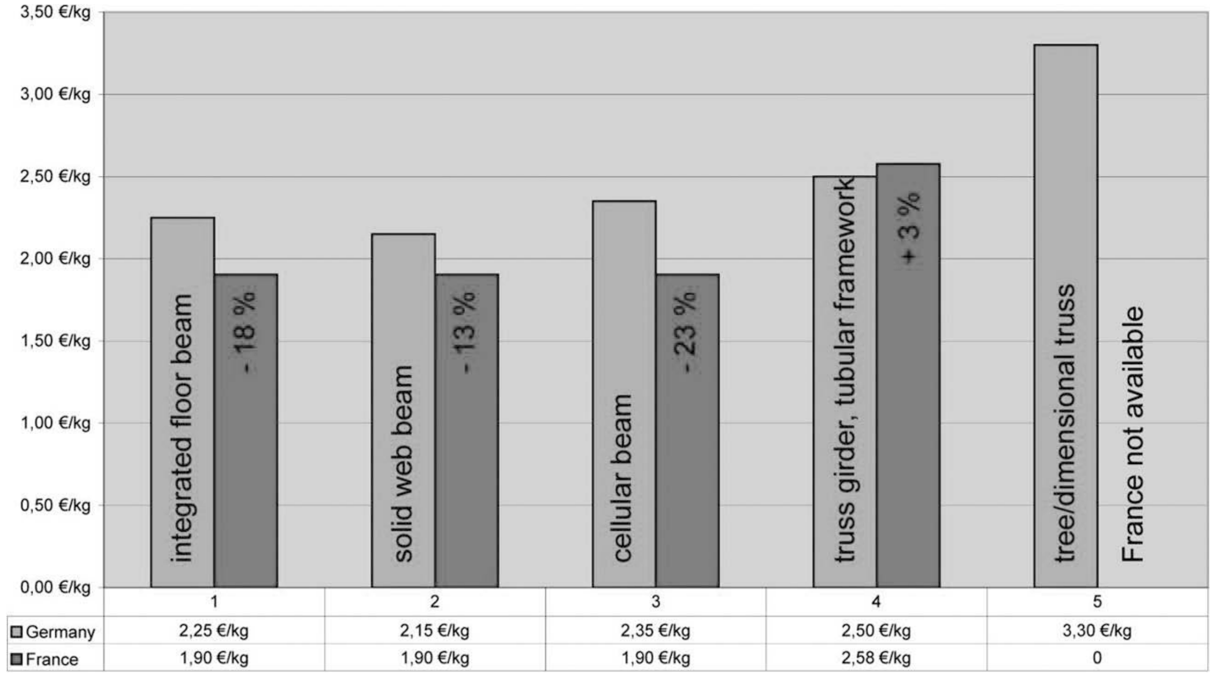
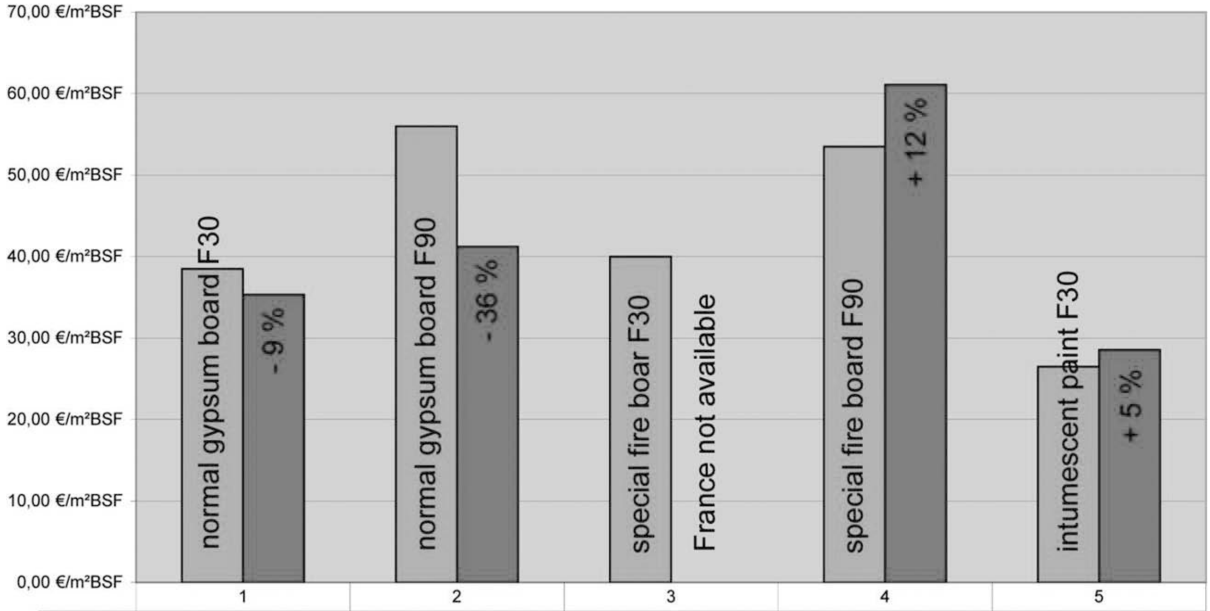


Figure 2: Comparison of results (extract of: framework)



	1	2	3	4	5
Germany	38,50 €/m²BSF	56,00 €/m²BSF	40,00 €/m²BSF	53,50 €/m²BSF	26,50 €/m²BSF
France	35,33 €/m²BSF	41,24 €/m²BSF	0	61,09 €/m²BSF	28,56 €/m²BSF

Figure 3: Comparison of results (extract of: fire protection)

CONCLUSIONS

This paper describes a survey carried out on steel construction cost indicators in Germany, based on a similar project in France. The results of the present study show clearly, that it is not possible to use a single French-German coefficient for simple mathematical translation of steel construction cost indicators at the level of single items from France to Germany.

One of the reasons is the fact of different standards used in both countries for quantity determination. Further research may show, to what extend the possible introduction of an European Code of Measurement for Cost Planning could solve this problem. On the other hand, the impact of different market situation as well as different construction habits (technical solutions applied) still remains to be analysed.

This could be useful for example when the existing steel construction cost data bases will be translated to even more European countries within the next years.

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REFERENCES

ArcelorMittal (Ed.) (2008) Kosten im Stahlbau, Basisinformationen Deutschland 2008. Luxembourg: ArcelorMittal. Available as PDF at: http://www.constructalia.de .

BKI Baukosteninformationszentrum Deutscher Architektenkammern (2008) BKI Baukosten 2008, Teil 3: Statistische Kostenkennwerte für Positionen. Stuttgart: BKI.

DIN Deutsches Institut für Normung e. V. (2005) DIN 277-1 Grundflächen und Rauminhalte von Bauwerken im Hochbau – Teil 1: Begriffe, Ermittlungsgrundlagen. Berlin: Beuth Verlag.

DIN Deutsches Institut für Normung e. V. (2005) DIN 277-2 Grundflächen und Rauminhalte von Bauwerken im Hochbau – Teil 2: Gliederung der Netto-Grundfläche. Berlin: Beuth Verlag.

DIN Deutsches Institut für Normung e. V. (2005) DIN 277-3 Grundflächen und Rauminhalte von Bauwerken im Hochbau – Teil 3: Mengen und Bezugseinheiten. Berlin: Beuth Verlag.

DIN Deutsches Institut für Normung e. V. (2006) DIN 276-1 Kosten im Bauwesen – Teil 1: Hochbau. Berlin: Beuth Verlag.

Hagmann, C., Stoy, C., Terashima, N. (2008) Steel construction costs in Germany. Conference proceedings of AACE International's 53rd Annual Meeting 2008. Toronto, AACEI. 128-136.

INSEE Institut National de la Statistique et des Études Économiques (2008) Informations Rapides, Série « Principaux Indicateurs », Indice du coût de la construction – Troisième trimestre 2007. Paris: INSEE.

Le service public de la diffusion du droit (2007) Code de l´urbanisme, Livre I, Titre I, Chapitre II : Surface hors oeuvre des constructions, Article R112-2. Available at: http://www.legifrance.gouv.fr .

Les carnets de l´acier (Ed.) (2006) Économie et solutions acier 2006. Paris: Groupe Métal UNTEC-Arcelor. Available as PDF at: http://www.constructalia.fr .

Ruf, H.-U. (2003) Verfahren der Kostenermittlung, Kostenkontrolle und Kostensteuerung. BKI Handbuch Kostenplanung im Hochbau. Stuttgart: BKI Baukosteninformationszentrum Deutscher Architektenkammern. 90-109.

Stoy, C., Pollalis, S., and Schalcher, H.-R. (2008) Drivers for Cost Estimating in Early Design : Case Study of Residential Construction. Journal of Construction Engineering and Management, 134(1), 32-39.

THE ACCURACY OF PRE-TENDER COST ESTIMATES OF CONSULTANT QUANTITY SURVEYORS IN NIGERIA

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The construction procurement process relies heavily on an adequate level of financial management to maintain commercial feasibility and smooth operations. This paper examined the accuracy level of pre-tender cost estimates of consultant quantity surveyors on building projects in Nigeria. A quantitative approach was used for the research. The data for the research were obtained from a consulting quantity surveying firm practising in Nigeria for eighty two (82) building projects carried out between 2005 and 2008. The results of the study showed that the accuracy of pre-tender cost estimates of the consultant quantity surveyors varies according to the project size and the sector when the pre-tender cost estimates were compared with the contract sums. It was revealed that smaller projects are more biased than the larger ones and at the same time projects that belong to the public sector are more biased than those that belong to the private sector. Overall, the average deviation (error in %) is 2.11% with a standard deviation of 10.15. A model was then formulated to predict the contract sums from the known values of the quantity surveyor's pre-tender cost estimates by the use of linear regression analysis. This was then verified and validated by collecting data of ten (10) building projects that have been awarded from an independent consulting quantity surveying firm practising in Nigeria. It was found out that the accuracy level of the model is between 1.72% and -5.83%.

KEYWORDS: accuracy, Nigeria, pre-tender cost estimate, regression analysis, quantity surveyors.

INTRODUCTION

One of the most important aspects of construction procurement process is the management of client expenditure in the form of budgetary control. This is done throughout the procurement period. One aspect of client expenditure management that has received some attention by researchers is the accuracy of pre-tender cost estimate. A pre-tender cost estimate is an important piece of information required when feasibility of building projects are being evaluated and decisions on design and construction issues are to be made (Aibinu & Pasco, 2008). Ideally (i.e. in purely deterministic world) costing of the construction implications of design decisions; taking into consideration the effects of trade-offs against any indirect value effects such as time for completion, construction quality, resale or letting values; suppose to be accurate (Skitmore & Picken, 2000). In the practical situation, however, this is almost completely not so. Estimates have to be as accurate as possible because these form the basis for tender comparison or negotiation and if these are grossly inadequate, award decisions may be extremely difficult. To this end, it is required of quantity surveyors to improve on the accuracy of their pre-tender estimates in order to ensure clients satisfaction (Odusami & Onukwube, 2008). In Nigeria, however, much attention has not been given to the accuracy of pre-tender estimates and it is against this background that this study intends to carry out an evaluation of the accuracy level of pre-tender cost estimates of consultant quantity surveyors in Nigeria and develop a model to predict the contract sum from the estimates of the consultant quantity surveyors. The study has the capability of contributing to the body of knowledge in the area of pre-tender cost estimates forecasting. The study can as well form a baseline for further studies.

Previous Studies on the Accuracy of Pre-tender Cost Estimates

Issues relating to the accuracy of pre-tender cost estimates have blessed construction management literature over the decades. Odusami and Onukwube (2008) while referring to Morrison (1984) defined the accuracy of the quantity surveyors' estimates as the deviation from the lowest acceptable tender received in competition for a project. Skitmore (1986) analysed 36 medium-large projects in the UK and found an average error of 1.29% with a coefficient of variation of 5.88. In a similar research carried out by Tan (1988) for 103 building projects in the UK, it was reported that the average error is 11.50% while coefficient of variation is 15.00%. Cheong (1991) sought the opinions of quantity surveyors regarding the level of accuracy of pre-tender cost estimates prepared by the consultant quantity surveyors in Singapore and reported that the level of accuracy is between 5% and 10% deviation from the contract sum. He further analysed 88 projects from one quantity surveying firm in Singapore and found out that the difference between estimates and contract sum ranges from over-estimates of 33.79% to underestimates of 31.30%. Gunner (1997) carried out an analysis of pre-tender estimate of 86 projects in Singapore and an average error of 3.47% was found with a coefficient of variation of 8.46. 181 projects estimated by one quantity surveying firm in Singapore were analysed by Gunner and Skitmore (1999) and an estimating accuracy of 10% was found. Skitmore and Picken (2000) got a coefficient of variation of 7.82% when they carried out the analysis of the pre-tender estimating performance of a USA consulting organisation where 217 projects were analysed. They further ascertained that there is a positive correlation between year by year changes of pre-tender cost estimates and the USA annual inflation rate. Skitmore and Drew (2003) carried out an analysis of pre-tender building price forecast (estimates) made by a Hong Kong consulting organisation for building projects from 1995 to 1997 and used Analysis of Variance (ANOVA) to detect significant difference in the errors grouped according to building size (value), building size (area), forecasting (estimating), method (approximate quantities and superficial), nature of the work (new build and alteration work), and type of project. Aibinu and Pasco (2008) examined the important project characteristics influencing the accuracy of pre-tender building cost estimates in Australia. Their research, based on the data from 56 building projects and a questionnaire survey of 102 quantity surveying firms, revealed that the accuracy of estimates is influenced by project size. In a similar research carried out by Gunner (1997), Gunner and Skitmore (1999), Skitmore and Picken (2000), a dramatic change was noted when the effects of Type, Size and Year were partialled out. They all identified the Year as being the underlying variable responsible for systematic bias and inconsistency in forecasting by cost consultants. A number of researchers have worked on the factors affecting the accuracy of pre-tender cost estimates (Sey & Dikbas, 1990; Shash, 1993; Akintoye, 2000; Enshassi, Mohammed & Madi, 2007; Odusami & Onukwube, 2008). From the reviews carried out, research on the accuracy of pre-tender cost estimates in Nigeria has not received much attention. The work of Odusami and Onukwube (2008) only focussed on the factors affecting the accuracy of pre-tender cost estimate in Nigeria. But the accuracy level of pre-tender cost estimate in Nigeria is yet to be studied. This paper intends to close this gap and contribute to the body of knowledge in the area of the accuracy of pre-tender cost estimates in Nigeria.

Research Methods

The data for the research were obtained from a consulting quantity surveying firm practising in Nigeria for eighty two (82) projects carried out between 2005 and 2008. The approach used for the research is a quantitative one. The author went into the database of the firm to retrieve the consultant quantity surveyor pre-tender cost estimates (QSE) prepared and the contract sum (CS) of those projects. Information gathered include project type, sector to which the projects belong and year of estimates/awards. From the data retrieved, the deviation of QSE from CS (called ‘Error’ here) was calculated in percentage form with the use of Microsoft Excel 2007 (MS Excel) software as follows:

$$Error\ (\%) = \frac{(QSE - CS)}{CS} * 100\% \quad \ldots\ldots\ldots\ldots\ldots (1)$$

The positive value of Error (%) indicates that QSE are being overestimated while negative value means QSE are being underestimated. The authors made use of the CS instead of the lowest acceptable tender sum in order to establish the relationship between QSE and CS. It should be noted, however, that the contractors’ bids are supposed to be the same thing as the QSE, as both are estimates of the same market price which will then lead to CS once accepted.

Data Analysis and Results

The obtained data were analysed with the use of Statistical Package for Social Sciences (SPSS) and MS Excel. Deviation of the QSEs from CSs was obtained from MS Excel by inputting the equation 1 above. For the entire 82 projects analysed, Figure 1 and Table 1 gave the summary of distribution of Error (%). It can be observed from the Figure that the distribution is normally distributed with a mean of 2.11 and standard deviation of

10.15. Also, Table 1 showed the descriptive statistic analysis carried out. The skewness and kurtosis of the variable, error (%) are 0.604 and 4.748 respectively.

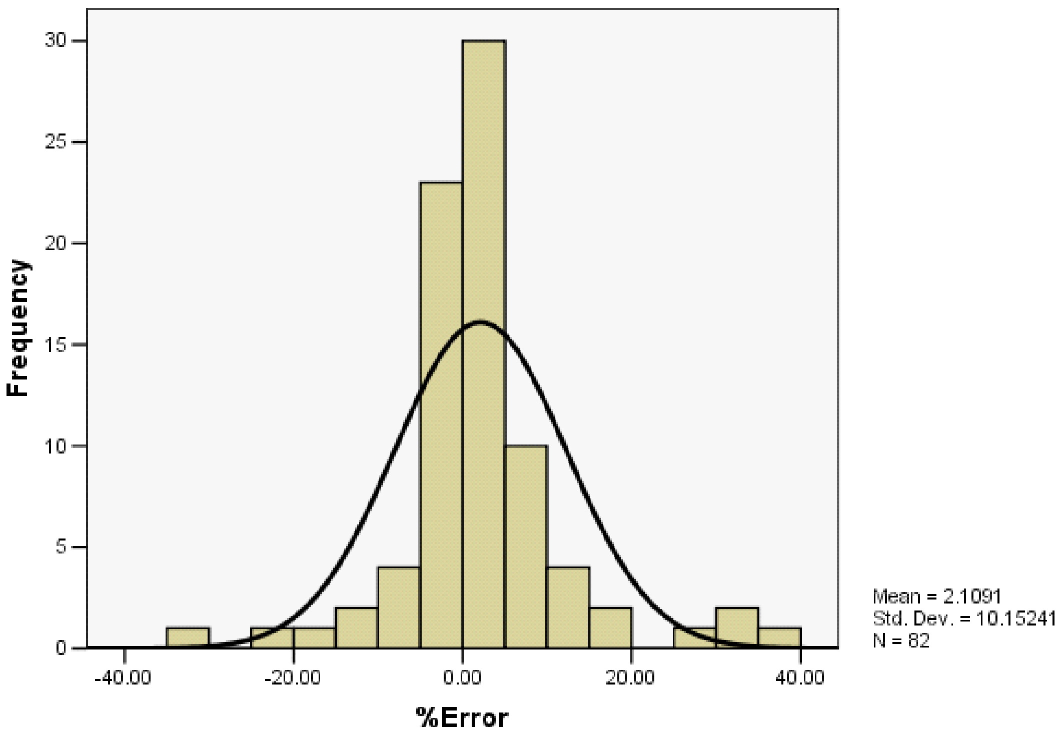

Figure 1. Histogram showing the distribution of Error (%)

Table 1. Statistic showing the distribution of Error (%)

Statistic	Value
Standard Deviation	10.152
Skewness	0.604
Kurtosis	4.748
Minimum	-34.010
Maximum	36.73

Of interest is the minimum and maximum percentage deviation (Error in %) shown in the Table 1 to this study. It showed that the difference between QSEs and CSs ranges from underestimates of 34.01% and overestimates of 36.73%. Overall, the projects were overestimated on the average by 2.11% (Mean error = 2.11%).

Table 2. Project Size Results

Project Value Range (Naira)	No of Projects	Maximum Error (%)	Minimum Error (%)	Mean Error (%)	Standard Deviation
<50m	20	36.73	-34.01	6.29	18.02
50m - 100m	7	10.50	-24.11	-0.86	11.76
100m - 200m	12	9.43	-3.73	0.91	5.97
200m - 500m	17	7.47	-6.59	0.89	4.11
500m - 1b	17	5.79	-3.71	1.5	2.81
>1b	9	1.55	-0.42	0.18	0.58
Overall	***82***	***36.73***	***-34.01***	***2.11***	***10.15***

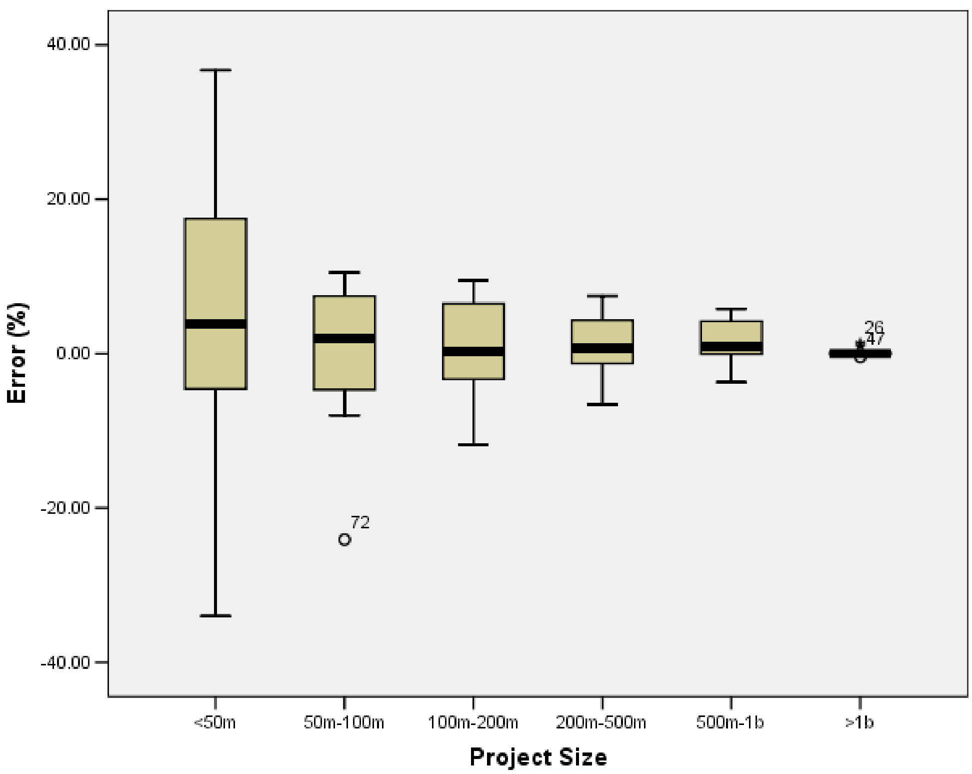

Figure 2. Boxplot Chart for Error (%)

It is necessary to study, in a greater detail, the pattern exhibited by the results generated. Tables 2, 3, and 4 gave the results based on Project Size, Project Type and Sector respectively. Table 2 reported errors (%) for the project size. Twenty (20) out of 82 projects are less than ₦50 million (m), seven are between ₦50m and ₦100m, eleven are between ₦100m and ₦200m, seventeen are between ₦200m and ₦500m, seventeen are between ₦500m and ₦1billion (b), and the remaining nine projects are of the value greater than ₦1b. Maximum and minimum error (%) values including the mean error (%) and standard deviation for each project value range are also given in the table. The results have it that for projects that are less than ₦50m, consultant quantity surveyor (CQS) overestimated by 36.73% and underestimated by 34.01%. Also, for projects between ₦50m and ₦100m, CQS overestimated by 10.50% and underestimated by 24.11%. Not only that, for projects between ₦100m and ₦200m, an overestimated and underestimated of 9.43% and 3.73% are witnessed by the CQS. Others are as shown in Table 2 and Figure 2. In order to have a better insight into the pattern exhibited, a boxplot chart (Figure 2) was used to depict the spread of the values gotten. A boxplot chart provides the medians, quartiles, and ranges in a single chart. It also provides information on outliers. As depicted by Figure 2, the estimates of smaller projects are more biased than the estimates of larger projects by looking at the ranges. It will be seen that project 72 for project value between ₦50m and ₦100m is an outlier. In all, it can be said that the accuracy of estimates is influenced by the project size.

Table 3. Project Type Results

Project Type	No of Projects	Maximum Error (%)	Minimum Error (%)	Mean Error (%)	Standard Deviation
Educational	13	33.60	-8.00	6.69	13.32
Residential	29	6.04	-10.15	0.48	3.64
Offices	11	13.04	-2.90	1.62	4.49
Health	11	36.73	-11.78	6.14	14.69
Commercial	5	7.47	-0.27	2.60	3.37
Other	13	15.15	-24.11	-2.01	14.92
Overall	***82***	***36.73***	***-24.11***	***2.11***	***10.15***

The results based on Project Type are shown in Table 3. It can be seen from the table that 'health' projects is overestimated by 36.73% and underestimated by 2.90%. 'Educational' projects are being overestimated by 33.60% and underestimated by 8.00%. Also, 'offices' projects are overestimated by 13.04% and underestimated by 2.90%. 'Residential' projects overestimated by 6.04% and underestimated by 10.15% while 'other' projects are overestimated by 15.15% and underestimated by 24.11%.

Table 4. Sector Results

Sector	No of Projects	Maximum Error (%)	Minimum Error (%)	Mean Error (%)	Standard Deviation
Public	34	36.73	-34.01	3.71	15.12
Private	48	9.13	-10.15	0.98	3.67
Overall	***82***	***36.73***	***-10.15***	***2.11***	***10.15***

From the results gotten, projects belonging to the public sector are overestimated by 36.73% and underestimated by 34.01% (Table 4). Private sector projects are overestimated by 9.13% and underestimated by 10.15%.

Model to Predict Contract Sum from Consultants Quantity Surveyors' Pre-tender Estimates

In order to generate a model to predict CSs from the CQSs estimates, a linear regression analysis was used. The model to be generated will be in the form of equation 2.

$$CS_i = \beta_0 + \beta_1 * QSE_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The results from linear regression analysis showed a *F* value of 271239.51 and $p<0.01$(as revealed by the ANOVA table) which means that the model is significant at 99% confidence level. R Square for the model was checked. R Square for CS_i is 1.000 meaning that 100% of variation in the dependent variable, CS_i can be explained by the independent variable, QSE_i. Adjusted R Square (in the model summary table) was checked to give a superior explanation of the proportion of variance in the dependent variable that can be explained by the independent variables. This is still 1.000 which means that 100% of variance in the CS_i can be explained by the independent variable, QSE_i. The normal P – P plot of the regression-standardized residual (Figure 3) for the model showed that the normality assumption of the linear regression is reasonably satisfied. So, the model generated is shown in equation 3.

$$\boldsymbol{CS_i = -3574398 + 1.002QSE_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)}$$

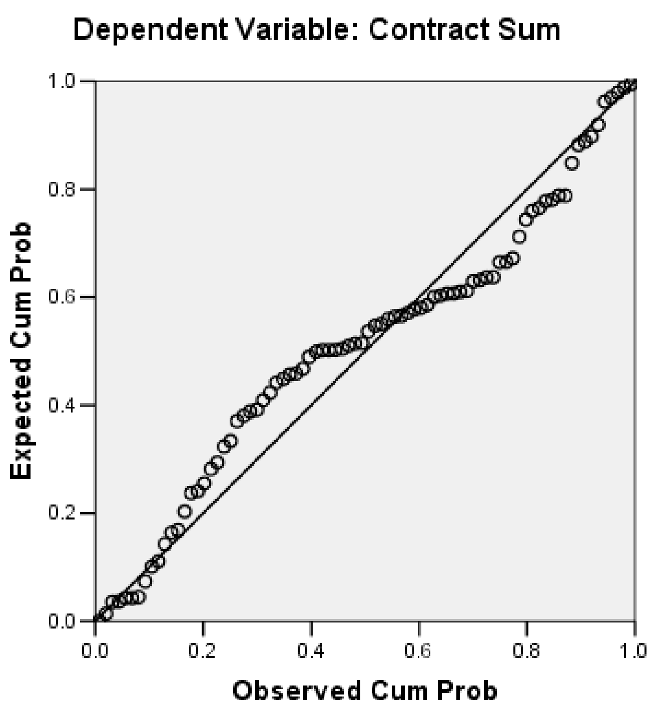

Figure 3. Normal P-P Plot of Regression Standardized Residual

Model Verification and Validation

It is important to carry out the verification and validation of the model generated. In order to verify and validate the model, data for ten (10) building projects that have been awarded were retrieved from a separate consulting quantity surveying firm practising in Nigeria. The data captured are the consultant quantity surveyor's pre-tender estimates and the corresponding contract sums. An MS Excel template was then designed based on the model generated. For each value of the consultant quantity surveyor's pre-tender cost estimate, a predicted contract sum was generated and this is compared with the actual contract sum awarded the project in order to generate the percentage deviation from the actual contract sum. It was found out that the accuracy level is between 1.72% and -5.83% (Table 5).

Table 5. Model Verification

Consultant Quantity Surveyor Pre-Tender Sum (₦)	Actual Contract Sum (₦)	Predicted Contract Sum (₦)	Deviation (%)
359,218,461.74	363,602,548.01	356,362,500.66	-1.99
434,396,060.63	436,685,012.74	431,690,454.75	-1.14
699,065,326.85	691,376,504.26	696,889,059.50	0.80
209,719,598.05	211,864,204.86	206,564,639.25	-2.50
253,609,925.26	251,739,032.18	250,542,747.11	-0.48
154,519,708.87	148,697,023.53	151,254,350.29	1.72
495,897,165.80	491,067,984.08	493,314,562.13	0.46
599,679,020.56	596,638,259.46	597,303,980.60	0.11
1,072,825,767.77	1,071,857,401.94	1,071,397,021.31	-0.04
132,441,413.86	137,119,746.02	129,131,898.69	-5.83

Limitation of the Model

The model is limited in the sense that the data captured are from only a consulting quantity surveying firm practising in Nigeria. These were the ones used in the development of the model, which are considered a bit small to a very accurate predictive model. Nonetheless, the model is capable of forming a baseline for further studies and guide in predicting the accuracy of pre-tender cost estimates in Nigeria.

DISCUSSION

In the analysis carried out, it was discovered that the estimates of smaller projects are more biased than that of larger ones. This is in consonance with the work of Aibinu and Pasco (2008) in Australia. This can be attributed to the fact that the consultant quantity surveyors are not thorough in the preparation of pre-tender cost estimates of smaller projects compared to that of larger ones. The lack of adequate information on the project could be responsible for this result. It was also found out that public projects are more biased than the ones owned by the private entities. This reflects in the fact that private sector are more manager of funds that the public. The corruption level in public projects is more intense in the country, even with the era of ‘due process’ method of procuring public projects. Private sector is more informed than the public entity. This reflects in the treatment given to the projects belonging to the two entities. Consultant quantity surveyor could be rest assured that if they do not perform as expected on private projects, it is possible for them to have the consultancy job revoked. But for public projects, it is not impossible to say that the officials in charge of the project will even mandate the quantity surveyor to tamper with the estimates in order to make provision for their ‘kickbacks’. Odusami and Onukwube (2008) identified some factors affecting the accuracy of pre-tender cost estimates in Nigeria. Those factors could also be attributed to the results of this study. The seven most ranked factors in descending order according to Odusami and Onukwube (2008) are: expertise of consultants; quality of information and flow requirements; project team’s experience of the construction type; tender period and market condition; extent of completion of pre-contract design; complexity of design and construction; and availability and supplies of labour and materials. Expertise of consultants here means special skills or knowledge in estimating. This factor is very important in obtaining a very accurate pre-tender estimate. Also, the amount of details available on the project as well as the cost data used by the quantity surveyor goes a long way in affecting the accuracy of the pre-tender estimate. Project team’s experience of the construction type as well as the tender period and market condition are other factors that are very crucial to quantity surveyors while preparing their pre-tender cost estimates. The authors believe that all these factors are among the factors responsible for the results of this study.

CONCLUSION

The construction procurement process relies heavily on an adequate level of financial management to maintain commercial feasibility and smooth operations. This paper has described the analysis of pre-tender estimating performance of a Nigerian consulting firm. It is shown that the accuracy level achieved by the firm is between 36.73% and -34.01%. But overall on the average an accuracy level of 2.11% with a standard deviation of 10.15 was achieved. One cannot say that this accuracy level is the best because so much work still needed to be done.

REFERENCES

Aibinu, A. and Pasco, T. (2008). The Accuracy of Pre-Tender Building Cost Estimates in Australia. *Construction Management and Economics.* 26 (12), 1257-1269.

Akintoye, A. (2000) Analysis of Factors Influencing Project Cost Estimating Practice. *Construction and Economics,* 18, 77-89.

Cheong, P.F. (1991) *Accuracy in Design Stage Cost Estimating.* MSc Dissertation, National University of Singapore.

Enshassi, A., Mohammed, S. and Madi, I. (1997) Cost Estimation Practice in the Gaza Strip: A Case Study. *The Islamic University Journal*, 15 (2), 153-176.

Gunner, J. (1997) *Accuracy of Construction Pre-Bid Forecasts.* PhD Thesis, University of Salford.

Gunner, J. and Skitmore, R.M. (1999) Comparative Analysis of Pre-Bid Forecasting of Building Prices Based on Singapore Data. *Construction Management and Economics*, 17, 635-646.

Odusami, K.T. and Onukwube, H.N. (2008) Factors Affecting the Accuracy of Pre-Tender Cost Estimate in Nigeria. *In Proceedings of the Construction and Building Research Conference of the Royal Institute of Chartered Surveyors (COBRA).* 4-5 September.

Sey, Y. and Dikbas, A. (1990) A Study of Factors Affecting Tender Price of Contractors. *In Proceedings of CIB 90 Congress, Sydney Australia*, 14-21 March, 451-64.

Shash, A. A. (1993) Factors Considered in Tendering Decisions by top UK Contractors. *Construction Management and Economics*, 11, 111-118

Skitmore, R.M. (1986) *A Model for the Construction Project Selection and Bidding Decision.* University of Salford.

Skitmore, M. and Drew, D. (2003) The Analysis of Pre-Tender Building Price Forecasting Performance: A Case Study. *Engineering, Construction and Architectural Management*, 1 (10), 36-42.

Tan, S.H. (1988) *An Investigation into the Accuracy of Cost Estimates During the Design Stages of Construction Projects.* BSc Dissertation, Department of Civil Engineering, University of Salford.

TRENDS IN THE IRISH HOUSEBUILDING SECTOR: IMPACT ON EMPLOYMENT LEVELS

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The objective of this paper is to provide an updated correlation between construction output and employment trends in the housebuilding sector of the Irish construction industry. The research methodology for this paper uses two methods, namely a literature review of reports and reviews of the housebuilding sector (produced by a number of state agencies and private companies) and information gathered from a series of discussions with expert commentators and professionals from the construction industry. All this information gathered is analysed to establish the level of correlation between changes in construction residential output and direct employment in the sector. An examination of the correlation will provide a further insight into the consequences of the contraction in residential construction. The evaluation of data from these reports and discussions different construction economists will enable policy-makers to develop a framework for this important sector of the Irish construction industry.

KEYWORDS: housebuilding sector, trends, output, employment.

INTRODUCTION

Given recent and ongoing events in the Irish housebuilding sector, this paper has significant contemporary relevance. The paper will focus on the residential construction market, which includes new house building, home improvements, and repair and maintenance as a sub-section of the overall construction market which also covers commercial/industrial development, public buildings (e.g. schools, hospitals) and civil engineering projects (e.g.roads, bridges). It will chart the movement in Irish residential construction with comment on the role of financial institutions in fuelling the boom and exacerbating the downturn.

In the context of the residential construction sector, the paper will analyse the relationship between output, i.e. completion of new houses/apartments and improvement/maintenance of existing housing stock, and employment (those directly employed in the building sector). Data will show that at the peak of output in 2007, 280,000 were directly employed in the building/construction sector, corresponding to 13.4% of total employment. Between April 1994 and February 2007, construction employment increased by 208%, an average of 9.2% p.a. This compares with 4.2% p.a. for the economy as a whole (DKM, 2007). It will show the massive deterioration in construction employment up to end of March 2009.

The ability of workers to survive the downturn in the housebuilding market, and consequent job losses, by switching to different sectors or locations will be examined. We will discover that alternative employment options are increasingly limited. These findings will have a number of implications for the construction industry as a whole and ultimately the wider economy. For example, policy-makers need to have the tools and information with which to determine future employment and economic policies arising from the current scale of construction job losses, and the extent to which other sub-sectors within the construction market can absorb excess capacity. Stakeholders include workers, employers, educational/training institutions and government departments.

Methodology

The research for this paper was mainly based upon reports and reviews of a large number of state and private companies and agencies, including FÁS (Employment and Training Authority), Department of the Environment, Heritage and Local Government (DoEHLG), Construction Industry Federation (CIF), Economic and Social Research Institute (ESRI) and DKM Economic Consultants. A number of informal discussions were also conducted with construction economists from various bodies such as FÁS, DoEHLG and CIF. These discussions were conducted in two phases; the first were held during May-June 2008 with subsequent ancillary information sourced in April-May 2009. Given the nature of the construction industry in Ireland and the traditional difficulty in obtaining data, it was felt that the combination of the above methods would yield the best results for the purposes of this paper. The research is now being updated.

Background: The Irish Construction Industry

Background

According to the Ruddock, the United Nations defined construction in 2001 as comprising of 'economic activity directed to the creation, renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature, and other such engineering constructions as roads, bridges, dams and so forth' (Ruddock, 2008). For analysis purposes, the construction industry is typically divided into a number of sub-sectors. The research sources used in this report differ in their categorisation of industry sub-sectors. It must be noted that each organisation, (e.g. FÁS, DKM, CIF) prepares its research with a specific target audience in mind; therefore each has its own perspective on the structure and future needs of the industry. This paper uses a categorisation according to CIF standards, the so-called 'Pillars of Construction'. Stafford (2008) outlines these as follows: New houses and apartments (New Houses), Home improvements, repair and maintenance (RMI), Public Buildings, Civil Engineering, Commercial and Industrial Developments. The focus of the research will be primarily on the first two categories, New Houses and RMI.

Chronology of the Irish housing market 1997-2009

The factors behind the Irish housing market boom are well documented. Coinciding with a period of sustained economic growth, measures such as increased affordability, a benign interest rate regime and favourable demographics underpinned the housing boom. Those factors may or may not have been specific to Ireland. In common with the majority of developed markets, the abundant availability of credit and liquidity in the financial system pre-July 2007 fuelled an explosion in the Irish property market which lasted for a decade. The extent to which the Irish financial system is exposed to the construction and property sector is highlighted in data published by the Central Bank (Central Bank of Ireland, 2008). Of a total €401bn advanced by Irish financial institutions to the private sector at March 2008, 62.6% (€251bn) comprised construction and property-related lending (including personal mortgages). This contrasts sharply with the comparable figure of 36.8% 10 years ago.

It is difficult to pinpoint the top of the cycle, although the commonly held view is that the market started to stall from autumn 2006. The already waning housing market was then hit by a further thunderbolt, the so-called 'Credit Crunch', which hit the global financial system in the summer of 2007, the fall-out from which is still ongoing.

The US financial sector has become increasingly pro-cyclical (Adrian and Shin 2008) and this could equally be applied to the Irish market. As increasing asset (house) prices are accompanied by an increase in banks' balance sheet strength, the required adjustment in leverage creates greater demand for houses and a further increase in prices. However, the mechanism has now moved in reverse and asset sales combined with the limited availability of credit is amplifying the downturn.

Given the tightening of credit terms, many first-time buyers are unable to get mortgage approval, and therefore many housebuilders have ceased work on sites due to lack of sales. As a result, developers now find themselves with uncompleted developments and a high proportion of unsold stock. Cashflow pressures is resulting in builders seeking to reduce their cost base to remain solvent. Variable costs are the first to be cut – in the Irish housebuilding market, this means large-scale headcount reduction.

Valuing Construction Output

The measurement of construction output as a function of Gross National Product

In 2006, Gross National Product (GNP) was estimated at €149 billion (DKM, 2007). Construction output was valued in a range between 23.8% of GNP (€35.5bn) and 10.2% (€15.1bn), depending on the measure used to establish the value of output in the construction industry. Regardless of valuation method used, all measures reveal the extent of the expansion in construction to its peak in 2006/2007. Construction, in gross terms, represented almost a quarter of economic activity in 2006, an increase from a fifth at the outset of the 21st century (DKM, 2007). According to DKM, output is defined as gross value of outputs less the value of intermediate consumption and consists of the wages and profits earned by building workers and construction companies. Based on this definition of output, this implies that construction represented 10.2% of GNP in 2006 (DKM, 2007). This compares with agriculture, for example, which in terms of value added, accounted for 2.6% of GNP in 2006. GNP increased from €149bn in 2006 to €161 billion in 2007 (DKM 2007). The figure estimated for 2008 is €156.5 billion (ESRI, 2009).

The measurement of construction activity: an employment perspective

The Irish Central Statistics Office uses industrial classifications which are consistent with European and international standards to classify all forms of economic activity. The CSO uses NACE 45 measurement criteria with which to assess employment levels in the construction sector as a whole. The definition of construction in an Irish context (NACE 45) comprises site preparation, building of complete constructions or parts thereof, civil engineering, building installation, building completion, and renting of construction or demolition equipment with operator (CSO, 2008). This definition does not include upstream and downstream activities.

The correlation between construction output and employment trends

Employment Levels in the Construction Industry

As stated above, the Irish economy was disproportionately reliant on the construction and specifically housebuilding sectors. An interesting statistic from the International Monetary Fund (IMF) in its World Economic Outlook states that the Irish ratio of housing investment to GDP at 13.3% in 2006 was more than twice the average for advanced economies (IMF, 2008). This gives credence to the extent to which the Irish economy was over-reliant on housebuilding.

As expected, the growth in activity up to 2007 was matched by an increase in those employed. Data from the CSO shows that at its peak in 2007, c.282,000 were employed, corresponding to 13.4% of total direct employment. The figure for end of March 2009 is 179,900 (CSO, 2009).

Table 1: Direct employment in building and construction (not seasonally adjusted): (DKM, 2008 & Construction Indicators Report, March 2009)

Year	Period	Employment (000's)	% change year-on-year	% of total employment
1998	March – May	126.1	14.2%	14.2%
1999	March – May	142.1	12.7%	8.9%
2000	March – May	166.2	17.0%	9.9%
2001	March – May	180.0	8.3%	10.5%
2002	March – May	182.2	1.2%	10.3%
2003	March – May	191.4	5.0%	10.7%
2004	March – May	204.7	7.9%	11.2%
2005	March – May	243.0	18.7%	12.6%
2006	March – May	265.0	9.1%	13.1%
2007	March – May	281.8	6.3%	13.4%
2008	March – May	255.0	-9.5%	12.1%
2008	September – November	233.1	n/a	n/a

The Live Register in Ireland is an indicator of unemployment across all sectors. It has risen from 196,000 persons unemployed (corresponding to 7.7% unemployment rate) in April 2008 to 384,000 in April 2009 (11.4%) (CSO, 2009). It must be noted that the Live Register is not a measure of unemployment per se, as it includes part-time & casual workers, although it is a fairly accurate indicator.

Drilling down further into the numbers shows an increase in the Live Register of 119,320 persons between October 2008 and March 2009, i.e. the rate of unemployment continues to accelerate. The occupational group of construction, woodwork and metal accounts for 38.2% of this increase (ESRI, 2009). Crude extrapolation of this data would suggest that there may have been an additional 50,000 construction job losses since October 2008 and over 100,000 job losses since the peak in the first quarter 2007.

Current Housing Indicators: evidence and impact on employment levels

The housing market is currently experiencing a marked slowdown which has inevitably impacted on the number of people employed in this and related industries. There are a number of methods of evaluating activity in the housebuilding market. For the purpose of this analysis, data on housing registrations and completions is used. Registrations occur when the builder registers with Homebond and Premier Guarantees, usually one month before site construction commences. It can be viewed as a proxy for housing starts, in that there is a time lag of c.6-9 months between registration and completion in a normally functioning market. Completions are recorded when new dwellings are connected to the electricity network. The graph shows data on housing registrations and completions in the 4 years up to Q4/2008.

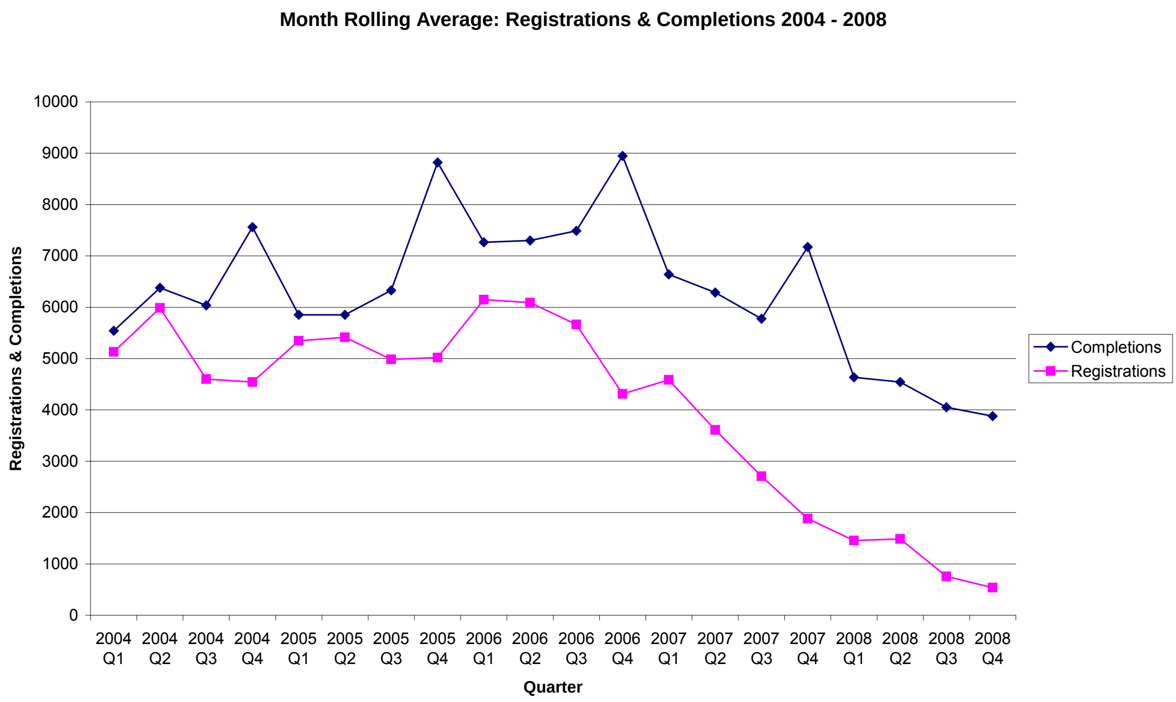

Figure 1: 3 Month Rolling Average: Registrations and Completions

Source: CSO, DoEHLG, 2008 & 2009

Total completions came in at 78,027 units for 2007. This is a drop of 16.4% from the peak in 2006. In 2008, 51,724 units were completed (DKM, 2009). This figure needs to be treated with caution, as it is based on connections to the electricity supply grid as opposed to actual sales. The latest adjusted published figures for registrations for 2008 has declined to 16,000 from an estimated 50,000 in 2007 (DKM, 2009). Some commentators are suggesting a figure for registrations could be as low as 5,000 for 2009. According to Homebond, the home guarantee scheme, the number of new homes registered in April 2009 fell by almost 80% at 327 registrations compared with the same month for the previous year which was 1,595 registrations (DKM, 2009). These figures are seen as an indicator of future housing activity and show that builders have reacted rapidly to changing market conditions.

Correlation between Current Housing Indicators and Employment

In terms of the correlation between actual housing output and construction employment, the table below shows that as housing output increased to its peak level in fourth quarter of 2006, construction employment also peaked at between 280,000 and 285,000 as would have been expected. As housing output declined dramatically in 2007 and 2008, the level of employment has now begun to drop in proportion with the overall housing output.

Table 2: Relationship Between Housing Output and Construction Employment on a Quarterly basis: CSO/ DoEHLG (2008 & 2009)

	Housing Output	Construction Employment
Q2 2006	22,005	265.2
Q3 2006	22,571	280.4
Q4 2006	26,949	284.6
Q1 2007	20,018	284.2
Q2 2007	18,960	281.8
Q3 2007	17,427	283.2
Q4 2007	21,622	279.0
Q1 2008	14,010	274.4
Q2 2008	13,726	255.0
Q3 2008	12,250	257.3
Q4 2008	11,728	233.1

Transience of the Sector

The definition of transience is staying or working in a place for a short time only. The term transient should be examined from the perspective of transience of sector where labour moves from one sector to another.

As the ‘New Houses’ segment contracts, there has been a corresponding reduction in those employed in this sub-sector. The question is whether the excess capacity in the housebuilding sector could have been absorbed in one of the other Pillars. In terms of transience, is it possible for workers in the construction industry to switch from sub-sector to sub-sector and are employees flexible in terms of possessing a transferable skills base? This will be examined later. The first question relates to the extent of under-capacity or demand for labour in the other sectors.

Growth in Commercial and Industrial developments tends to track general economic conditions. There is a noticeable lag effect between housebuilding and commercial activity. The commercial sector commenced its decline in August 2007- a full year after housing peaked with the pace of decline only becoming truly evident throughout 2008.

The Civil Engineering and Public Buildings sectors are to a large extent inter-linked given the increasing element of public private partnerships in the construction of public infrastructure. While the fortunes of some private civil engineering firms are susceptible to swings in the construction market as a whole, it could be argued that demand for infrastructure is not cyclical – i.e. roads/road upgrades will be required regardless of economic activity. The lynchpin of growth in infrastructure is the government's National Development Plan 2007-2013 (NDP), in which numerous private civil engineering firms are involved. The NDP was launched in January 2007 and planned to invest €184bn on physical infrastructure, i.e. roads, public transport. However the plan was predicated on economic growth of 4-4.5% annually over the following six years. Economic activity declined by over 7% in 2008 and could be approaching an 8% decline for 2009 (ESRI, 2009).

This is primarily due to the sharp contraction in the Irish property market, severe credit market tightening and global economic downturn. The property related categories of capital gains tax, value added tax and stamp duty had the biggest proportional declines. It is must be noted that the broadening of the economic slowdown since 2008 is now evident under other taxation headings. The ESRI in its Spring Quarterly Economic Commentary is forecasting that the exchequer deficit would increase to €21.7 billion in 2009 from €12.7 billion in 2008. The figure for 2007 was €1.6 billion (deficit).

The state of Ireland's budgetary deficit has implications for future investment in the National Development Plan (NDP). The recent budget in April 2009 advised that 2009 capital spending will be €2bn or 20% lower than 2008. For 2010-2013, average capital spending will be a further €1.3bn lower compared to the 2008 level. These marked cuts will undoubtedly result in higher construction unemployment.

Similarly the construction of social housing was traditionally considered counter-cyclical, and some movement of the labour force could have been diverted to that area. However the phenomenon of public/private initiatives in this area has also impacted growth forecasts. This was exemplified in 2008 when a leading Irish developer reneged on contracts to build social housing, on the basis that it was economically unviable for him to continue with the project.

In summary, it is unlikely that the number of construction workers likely to be employed in the Civil Engineering/Physical Infrastructure sectors will materially increase over the next few years. There are also issues in terms of transferability of skills between sectors. Can someone employed on a house building site be readily employable by a civil engineering contractor, or is it likely that he will require re-training? This is another factor to be considered by policy-makers.

The fifth sub-sector is that of Repair, Maintenance and Home Improvements (RMI).

RMI is viewed as a standalone Pillar by the CIF (Stafford, 2008) although it is also considered as a sub-sector of the residential market. It is estimated to comprise between 10% and 20% of the overall residential sector, although FÁS have indicated a figure of 12% for this particular sub-sector (FÁS, 2008). It is viewed by most commentators as having the most significant growth potential in the construction market. During the economic boom period, this area was under-serviced and the extent of decline in total residential investment will be slowed somewhat by the strength of RMI. This statement is based on anecdotal evidence.The positive growth potential of the RMI pillar may be attributable to:

- Affordability/market issues – people cannot afford to trade up, or because of the stagnant credit market. Therefore some homeowners will choose to build extensions instead. No planning permission required for extensions of less than 40 square metres.
- Retrofitting of residential units to meet requirements of energy efficiency rating. The housing stock of 900,000 units built before 1991 would not even register on the rating scale (FÁS, 2008).

In a European context, Ireland lags well behind other countries in terms of the importance of RMI to the total residential market. EuroConstruct (2007) analysed data for 19 European countries which showed that on average, renovation/RMI accounts for 48% of total residential market investment. The corresponding figure for Ireland is was 22% in 2008. The conclusion to be drawn from these figures is that as the Irish housing stock ages, an increasing proportion of expenditure, and thus employment, will relate to RMI as opposed to new housebuilding, but this particular pillar of RMI is still small within the overall residential investment figure. While the decline in new building (houses and apartments) could be offset to some extent by an increase in this area, it will not absorb the full over-capacity in the new build market.

Analysis

This paper's findings suggest that the overall level of construction employment is now contracting in conjunction with the decline in housing output. As housing activity decreases, the question a year ago was whether one of the other sub-sectors of the construction industry can absorb the excess capacity in the housebuilding labour market. FÁS had anticipated that other pillars of construction such as RMI, Civil Engineering and Commercial & Industrial Developments would experience positive job creation by 15,000, 13,000 and 18,000 jobs respectively (FÁS, 2008). However, this data is in the process of being revised and should be completed towards the end 2009.

In the short term, it is unlikely that a significant level of uptake will be achieved in some sub-sectors. This is because there is a slowdown in the Commercial sector and thus an under-capacity of labour is not considered likely even in the medium term. Demand for public buildings, social housing and infrastructure is usually considered more recession-resilient; however, given the inter-reliance between public and private funding for such projects, output is likely to be lower than forecast in the short to medium term.

Ireland has the second lowest figure of RMI as a proportion of residential output in the 19 Euroconstruct countries. There should be a concentrated shift towards looking after the old existing housing stock as has been the experience in Europe. It should be highlighted that it is not only old existing housing stock which may require RMI but also newer housing stock (up to five years old).

Given the upside potential in the market compared to our European colleagues and the ongoing affordability issue which will influence people's decision to upgrade their homes, it is likely that RMI will increase as a proportion of the overall residential market in the medium term at least. As all property moves in cycles, the likelihood is that the current downturn will last for a couple of years, followed by a period of low growth. We may never see a return to the activity levels of 2000-2006. Some commentators suggest that, regardless of the current situation, there is underlying demand for new housing units. This is borne out by the fact that the EU as a whole has 482 housing units per 1000, versus 417 per 1,000 in Ireland, despite increasing our housing stock by more than 50% in a little over a decade. In terms of demographic trends, the population is expected to increase by 20% from 2006 to 2015 (Stafford, 2008).

Recommendations

Based on the above findings and analysis, the following recommendations are made:

Third-level institutes of technology ("IOT"s) and training providers will have to ensure continued supply of highly qualified entrants. However this is against a backdrop of a decline in new apprentices due to the new housing sub-sector slump. There may be a consequential capacity reduction by the IOT sector and relevant training authorities. These entities should be mindful of the long term skill requirements of the economy. The displacement of labour and its implications for human capital will have to be considered. Programmes needed to achieve long term objectives in the education area should not be shrunk or sacrificed. The fact that a large element of government spending on education is categorised as current does not mean that it doesn't play a critical role in developing the productive potential of the economy.

Investigate ways of increasing RMI investment, e.g. change regulations to allow for an increase in the size of extensions without the need for planning permission. The upgrading and improvement of older housing stock should be allowable against taxation. It would have the effect of stimulating activity in this particular pillar of the industry.

The performance of the economy should be guided by the longer term. This perspective applies particularly to policy-makers who must be focused on this long term horizon. In terms of the National Development Plan, it is essential that the problem of deteriorating public finances is not addressed, as in the past, by deferring or postponing key infrastructure projects. Nothing must interfere with improving the capital stock that will boost productivity and, therefore, overall welfare for current and future generations. The construction infrastructure bond proposal which in essence would mean Irish pension funds investing about €6 billion in a range of State building projects should be strongly considered.

The statistical authorities should improve the methodology in the classification of people into different sectors of the industry. This would enable policy-makers to gain a better insight into the structure of the industry and engage in capacity planning. In this context, FÁS has proposed a feasibility study to examine future labour trends in the industry, specifically with the aim of identifying appropriate skills sets

CONCLUSION

The recent housing boom peaked in 2006 when 90,000 new housing units were constructed. This figure, in relation to our population, represented a housing construction rate three times the European average (Fitzgerald, 2007). At its peak, the Irish construction sector directly employed 280-285,000, of which c.180-190,000 are estimated to have been involved in the residential sector. While 2007 and 2008 displayed a significant reduction in housebuilding activity as evidenced by the material reduction in housing completions, the decline in construction employment is now keeping pace. It must be stated that there is now a stronger correlation between decline in construction activity and employment levels given the rapid decline in new housebuilding than there was a year ago. The overriding outcome of this research is that construction employment levels are now emulating the construction housing contraction.

The actual decline in the numbers directly employed in the construction industry has become much more apparent over the last 6-12 months. The lag effect discussed in a previous paper could be explained by the fact that there was a spike in housebuilding activity in fourth quarter of 2007 which temporarily boosted the numbers in employment. The pace of decline in housebuilding accelerated in 2008, and the impact on employment figures was not fully reflected in the available data to the fourth quarter 2008. Data released by the CSO (2009) is now indicating a very strong correlation between construction output and employment levels. Furthermore, employment levels in this paper are largely based on those directly employed in the construction industry as a whole, not just new housebuilding. It has been suggested that the Irish construction sector is now past the worst point of its two year recession and that new commercial building category could be leading the improvement.The statistics presented in this paper require further updating in 12 months to ascertain a true picture of the interrelationship between output and employment in the construction industry.

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REFERENCES

Adrian, T., and Shin, H. S. (2008) Liquidity, Monetary Policy and Financial Cycle, Current Issues in Economics and Finance, Vol. 14.

Central Bank of Ireland (2008) Sectoral Developments in Private-Sector Credit, Dublin. Central Bank of Ireland.

Central Statistics Office (2008) Quarterly National Household Survey, Dublin. Central Statistics Office.

Central Statistics Office (2009) Quarterly National Household Survey, Dublin. Central Statistics Office.

Department of Environment, Heritage and Local Government (2008) Housing Statistics. Dublin, Department of Environment, Heritage and Local Government.

DKM Economic Consultants (2009) Construction Industry Indicators, Issue 16, Dublin. DKM Economic Consultants.

DKM Economic Consultants (2007) Review of the Construction Industry 2006 and Outlook 2007-2009, Dublin. DKM Economic Consultants.

ESRI (2009) Spring Quarterly Economic Commentary 2009. Dublin, ESRI.

Euroconstruct (2007) Construction Market Trends, November, Euroconstruct, Vienna.

FÁS (2008) Future Employment Needs, Dublin, FÁS.

Fitzgerald, G., (2007) Impact of Housing Downturn will be Limited, The Irish Times, June 23rd, 2007.

International Monetary Fund (2008) World Economic Outlook, Housing and the Business Cycle, Chapter 3, Washington, International Monetary Fund.

Ruddock, L., (2008) A Holistic View of the Value of Construction, Research Institute for the Built and Human Environment, University of Salford.

Stafford, P., (2008) Future Trends in Construction, Construction Industry Federation, Dublin.

A CRITIQUE OF INITIAL BUDGET ESTIMATING PRACTICE

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Budget estimating practice has not changed fundamentally since cost planning was introduced some five decades ago. It continues to provide reasonable accuracy and confidence in the budgets for the majority of projects. As new projects seek to do things differently, on a different scale and unlike almost anything that has gone before, the practice of budget estimating based on traditional cost planning principles must be called into question. This paper presents a critical review of current initial budget estimating models and highlights the extent of the uncertainty and the lack of improvement in estimating accuracy over time. The argument that technical explanations (estimating error) or psychological explanations (optimism bias) are the basis for inaccurate cost estimates is rejected. Instead, a more objective and simplified statistical model is outlined – reference class forecasting.

KEYWORDS: initial budget estimates, estimating accuracy, reference class forecasting.

INTRODUCTION

Cost overruns, time delays and contract terminations are likely to be a growing challenge for the construction industry in the current economic climate. Fortunately, we have a generally well-established process of cost planning specifically developed to contain and control design, procurement and construction decisions effectively in project cost terms (Ferry et al, 1999). Around that broad process of cost planning has grown a range of cost estimating techniques, modifications and extensions to the basic cost planning process, and a wealth of the standardised cost data necessary to satisfy the basic principles of cost planning. The basic principles of cost planning were established at the outset, requiring: a frame of reference; a method of checking; and a means of remedial action (RICS, 1969). These principles have generally persevered, and cost planning is now recognised as an important management tool for any significant construction project.

However, projects develop through various stages from inception to completion. Smith and Jaggar (2007, p.81), for example, use the RIBA Plan of Work to illustrate how the application of cost planning changes depending on the particular stage the project has reached, specifically:

- Pre-stage A: Establishing the Need – *establish the budget*.
- Stage A: Options Appraisal – *cost of preferred solution*.
- Stage B: Strategic Briefing – *target cost*.
- Stage C: Outline Proposals – *prepare initial cost plan*.
- Stage D: Detailed Proposals – *firm cost plan*.
- Stage E: Final Proposals – *cost checks, design against cost plan*.
- Stage F: Production Information – *final cost checks of design against cost plan*.

The stages listed here represent but one way of breaking down the pre-construction process, and are not necessarily discrete stages in any particular sense. However, they usefully illustrate how the focus and outcome of cost planning does change over the course of a project. In particular, that the nature of the cost planning process in the early stages (when the specifics of a project are not clearly known) is distinctly different to that of the later stages (when more accuracy and higher fidelity is both required and possible).

Of particular interest to this paper is the very earliest stage. In Plan of Work terms, the Pre-stage A: Establishing a Need. In any terms, however, the focus at that stage of the cost planning process is on the establishment of an initial budget estimate figure. It is at this earliest stage of the project that the specificity of what is to be constructed is at its broadest and most poorly defined, and the accuracy of the cost estimating technique likely to be at its most variable. Ashworth (2008, p.251) presents the usual levels of cost estimating accuracy achieved in practice, across all construction types, as follows:

Table 1: Estimate Classification and Accuracy (from Ashworth, 2008, p.251)

Estimate	**Purpose**	**Accuracy**
Order of magnitude	*Feasibility studies*	25-40%
Factor estimate	*Early stage assessment*	15-25%
Office estimate	*Preliminary budget*	10-15%
Definitive estimate	*Final budget*	5-10%
Final estimate	*Prior to tender*	5%

In other words, at the earliest stage there is the maximum potential discrepancy between the budget figure estimate and the final project cost, and this discrepancy can be between 25 and 40%. What can be confusing about such accuracy predictions is the lack of consistency in what actually is being estimated: is it the lowest tender price, the total construction costs, or the overall project costs. Clearly, the accuracy variations will change depending on how far into the overall project the cost estimate is forecasting, but the earliest stage/maximum potential discrepancy relationship will always tend to hold.

There have been several studies seeking to determine which factors most contribute to such a substantial potential variation in cost, or the accuracy with which such cost variation can be estimated (see for example, Aibinu and Pasco, 2008; and Serpell, 2005). The focus of this paper, however, is not so much on the factors that contribute to problems of accuracy, but rather, critically to review the alternative cost estimating approaches typically employed at the earliest stages of a project: the, so-called, Initial Budget Estimate models in current use. The objective of the review is to determine which cost estimating approach might best be used in the earliest stages of a project, when the intention is to estimate the overall project costs, or Outturn Cost.

Determining the utility of competing budget estimating methods is now critically important, not least because project uncertainties at the earliest stages are unlikely to be mitigated any time soon. Indeed project uncertainties and are most likely actually to increase: economic conditions have become extremely volatile; the complexity of construction is increasing progressively as projects are required to become more innovative in order to satisfy a new order of constraints and expectations from environmental and social perspectives; financing and risk management margins are being tightened, and the relative significance of traditional cost drivers has become almost chaotic and certainly unstable – among various other factors also likely to increase uncertainty.

INITIAL BUDGET ESTIMATE MODELS IN CURRENT USE

It is, generally speaking, the purpose of any budget estimating model to provide as realistic an indication as possible of the final project cost (Outturn Cost), for a given project proposal. Every current form of model begins by generating an initial, best estimate of the final project cost (Base Estimate) for the project as it is conceived at that stage of the project development. The different models then employ different methods to estimate an amount to be added to the Base Estimate to allow for the inevitable uncertainty that is inherent in any estimating process. This amount is then the Uplift which is applied to the Base Estimate. Thus, ideally:

Base Estimate + Uplift = Outturn Cost

The three (3) generic model types most typically being used for budget estimating purposes are:

- Model 1: Deterministic Contingency Allowances
- Model 2: Quantitative Risk Analysis
- Model 3: Optimism Bias

The Base Estimate is determined using one of a variety of preliminary estimating techniques, such as: functional unit pricing (where the cost is calculated on a per bed, per student, or other operational unit basis); area unit costing (where the cost is calculated on a per square metre of gross floor area or other measure of space provision); and/or elemental cost estimating (where consistent building elements such as foundations, frame, roof, etc., are costed individually).

Model 1: Deterministic contingency allowances

This is the traditional approach and variations of this model are used extensively. The level of experience and estimating competence are always important factors in the accuracy of the Base Estimate. They are particularly critical factors in determining the Uplift to apply in adjusting the Base Estimate for uncertainty using a deterministic contingency allowance. In this model the Uplift is determined through expert judgement and applied as a deterministic contingency added to the deterministic Base Estimate. Three (3) major types of contingency allowance are normally considered:

- estimating inaccuracy – an allowance is added for the potential inaccuracy of the Base Estimate due to factors such as the lack of precedents and relevant cost data, the experience of the estimator, etc. Indications from a recent survey (Aibinu and Pasco, 2008) suggest that a contingency allowance of about 20% of the Base Estimate should be applied to take account of potential estimating inaccuracy in general.
- project uncertainty – an allowance is added for the inevitable adjustments that occur as a project develops and becomes more resolved. At an early stage the Base Estimate may be generated on little more than a functional specification and a range of assumptions. Those assumptions are tested as specific scope, design and construction decisions are made. In line with the figures generated by Ashworth (2008, p.251), in

addition to the allowance for estimating inaccuracy, project uncertainty might require a further contingency allowance of up to 20% (maximum range of 40%, less 20% for estimating inaccuracy) of the Base Estimate.

- project complexity – the contingency allowances for estimating inaccuracy and project uncertainty presented above are factors for all projects. The inherent complexity of a project has an aggravating effect on these normal factors. For particularly large, complex, innovative and high-profile projects a further contingency allowance may be appropriate. Given the other Uplift components are taken as averages, and complex projects tend to be at the top-end of potential cost overruns, an additional contingency for known project complexity of up to 35% might be reasonable. In very broad terms, that figure is determined from other research reported by The Allen Consulting Group (2007), The Tax Payers Alliance (2007), and Flyvbjerg et al (2002).

It is apparent from the above that at the preliminary stages of a project, an overall contingency allowance of perhaps 75% (20% + 20% + 35%) of the Base Estimate might reasonably be applied. As the scope, design and construction details of a project develop, the level of confidence in the estimating accuracy and project certainty will improve, and the impact of project complexity will be mitigated.

This method has the benefit of being relatively simple to apply and having a broad base of application. However, it does depend directly on the level of experience in the cost estimating technique and competency in risk analysis and management procedures. In any event it does remain a highly subjective approach, susceptible to inconsistent or biased judgement on the level of contingency to apply. The bias can be reduced by having multiple experts or an experienced team providing varied and independent opinion. It is problematic where a high level of confidence is required of the Initial Budget Estimate, as there is no indication on the degree of variation that might occur around the averages used. Thus, ultimately it is a deterministic (single figure) approach and, given the vagaries that attend the determination of an appropriate contingency amount, significantly higher levels of Uplift may be necessary where higher levels of certainty are required.

Model 2: Quantitative risk analysis

This model is used extensively in many government agencies and other large clients with consistent and ongoing construction needs. Its use has grown significantly in recent years, especially on particularly large-scale and/or complex projects.

Sometimes it is possible to anticipate the circumstances that give rise to variability in outcome deterministically, but most often only a range of possible outcomes can be anticipated. In those circumstances the Base Estimate needs to incorporate an assessment of the risk and the confidence that attends such a forecast. The most significant benefit of making an explicit assessment of risk and confidence is that effective sensitivity analysis and planning control are then possible. This can further mitigate the inevitable uncertainty that attends a budget forecast.

The most common form of quantitative risk analysis employs a three-point estimating practice based on Monte Carlo simulation (MoD, 2007). In that case, rather than a single cost estimate for each element of the overall Base Estimate, each element estimate comprises a range of possible costs defined by a Minimum and a Maximum, with the Most Likely element estimate located somewhere between those two extremes. The Minimum is an optimistic estimate of what might be the outcome if everything goes as well as could be hoped. The Maximum is a pessimistic estimate that assumes what can go wrong, will go wrong (within reason). The Most-Likely estimate is the single figure estimate otherwise included in a deterministic estimating approach.

The output of this method provides a cumulative probability (s-curve) distribution of the potential Outturn Costs. In most cases the distribution can be analysed further to determine the key factors ‘driving’ the distribution (and variability). The actual Initial Budget Estimate is then selected from the probability distribution depending on the level of confidence expected/required at that stage of the project and the risk aversion of the budgeting authority. Typically:

- 10% Confidence represents a lean estimate, achieved only if most of the likely risks fail to materialise
- 50% Confidence represents the best estimate given that some risks will materialise and some will not, and
- 90% Confidence represents a value that could be reached if several unlikely risks all materialise together.

This method has the benefit of providing a robust analysis and planning tool for risk management. It provides an explicit measure of confidence in the Initial Budget Estimate and indicates the general level of uncertainty applicable to that figure. More so even than for Model 1, it is critical that the quantitative risk analysis method be developed by a team of individuals and stakeholders, each bringing a slightly different perspective and expertise to the three-point estimating process. In addition, the technique does demand a specialist competence, training and experience to be applied effectively – as with all statistical techniques, poor quality input data leads to poor quality output. It is also important that the method be employed as part of a broader framework of project risk management. There is the danger of biases and correlations going unnoticed in this technique, as it is a relatively ‘black-box’ process. However, these concerns are best allayed through correct application of the technique and a process of effective sensitivity testing.

Model 3: Optimism bias

Optimism Bias is a concept used to explain the tendency of people to be over-optimistic about the outcome of planned actions (Flyvbjerg et al, 2002). This includes over-estimating the likelihood of positive events and under-estimating the likelihood of negative events. Optimism bias arises in relation to estimates of costs and benefits and duration of tasks. It must be accounted for explicitly in appraisals, if they are to be realistic. Optimism bias typically results in cost overruns, benefit shortfalls and project delays.

The UK government explicitly acknowledges that optimism bias is a problem in planning and budgeting (HM Treasury, 2003), but different departments have differing interpretations on the level of optimism bias to apply. For example, DEFRA (Dept of Environment Food and Regional Affairs) encourage the use a 50% optimism bias; Lancaster City Council use 60% initially; and Northern Ireland Building Procurement recommend an allowance of 35-40%.

The UK Treasury itself has set optimum bias uplifts for projects as a whole and broken down for a variety of project characteristics. For smaller, less complex projects the optimism bias can be used directly as a general risk adjustment (as a direct alternative to the deterministic contingency allowances of Model 1). In all other situations the calculated optimism bias is used as a 'top-down' assessment of risk, and compared directly with a 'bottom-up' calculation of risk from one of the quantitative risk analysis techniques of Model 2.

Data collection from past experiences is an essential part of the optimism bias calculation process. HM Treasury (2003) suggests budgetary adjustments be based on experiential data from past projects and adjusted as required for the unique characteristics of the target project.

For example, Figure 1 illustrates how an optimism bias adjustment to the Base Estimate is constructed and compared with an s-curve derived using some form of quantitative risk analysis model. Ideally, the Initial Budget Estimate so determined should be in the immediate vicinity of the 50 percentile confidence figure indicated by the s-curve. A traffic light marking system has been developed to aid this comparison. If the comparison result does not lie within the "Green" zone of the traffic light, then all calculations and assumptions should be reviewed.

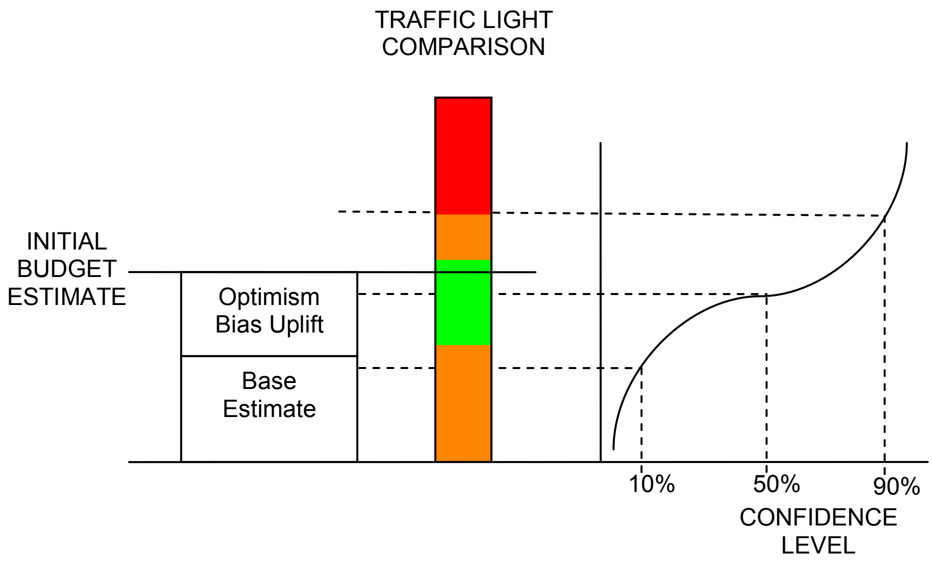

Figure 1: An Optimism Bias Uplifted Base Estimate Comparison (based on MoD, 2008)

The advantages of this method are that it is relatively simple to understand and provides a consistent basis for comparison and benchmarking. However, the quality of the result directly reflects the accuracy of the tables of figures established for optimism bias. As indicated above, recommended values for optimism bias do vary and they will, in any case, require a large and robust data set to get even approximately right. As with all models, the final application is improved to the extent that empiricism and expertise are applied to the mitigating factors. The danger is always that such apparently 'simple' models become more tempting for inexperienced users to apply. Guidelines are therefore particularly important with the optimism bias approach.

Discussion of the current models

The basic tenet of an effective cost planning process is to give primacy to the specific project under consideration. The more that is known about the current project (specific features and circumstances), then the more accurate the cost estimate is likely to be and the more effective the cost planning process becomes as a consequence. What this has tended to do is to privilege traditional methods, where there is a familiarity with the process and its various tolerances and where extensive data sets already exist.

But what is clear from the model descriptions provided above, is that the degree of variation around the potential contingency allowance, cost uncertainty and optimism bias figures used is substantial. If the Uplift amount might vary from 25%-75% for innovative projects under Model 1, or 35%-60% under Model 3, then the growing economic uncertainty is just further cause for concern. According to the Tax Payers Alliance (2007) – a UK lobby group – the total net cost of overruns in 305 public sector capital projects for the preceding 2 years was approximately US$35 billion.

Despite the advent of improved estimating techniques and models, however, many studies conclude that estimating accuracy has improved only slightly, if at all (Aibinu and Pasco, 2008; Cheung et al, 2008; Flyvbjerg, 2007a). Flyvbjerg (2007a) goes on to reject the arguments that claim technical explanations (estimating error) or psychological explanations (optimism bias) are the basis for inaccurate cost estimates. Instead, Flyvbjerg shows that strategic misrepresentation on political and economic grounds (such as knowingly underestimating costs in order to gain national funding) is the stronger driver of poor estimating performance. What this suggests is that the fundamental premise of budget estimating as currently applied, where Uplift is determined through informed and specific insight into the particular project and its immediate context, might itself represent the real barrier to improved cost estimating performance.

Could there be a tyranny of insight in operation here? It is unlikely (if not implausible) that the real culprit here is the application of specific project knowledge. More reasonably, if the genuine driver of poor budget estimate performance is a political-economic one, the real culprit may be the attachment to the project and its funding success that typically accompanies a more intimate understanding of the project. What may be required is a budget estimating model that displaces the need for insight and specific project knowledge with objectivity and distance.

A FUNDAMENTALLY DIFFERENT INITIAL BUDGET ESTIMATE MODEL FOR MAJOR PROJECTS

The clear distinction of this method is the way in which it provides an outside view on a specific project (how it sits within a context of a similar set of previous projects), where other methods look at a project from the inside (taking account of the specifics of the project, be that from a top-down or a bottom-up perspective). The advantage of this outside view is that all of the subjective elements associated with other methods of calculating an appropriate Uplift are dispelled. Being a statistical approach, a significant number of similar previous projects have to have been analysed in terms of their cost overruns, which may be particularly problematic for projects in smaller construction markets. It is also the case that as the project progresses, typically budget uncertainty is reduced. In order to arrive at a valid Total Budget Estimate at a later stage than the preliminary stage, Uplifts should normally be adjusted progressively downwards.

According to Flyvbjerg (2007b), “The Dutch econometrician Henri Theil (1961) liked to study the accuracy of forecasts. Once he did a study of accuracy in Dutch weather forecasts. Much to his surprise he found that if the weather forecasting service, instead of doing its forecasts, had simply played an automated recording stating every day that "the weather tomorrow will be like the weather today," then the accuracy of predicted weather would have been higher than the accuracy actually achieved with the weather forecasts."

Extending this anecdote, Flyvbjerg et al have proposed a fundamentally different initial budget estimating model from those currently used. Effectively, the model takes the position that the Uplift required to be applied to a new project will be like the Uplift that characterises recent projects of a related type. The model is called Reference Class Forecasting.

Model 4: Reference class forecasting

This model is a recent development in Europe, and was recently endorsed by the American Planning Association. Reference class forecasting takes a statistical view of any given project, based on a comparison of the Initial Budget Estimate and the final Outturn Costs derived from a set of related previous projects. It does not try to predict specific uncertainties, but rather simply places a given project in the statistical distribution generated from the reference set. Any approach that calls on human judgement and intervention in the estimating process is going to be biased in some direction and to some extent. Reference class forecasting, by making the assessment objective and statistical in nature, is a method for removing the bias from an Initial Budget Estimate – or at least the Uplift component of same.

Reference class forecasting requires the following three steps in order to determine the most appropriate Uplift to apply to a given Base Estimate:

- a relevant set of reference projects are identified from past data sources. The set must be broad enough to be statistically meaningful but narrow enough to be truly comparable with the particular project under consideration.
- a probability distribution for the selected reference set is generated. This requires access to credible, empirical data for a sufficient number of projects within the reference set to make statistically meaningful conclusions.
- comparing the specific project with the reference set distribution, in order to establish the most likely Uplift to apply to the particular project.

Undoubtedly simple statistics, based on historical precedent, will fail to predict the extreme outcomes that lie outside the original set of precedents. However, for the vast majority of other cases the statistical approach will produce more accurate results because the model avoids having to allow separately for psychological and systemic biases such as optimism bias.

Figure 2 illustrates how a reference class forecast is used to uplift a Base Estimate. The reference class forecast is presented in the form of an s-curve that represents the actual cost overruns as a percentage of the original Base Estimate, determined from a reference set of past projects. The Initial Budget Estimate figure is then determined by selecting the required level of confidence (percentage of projects within a given cost overrun) and reading off the required Uplift from the actual cost overrun axis. This Uplift is then applied to the current Base Estimate.

For example, in 2004 the first instance of reference class forecasting was used by Ove Arup to demonstrate that an original budget estimate of £320 million for a proposed Edinburgh Tram Line project was likely to be conservative. Their forecast at the 50th percentile was £357 million (Flyvbjerg, 2006).

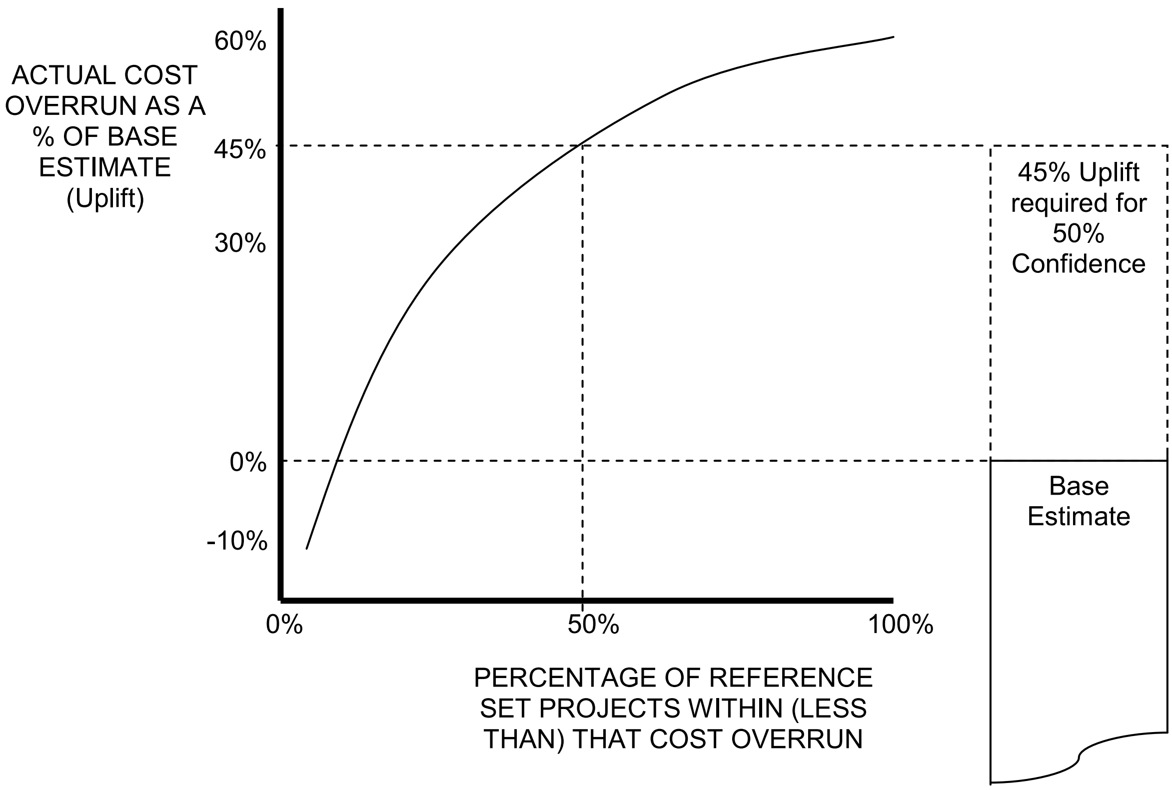

Figure 2: A Reference Class Forecast

CONCLUSIONS

A critical review of current initial budget estimating models has highlighted the extent of the uncertainty and the lack of improvement in estimating accuracy over time. There seems no end to the growing number and substantial financial impact of project cost overruns. At a time when uncertainty is increasing, other models must be considered. The argument that technical explanations (estimating error) or psychological explanations (optimism bias) are the basis for inaccurate cost estimates has been rejected. Instead, a more objective and simplified statistical model has been outlined – reference class forecasting.

The clear distinction of reference class forecasting is the way in which it provides an outside view on a specific project, where other methods look at a project from the inside. The advantage of this outside view is that all of the subjective elements associated with other methods of calculating an appropriate Uplift are dispelled.

The limitations of this approach, being a statistical approach, are that a significant number of similar previous projects have to have been analysed in terms of their cost overruns. This may be particularly problematic for smaller construction market contexts. It is also the case that the approach only works when the bias that causes the inaccuracy is not deliberate. In that circumstance the potential for reference class forecasting is low.

REFERENCES

Aibinu, A. A. and Pasco, T. (2008) The accuracy of pre-tender building cost estimates in Australia, *Construction Management and Economics*, 26(12), 1257-1269.

Ashworth, A. (2008) *Pre-Contract Studies: Development Economics, Tendering and Estimating* (3rd Edition). Oxford: Blackwell Publishing.

Cheung, F. K. T., Wong, M. W. L. and Skitmore, M. (2008) A study of clients' and estimators' tolerance towards estimating errors, *Construction Management and Economics*, 26(4), 349-362.

Ferry, D. J., Brandon, P. S., and Ferry, J. D. (1999) *Cost Planning of Buildings* (7th Edition). Oxford: Blackwell Science.

Flyvbjerg, B. (2006) From nobel prize to project management: getting risks right, *Project Management Journal*, 37(3), 5-15.

Flyvbjerg, B. (2007a) Policy and planning for large-infrastructure projects: problems, causes, cures, *Environment and Planning B: Planning and Design*, 34, 578-597.

Flyvbjerg, B. (2007b) *Truth and Lies About Megaprojects: Inaugural Speech*, available at: http://flyvbjerg.plan.aau.dk/Publications2007/InauguralTUD21PRINT72dpi.pdf

Flyvbjerg, B., Holm, M. S. and Buhl, S. (2002) Underestimating costs in public works projects: error or lie?, *Journal of the American Planning Association*, 68(3), 279-295.

HM Treasury (2003) *The Green Book: Appraisal and Evaluation in Central Government*, London: TSO.

MoD (2007) *Three-Point Estimates – Overview*, available at:
http://www.aof.mod.uk/aofcontent/tactical/risk/downloads/3pepracgude.pdf

MoD (2008) *Policy, Information and Guidance on the Risk Management Aspects of UK MOD Defence Acquisition: Version 4.0.2* - November 2008, available at:
http://www.aof.mod.uk/aofcontent/tactical/risk/content/optimism.htm

RICS (1969) *Building Cost Information Service (BCIS) Standard Form of Cost Analysis: Principles, Instructions and Definitions*. London: Royal Institution of Chartered Surveyors.

Serpell, A. F. (2005) Improving conceptual cost estimating performance. *AACE International Transactions*, EST.13, 1-6.

Smith, J. And Jaggar, D. (2007) *Building Cost Planning for the Design Team*. Oxford: Elsevier.

The Allen Consulting Group (2007) *Performance of PPPs and Traditional Procurement in Australia: Final Report*. Available at: http://www.infrastructure.org.au/Content/PPP.aspx

The Tax Payers Alliance (2007) *Beyond the Dome: Government Projects £23 Billion Over Budget*, available at: http://tpa.typepad.com/bettergovernment/files/beyond_the_dome.pdf

CRISIS OR CHALLENGE? THOUGHTS ABOUT INTERNATIONAL CONSTRUCTION-INDUSTRY RECOVERY STRATEGIES

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Within only a few months the international economy has faced a truly slow-down, and in certain areas even a kind of break-down. Looking backwards about ca. two years ago, hardly anyone would have expected a so sudden impact on the (fraghile?) world economy as it is in these days. However, only facing it from the negative point will not just help the economy, and only facing it from the positive point will not help the economy, too. But what should one think of all these developments now? This discussion-paper tries to discuss some aspects of specific the construction industry, being part of this global (down?)turn, just to help in finding solutions for a way to recovery. Not as 'the' solution, but merely as 'a thought' on what could be learnt from the near past, and to serve as a possible pro-active 'outlook' to a (new) bright future of construction industry.

KEYWORDS: challenge, construction, crisis, culture, thoughts.

INTRODUCTION

During the writing of this discussion-paper in the spring of 2009, the global crisis still exists on a broad scale: On the one hand e.g. construction-companies going bankrupt, banks taken over by governments, merging of companies left, banks unwilling or unable to lent capital to the markets, etc.; and on the other hand growing web-based businesses because of the globalizing markets and increase of broadband-connections, decrease of interest rates towards historical low levels, etc.
So, in fact during this crisis, there are negative impacts as well as positive chances on the market and the businesses therein. And because the construction industry is quite strongly involved within the daily (national/international) markets, this industry also has the negative impacts but also the positive chances.
This discussion-paper focuses on a broad discussion of some of the threats and opportunities, caused by the present crisis; not as a negative 'prophecy', but to serve as a possible pro-active 'outlook' to a (new) bright future of construction industry.

CRISIS IN CONSTRUCTION INDUSTRY: SOME EXAMPLES

Crisis-situations in the construction-industry are not new; also in earlier days they occurred, and were related to several origins. Some of them are e.g.:

a. Increasing interest-rates;

Think e.g. on the 1980's were interest-rates increased towards 13-15% etc.). These crisis-situation was merely influencing the real-estate market, being driven by the hesitating consumers; private house-owners were nearly unable to attract affordable mortgages for their houses, and the industry was confronted with high capital costs too. Governments over interefered by anti-cyclic market mechanisms, such as e.g. subsidizing, guarantees, etc. [Tempelmans-Plat, 1984]. However, because of e.g. the European regulations nowadays, such intereference-possibilities are much more restricted.

b. Oversupply of projects:

As being an example of the so called 'pig's cycle', often existing in -developing- markets [Tijhuis, 2001], this situations generally occur after an over-heating of a market. Recent examples are e.g. the collapse after the market-boom in the former East Germany area in the early 1990's, after the break-down of the Berlin Wall in 1989 [Der Spiegel, 1994; 1995].

c. Fraud-cases:

As e.g. discovered in the early 2000's, the Dutch construction industry had been influenced for years by collusion-practices in public infrastructure projects [Vos et al, 2002]. Several tenders had been influenced, so the Dutch public clients had paid far too high prices for their tendered projects. This fraud-case severely hit the construction industry, especially the infrastructure-related branches.

d. Increasing conflicts between parties involved:

In the mid-1990's, the British construction industry got aware of it's growing level of conflict/disputes, which increasingly paralysed the whole construction industry: Clients and contractors became the 'ideal playing field' of lawyers and sollicitors, often making construction projects to 'battle-fields'[Latham, 1994; Egan, 1998]. There was a growing level of conflicts and distrust between contractors and clients, often leadiong towards high construction prices, claims, etc. Maybe William Shakespeare did not realize himself this, but it may be a reason why he wrote the statement *"The first thing we do, let's kill all the lawyers"* [Cairncross, 1964], focusing at the situation that the lawyers often influence the business-atmosphere negatively, despite their often positive influence for getting the contracts finished, etc.

WHAT MAKES NOWADAYS CRISIS (2007-?) SO SPECIAL?

When overlooking at the above ementioned examples of construction-crises, they have at least two important distinguishing backgrounds, based on the -behavioral- way of influencing the construction industry:

Example a (increasing interest-rates):

- *They all were specifically related to a specific behaviour of the clients themselves.*

Example b, c & d (Oversupply, Fraud-cases & Increasing conflicts):

- *They all were specifically related to a specific behaviour of the construction industry itself.*

When looking to nowadays cirsis, it seems to have similarities with the background of example a, which has to do with the (hesitating) *behaviour of the clients towards construction industry*.
However, compared to earlier days, this crisis nowadays really seems to have an industry-wide and global impact, escpecially because of the global interference via the increasing ‘digital society’, etc. In figure 1 this situation is represented schematically.

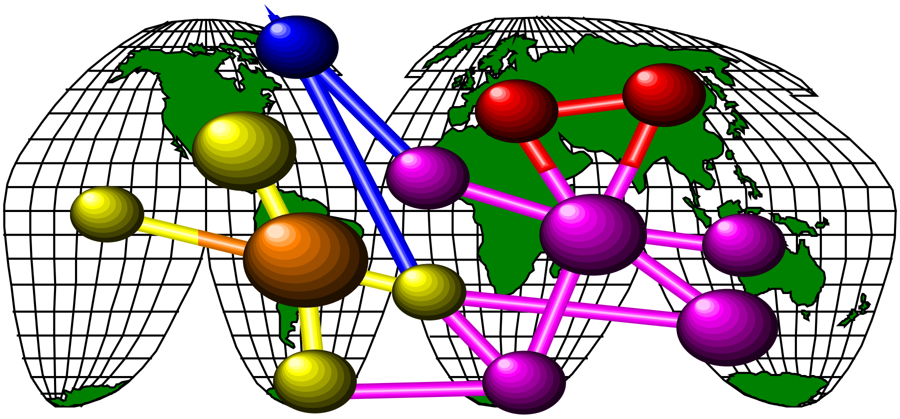

Figure 1: Globalizing influences due to the globalizing ‘digital society’.

Remarks:
In earlier days, crisis were merely on a regional scale, although e.g. the large depression of ca. 1933 really was on a global scale. However, interesting aspect of nowadays crisis still is, that the actual interest-rates are nearly as low as possible, and even on an historic low level. But because of the obviously still existing instability of the financial system, this moment in time really seems to be a ‘turning-point’: In fact there is a call for a total restructuring of business-models and governmental policies in this field.

So, apart from other influences, the client really is in the centre of the business, playing the most important role. Re-focusing on the client may therefore result in a reduction of the present crisis’s influences on construction industry.
And this may result into a strategy for the construction industry to put a stronger focus on the background of the examples b, c & d, so e.g. *Changing the behaviour of the industry towards the client.* This may even be a business-cultural change.

DISCUSSION ON RECOVERY STRATEGIES

Based on the above descriptions, the change of construction industry's behaviour may really be a first starting point to a recovery from the nowadays crisis. Especially 'putting the customer first' may become a real 'discovery' for the customer themselves, finding the construction industry paying serious attention again to them.

However, on the other hand, several of todays bad behaviour between construction industry and clients is also rooted into the fact that this industry has a quite low entrance-barrier for newcomers, being also a discutable 'playing field' of non-professional parties in this field. Especially during the recent periods of booming construction-production, the onstruction industry obviously has attracted quite a lot of less-professional and even non-professional parties, just showing a hit-and-run approach and going for the 'quick money'. Therefore, focus on clients cannot without a serious (re)focus on professionalism, although it might also being necessary to optimize the level of professionalism itself, regarding attention to the client's issues, etc. A (re)focus on client's and business-cultures may indeed be a serious driver to be 'part of the deal'.

Nevertheless, although one might be seriously focusing on the clients, without a project or a job there is still no income for a business. So how to survive then? As during every crisis, several weaker parties will be going bankrupt. However, this may somewhat enlarge the (shrinking?) existing market for the parties left, so dealing with that shift of the markets, often also means a shift of power: *Who will become the new market-leaders, etc.?* So not only threats, but also opportunities!

An interesting parallel can be found with e.g. the Google™-searchmodel business-case : In the late 1990's, even before the official founding of the company, very few parties saw the values of this developed patented searchmodel, obviously because the existing searchmodels from e.g. Netscape™, Alta Vista™, etc. were still functioning and serving users worldwide. There was obviously no really 'drive' for serving the clients better, although clients were also complaining too about the existing (incomplete) searchmodels. But industry did not really change then...Until Google™ started and 'restructured' the way of doing business, resulting into a complete awakening of it's competitors in industry. An interesting statement or advise out of those early days is e.g. [Vise & Malseed, 2006]: *'Having a healthy disregard for the impossible'*
Maybe still one of a good lesson for the construction industry during this crisis?

CONCLUSIONS & RECOMMENDATIONS

As a summary of the analyses and discussions in the previous parts of this discussion-paper, the following conclusions/recommendations are presented:

1. *Although a recovery of the crisis is obviously no stand-alone scenario for the construction industry, a stronger (re)focus on the client and the involving may improve and speed-up this foreseen recovery.*

2. *Within crisis-times in general, several (weaker) businesses go bankrupt. However, this may strengthen and improve the healthiness of the existing parties left.*

Nevertheless, this often means also a shift of power towards (new) market leaders, with all the opportunities (and threats) included.

3. *A (re)focus on professionalism, including improvement of the accompanying business-culture, strengthens the need for parties to (re)define their market strategies: Merely focusing on a longer lasting mid to long-term approach, instead of focusing on just a short-term (hit and run) approach, although this last approach may still be profitable, but less lasting.*

REFERENCES

Cairncross A.S. (1964) "King Henry VI, Act IV, Scene II"; *William Shakespeare*; Edited by A.S.Cairncross; 3rd Edition; pp.111; Methuen and Co. Ltd.; London; Harvard University Press.

Egan J. (1998) "Rethinking Construction: The Report of the Construction Industry Task Force"; *Commission-Report*; HMSO; London.

Latham M. (1994) "Constructing the Team – Joint Review of Procurement and Practitioners Contractual Arrangements in the United Kingdom Construction Industry"; *Commission-Report*; HMSO; London.

Spiegel Der (1994) Die Gier frisst das Hirn; Article in 'Der Spiegel'; *journal*; nr.15,1994.

Spiegel Der (1995) Wie von selbst – Der Spekulationsrausch in Berlin ist Vorbei – Viele Buroturme stehen leer, dem Markt droht der Kollaps; Article in 'Der Spiegel'; *journal*; nr.23, 1995.

Tempelmans-Plat H. (1984) Een Bedrijfseconomische Analyse van Bouwen en Wonen – De woondienstenvoorziening beschouwd vanuit een elementenmatrix; *Ph.D-thesis*; Eindhoven University of Technology; Van Gorcum Publishers, Assen.

Tijhuis, W. (2001). Controlling failure-costs in emerging markets - Improving processes without a hit-and-run approach. In Liu, A.M.M., Fellows, R. & Drew, D. (Ed.), *Proceedings of the international conference on project cost management.* (pp. 182-188). Beijing.

Vise D.A. & M.Malseed (2006) The Google Story - Inside the Hottest Business, Media and Technology of Our Time; *book*; August 2006; Pan MacMillan Publishers, London.

Vos M. et al (2002) De bouw uit de Schaduw – Parlementaire enquête Bouwnijverheid – Eindrapport; *Final Investigation Report*; SdU-Uitgevers; Den Haag.

RESULTS OF THE SURVEY ON IMPLEMENTATION OF MARKET STRATEGY IN BUSINESS ACTIVITIES IN CROATIAN CONSTRUCTION COMPANIES

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A suitable and clearly defined business strategy which is tailored to the demands of the market and clients' wishes can lead the company to better business results. Market strategy as a part of complete business strategy can accelerate the success of any company. Ever since Croatia became independent, construction industry has played an important part in her economic development. Are Croatian construction companies aware of that, do they have a business strategy, do they maintain market activities, and what is their opinion about all that? The survey research on the implementation of market strategies in Croatian construction companies was carried out and its results will be presented in this paper.

KEYWORDS: marketing strategy, construction industry.

INTRODUCTION

Ever since Croatia became independent, construction industry has played an important part in her economic development. The profit it made has been a considerable portion of the total income, and it is constantly increasing year after year. The number of entrepreneurs in construction industry has also grown, as well as the number of people employed in the construction sector. The end of the war was the beginning of reconstruction of many objects, Public Incentive Apartment Housing Construction (POS) started, numerable infrastructure object investments began, all of which caused an increase in construction activities.

The crisis which started in the USA at the beginning of 2008 and rapidly spread on to Europe triggered the first slowdown of the increase of activities in the construction sector in the last seven years. There has been stagnation in the property market, and business banks increased interest on housing loans. All that puts new challenges before construction enterprises, challenges that may even become the question of survival.

However, a suitable and clearly defined business strategy which is tailored to the demands of the market and clients' wishes can lead the enterprise to better business results. Market strategy as a part of complete business strategy can accelerate the success of any company.

Are Croatian enterprises aware of that, do they have a business strategy, do they maintain market activities, and what is their opinion about all that? The results of the survey carried out in a number of Croatian construction enterprises have provided answers to these questions.

SURVEY RESEARCH AND CAUSE DETERMINATION METHODOLOGY

The survey research on the implementation of market strategies in Croatian construction companies was carried out in the way that the questionnaires were sent to 100 leading Croatian construction companies. The questionnaire consists of three parts: the first part comprises 15 general questions about the company and its marketing, the second is 10 statements that the eximenees gave their opinions on, and the third one is the SWAT analysis.

The questionnaire was completed and returned by 30 construction companies, which are grouped by their size. The criterion for the size of a company is the number of employees, therefore a small company has 0 - 50 employees, a medium-sized one has 51 - 250, while the large company has 251 or more people employed. (Table 1).

Table 1: Size of Croatian construction companies in a sample

Size of company	Number of companies in a sample	%	Number of construction companies in Croatia in 2007	%
Small	11	36.67	8,845	97.60
Medium-sized	11	36.67	177	1.95
Large	8	26.67	41	0.45
Total	30	100.00	9,063	100.00

Source: Financial Agency, The author's research

In 2007 there were 9,063 construction companies registered in Croatia. According to their size 41 were categorized as large, 177 as medium-sized, and the rest of them, 8,845 were small companies. Almost half of 8,845 small enterprises have no employees, and 35% have 1 - 9 employees. So it is obvious that the data and opinions of these companies are relatively insignificant, as they do not have the interest nor can afford to engage experts in marketing or establish a marketing sector.

Large enterprises (only 45% of the total number) have shown their interest in defining marketing strategy and market development, and their experiences are much more important for this survey.

It is essential to point out that the sample does not correspond to the structure of the basic group but is only an indicator of the situation in the construction industry in Croatia.

SURVEY LIMITATIONS

Taking into consideration the earlier stated structure of construction companies in Croatia according to their size, one of the basic limitations of this survey is a wide range of their activities. Majoritiy of construction companies are engaged in both building construction and civil engineering construction, as well as in construction design and consulting.

Also, a different angle should be taken when talking about the companies whose clients mostly come from the public sector; or at least a difference should be made between the companies with clients from a private and business sector.

There are also narrowly-specialized companies that have no competition in Croatia, and they depend on their employees' knowledge and expertise and the quality of the jobs done. The question is whether they need marketing at all, and how much they know about the concept of marketing business.

SURVEY RESULTS

1. Do you have a defined and a written-down mission of the company and the vision of its development?

13 out of 30 companies that were analysed possess a clearly defined and written-down mission. Among these 13 construction companies there are 3 small ones, 5 medium-sized, and 5 large companies. Detailed results are presented in Table 2 in the Appendix.

2. Is there a marketing department within the organization structure of the company?

Only 10 out of the 30 companies that completed the questionnaire have the marketing department within their organization structure, that is 33.33%. The percentage relates to 5 large companies, 2 medium-sized, and 3 small ones. Just one company which does not have the marketing department uses outsourcing. (See Table 3 in the Appendix)

It has already been said that it is not a representative sample, but it still provides elements for conclusion which is, although only indicative, still important.

In large construction companies the marketing department existed for a longer period of time, in one of the companies it was formed as far back as 1992. In two of the medium-sized enterprises which have the marketing department it was established in 1995 and 2008, while small companies formed these departments relatively late (in 2007 or 2008).

The number of people employed in the marketing departments of these companies ranges from 1 to 5, with the exception of two of the large companies which employ as many as 47 and 43 people respectively. However, these employees of marketing departments also do the work of bidding and contracting, designing and calculation, while the majority of them are in charge of a sale. Marketing department employees mostly have high qualification, a smaller number of them has higher or medium-level qualification. There is only one master of sciences working in the marketing department.

3. What are the functions performed by the marketing department employees?

The most frequent work done by the marketing department employees is market research and promotion activities, in as many as 9 out of 10 companies. It is followed by price analysis and sale, the smallest number of them is engaged in new product development. One large company stated in "other" that those employed in the marketing department also work in bidding and contracting, planning and plan supervision and execution analysis, as shown in Table 4 in the Appendix.

4. Do you plan to increase the number of employees in the marketing department?

Only one small enterprise gave a positive answer to the question whether they intend to increase the number of people employed in the marketing department, and they plan to do it this year, 2009, while all the other companies do not intend to increase the number of empoyees in the marketing department. One small enterprise stated that their plan was to establish the marketing department in 2009, and in that way to increase the total number of employees.

5. Do you maintain market analysis?

36.67% of the exeminees maintain market analysis, that is 11 companies. The structure according to their size is 4 small companies, 3 medium-sized, and 4 large ones. (See Table 5 in the Appendix)

Croatian construction companies which maintain market analysis stated various topics they used as the basis of market analysis. Therefore small enterprises mostly analyzed prices of property on particular markets (Zagreb, the Adriatic coast, Croatia in general), and property supply and demand.

Medium-sized construction companies which maintain market analysis mostly specialize in certain fields, so they stated more particular analysis topics like: building on bad terrain, interpolations in urban areas, prices of competitors' products or the impact of manufacturers' prices on the behaviour of potential customers.

As topics for market analysis large construction companies stated prices and locations of apartment building construction, analysis and comparison of construction companies in Croatia, how customers are satisfied with the jobs done or potential investors.

Construction companies that maintained market analysis only recently are mostly satisfied with its results or partly satisfied, and only two small enterprises expressed discontentment with the market analysis results.

6. Do you group (segment) your clients according to certain criteria?

A positive answer to this question came from more than a half of the construction companies that took part in the survey, 17 to be exact, which is 56.67%. Almost half of these 17 companies which segment their clients according to certain criteria, 8 of them are medium-sized companies. There are 4 small enterprises, and 5 large ones, as shown in Table 6 in the Appendix.

Croatian construction companies which conduct segmentation of their clients stated different criteria, which obviously depend on the type of their activity and their clients. The client segmentation criteria in small enterprises are their age, how they are paying, the size of the apartment they want to buy, quality of construction work, location, equipment level, their purchasing power, their lifestyle, whether the clients are private or state investors.

Medium-sized companies stated the following client segmentation criteria: quantity of the goods/services delivered, possibility of mutual exchange, public or private companies, ownership, reference, stability on the market, cooperation, experience, while majority of the companies stated the ways and dates of payment.

For large construction companies the primary client segmentation criteria are whether public or private investors are involved, if it is investment construction or marketing construction, if it is a residential or business construction, civil engineering construction, customers according to income, potential investors/customers.

7. Which promotion activities do you maintain to make your company recognizable?

This question remained unanswered by only one company (small one), which means that it does not maintain company promotion of any kind. All the other companies implement at least one of the promotion activities listed, as shown in Table 7 in the Appendix.

Croatian construction companies mostly use the Internet as the instrument of promotion (80.00%); it is followed by newspaper advertising and professional trade fairs, while radio and TV advertising appears to be least used. Under "other" promotion activities the companies taking part in the survey stated the company monograph, dvd-s, brochures, leaflets, direct advertising or socialising.

Based on the results of the the first part of the survey it can be concluded that the majority of examinees do not have the department or the person in charge of marketing as part of their organization structure. The examinees that have the marketing department are satisified with the number of people working in the department and do not plan to increase the number of its employees. Only one company occasionally uses services of marketing agencies and intends to form a marketing department. Companies without a marketing department mostly stated advertising and promotion as marketing activities, while those that have their marketing sector use it for certain activities like client segmentation, price analysis, market research, and also for new product development in only one of the companies.

The second part of the survey related to agreeing or disagreeing with the given statements, where the examinees gave their opinions choosing among "agree", "partly agree", and "disagree" answers. Here are the results:

Table 8: Promotion activities maintained by Croatian construction companies

			Small	Medium-sized	Large	Total	
1	To achieve success in business it is important to have an articulate business strategy.	Disagree	0	1	0	1	3.33%
		Partly agree	3	2	0	5	16.67%
		Agree	8	8	8	24	80.00%
2	Marketing activities should be a part of construction companies' strategy.	Disagree	0	0	0	0	0.00%
		Partly agree	5	7	1	13	43.33%
		Agree	6	4	7	17	56,67%
3	In construction industry there is the need for marketing.	Disagree	1	0	0	1	3.33%
		Partly agree	3	6	1	10	33.33%
		Agree	7	5	7	19	63.33%

4	Croatian c onstruction companies maintain marketing insufficiently.	Disagree	2	0	0	2	6.67%
		Partly agree	5	7	5	17	56.67%
		Agree	4	4	3	11	36.67%
5	Companies with m arketing function bu ilt i n achieve better business results.	Disagree	2	2	0	4	13.33%
		Partly agree	6	5	4	15	50.00%
		Agree	3	4	4	11	36.67%
6	Our company is recognizable on the market.	Disagree	1	1	0	2	6.67%
		Partly agree	4	2	2	8	26.67%
		Agree	6	8	6	20	66.67%
7	Potencial buyers recognize our logo (visual identity).	Disagree	1	1	0	2	6.67%
		Partly agree	7	5	2	14	46.67%
		Agree	3	5	6	14	46.67%
8	Our company invests enough in marketing.	Disagree	4	3	1	8	26.67%
		Partly agree	4	7	7	18	60.00%
		Agree	3	1	0	4	13.33%
9	There is a positive marketing investment t rend in o ur company.	Disagree	5	4	2	11	36.67%
		Partly agree	4	3	3	10	33.33%
		Agree	2	4	3	9	30.00%
10	Maintaining marketing activities might l ead C roatian construction c ompanies t o breakthrough on to the new markets.	Disagree	0	0	1	1	3.33%
		Partly agree	5	4	2	11	36.67%
		Agree	6	7	5	18	60.00%

Source:The author's research

The majority of companies that were analyzed, 80.00% of them, agree with the first statement – an articulate business strategy is important for business efficiency.

That construction industry needs a marketing strategy is the opinion of 63.33% companies, and 60.00% believe that maintainace of marketing activities may lead to a breakthrough onto the new markets.

The same number of examinees, that is 36.67%, think that Croatian construction companies' maintainance of marketing activities is insufficient, and also that those companies with marketing strategy built in their organization structure achieve better results.

As many as 66.67% of the construction companies believe that they are recognizable on the market, 46.66% believe the customers recognize their logo, while on the other hand only 13.33% of the companies invest sufficiently in marketing, 30.00% think that there is a positive marketing investment trend.

The results of the survey presented in Table 8 show that a large number of respondents partly agree with the statements offered there. It reveals that they do not actually have a definite opinion about the matter or a defined point of view. This mostly applies to the statements that Croatian construction companies maintain marketing activities in an insufficient measure, and that those with marketing built in their organization structure achieve better business results.

The third part of the survey was the SWOT analysis. It is quite interesting to see what Croatian companies believe are their advantages and their disadvantages, what they see as opportunities, and what as threats. The results are shown together for small, medium-sized, and large companies.

All the companies think the quality of their products and services is their advantage, which indicates a really strong competition in the construction sector. Also, all the companies, whether they are small, medium-sized or large, see education and expertise of their employees as their advantage.

Small and medium-sized companies find their flexibility to be an advantage, while at the same time it is one of the biggest disadvatages for large companies.

The common disadvatage to all of the respondents is a bad organization structure, which can be seen in several organization structures of Croatian construction companies presented here. It is very interesting to see that only large construction companies think that not having the marketing department within their organization structure is their disadvantage.

What all the construction companies see as opportunities are adjusment to the new situation on the market and focusing on foreign markets, as well as entering EU and the use of new technologies.

As the biggest threat to all of them they see the economic crisis and recession, apartment construction stagnation, and a decrease in the number of infrastructure projects.

CONCLUSION

The purpose of marketing philosophy implementation in business organization system is to create and strengthen the company as a constantly growing concern. This opinion and point of view put before the company the task to combine the things it does best with the best way of presenting them to the clients. (Pettinger, 1998)

A lot has already been said about the construction industry so far. Its specificities and its influence on national economies in general are unquestionable. The complexity of the construction market, as well as meeting the needs and wishes of clients are a huge challenge for all participants of this sector. Additional problem to it is the global economic crisis, whose consequences are being felt more and more in every segment of economy, especially in construction industry, where it caused its growth to stop after many years of constant increase. Croatian construction industry has had a constant growth in the last ten years, particularly in apartment building construction and road building. And while writing this article an investment slowdown into infrastructure objects is being announced.

Working in road, bridge, and railroad construction, companies were encouraged to do the majority of work at home, while appearing on foreign markets was neglected. The project of Public Incentive Apartment Housing Construction caused a large demand for apartments, and the activities of construction industry grew. But, as the purchase power of the population has decreased, many apartments on the market have not been sold. What is left are the works of maintainace, rebuilding, reconstruction of the existing objects, as well as some local infrastructure investments. Therefore, there is the question of what construction industry is about to work on in near future.

This survey research results lead to the conclusion that Croatian construction companies maintain marketing in an insufficient measure. Therefore due to inadequate awareness of the importance of marketing concept and facing the crisis on property market, in state investments, as well as reduced financing possibilities, they lose their place on the market and business efficiency.

However, what is encouraging in this survey is the opinion given by the majority of construction companies which took part in the survey that there is the need for marketing, and that the implementation of marketing activities might lead to the breakthrough onto foreign markets. A breaktrough onto foreign markets by the use of well defined marketing strategy might be the essential factor of business efficiency of Croatian construction companies.

REFERENCES

Fisher, N (1996) Marketing for the Construction Industry. New York: Longman Inc.

Howes, R., Tah, J.H.M. (2003) Strategic management applied to international construction. London: Thomas Telford Publishing

Katavić, M., Lovrenčić, L. (2008) The Marketing Concept in Construction Companies. Umag: 8th International Conference on Organization, Technology and Management in Construction

Lovrenčić, L., Katavić, M. (2009) Marketing Strategy in Croatian Constraction Companies. Brno: XIIth International Scientific Conference

Pettinger, R (1998) Construction Marketing – Strategies for Success. MACMILLAN PRESS LTD.

Renko, N (2005) Strategije marketinga. Zagreb: Naklada Ljevak

Poslovanje poduzetnika građevinarstva RH u 2007.godini, FINA, Zagreb, 2008.

Statistički ljetopis 2007., Državni zavod za satistiku, Zagreb, 2007.

APPENDIX

Table 2: Croatian construction companies that have a mission and a vision of their company

Size of company	Have mission	%
Small	3	23.08
Medium-sized	5	38.46
Large	5	38.46
Total	13	100.00

Source:The author's research

Table 3: Croatian construction companies that have marketing departments

Size of company	Have marketing department	%
Small	3	30.00
Medium-sized	2	20.00
Large	5	50.00
Total	10	100.00

Source: The author's research

Table 4: Functions performed by marketing department employees

Functions of marketing	Small	Medium-sized	Large	Total	
Sale	2	1	4	7	70.00%
Market research	3	1	5	9	90.00%
Price analysis	3	1	4	8	80.00%
New product development	1	1	2	4	40.00%
Promotion activities	3	2	4	9	90.00%
Other	0	0	1	1	10.00%

Source: The author' research

Table 5: Croatian construction companies that maintain market analysis

Size of company	Maintain market analysis	%
Small	4	36.36
Medium-sized	3	27.27
Large	4	36.36
Total	11	100.00

Source: The author's research

Table 6: Croatian construction companies that segment their clients

Size of company	Segment their clients	%
Small	4	23.53
Medium-sized	8	47.06
Large	5	29.41
Total	17	100.00

Sourec: The author's research

Table 7: Promotion activities maintained by Croatian construction companies

Promotion activities	Small	Medium-sized	Large	Total	
Radio advertising	2	2	3	7	23.33%
TV advertising	1	1	3	5	16.67%
Newspaper advertising	7	5	6	18	60.00%
Professional trade fairs	2	3	6	11	36.67%
The Internet	8	8	8	24	80.00%
Other	1	3	1	5	167%

SUSTAINABILITY APPROACH TO BUILDING APPRAISAL

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How can we choose the best alternative of a project? Most frequently, alternatives of a project are compared based on estimated costs. Number of a financial indicator calculation become commonplace. Customers are interesting in investment costs of a project and their rate of return. The traditional building's appraisal is based only on economic returns. In case a customer will be user, she or he is interesting in amount of cost she or he will spend during the life cycle of a project too. There are mostly replacement costs, operation costs, service costs, and disposal costs. This paper is concerned with questions how to asset the value of a building concept as a support for decision-making processes. There are impact of building on environment, life cycle cost of building, social and cultural issues, not only the low cost, that the clients or public should be interested in during deciding among project's alternatives. The traditional building's appraisal is based only on economic returns and does not adequately and readily consider environmental effects, social, and environmental issues. This traditional approach is shown to be no longer feasible. Buildings have a long life, so any improvement in their appraisal techniques can reduce their future environmental impacts and can satisfy the requirement of sustainable development. The traditional approach to building appraisal can be modified with the life cycle cost calculation for analyzing the total cost of the acquisition, operation, maintenance and support of a building throughout its useful life, and including the cost of disposal. The sustainability approach to the building appraisal has to consider the quality of environment, economics constraints, social equity and cultural issues. Proposed building appraisal using the sustainability indicator includes criteria assessing financial return, energy consumption, external benefits, and environmental impact. The sustainability indicator includes financial return, energy consumption as well as social and environmental issues in decision-making framework.

KEYWORDS: appraisal, decision-making, life cycle cost, sustainability.

SUSTAINABILITY IN BUILDING

The interpretation of sustainability in building has gone change over the years. At the beginning, the accent was on how to deal with limited resources and on how to reduce the impacts on the environment. Later, the accent was on technical issues – energy related design (passive houses, low energy houses), construction technologies, buildings components, materials. Presently, the accent on soft issues of sustainability is growing. There are the economic, social, cultural issues, and cultural heritage, that gain ground.

According to CIB (CIB 1999), outside and inside factors affect the use of sustainability concept in building and construction, there are:

- quality and property value,
- meeting user needs, flexibility, adaptability,
- prolonged service life,

- use of local resources,
- building process,
- efficient land use,
- water saving,
- use of by-products,
- distribution of information relevant to decision making,
- immaterial services,
- urban development and mobility,
- human resources,
- local economy.

Three pillar of sustainability characterize the sustainability development and, in the strict sense of the conception, the sustainability building and construction according to the new approach in a global context, there are:

- quality of environment (internal and external),
- economic effectiveness and economic constraints,
- social equity and cultural issues.

The Figure 1 illustrates the process of traditional engineering concept. Traditional building process focuses on cost, time, and quality. In the new concept, the impacts on environment - limited resources, emissions quantity and type, biodiversity are considered. In the global context, the economic, social, and cultural issues are counted together with the environmental issues.

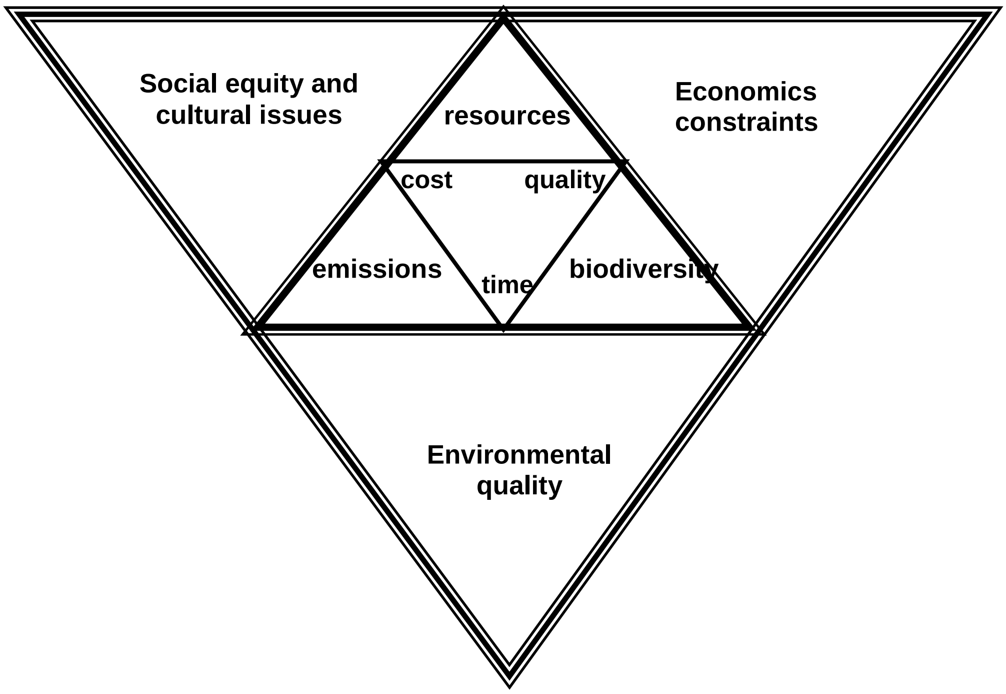

Figure 1: The New Concept of Building Process in Global Context

Sustainable construction is considered as a way for the construction industry to contribute to the larger effort of achieving sustainable development.

THE BUILDINGS APPRAISAL

Traditional approach to buildings appraisal

Traditional approach to buildings appraisal is based only on financial return. Net present value, recovery of investment, internal rate of return are calculated and represent only economic point of view on building or project. Traditional project appraisal does not adequately and readily consider environmental effect and therefore does not satisfy the requirement of sustainable development.

This traditional approach to building appraisal can be modified with life cycle cost calculation. The life cycle costs are the cost of a building over its entire life. Life cycle costing (LCC) is a method for analyzing the total cost of the acquisition, operation, maintenance and support of a building throughout its useful life, and including the cost of disposal. This LCC analysis can provide important inputs for the decision making process. Classification of life cycle costs can be:

- investment, maintenance, repairing, reconstruction, modernization, disposal – the costs associated with technical parameters of building,
- energy, cleaning – operational costs
- realty tax, insurance, property management – administrative costs.

It is evident, from this classification, that the approach to building appraisal using the life cycle calculation considers energy consumption. The social and cultural issues are not considered.

Sustainability approach to building appraisal

Sustainability approach to building appraisal has to consider quality of environment, economics constraints, social equity and cultural issues. Proposed building appraisal using sustainability index includes the following four criteria:

- financial return,
- energy consumption,
- external benefits,
- environmental impact.

The four criteria and their sub criteria are measured by different methodologies and in different units. Transformation into a common dimension or common dimensionless unit using standardization procedure is necessary.

Criteria can be individually weighted to reflect particular client motives and community requirements. The weight depends on the requirements of the client and other stakeholders for each project and the importance of the facility in support of the missions, goals, and purpose of the organization, or in support of the objectives of an individual or family. Different methods can be used, such as paired comparison, ranking, rating, etc. The Figure 2 illustrates the evaluation matrix.

Criteria	Alternative of Project P_1 P_2 … Pj	Weights
C_1 C_2 C_3 . . . C_i	Criterion scores	w_1 w_2 w_3 .. . . w_j

Figure2: The Evaluation Matrix

The Sustainability Indicator Model

The criteria can be incorporated into a decision making model. The sustainability indicator model can be expressed as follows:

$$I_i = \sum_{j=1}^{m} V_{ji} w_j \qquad (i=1,\ldots,n)$$

where I_i is the sustainability indicator for an alternative I, w_j is weight of criterion j, V_{ji} is the value of alternative I for criterion j.

$$V_{ji} = f\left(BC, EC, EB, EI)\right)$$

where V_{ji} is the value of alternative I, BC is financial return, it means benefit – cost ratio during the life cycle of building, EC is energy consumption, EB are external benefits and EI are environmental benefits (impacts).

Benefit – cost ratio during the life cycle of building can be expressed as follows:

$$BC = \frac{\sum_{t=0}^{LC} B_t \,/(1+r)^t}{\sum_{t=0}^{LC} C_t \,/(1+r)^t}$$

where BC is benefit – cost ratio, B are benefits during the life cycle of building, C are costs during the life cycle of building, r is discount rate, t is time, LC is life cycle of building.

Energy consumption EC consists of embodied energy (manufacturing energy of building materials and component, energy for transportation, energy used in processes) and operational energy.

External benefits EB consist of functional and technical layout, maintenance, economic and process performance, aesthetics impact, heritage preservation, social benefits. External benefits can be, for example, rated using formula:

$$EB = \sum_{j=1}^{J} U_{ji} v_j$$

where U_{ji} is the value of an alternative i for sub criterion j, v_j is weight of sub criterion j.

Environmental impact EI consist of manufacture (recycled materials, hazardous materials, greenhouse gas, pollution, manufacturing waste), design (evaluation of products, energy consumption, energy efficient), construction (air and noise pollution, water run off, construction waste), site context (groundwater, natural, rare/endangered species, transport system, traffic noise, access to site), disposal (non-recyclable waste, demolished waste/materials).

THE PROPOSAL OF CRITERIA - EXTERNAL BENEFIT

Functional Benefits

Functional benefits describe and assess how well activities and processes can be performed in the building. Functional benefits are closely related to the needs of the building users and others – visitors, public community. Criteria include:

- suitability of the surface and space program for planed use,

- accessibility, barrier-free design,
- adaptability to changing user requirements and uses, etc.

Technical Benefits

Technical benefits describe structural, physical and other technical characteristics. Criteria include:

- suitability for planed service life,
- load capacity,
- maintenance and revitalization capability,
- structural resistance to fire,
- control of noise transmission,
- heat insulation, etc.

Social Benefits

The description and assessment of social benefits can be based on criteria:

- health, comfort and safety of users, visitors, residents and neighbours of the building,
- building's cultural value, etc.

Process Benefits

The overall building performance is influenced by the quality of processes involving planning, construction, use and facility management. The description and assessment of process benefits can be based on criteria:

- quality of planning,
- quality of construction on site,
- quality of management,
- quality of building related services, etc.

CONCLUSION

The parties involved in the building process each have a specific scope of interests with various resulting information requirements. Each of the actors involved view and assess to building differently. The investor is primary interested in the economic point of view. The user and facility manager have an interest in operating cost. Authorities and regulators are interested in environmental impacts because of an interest in protecting the environment, health, safety, security, fire, and compliance with current codes and regulations.

Traditional building's appraisal considering only economic returns, does not adequately and readily consider environmental effects, social, and environmental issues. This approach is shown to be no longer feasible. Buildings have a long life, so any improvement in their appraisal techniques can reduce their future environmental impacts and can satisfy the requirement of sustainable development. The sustainability index includes financial return, energy consumption as well as social and environmental issues in decision making framework. Presented project (building) appraisal does adequately and readily consider economic, environmental and social effects and therefore does satisfy the requirement of sustainable development.

References:

CIB (International Council for Research and Innovation in Building and Construction) (1999): *Agenda 21 on sustainable construction.*

Čápová, D., Tománková, J., Schneiderová Heralová, R., Kremlová, L. (2006), *Cost Planning in Renovation and Maintenance Processes during Building Life Cycles* (*Plánování nákladů na obnovu a údržbu v průběhu životního cyklu stavebního objektu)*, Economics Risks of Building Life Cycles (Ekonomická rizika životního cyklu staveb), Czech Technical University in Prague, Faculty of Civil Engineering, Prague, 13-20.

Čápová, D., Tománková, J., Schneiderová Heralová, R., Kremlová, L. (2006), *Life Cycle Costing of the Building*, Construction and Professional Practices (Proceedings of EASEC 10). Bangkok: Asian Institute of Technology, 97-102.

Ding, G.K.C.(2005), *Developing a multicriteria approach for the measurement of sustainable performance*, Building Research and Information, 33 (1) 3-16.

Lutzendorf, T., Speer, T., Szigeti, F., Davis, G., Le Roux, P.C., Kato, A., Tsunekawa, K.(2006), *A comparison of international classifications for performance requirements and building performance categories used in evaluation methods*, CIB Helsinki Symposium.

Měšťanová, D. (2007), *The Analysis of the Implementation Process of the Performance Audit in Context of the Czech Republic Entry to EU* (*Analýza procesu implementace auditu výkonnosti v souvislosti se vstupem ČR do EU)*, Prague: Czech Technical University in Prague, Faculty of Civil Engineering, Prague.

Schneiderová Heralová, R.(2007), *The building's value assessment using the utility and the LCC*, Central Europe towards Sustainable Building 07 Prague. Prague: CTU, Faculty of Civil Engineering, 126-131.

Schneiderová Heralová, R.(2007), *TheValue, the Utility and the LCC of the Building,* Sustainable development of regions. Prague: CTU Czech Technical University in Prague, Faculty of Civil Engineering, 407-412

Schneiderová Heralová, R.(2007), *The Utility of Buildings during the Life Cycle* (*Užitek stavebního díla v průběhu životního cyklu)*, The Price, the Life Spam and the Effeciency of Buildings (Cena, životnost a ekonomická efektivnost stavebního díla). Brno: Technical University in Brno, Faculty of Civil Engineering, 83-89.

Schneiderová Heralová, R.(2006), *The Value of Building with Long Life Cycle* (*Hodnota stavebního díla s dlouhým životním cyklem)* , In: The Price and Life Spam of Building (Cena a životní cyklus stavebního díla). Brno: Technical University in Brno, Faculty of Civil Engineering, 136-140.

Schneiderová, R. (2008), *The Buildings Appraisal with Respect to the External Benefits - the Way to the Sustainability Development* In: Proceedings of the BuHu 8th International Postgraduate Research Conference 2008 - Part II. Praha: CTU Publishing House, 2008, vol. 2, p. 308-314.

Schneiderová, R. (2006), *Contract Prices Assessment Using Dynamic Calculation* In: Book of Abstarcts and Congress Programme. Ljubljana: Slovenian Project Management Association (Slovensko združenje za projektni management - ZPM), 2006, vol. 1, p. OCE-23.

Vlček, R.(2002) *The Value for Customer* (*Hodnota pro zákazníka),* Management Press, Prague.

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HOW WOULD YOU LIKE IT: CHEAPER OR SHORTER

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Least cost scheduling techniques were accompanying the history of modern project management, however they have never gained much importance in the practice. Even in our days only a few computer application provide this kind of feature to the users. In this paper a generalized PDM least cost scheduling problem will be introduced, and a case study will be presented to demonstrate the effectiveness of the model. The case study is based on a highway construction project, where the least cost scheduling technique developed by the authors was used in applied in order to calculate the minimum direct cost solution to a given project duration. The authors came to a conclusion that least cost scheduling can be a useful tool in the cost planning of the projects, however further research are necessary (e.g. handle of the activity calendars) to make the model suitable for everyday use.

KEYWORDS: project management, scheduling, cost.

INTRODUCTION

The original CPM problem, developed by Kelley and Walker (Kelley at al. 1959) was a least cost scheduling problem. Some unusual characteristics and their implications in project management are discussed in (Weist, J.D. 1981). The basic hypothesis concerning the activities in the original CPM problem is, that it can be determined a normal duration and a normal cost related to the normal duration for each and every activity, and a crash duration and crash cost related to the crash duration. The crash cost always greater or equal to the normal cost (see Figure 1.), and the change of the cost is described by a linear function, within the interval of the normal and crash duration. The cost slope shows the increment of the cost for one day shortening of an activity duration, from the normal to the crash duration.

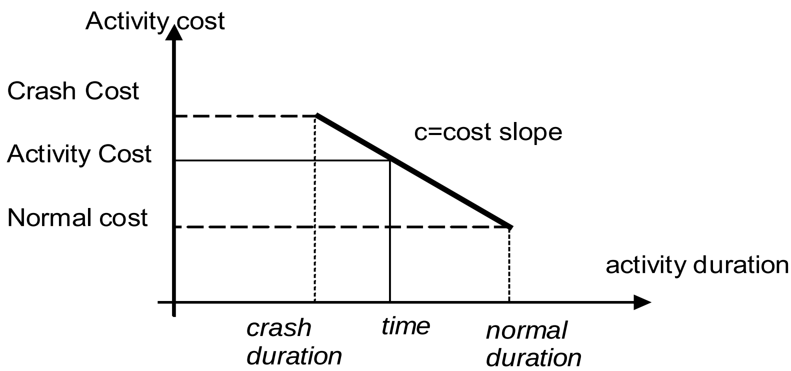

Figure 1. Activity duration versus activity cost assumptions of the model

The goal in the CPM least cost scheduling model is to define the minimum direct cost to a given project duration, that is to define the curve of the minimum direct cost solution within the interval of the maximum and minimum project duration. The CPM technique has lost his importance from the mid sixties, early seventies, due to its rigid structure, problems of the graphical displaying of the network, and the poor modelling possibilities in describing logical relationships between activities. Instead a new technique, the so called Precedence Diagramming Method (PDM) started to disperse all over the world. One of the pioneers of the PDM technique was Roy (Roy, 1959).

In our days the majority of the available project management tools use the PDM technique as their basic model, due to the extended modelling function of the technique (compared to CPM technique), and the greater flexibility in modelling..

The PDM technique gives more flexibility in modelling by introducing the minimal and maximal precedence relationships. The precedence relationships describe the minimum necessary, or maximum allowable time span between the start or finish times of the two activities, connected by the precedence relationships.

Minimal precedence relationships are well known by most of the planners, however maximal precedence relationships are considered relatively new in project management practice, only a small minority of the planners understand and apply them during their work. Further details on maximal precedence relationships can be obtained from the book of Hajdu. (Hajdu, 1996a)

THE PDM LEAST COST SCHEDULING MODEL

In a PDM network techniques for construction scheduling, arrows represent activities and logical relationships between activities and nodes present events. Let *a* and *b* assign to each activity as crash duration time and normal duration time. Assign to each activity a cost K_b (normal cost) to complete the activity at the normal duration and a cost K_a (crash cost)– greater than normal cost to complete at the minimum duration. Let us supposed that cost function of each activity is linear and its slope is $\frac{K_b - K_a}{b - a} = tg\alpha = -c$, where $c \geq 0$. For a given activity time „τ” the cost is $K_b + (b - \tau)c$. If *a* and *b* are nonpositve numbers let *c* be zero.

Let us see the model from the general contractor's point of view.

According to the contract between general contractor and client, accomplishment of event *i* will be occurred at time $e_i \geq 0$. General contractor also has contract with subcontractors. Let us assume that general contractor gets and/or pays D_i amount of money if event *i* has occurred. If $D_i > 0$ then client pays D_i amount of money to the general contractor. If $D_i < 0$ then general contractor pays D_i amount of money to the subcontractors. Based on the scheduling event i will be occurred at a time μ_i. Let interest rate per a day is q and $d_i = D_i q$.

It means that d_i is a daily benefit or outcome depending of the sign of D_i and the sign of difference between μ_i and e_i.

In an alternative reading let d_i *be a daily penalty for delayed delivery. From the general contractor point of view if* d_i *positive and* $(\mu_i > e_i)$, *general contractor should pay to the client since event i delayed. If* d_i *positive and* $(\mu_i < e_i)$, client pays to the general contractor daily d_i *amount of money because event i completed earlier. If* d_i *negative and* $(\mu_i > e_i)$, *it means that subcontractor pays to the general contractor because event i is delayed. s a daily penalty for delayed delivery. If* d_i *negative and* $(\mu_i < e_i)$ *general contractor should pay to the subcontractor because event i completed earlier.*

Mathematically the sum of $K_{bij} + (b_{ij} - \tau_{ij})c_{ij} + (\mu_i - e_i)d_i$ for each activity should be minimized.

Mathematical model

Denote [N,A] a directed graph (network) where N is a set of nodes and A is a set of arcs whose elements are ordered pairs of distinct nodes. Let it n be the number of nodes and m be the number of arcs. There is only one starting node s and one end node t in [N,A] directed graph. Directed graph contains no parallel arcs (i.e., two or more arcs with the same tail and head nodes. This assumption imposes no loss of generality. There is a path in a network from node s to every other node in the network.

Denote $a_{ij}, \tau_{ij}, b_{ij}$ integer values for all $ij \in \mathrm{A}$ associated with network's arcs, where $a_{ij} \le \tau_{ij} \le b_{ij}$ for all $ij \in \mathrm{A}$ and sign a_{ij}=sign b_{ij} for all $ij \in \mathrm{A}$, moreover given $c_{ij} \ge 0$ integer value for all $ij \in \mathrm{A}$ associated with each network's arc that represents the cost of acceleration of activity *ij* if activity time is reduced by one unit time. If b_{ij} is negative then let $c_{ij} = 0$. For the sake of simplicity **a**, **b, c, τ** represent the corresponding vectors.

In engineering term τ_{ij} represents activity time of an activity $ij \in \mathrm{A}$ with a_{ij}, b_{ij} lower and upper bound respectively normal and rush time. Denote k_{ij} the cost of activity *ij* for all $ij \in \mathrm{A}$. Denote *p* the project duration time. Find to each node a $\mu_i, \forall i \in N$ value. An obviously natural condition that $\tau_{ij} \le \mu_j - \mu_i \ \ \forall ij \in \mathrm{A}$. The duration time of the network is *p*, where $p \ge \mu_t - \mu_s$. Let $\mu_s = 0$. Let [N,A] directed graph be supplemented with an arrow *(t,s)* for which $a_{ts} := -p, \quad b_{ts} := 0, \quad c_{ts} := 0.$

Remark. For a non-splitting $ij \in \mathrm{A}$ activities $\tau_{ij} = \mu_j - \mu_i$ is a condition. If $\tau_{ij} \le \mu_j - \mu_i$, $a_{ij} \le \tau_{ij} \le b_{ij}$, and $\tau_{ji} \le \mu_i - \mu_j$, $-b_{ji} = a_{ij} \le \tau_{ij} \le b_{ij} = -a_{ji}$ then; $a_{ij} \le \mu_j - \mu_i \le b_{ij}$. Moreover if $c_{ij} > 0$ then objective function attains its maximum value if $\tau_{ij} = \min(b_{ij}, \mu_j - \mu_i)$ for all $ij \in \mathrm{A}$, that is for all non-splitting activities $\tau_{ij} = \mu_j - \mu_i$ is satisfied. If $c_{ji} = 0$, then τ_{ji} is arbitrary so let us choose τ_{ji}, that $\tau_{ji} = \mu_i - \mu_j$. For splitting activities $\tau_{ij} \le \mu_j - \mu_i$ is the only condition.

We seek for all possible p values such a τ és μ systems that

$$\sum_{ij\in A} K_{bij} + \left(b_{ij} - \tau_{ij}\right)c_{ij} + \sum_{i\in N} (\mu_i - e_i)d_i \text{ be minimal.}$$

Least cost scheduling problem leads to the following mathematical model.

Mathematical model.

Given a directed network [N,A] with a_{ij}, b_{ij}, c_{ij} integer values where $c_{ij} \geq 0$ for all $ij \in \mathrm{A}$ and $d_i, \forall i \in N$ integer values where $\sum_{i\in N} d_i = 0$. Find μ_i for all $i \in N$; and τ_{ij}, for all $ij \in \mathrm{A}$, for a given p (where $a_{ts} := -p$) project duration time that

$$\tau_{ij} \leq \mu_j - \mu_i \quad \forall ij \in \mathrm{A} \tag{1}$$

$$\tau_{ij} \leq b_{ij} \quad \forall ij \in \mathrm{A} \tag{2}$$

$$\tau_{ij} \geq a_{ij} \quad \forall ij \in \mathrm{A} \tag{3}$$

$$\mu_s = 0 \tag{4}$$

$$-p \leq \mu_s - \mu_t \tag{5}$$

$$\sum_{ij\in A} K_{bij} + \left(b_{ij} - \tau_{ij}\right)c_{ij} + \sum_{i\in N} (\mu_i - e_i)d_i \text{ should be minimized that is}$$

$$\left\{\sum_{ij\in A} c_{ij}\tau_{ij} - \sum_{i\in N} d_i\mu_i\right\} \text{ should be maximized.}$$

It is a dual of a special minimum cost flow problem that can be solve by wide range variety of algorithms. In our case study a PDM least cost scheduling technique was used to find the optimal cost solution in a given project duration interval. The algorithm originally was developed by Hajdu (Hajdu,1993) later some generalizations were developed by Hajdu and Malyusz (see below). The algorithm was used for this case study provides solutions for the following specific cases:

1. Original CPM cost model (Kelley et al, 1959)
2. CPM least cost scheduling, with penalty payment for late delivery, bonus payment for earlier delivery.
3. PDM least cost scheduling: only minimal precedence relationships allowed, activities are carried out continuously, that is activity splitting is not allowed (EF-ES=t, LF-LS=t) (ES: Early Start; EF: Early Finish; LS: Late Start; LF: Late Finish; t: activity time (Hajdu,1993)
4. PDM least cost scheduling: only minimal precedence relationships are allowed, splitting of activities are allowed, that is in case of some activities EF-ES $\geq$ t; and LF-LS$\geq$ t. (Hajdu, 1996b)

5. PDM least cost scheduling: both minimal and maximal type of precedence relationships are allowed, activity splitting is not allowed. (Malyusz, 2003)
6. PDM least cost scheduling: both minimal and maximal type of precedence relationships are allowed, splitting of activities are allowed, that is, in case of some activities EF-ES≥t; and LF-LS≥t (Hajdu and Malyusz 2008b)
7. PDM least cost scheduling allowing the application of time constraint in the network. (Hajdu and Malyusz, 2008a) The following constraints are handled in the model:
    - Must start on...
    - Must finish on..
    - Start earlier then…
    - Start later then…
    - Finish earlier then ….
    - Finish later then …
    - Any combination of the aforementioned constraints

    Constraints above can be transformed to an inequality (1), (2) or (3) in mathematical model.
8. PDM least cost scheduling accomplishing points 5,6 and 7 with penalty payment for late delivery and bonus payment for earlier delivery. (Hajdu and Malyusz 2008b)

CASE STUDY

The development of an algorithm that solves the above mentioned generalizations, and the software application was finished in the summer of 2007, and after some sample testings we have decided to test the application on several real and possibly large-size project.

The following prerequisites were required towards the project to be chose:

- must be a construction project
- must be an ongoing project
- possible large scale project with long project duration (above 2 years)
- must be an original well defined and accurate baseplan (schedule), with more than 1000 activities

The project chosen for testing is a construction of a motorway in 6 km length. This project is a relatively small section of a huge construction programme, that aims to make a motorway ring in more than 150km-es around Budapest – capital of Hungary - in order to relieve the capital from the load of the - mainly- international transit traffic. The realization of the whole program started in the late 70's and will finish around 2025. The dense built area, the vast number of land owners (more than 30.000 owners on more than 20.000 properties) that makes the acquisition very slow, non-governmental-environmental organizations, make the whole programme very slow and expensive.

The start of this project was October, 2005 the planned finish was June, 2007. Due to some legal and technical problems the project has been rescheduled in January, 2007 at the stage of project completion below 10%. The new deadline is October, 2008. In the time of the submitting of this paper (July, 2008), it seems that de deadline will be met. At this time another 3 section, and a bridge over the river Danube will be finished, and the total length of the ring will be more than 90 km.

The length of this section is 6,7 km, contains 8 bridges, two junctions, replacement of more than 30 public utilities, crossing the planned road, and involves around 2million m3 earthwork. The contracted fee € 45million. The client is the National Infrastructure Development Ltd (NID), the contractors' consortia is formed by Porr, Teeraq-Asdag and Viadom Zrt. The leading firm is Porr Hungary, the Hungarian affiliate of Porr Ag. NID is responsible for managing all the government financed infrastructural projects (road and railway). Its current contracted portfolio is above € 10billion.

NID has a very strict requirements regarding project planning and monitoring, and requires from all the contracted partners to fulfil their regulations in these fields. The reason for this is that NID manages not only the project but the whole portfolio, therefore projects have to be managed and handled in the project management system in a uniformed way. This includes:

- the methodology of developing the schedule of quantities (A general schedule of quantities comprises around 3000 items, but in some cases can go above 15 000 items.)
- the methodology of establishing the bill of quantities (priced schedule of quantities).
- the methodology of preparing the baseline plan (A baseline plan generally consist of 1000 activities but in some cases can go over 5000 activities.)
- the methodology of monitoring, which is carried out monthly
- the methodology of handling claims and paid and unpaid extra works,
- the methodology of monthly actualization of schedule

These regulations are in use from the year of 2000, a non-adequate or late accomplishment costs a lot of money to the contractors, therefore they produce much better schedules comparing the average construction industry level.

The baseline plan that was the basis of our work was made in January 2007, and comprises 576 activities and 746 logical relationships. The schedule of quantities consisted of 1311 items. The WBS (Work Breakdown Structure) has been developed automatically from the schedule of quantities according to the standardized rules of NID. This project is considered as a relatively small one in NID's practice.

In the baseline plan there was one critical path with the length of 532 days. The plan has been developed in a scheduling tools used by NID and the contractors, which can handle maximal type of precedence relationships. Four different calendars were used in the network.

Preparations for least cost scheduling

Least cost scheduling requires the existence of normal time with the related normal cost, and crash time with the related crash cost for each activity, so the most important task during the preparation for least cost scheduling was the definition of these data. The second important part of the preparation was to standardization of the calendars, because the model has been developed within the frame of this research project do not handle different activity calendars. During the preparation of activity durations and activity costs we followed the principle, that the activity durations and costs in the baseline plan will serve as the normal duration and normal cost of our model, so our task was to define the crash duration and crash cost for each activity. For this two methods were applied:

- detail investigation of an activity
- estimation, based on experts opinion

Detail investigation has been carried out for only 20 activities. At the and of the investigation, crash durations were reduced to 70-90 percent of the normal durations, with the average 30-10 percent cost increment. It is important to notice that detailed investigation and estimations have been led to almost the same results.

During the process of the estimation several meetings with the chief engineer responsible for the construction were held in order to develop crash durations and crash costs. The result of the estimation was that activity durations could be reduced to 60-80 percent comparing to the original durations, that is normal duration, which resulted in an average 25 percent (10-40 percent) increment in cost.

As the least cost algorithm developed by the authors can not handle different calendars in the schedule, standardization of the calendars was the most time consuming activity during the preparation. It has involved the modification of the activity durations , modification of precedence relationships' lag time, and sometimes adding new relationships to the schedule. Our aim was to get the same start and finish time after the modification as they were before, that is to keep the results of the original schedule.

Least Cost Scheduling

The problem was solved with the least cost scheduling module of ProjectDirector 4.0. There were 34 breakpoints in the cost curve. The minimum project duration decreased to 530 from 467 days. The increment of the project direct cost in this interval was € 4 755 537, that is more than 63 days shortening in the project duration is possible and this costs less than 10% of the contracted fee. The results of the calculations are shown in Figure 5, and Table 1.

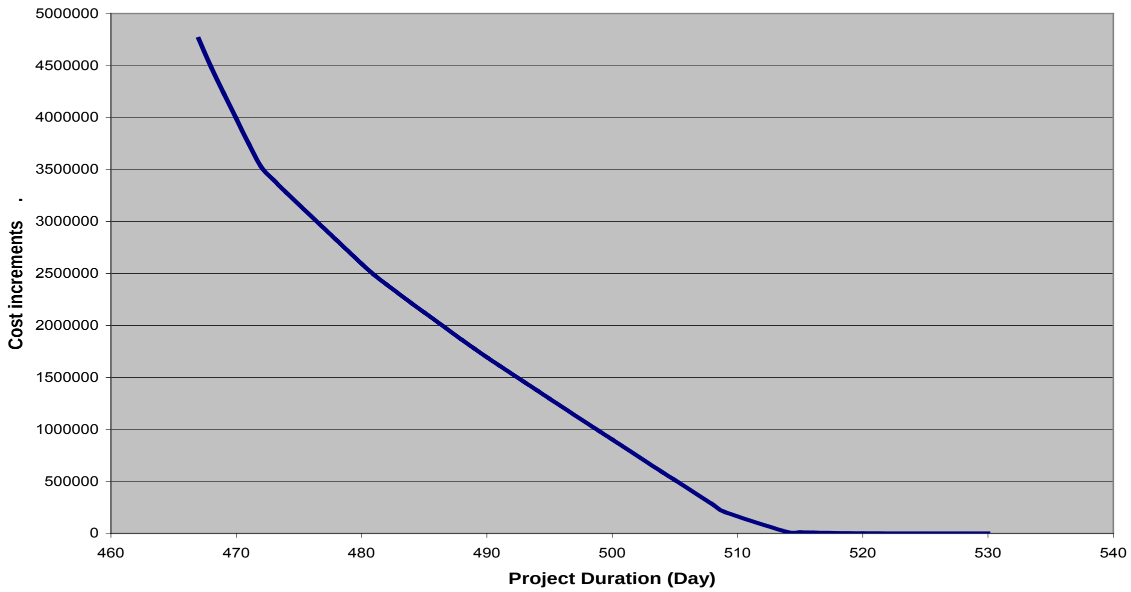

Figure 2. Project duration versus increments of project direct costs

Table 1: Result of PDM Least Cost Scheduling calculations. Project duration versus cost increment

Project dur. (day)	530	528	525	520	516	515	514	509	508
Cost increment (Euro)	0	0	0	1335	8491	10406	12 399	206 519	281 142

505	504	500	499	495	494	493	491	490
512763	589 987	902 575	981 326	1 296 358	1 375 184	1 454 473	1 613 789	1 693 539

489	488	485	484	482	481	480	478
1 777 483	1 862 311	2 125 045	2 212 995	2 392 723	2 485 808	2 594 560	2 821 060

474	473	472	471	470	469	468	467
3 277 044	3 396 876	3 522 697	3 748 535	3 988 563	4 232 704	4 484 993	4 755 537

CONCLUSIONS

The results of the calculations were promising. It can be stated that serious savings can be achieved by using a least cost scheduling model, if project speed up is necessary. The preparations especially the elimination of the different calendars were very time consuming. This took more than 70% of the total preparation time, therefore the work is much convenient if only one calendar is used in the schedule. During the calculations we came to the conclusions that in some cases precedence lag times depend on the duration of the preceding or succeeding activity. So far this was left out of consideration.

REFERENCES

Hajdu., M., 1993 “An algorithm for Solving the PDM Time -Cost Trade Off Problem”, Periodica Politechnica Vol. 37.,No3., pp. 231-247, Budapest, Hungary

Hajdu, M, 1996a, Network Shceduling Techniques for Construction Project Management, Kluwer Academic Publisher, ISBN 0-7923-4309-3.

Hajdu, M 1996b „PDM Time Cost Trade Off: Activities Are Splittable or Non-Spittable”, Optimization, Vol. 38. pp 155-171 Spinger

Hajdu M, Malyusz L 2008a "Constraints and Least Cost Scheduling" Approved for publication. To appear in Ybl Scientific Papers, Budapest, Hungary 2008,

Hajdu M, Malyusz L 2008b. "Some new generalization of the PDM Least Cost Scheduling Problem: Activity splitting together with maximal precedence relationships are allowed, penalty for late completion is introduced" Research Report carried out under the frame of the contract YDCM/01 between the Ybl Miklos School of Architecture and Civil Engineering, Budapest, Hungary

Kelley.J.,E., Walker.,M.,R., 1959. "Critical Path Planning and Scheduling", Proc. the Eastern Joint Computer Conference, Boston

Malyusz L., 2003 "An efficient network flow algorithm for MPM/PDM least cost scheduling problem" Proceedings of the 6th International Conference on Organisation, Technology and Management in Construction, Moscenicka Draga Croatia, 17-20 September 2003.

Roy, B 1959. "Theorie des graphes: Contribution de la theorie desígraphes a l'etudede certains problemes linearies" Comptes rendus des Seances de l'Acedemiedes Sciences, seence du Avril 1959, p2437-2449

Weist, J.D. 1981, "Precedence Diagramming Method: Some Unusual Characteristics and Their Implications for Project Management" Journal of Operations Management Vol.1. No3, Feb,1981, pp121-136.

ABSORPTIVE CAPACITY MODELS AND CRISIS MANAGEMENT

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The term ‘absorptive capacity’ as a fundamental paradigm of knowledge management has been explained in numerous scientific works which have created capacious theoretical basis, but the component of practical application in construction has remained relatively poor. Starting from the assumption that absorptive capacity models are an adequate mediating instrument among theoretical preferences and empiric phenomena, the availability of Cohen and Levintal (1990), Van den Bosch et al. (1999) and Zahra and George (2002) models has been particularly examined. This paper presents the Croatian consulting firm case study. The intention of applying a crisis management firm usage is to increase the absorptive capacity in order to support concentrated diversification and focusing strategy on energetic sector market niche. However, due to the rigid functional organizational architecture and cost requirements that process has been made impossible.

KEY WORDS: absorptive capacity, crisis management, strategic management.

INTRODUCTION

The crisis threat emphasizes the significance of construction industry Dynamic Capabilities. The Dynamic Capabilities concept which has been defined by Teece et al. (1997) as ‘the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments’ is based on organizational learning (Collis, 1994). The Dynamic Capability of acquiring knowledge of interorganizational relations with intraorganizational learning processes (Fiol et al., 1985) is called the Organizational Absorptive Capacity (ACap). ACap is one of basic paradigms of Knowledge Management (KM) which resulted in numerous definitions and models, creating a prolific theoretical basis although the component of practical application in construction has remained relatively poor. Therefore the intention was to close the gap between the issues in question and point out the values and the meaning of the ACap concept in crisis and strategic management. In these terms the relevant generic ACap models by Cohen and Levintal (1990), Van den Bosch et al. (1999) and (2003) and Zahara and George (2002) have been chosen and analyzed.

The case study introduction offers a brief survey of national construction market principal characteristics, while the continuation deals with crisis context elaboration and market participant strategy review. The Croatian consultant organization cross case study data have been collected mainly through semi-structured interviews with senior management as key actors. The analytical model has been directed towards the phenomenological research of actors lived experiences so that the data obtained from the interview were suitable for causal relation analysis and holistic interpetation. The research is of both logic-deductive and interpretive character. The case study has also registered manager activities within the crisis context and analyzed its relation to the ACap. A separate analysis was conducted on consolidation strategy results based on contraction a consultant applies on a crisis-stricken market and on production expansion results by means of which a consultant tries to break into the energetic sector market niche. It has been noted that the ACap growth has been significantly influenced by the cost component and the organizational structure. It has been generally concluded that the Acap theory models can significantly improve strategy organization when used by the management in strategic positioning and crisis situation resolving.

ABSORPTIVE CAPACITY MODELS AND MANAGERIAL ROLES

Three theoretical models created by Cohen and Levintal (1990), Van den Bosch et al. (1999) and (2003) and Zahra and George (2002) will be discussed in detail within the management scope context. Cohen and Levintal (1990) offered the first definition and structured explanation of ACap term. According to these authors ACap is three-dimensionally defined as a combination of related abitilies of recognizing, accepting and exploiting knowledge from environment. The authors recognize in the process the 'Prior Related Knowledge' - (PRK) as the sole ACap point of reference claiming that no absorption and usage of new knowledge from the environment is possible without a sufficient level of PRK. R&D programs are singled out as the ACap moving force which is essential for a proactive behaviour of the organization. Valuable contribution to the organization is made by innovations which, based on managerial decisions, are adopted from the exogene knowledge potentials. The applied component of this model is represented by strategies based on the production market expansion which is considered to be the answer to the production market threat.

By reconceptualization of Cohen's and Levintal's model Zahara and Georg (2002) four-dimensionally define ACap as a combination of organizational routines and acquisition, assimilation, transformation and exploitation strategic processes. The knowledge acquisition and assimilation enable a valuable contribution in form of strategical reorganization ability - 'Potential Acap' (PACap) while the knowledge transformation and exploitation represent the 'Realised Acap' (RACap) upon which the innovations and performance parameter improvement are based. The authors also differentiate the PRK by identifying two categories: the PRK from external sources such as aquisitions and other interorganizational relations and the intraorganizational PRK which is based on the past experience and the 'learning by doing' principle. Managerial role is therefore a complex one, has a time component and relates to observation of exogene and endogene situations (activation triggers such as crisis and innovation within the environment, social integration and newly acquired knowledge protection mechanisms which are incorporated into the innovative products or processes). Moreover, the managerial role is the crucial one for transforming the PACap into the RACap. Sustainable Competitive Advantage is achieved by performance level, process and production innovation strategy and strategical flexibility.

The Van den Bosch et al. model (1999) is directed towards the ACap organizational determinants. This model explains the PRK as 'Component Knowledge' (CK) related to knowledge about the products or services, production processes and market environment. Such PRK can be stored within the organization, organizational traditional environment or a larger environment. The authors have offered a four-dimensional model (evaluation, acquisition, integration and commercial utilization) which consists of ACap efficiency, scope and flexibility factors. The efficiency relates to identification, assimilation and knowledge utilization methods from marketing and economic perspective. The scope relates to CK range the organization operates on. The flexibility relates to the limit up to which the organization can acquire further knowledge and/or reconfigurate the existing one. While the efficiency is related to the exploitation adaptation of the organization, the scope and the flexibility are related to the exploration adaptation of the organization. A stable knowledge environment implies the exploitation strategy, while the turbulent knowledge environment implies the exploration strategy which results in forming the managerial strategies as active or reactive ones.

Furthermore, the authors focus on the ‘Organizational Form’ (OF) and ‘Combinative Capabilities’ (CC) which, besides PRK, form the Acap ‘Organizational Determinants’. OF must be interpreted as a infrastructure which enables related evaluation, assimilation, integration and knowledge utilization processes. There is no doubt that different organizational structures (interorganizational structures included) will influence the ACap differently. The modfication of OF also means the reconfiguration of knowledge and vice versa (Van den Bosch et al., 2003). The very reconfiguration of knowledge is one of the main managerial leverages.

The CC can be divided into three categories. The first category are ‘System Capabilities’ (SC) which are a combination of formalized directives, instructions, statutory policies and procedures (prescriptive knowledge) and technical information and/or method and tool characteristics (descriptive knowledge). The prescriptive and the descriptive knowledge form the explicit knowledge category (Nonaka, 1994) which basically reduces the need for communication and coordination among specific organizational structures and individuals. The second category are ‘Coordination Capabilities’ (CoC) which represent the capability of lateral coordination among members of the specific organizational groups (DeLeeuw and Volberda, 1996). The third category are ‘Socialization capabilites’ (SoC) which by their group identity and collective interpretation create system of values, beliefs and organizational culture. By socialization ability a dominantly ‘Tacit’ knowledge is transfered – an implicit category of knowledge which exists in non-coded forms and can therefore not be expressed formally and is dominantly transfered from one individual to another by action imitation. It is based on personal knowledge, skills and practice as well as on subjective experience. ‘Tacit’ knowledge is included into technological knowledge in an unexpectedly large amount. What is interesting is that this amount is not reduced when applying contemporary sophisticated technologies – on the contrary! (Perrin, J.1990)

CASE STUDY

Although the Croatian construction market is a small one and the GNP shares significantly lower than those in EU, due to the effects of investing into the fixed capital, the construction industry is an important moving force in GNP growth and due to the number of employees also an important factor of social peace (at present moment the construction industry is employing ca 100.000 workers which is about 11% of working population all together). Moreover, the share in the GNP and construction work value have been continously increasing since the crisis in 2000 when the figure in question was only 3.9%, while in 2008 it grew up to 5.9% (Anušić and Pogačić, 2008, p. 514). The last decade has been marked by a trend of enlarging small companies, while the number of large companies has stagnated and is in accordance with the EU trends where the small and medium-size companies adapt to market requirements more easily. Since smaller companies in Croatia are identified with private initiative while the larger ones are at the public works market, it leaves no doubt that a major change of already established trends will occur during the already present recession process. The value structure of performed works is characterized by a large scope of road infrastructure construction works (about 40% in 2008) which is associated with the state programs of highway construction and reconstruction of the existing road network. It can be stated that the state demand in this segment is so large that it has formed the overall relations in national construction industry to a large extent. Since 2001 a continuous growth has been recorded on the housing construction market (about 17% in 2008), so that it is being estimated that about 25.000 flats of average 85 m2, that is, about 2.125.000 m2 of housing space was built in 2008. According to the available data, the consultants operate through ca 4000 companies which employ about 7200 certified engineers. About 3800 companies employ less than 5 certified engineers, while only one consultant has more than 1000 employees, 500 of those being certified engineers (Anušić and Pogačić, 2008, p. 508).

Crisis Context of Case Study

The GNP has been growing in Croatia also in the last quarter of 2008, so that it was 0.2% higher than in the last quarter of 2007 (which is the lowest quarter growth in the last nine years). What is interesting is that this minimal growth was a result of construction industry activities which grew for 7.3%. (Anušić and Pogačić, 2008, p. 506). This enabled Croatia to join the small group of European countries which have made at least some growth. However, while the European countries felt the largest impact of the financial crisis caused by a large recession in manufacturing industry already at the end of 2008, this impact will reach its peak in Croatia in the first and the second quarter of 2009 because service industry has a larger share in Croatian economy. The consequences of banking crisis were swiftly manifested in run-up in interest rates of loans which in the housing sector resulted in falling-off in housing sales, so that there were about 15.000 unsold flats on the market by the end of the first quarter. The same reasons caused a slowing down of the individual housing construction as well as the initiative of smaller contractors in housing industry. A further fall in prices of flats is beyond dispute, especially of flats of lower category at less attractive locations. The government anti-recession program with budget revision resulted in public investment reduction. It is being estimated that the performed work scope in road construction sector in 2008 will be about 75% in relation to the planned scope. As a result of a high balance on current account deficit and a large foreign debt the state can not get onto new debt. That will result in permanent reduction of public works and national construction industry crisis which could last for several years. It can not be excluded that the existing recession movements could aggravate and reach the depression movement level in the following years.

It leaves no doubt that the recession crisis has accentuated the problems of national economy and thereby the influence of crisis on the national construction industry. From the characterization of the ingoing and outgoing market obstacles at the construction industry market can be seen that the ingoing market obstacles are high and the outgoing low, which resulted in the high and stabile profits characteristical for the consolidated market. However, it has been evident for at least past five years that the conditions of long-term profitability and market sustainability have not been met because the life-cycle of construction industry in road construction was at its inflexion point during 2004 by which the conjuncture stage with further tendency towards a mature industry with a continuous decrease in growth was finished. Nevertheless, under such circumstances, the majority of the market participants has developed the Grand Strategy as the continuity strategy and/or growth strategy. The continuity strategy has been, as a rule, of a defensive nature with the primary intention of keeping the market share. The growth strategy choice primarily refered to the internal growth with penetration (share growth on the conquered market with already existing products), which particularly marked the strategic behaviour of housing construction companies. Except the internal growth strategy which also implied the market expansion (to foreign markets), the external growth strategy with a vertical and a horizontal integration was also present in infrastructure engineering. Due to the all-pervasive penetration competition strategy on the Croatian market this strategy has partly taken hold exclusively on the foreign market. The production expansion based on assortment and service development on the existing market which will be accomplished by the related or conglomerate diversification strategy has stayed at a low level. As far as generic business strategies (Porter, 1980) are concerned, it is to be expected that the differentiation strategy will give way to the market performance strategy, that is, the competition through low costs. The national construction industry is behaving reactively under the circumstances of incoming crisis and is primarily trying to overcome the current performance crisis (liquidity and solvency crisis), while it has not yet examined the current performance crisis effects and the strategical position crisis effects. Thereby, the well-known fact that the construction industry is actually a very open and sensitive, but also inert and traditionally conservative system has been proven once again!

Nevertheless, it must be noted that the market niche has gained status on the national market, is related to the investments in the energy sector and has been continually growing so that it has been estimated that it has reached 10% of total completed construction industry work value in 2008. This market niche comprises the investments which are mostly defined by the Energy strategy of Republic of Croatia in the total amount of 13.500 million Euro up to 2020 (gas transport system, LNG terminal, power plants – in total 5375 MW). It is expected that about 60% of works should be performed by a domestic industry (engineering, construction, installation and equipment works), that is a total of about 8.000 million Euro. Although the investments into the energy sector are risky, complex and broadly conditioned, it is justified to believe that exactly those investments will be the ones to shape the construction industry.

Research Methodology

The paper presents an explanatory single-case study of Croatian consultant organization (CCon) conducted under contemporary crisis conditions. Intention was to explain real-life managerial strategies in the organizational ACap body of knowledge context. Such approach is based on the fact that the ACap is the adequate mediator instrument among theoretical preferences and empiric phenomena. Analytical generalization has been based on the ground of single-case study revelatory nature. In that way, case study represents the vehicle for examining managerial strategies in a broad construction neighborhood, so further case study replications should be performed for external validity testing (Yin, 2003).

The analytical model is directed towards the phenomenological research of actor's lived experiences, so that the data which was obtained by interviews were adequate for causal relations analysis and holistic interpretation. The research has both a logic-deductive and an interpretive character. The research is approached to ‘Grounded Theory’ theses (Strauss and Corbin, 1998) mostly through researcher position and ongoing self-reflection by collecting, interpreting and analyzing data. The data has been collected through direct observation and semi-structured interviews (25 interviews) with key actors – mostly the senior management, selected in accordance with their authority to create or participate in strategic decisions creation (10 functional managers including CEO, 3 former CEO, 4 managers of main regional units, 8 project managers). Since no examinee had any detailed knowledge about the ACap, the data were relatively rough, but uncontaminated. The role of the researcher in interview was to find out and select the intuitive managerial actions which can be recognised and explained from the aspect of chosen theoretical ACap models.

CCon Case Study

CCon is the largest national consultant company and market leader in the south-eastern Europe, a specialist and the main state consultant for capital infrastructure projects in road construction. The remaining part of the business portfolio such as design in hydraulic engineering, building construction, environmental engineering, geotechnical design and geotechnical investigation work, proof of quality for concrete, reinforced-concrete and steel structures has also a considerable market share. CCon has the monopol in laboratory industry because it has 90% of market (quality control, quality assurance programs, conformity certificates, technical approvals, laboratory and in-situ testing – 350 test methods) througout a net of 20 accredited laboratories covering an area where it provides its consultant services. The volume economy is CCon's traditional strategy and endogene measure by which a high and discuoraging market entrance barrier is created for the competition. However, due to the size of investment into the infrastructure and laboratory industry this barrier also represents a high market exit barrier which limits the dynamic capabilities of the company. On the other hand, this strategy is vital for shaping the basic competence which is found in the CCon's capability to test, prove and develop theses by using its own research and scientific potential and build them into its products thus covering all the work of construction industry. The general strategic CCon intention or vision about having a full scale and trustworthy product based on professional and scientific enquiry was created on this idea.

It can be concluded that CCon does not build its competition capability on low cost (while at the same time the competition uses the parity principle and tries to make the customers believe that it offers the same quality and scope of services for a lower price and is therefore more successful at customers who look for lower price offers). The CCon business strategy is based on a generic differentiation strategy with the requirement of creating superior products which will outrival the differentiation costs with their market price. Through the requirement for product innovation, high quality and highly developed attitude towards the customers, this very differentiation strategy comprises all the elements of coevolutionary effects of a firm ACap which were explained by Van den Bosch et al. (1999, p. 599). Furthermore, Zahra and Georg (2002, p. 195) state that the Sustainable Competitive Advantage is reached by the performance level, process and production innovation strategy and strategical flexibility, which is also congruent to the generic differentiation strategy. However, the term of educating the customer to recognize the value of the product is linked to the differentiation term. In construction industry, the ‘signal criteria’ for recognizing the value of the product are mostly correlated with the client's competence. CCon actions of supportive training and knowledge transfer towards the clients are undertaken in order to reach the PRK congruency. It is reached by opening specialized communication channels, co-autorship in writing scientific papers, choosing the topics of applied researches and other. The final goal is to design the value chain of customers and to direct their preferences towards loyalty. CCon spends 25% of time of medium nanagement and leading engineers for that purpose. Although based on the experience and intuition, this strategy is completely congruent with the theoretical theses about interorganizational merging whose purpose is to transfer the technological or organizational knowledge which will depend on PRK congruency of single organizations (Lane and Lubatkin, 1998).

CCon is by all means a ‘knowledge intensive’ organization. The awareness and the need for strengthening the PRK are part of the organizational culture. There is also an intuitive awareness of correlation between the PRK, ACap and the company proactivity. CCon carries out numerous intriguing programs by which professional and scientific education of its professionals is stimulated. It can therefore be concluded that there is a satisfactory level of ‘explicit-to-tacit’ knowledge conversion, that is, knowledge internalization. Nevertheless, the ‘tacit-to-explicit’ knowledge conversion, that is, knowledge internalization is on a lower level. It has also been noted that neither KM ‘codification’ strategies nor KM ‘personalization’ strategies are sufficiently structured, by which the temporary organizational forms of project type and the prominent teritorial divisional organization charts were aggravating circumstances so that a loss of corporate knowledge form project-to-project has been present and strongly reflected on the PRK level. Starting from the CK definition by Van den Bosch et al, (1999, p. 552), CCon shows an affinity to knowledge related to the products and services while the knowledge related to the production processes and knowledge related to the markets is in the background. It is possible that such a CCon preference is a result of a strong identity related to SoC (Van den Bosch et al., 1999, p. 557) which is identified with the technically-technological, rather than organizational knowledge. In that sense a quite closed and specific environment is generated which negativelly influences the ACap level increase. Surely, those interesting indications should be confirmed by a detailed research with a time component for which the longitudinal case study is more adequate.

CCon's business portfolio has been positioned in the maturity stage of construction industry life-cycle and the competitive position of CCon SBUs is positioned from favourable to dominant. This is a good position for resource utilization and therefore the profit, that is, ‘exploitation’ strategies dominate (Van den Bosch et al., 1999, p. 553). However, there is a CCon management awareness that, by acting within the same industry, the whole portfolio is evenly exposed to consequences of life-cycle industry dynamics, so that the optimization or strategical regrouping within the portfolio will have neither significant nor permanent effect. The management is also aware that the internal growth strategies do not guarantee a permanent stability. Therefore the surplus cash flow is not spent on further strengthening of the position but on the external growth with market expansion to new (foreign) markets and expansion to borderline industries by a concentrated and conglomerate diversification. The concentrated diversification and the focusing on the energy sector market which is in its growing life-cycle is of special importance because it offers the possibility of a swift and prompt reaction which is very important in the incoming crisis conditions, while the expansion to the foreign markets is a longlasting process which will be obstructed by the crisis. The quickness of production expansion into the energy sector will depend on the capability of acquiring technological and organizational knowledge, that is, it will depend on the firm's ACap.

The immediate crisis threat resulted in a crisis strategy with accentuated time and cost component which developed in two directions: the first one which relates to the strategies on the existing construction industry market and the second one which relates to the concentration on the energy sector niche. On the existing market (especially the road construction one) the contraction based consolidation strategy was applied. The contraction was achieved by organizational reform in which the existing broad teritorial and divisional organizational form was substituted by a rigid functional form. The resource surplus within the same functional form was allocated to tasks of market and production expansion. The management justified this action with cost effect attainment based on the production redundancy reduction. When analysing the mentioned action through the ACap presented models it can be concluded that this measure will surely have a negative effect on ACap, that is, that it can be only conditionally accepted as a transition or intervention measure. Longer functioning within this organizational frame will result in PRK reduction. The CCon management based the strategy of concentrating on the energy sector niche on the external growth. The external growth was reached by horizontal linking into strategical associations and by acquisition of experts. The assimilation of knowledge from the environment has had a large and, what is equally important, a swift effect on PRK and ACap increase which was necessary for acquiring knowledge required for the production expansion. Starting the detailed analysis of this strategy's achievement from the CC concept (Van den Bosch et al., 1999, p. 556) it can be observed that the CCon has concentrated on so called SC, that is on the explicit knowledge integration through the usual coded forms (procedures, codes, manuals, information systems) in which process the utilization of the internal potentials and knowledge supplies remained in the background. At the same time, the new CCon rigid functional organizational architecture has prevented the CoC (lateral communication, of authorization assignment and participation in decision making) to a great extent, thus obstructing the ACap growth. Therefore the increase of the reached PACap level could have been noted through the increase of the strategic flexibility, but also the difficulties in its operationalization. The CCon management has justified the absence of RACap by cost demands the management was not prepared to meet which were strongly intensified by the current performance crisis, especially the liquidity and solvency crisis. At the moment of writing this case study the management had not recognized that the positive effects of total ACap growth will outrival its immediate cost component, which meant an inclination from the pricey strategical action of focusing on the differentiation, towards the strategical action of focusing on the cost efficiency.

CONCLUSION

Zahara and George (2002, p. 193) regard the crisis as an important external or internal activation trigger which connects the PRK and the PACap acquisition and assimilation processes, while Van den Bosch et al. (1999, p. 553) consider the turbulent environment as the vital one for exploitation path and strategies to exploration path and strategies transition. It must be concluded that the theoreticians have perceived the significance and created the crisis mechanisms influencing the ACap and the knowledge flow in their models. It must also be noted that the term ACap combines the capability of knowledge acquisiton from interogranizational relations with intraorganizational learning processes, yet is not the phenomenon per se but is a result of managerial activity and environmental influence. The cross case study was presented in that sense and is directed towards the analysis of managerial actions within the crisis context and their well-foundedness on the ACap statements. It has been observed that, apart from the exogene search, observation or anticipation of the crisis threat, the managerial tasks also comprise the endogene interpretation of the crisis. The interpretation is effectuated through the crisis threat reshaping of its intensity, broadness, direction and character and through market component establishment. This modelling is basis for creating a strategical flexibility which will result in creating the strategy action during which the management will be using the driving potential which any crisis threat undoubtfully owns (See Figure 1).

The CCon example shows how the crisis threat has resulted in strategy actions which can be analyzed and evaluated from the ACap aspect. By using the internal growth strategy through production penetration and the external growth based on horizontal integration, The CCon has been trying to raise the PRK level. However the transformation of the PACap into RACap was obstructed mostly due to cost demands and inappropriate organizational architecture which contributed to the low CoC level. The CCon has undoubtedly accomplished the PAcap level increase, but, if the RAcap is to be reached, a managerial perception about the cost feasibility and actions including the additional transformation – integration mechanisms (such as decision-making mechanism and creation of organizational structure and infrastructure) enabling the creation of a sustainable competitive advantage on ACap are required. The presented matter is a practical confirmation of ACap acceptablity division on the ‘Potential ACap’ (PACap) and the ‘Realized ACap’ (RACap) (Zahara and Georg, 2002, p. 190).

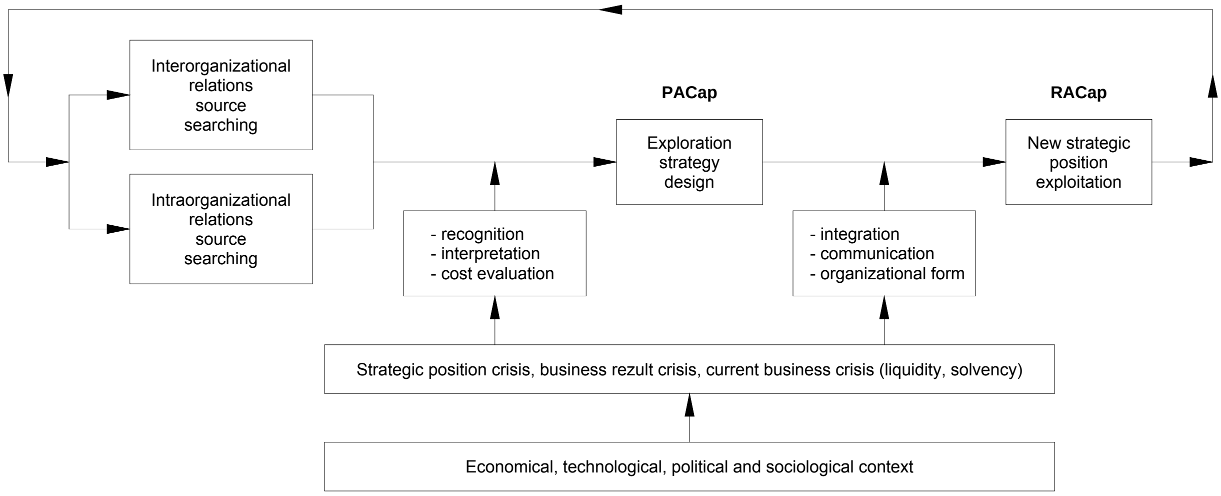

Figure 1: Managerial roles and crisis in ACap context

It can be generally concluded that the ACap theoretical model theses can significantly contribute to explaining and creating the strategies which the management uses for strategical positioning (and crisis situations resolving), but for analytical generalization at the level of construction, further case study replication should be performed. Since the practical application component in construction industry is quite small and the understanding of problems quite insufficient, every comparison of ACap empirical analyses and theoretical models will make a contribution to the matter. The specific quality of the construction production situation must also be taken into consideration because the usual mechanicistic organizational structures (the functional, the divisional and the matrix organization) are combined with temporary organizational forms which can be of a formal (e.g., projects) or an informal character (e.g., informal and spontaneous organizing). Their influence on ACap is a complex one and is not sufficiently explained, which determines the area in need of a research contribution. Moreover, the PRK level and character will be determined by the prolific presence of ‘Tacit’ knowledge which is typical for the construction industry and is an important component of technological knowledge. Therefore it must be examined how this circumstances influences the organizational learning and knowledge flow. Finally, if the ACap concept is to be applied in managerial strategies, a special attention must be paid to cost component. Each empirical research which focuses on the ACap cost component analysis will be a contribution to its practical application.

REFERENCES

Anušić, L., and Pogačić, Ž. (2008) Stanje u gospodarstvu i tržište građevinskih usluga, Sabor hrvatskih graditelja 2008, Cavtat – Zbornik radova, 505 -519.

Cohen, W. M., Levintal, D. A. (1990) Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35, 128-152.

Collis, D. (1994) Research note: How valuable are organizational capabilities. Strategic Management Journal, 15, 143-152.

De Leeuw, A. J. C., Volberda, H. W. (1996) On the concept of flexibility: A dual control perspective. Omega, 2, 121-139.

Fiol, C. M., Lyles, M. A. (1985) Organizational learning. Academy of Management Review, 10(4), 803-813.

Lane, P. J., Lubatkin, M. (1998) Relative absorptive capacity and interorganizational learning. Strategic Management Journal, 19, 461-477.

Nonaka, I. (1994) A dynamic theory of organization knowledge creation. Organizational Science, 5, 14-37.

Perrin, J. (1990) The inseparability of technology and work organizations. History and Technology, 7(1), 1-13.

Porter, M. (1980) Competitive strategy: Techniques for Analizing Industries and Competitors. New York: Free Press

Strauss, A., Corbin, J. (1998) Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Thousand Oaks, CA: Sage.

Teece, D. J., Pisano, G., Scuhen, A. (1997) Dynamic capabilities and strategic management. Strategic Management Journal, 18, 509-533.

Van den Bosch, F. A. J., Van Wijk, R., Volberda, H. W. (2003) Absorptive capacity: antecedents, models and outcomes. Blackwell handbook of organizational learning and knowledge management, Masterby-Smith and M.A.Lyles (Eds), 278-302.

Van den Bosch, F. A. J., Van Wijk, R., Volberda, H. W. (1999) Coevolution of firm Absorptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities. Organization Science, 10(5), 551-568.

Yin, R. (2003). Case study Research: Design and Methods. Thousand Oaks, CA: Sage.

Zahra, S. A., George, G. (2002) Absorptive capacity: A review, reconceptualisation, and extension. Academy of Management Review, 27(2), 185-203.

AN INVESTIGATION OF IT IMPLEMENTATION IN TURKISH CONSTRUCTION FIRMS

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Information technology (IT) provides significant advantages for the construction industry since it facilitates the exchange and management of information. Therefore, effective use of IT may increase construction companies' market share in the competitive business environment. In this study, the current use of IT in Turkish construction companies has been examined. Semi-structured interviews were carried out among 26 construction professionals within local construction companies. The interviews took place over a 3-month period between March and May 2008, and a survey questionnaire was administered during face-to-face interviews. The specific objectives of this study are to find out the current use of IT in these firms and approaches to IT implementation. Moreover, within this study, web sites of 69 construction companies that are all members of the Turkish Contractors Association have been examined to find out how effective they use their web sites. Based on the results, one of the main reasons for having a web site was found as company image. On the other hand, it was determined that the firms do not fully utilize the potential of IT.

KEYWORDS: construction, IT implementation, survey, Turkish construction industry.

INTRODUCTION

Construction is one of the most information-dependent industries; with its diversity of forms of information including detailed drawings, contract documents, cost analysis sheets etc. (Tam, 1999). Information is the driver of the project activities during all the phases of the building cycle. It specifies the resulting product and initiates and controls the activities required for constructing the facility (Rivard et al., 2004). Due to the involvement of many different parties including the client, general contractors, specialized contractors, material suppliers and manufacturers, there is an enormous amount of information exchange among these parties even in small-sized construction projects (Deng et al., 2001).

Communication among parties involved in a construction project is very important and is the key factor resulting to the success or failure of a construction project (Issa et al., 2003). Most of the construction companies still use the traditional way to communicate within their companies and with other parties. Moreover, most of the construction firms exchange documents like drawings and specifications in paper format. The use of these traditional methods in business processes lead to inefficiencies in these processes (Stewart and Mohamed, 2003).

As construction projects have become increasingly complex, companies are forced to find new methods to do business with their partners and other parties effectively. However, the industry seems not to have sufficiently adopted the new technologies compared to many other industries. Lacking network connectivity is a major liability that results in diminishing market share or losing opportunities (Bridges, 1997).

IT is defined as 'the use of electronic machines and programs for the processing, storage, transfer and presentation of information' (Bjork, 1999). IT has brought many advantages and opportunities to almost every industry in operation speed, collaboration, accessibility and exchange of information (Stewart and Mohamed, 2003). The use of IT improves coordination and collaboration between firms participating in a construction project (Nitithamyong and Skibniewski, 2004).

Especially the Internet has opened a new era and provided great advantages in business activities. Using Internet as the communication platform can help information transfer more effectively during the construction process (Tam, 1999). Moreover, it opens new business opportunities for construction organizations such as 'e-Trading' and 'e-Tendering'.

Several studies have been carried out to address the needs and trends of IT in construction in the future. Anumba and Ruikar (2002) identified some of the emerging trends of electronic commerce that could be used in the construction industry. These are M-commerce; wireless communications that will remove the need for cables connecting computer equipment; ubiquitous computers; and agent-based procurement of goods and services.

Sarshar et al. (2002) carried out a literature review and discussed the likely trends in the future application of IT in construction and based on these subjects, they proposed a scenario for the vision implementation during different phases of the construction project life cycle; conception of needs, tendering and team selection, design and briefing, construction, and facilities management. Froese (1999) proposed a diagram that shows IT trends in the construction industry. Moreover, in their study, Froese et al. (2001) indicated that richer forms of communication and information sharing will be the dominant role of IT in the future.

E-tendering is still not dominantly used in this industry but it is set to grow. Trading business to business electronically is the area that will increasingly be grown in the future in this industry.

THE SURVEY

The current use of IT in Turkish construction companies has been examined in this study. Within this context, semi-structured interviews were carried out among 26 construction professionals within local construction companies. The interviews took place over a 3-month period between March and May 2008, and a survey questionnaire was administered during face-to-face interviews. The specific objectives of this study are to find out the current use of IT in these firms and approaches to IT implementation.

Reasons for Having a Website

The respondents were asked the reasons for establishing a website. The main reasons for establishing a website are found as company image and advertising (Table 1). The majority of the respondents stated that the Internet platform could be an opportunity for improving the image of their companies. On the other hand, it was found that e-commerce is not widely used in these companies. Moreover, security issues were considered by the majority of the respondents as a major problem in having a website.

Table 1: Reasons for having a web site

Reasons for having a web site	(%)
Company image	26.9
Advertising	26.9
Marketing	19.2
Communication	11.5
Sharing information	11.5
E-commerce	4.0

Communication Tools

The participants were asked to indicate the communication tools used in the company in order to determine the type of connections with their suppliers, partners and customers. According to the results the companies mostly use phone, the traditional method, to communicate with other parties. E-mail is also extensively used however, wireless technologies seems not to be adapted in the majority of the companies for communication. The results show similarities with the survey done in USA (Issa et al., 2003), in which traditional means were also very common in communicating with other parties. Moreover, the majority of the interviewees considered face-to-face communication as an effective way to communicate with the clients, customers and partners.

The participants were also asked the most important reasons for using communication tools. Based on the analysis, easiness to use (69.3%) was determined as the most important factor in selecting the communication tool. On the other hand, the cost of the communication tools (7.6%) was not considered as a major factor.

IT Investment

In this study, IT investments of the companies have been investigated. According to the results, IT investments constitute only 1-5% of the annual total cost of the firms in more than half of the companies (Table 2).

The respondents were also asked the monthly IT investments in their companies. In more than half of the companies (18 out of 26), the average monthly IT investments are below $1500. Although the share and the average monthly IT investments are relatively small in the majority of the companies, the respondents indicated that they plan to increase the IT investments in the next 5 years. This shows that the firms are willing to implement IT tools even though the high cost, but the vital factors are providing them training for using these tools and user-friendly systems. The results correlates well with the studies done both in the UK (The IT Construction Forum, 2004) in which the respondents were addressed the IT investment as 42% more in the next 3 years, and in Canada (Rivard et al., 2004) in which the participants responded the IT investment as 64% more in the next 2 years than the current level.

Table 2: IT Investments

No. of companies	Share of IT investment in annual total cost (%)
14	1-5
5	6-10
6	11-15
1	more than 15

IT Usage in Business Processes

The use of IT tools in business processes was evaluated in this study. According to the analysis, in more than half of the companies (14 out of 26) the business processes are highly computerized. As illustrated in Table 3, IT tools are mostly used in accounting/finance. On the other hand, the tendering process is generally performed manually and based on paper format. Moreover, one company plans to establish a live-online camera system to control the ongoing works at construction sites. The interviewee of this company stated that the problems to establish such a system are the cost of this technology and lack of IT infrastructure.

The results show similarities with the survey done in Canada (Rivard et al., 2004), in which highly computerization in invoicing, specifications and bookkeeping was determined. However, the tendering process shows a higher percentage in computerization in the Canadian construction industry. E-tendering is still not widely used in Turkish construction firms. The bidding process is still mostly based on paper format. This result also correlates well with the survey conducted by Mui et al. (2002) in the Malaysian construction industry in which only 16% of the firms were involved in bidding of projects through Internet.

Table 3: IT usage in business processes

No. of companies	IT usage
12	Accounting / Finance
6	Design
6	Estimating
6	Invoicing
4	Tendering

Approaches to IT Implementation

The respondents were asked the company's approaches to adapt new technologies within their firms. Based on the responses, the majority of the firms follow the advanced technologies in the market and try to adapt them where possible. Almost half of the interviewees (10 out of 26) stated that they want to be one of the first users of the new technologies. However, the cost of the new technologies seems to be a challenging issue to adapt them for the business processes. On the other hand, 6 out of 26 participants indicated that the current technologies are enough for their works and do not feel any need to adapt advanced technologies.

INVESTIGATION OF THE WEB-SITES

In this study, web sites of 69 construction companies that are all members of the Turkish Contractors Association have been examined. The aim of this investigation was to find out how effective the companies use their web sites.

During the investigation, the web-sites of 3 of the companies could not be reached. 2 of these web-sites were not opened and one of them was still under construction. Therefore, 3 of the company web-sites were eliminated and the investigation was performed among web sites of 66 construction companies.

It was found that in 56 of the web sites the English translation is also available whereas in 8 web sites there are more than 2 languages used. However, 4 companies have not enough information in English, e.g. not all web pages in their sites are translated to English.

During the study, information about both completed and ongoing projects of the companies are investigated. In 50 out of 66 company's web sites, information can be obtained for both completed and ongoing projects of the companies. However, in only 38 of the company's web pages, enough information is given about the projects. Starting and completion date of the projects, bid amount, location and photos about the projects can be found in the web pages of these companies. Moreover, in 46 of these 50 web sites the English translation of the projects is also given. However, it was also found that only 27 out of these 46 firms regularly update information about their ongoing projects. Furthermore, it was determined that in 37 out of these 50 web sites the projects have been categorized according to project types such as transportation, dam, housing, airport and water structures.

The majority of the companies have been operating in the housing sector and involved in the real estate market. Therefore, the availability of e-commerce applications on the web sites of these companies is also investigated. It was found that only 5 of these firms have e-commerce applications on their web sites. E-commerce, as mentioned earlier, can give significant advantages in the competitive market. Thus, the relatively small number of companies that adapted e-commerce applications shows that IT usage is not fully utilized in the majority of the companies.

Online job applications can give the advantage of saving time and reducing paper work in the recruitment process. The availability of job application from the web sites of the companies has also been investigated. It was determined that there is access to online job applications in more than half of the company's web pages (37 out of 66). On the other hand, 32 of these companies have also online job application options prepared in English.

All of the companies have contact and e-mail addresses on their web sites. In order to find out the response rate for the e-mails, an e-mail was sent to all of the companies. The same e-mail was sent to all of the companies and some information (prices of products, information about the project etc.) was requested in these e-mails. During this study, 16 e-mails could not be sent because the contact addresses of these companies were not valid (Table 4). Only 7 companies responded to the e-mails. 6 of them responded within 24 hours while 1 of them responded within 48 hours. According to the results, although a valid contact address is given on the web sites, the relatively small number of responses may show that communication via e-mail is not effectively used in the majority of the companies.

Table 4: Responses to the e-mails

Responses to the e-mails	No. of companies
Within 24 hours	6
Within 48 hours	1
No response	43
Invalid contact address	16

CONCLUSIONS

The rapid developments in technology will continue to influence the construction industry in the future. Contractors, clients and other parties involved in a construction business will inevitably be participate more in design and operation through electronic tools. IT benefits include better communications, decrease in communication errors, increase in speed and quality of work, better financial control, and simpler and faster access to common data. Therefore, effective use of IT can increase construction companies' market share and chance of surviving in the construction industry's competitive business environment.

In this study, the current use of IT in Turkish construction companies has been examined. Semi-structured interviews were carried out among 26 construction professionals within local construction companies. Moreover, web sites of 69 construction companies that are all members of the Turkish Contractors Association have been examined to find out how effective they use their web sites.

Based on the survey results, the main reasons for establishing a website are found as company image and advertising. IT investments in the majority of the companies share a relatively small percentage of the total cost. However, the companies plan to invest more in the near future. Furthermore, e-tendering is still not widely used in the companies.

One of the main benefits of IT is preventing possible communication errors. However, the firms included in this survey have still mostly been using traditional means of communication, i.e. phone which may lead to an increase in possible communication errors.

The majority of the companies do not use e-commerce applications that can give significant advantages in the competitive business environment. In conclusion, the majority of the construction firms surveyed do not fully utilise the potential of IT, but they feel the need to catch up with IT, and therefore they are willing to implement IT tools more in the future.

REFERENCES

Anumba, C. J. and Ruikar, K. (2002) Electronic commerce in construction – trends and prospects. Automation in Construction, 11, 265-275.

Bjork, B. C. (1999) Information Technology in construction: domain definition and research issues. International Journal of Computer Integrated Design and Construction, SETO, London, 1(1), 3-16.

Bridges, A.H. (1997) Implications of the internet for the construction industry. Automation in Construction, 6, 45-49.

Deng, Z. M., Li, H., Tam, C. M., Shen, Q. P. and Love, P. E. D. (2001) An application of the Internet-based project management system. Automation in Construction, 10, 239-246.

Froese, T. (1999) Interwoven threads: trends in the use of information technologies for the construction industry. A white paper prepared for Berkeley-Stanford CE&M Workshop.

Froese, T., Waugh, L. and Pouria, A. (2001) Project management in the year 2001. Proceedings of Canadian Society of Civil Engineers Annual Conference, Victoria, Canada.

Issa, R. R. A., Flood, I. and Caglasin, G. (2003) A Survey of E-Business Implementation in the US Construction Industry. Electronic Journal of Information Technology in Construction, 8.

Mui, L. Y., Aziz, A. R. A., Ni, A. C., Yee, W. C. and Lay, W. S. (2002) A Survey of Internet Usage in the Malaysian Construction Industry. Electronic Journal of Information Technology in Construction, 7.

Nitithamyong, P. and Skibniewski, M. J. (2004) Web-based construction project management systems: how to make them successful?. Automation in Construction, 13, 491-506.

Rivard, H., Froese, T., Waugh, L. M., El-Diraby, T., Mora, R., Torres, H., Gill, S. M. and O'Reilly, T. (2004) Case studies on the use of Information Technology in the Canadian construction industry. Electronic Journal of Information Technology in Construction, 9.

Sarshar, M., Betts, M., Tanyer, A. M., Aouad, G. and Underwood J. (2002) A Vision for Construction IT 2005-2010: Two Case Studies. Engineering, Construction and Architectural Management, 9(2), 152-160.

Stewart, R. A. and Mohamed S. (2003) Evaluating the value IT adds to the process of project information management in construction. Automation in Construction, 12, 407-417.

Tam, C. M. (1999) Use of the Internet to enhance construction communication: Total Information Transfer System. International Journal of Project Management, 17(2), 107-111.

The IT Construction Forum (2004), ''Survey of IT in construction'', available at: www.itconstructionforum.org.uk

APPLYING MANAGEMENT INFORMATION SYSTEM IN CONSTRUCTION INVESTMENT PROGRAMMES: A CASE STUDY FOR A PUBLIC SECTOR COMPANY

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Investment programme management for the Greek railway modernization, undertaken by a public sector company (ERGOSE) necessitates the development of a corporate Management Information System (MIS). The system objective is to support the majority of the corporate processes, such as conceptual planning, design, procurement, expropriations and construction activities from the tendering phase to project completion. The system was designed and implemented in various phases with a common methodology, taking into consideration public sector related aspects and constraints stemmed from European Union funding processes. The system operation resulted in the significant improvement in the information control and flow between the various organizational units and with third parties, minimizing the time and efforts needed in order to support the requisite public sector bureaucratic procedures, regulations and legislation. The key benefit of the system is the significant improvement of the corporate project management effectiveness, efficiency and maturity.

KEYWORDS: MIS, project management.

INTRODUCTION

Corporate profile and aims

ERGOSE S.A. (ERGOSE, 2009) is a subsidiary of the Hellenic Railways Organization OSE (OSE, 2009), founded in 1996 in order to undertake the management of the organization's investment programme projects and in particular those co-funded by European Union (EU) programmes: European Regional Development Fund (ERDF), Cohesion Fund and Trans-European Transport Networks. The strategic investment plan for the development of the railway corridor has a total budget of 6,2 billion Euros (2000-2015).

ERGOSE's mission is the management of all activities related to the project implementation of the new railway network in Greece: programming, design, expropriations, construction, procurement, quality control. The company's main aims are: (a) to maximize absorption of the Greek and EU funds placed at the disposal of OSE for the modernization of its railway network and installations, which will benefit the Greek railways and the national economy; (b) to ensure that each of the approved Investment Programme items is delivered to OSE on time and at an acceptable cost and quality so that its economic value and appropriateness to OSE's goals are realized.

ERGOSE has developed a Company Quality System (CQS) in order to provide reliable project management services. The company has the following certifications (which are renewed in a tactical basis): International Standardization Organization (ISO) 9001:2000 and Occupational Health & Safety Assessment Series (OHSAS) 18001:1999.

Corporate Information Technology systems

The main aim of Information Technology (IT) and Infrastructure directorate in ERGOSE is the design, development, installation, operation and maintenance of important and innovative Information Systems (IS), in order to organize and improve corporate project management effectiveness and efficiency. It is important to state that a MIS should not be the only IT system in a company. Usually the upper level managers believe that a MIS will provide the “magical” solution to all their issues, but this is not the case. MIS is the most important IT system for the top level managers, but at the same time the installation and operation of several other IT systems that have on-line and batch interfaces with the MIS can highly contribute to the efficient support of all the corporate processes and procedures.

In this aspect several IS have been developed, customized, installed and are in operation the recent years, such as: (a) Primavera Project Planner Enterprise P3 for monitoring the time plan of design and construction projects; (b) Enterprise Resource Planning (ERP); (c) Human Resources Management System (HRMS); (d) Business Plan Monitoring System for the control and monitor of the corporate business plan with the concept of balanced scorecard and key performance indicators (Kaplan and Norton, 1996); (e) Geographical Information System (GIS) (Tomlinson, 2003), in cooperation with the Land Surveying Design department of ERGOSE, with Spatial Database Engine (SDE) technology (Peters, 2008) and Linear Reference System (LRS) approach (Buttler, 2008). GIS monitors and displays: the railway network and the progress of designs and constructions projects, based on orthophotomaps and satellite images.

The most important and innovative IS in ERGOSE is the MIS. The system was designed by the Information Technology directorate and developed in various phases during the recent years (2003-2008). MIS covers almost all corporate processes (programming, procurement, design, construction, expropriations, finance, document management etc.) and has on-line and batch interfaces with the rest of the IS (ERP, HRMS, GIS, Business Plan, Primavera etc.). MIS main scope is to organize, standardize, control and monitor the data and the information flow of the main corporate processes. MIS resulted in improving the company’s project management effectiveness as well as assisting substantially in various areas of important and vital decision making processes.

Paper purpose

In the paper the MIS objective is defined, acknowledged the important considerations that a MIS project manager should be aware off prior to the design of the project, and particularly when the project is applied in a programme management public sector company with constraints derived by National and EU legislation and regulations. Further on, the MIS project methodology and project implementation approach in several phases is presented. Finally the results of the MIS operation and the corporate benefits are analyzed. A preliminary paper (focusing on the technical aspects of the MIS) has been published in the Construction in the 21st Century 5th International Conference proceedings (Stavrinoudakis, 2009).

SYSTEM OBJECTIVE AND SCOPE

In 1995 the Organization for Economic Co-operation and Development **(**OECD**)** emphasized the following significant areas in facilitating the exacting of maximum organizational benefits from IT: (a) enhancing management, planning and control of the IS functions; (b) using technology to redesign and improve administrative processes; (c) providing better access to quality information; (d) harnessing the potential of new technologies; (e) developing and applying standards; (f) attracting and retaining high-caliber IS professionals; (g) increasing research into the economic, social, legal and political; (h) implications of new IS opportunities; (j) assessing experiences.

The operation of IS especially in the public sector has significant results in (Andersen, 2005):
(a) In the quality of information and data.
(b) Efficiency in operations: productivity gains, managerial control of subordinates and processes, and time-savings.
(c) Effectiveness of administration: improved planning and improved product and services
(d) Coordination, cooperation and communication between the corporate departments and with third parties
(e) Organizational control.

Realizing the benefits that we can achieve by a MIS and in order to define the system objective and scope, we identified the information flow and the obstacles that we needed to overpass which derived by our corporate profile. The incoming and outgoing information and data for an investment programme project management company co-funded by EU, follows the procedures of National and EU legislation which is modified constantly with complicated data flow processes. ERGOSE exchanges data with various companies, consortiums (tender participants, contractors), public administration, organizations, prefectures, municipalities, EU, managing authority, auditors etc. (Figure 1). The amount of data is vast and not coded. Data are neither normalized nor produced via proper IT systems, like the banking, telecom, and retail field. At the same time important part of these data are based on incoming and outgoing correspondence and a significant amount of document archives (contractual data, designs, as built drawings etc.) both in paper and electronic form needs to be maintained, controlled and monitored efficiently. Except from a complicated project management programmme, it is crucial to control and monitor, as efficiently as possible, the quality of the designs & constructions and the health & safety aspects in the construction sites (railways lines, tunnels, bridges, roads etc.).

The MIS objective is to assist the decision support functions on almost all corporate processes, such as: programming, procurement, design, expropriations, construction, document management, finance, quality control, quality assurance and health & safety.

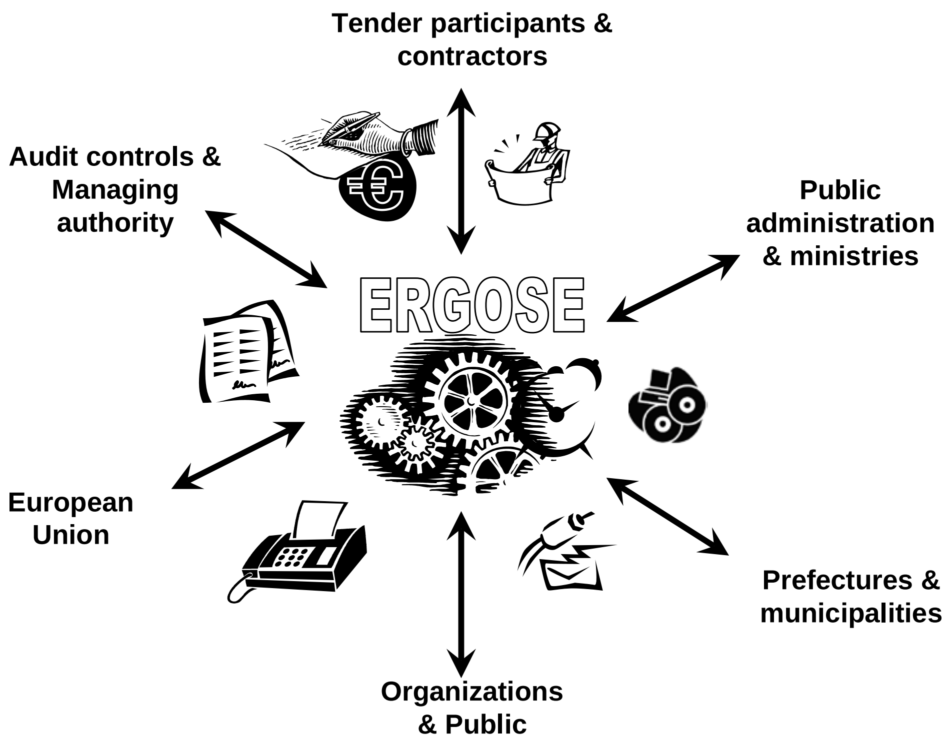

Figure 1: Information and data exchange between ERGOSE and third parties

The MIS scope is to:

(a) Organize, standardize, control and monitor the data and the information flow of the main corporate processes.
(b) Centralization of data storage with proper safety and security mechanisms.
(c) Categorization and coding of data.
(e) Multidimensional real time data analysis (Thierauf, 1997).
(f) Powerful, easy, flexible and fast in development decentralized reporting, that would require from the managers as less effort as possible (Riley, 1981).
(g) Assist the corporate processes to adapt to changes, via an open architecture design, always expandable and adaptable to new functional requirements.
(h) Exclude functional requirements that are covered through other IS, such as: ERP, HRMS, GIS, Business Plan and Primavera.

The MIS project in order to achieve our goals, required appropriate control and guidance on several important factors, which derive by the public sector company profile and the funding of EU:

(a) National and EU legislation is constantly modified, thus relevant corporate processes should rapidly adapt accordingly.
(b) For public and non profit organizations adapting to change is critical, otherwise they risk stagnation (Pynes, 1997). Change is an important part for growth and public sector organizations need to manage change in order to remain viable.

(c) Like a public sector company, ERGOSE has strong interference with public organizations, ministries, agencies etc. This is a drawback in terms of extended public sector related bureaucracy that should be followed and controlled in the most efficient manner.
(d) Each project activity should be documented and all relevant data should be archived in order to have successful results in National and EU audits.
(e) EU funds have specific and strict time frames for the relevant projects completion. The modernization of the Greek railway consists of a list of important projects, that each one is divided in several sub projects. A delay in the implementation time frame of a sub project can cause significant risk in the implementation time frame of the overall project. That can lead in the loss of funds by the EU and further on in incompleted projects that will be "haunted" for several years, until the appropriate budget is allocated.

These factors are only a part of the MIS constraints (Riley, 1981) in a public sector company, but several other factors can be also identified:
(a) The ERGOSE corporate ISO system, the relevant information flow and the predefined reports that were mandatory to be supported.
(b) The need for interfacing with other IT systems (ERP, HRMS, GIS, Business Plan and Primavera) in order to extract data from their databases and synchronize them with the MIS data.
(c) The time plan and the budget: the upper level management needed urgently the development of the MIS, so the initial system was implemented within a year and in line with the budget.
(d) The lack of experience and expertise of the management group for sophisticated IS.

Finally, we had to take seriously into consideration and perform a plan of actions, for each one of the following important issues (that could lead in drawbacks and issues during the development and operation phase of the MIS):
(a) In a public sector company the internal job rotation / transition is less frequent then the private sector. At the same time public sector employees not only accept job security in their workplace but expect it unlike the private sector employees, so they feel more relieved and relaxed in their jobs. Those two aspects tend to maximize the psychological disposition of the users due to their resistance to change, propensity to utilize ego defenses and apprehension toward the system (Riley, 1981). No one will deny the unsettling nature of change, with change comes insecurity and uncertainty (Pynes, 1997).
(b) Broad access and use of information is not common to everyone. Knowledge and data control becomes an asset that some are reluctant to share. This element contributes in the resistance of the users to share the MIS data due to their "data ownership" attitude. Prior to the MIS the storage of the data and the control of the information flow were decentralized, meaning that each organizational unit was "holding" and controlling it's own data, giving to middle and lower level managers a feeling of organizational power and authority. The operation of a modern MIS results in the centralization of data storage and control of the information flow, requiring that middle and lower level managers should adapt to the new framework and "their own" data should become "corporate data".
(c) With the MIS the access in data and the retrieval of information is easy and fast, so the upper level management can visualize instantly the progress of several tasks and realize the corrective actions that should be taken. The middle and lower level managers, who feel that their work and their possible wrong decisions are easily feasible to the upper level

management, react (in non predictive ways) in the operation of the system, trying to minimize the appreciation of the MIS to the upper level management.

(d) The operation of the MIS requires robust corporate processes. The employees, who are not focused in following the processes, resist in the operation of the system, as it places them in a strictly formed environment of workflow.

(e) Communication between the project team is a vital part for the project success, especially when a series of middle and lower level managers should collaborate for the same purpose.

METHODOLOGY

The MIS methodology was based on a strategic planning framework with a medium range plan in order to satisfy the short term (2-5 years) company's needs but at the same time a long range plan in conceptual terms for future needs (McLean and Soden, 1977). The medium range plan was based on several MIS sub-projects according to the upper level management priorities. Each one of the sub-projects corresponded to a "MIS project phase" and had followed a common methodology: gap analysis, detail functional requirements, system design and development, test and commissioning, training, corrective actions and system operation. The time plan for each MIS project phase was about 6 months to 1 year. It is important to state that a MIS Project follows a development and operation lifecycle. The MIS systems should adapt to changes, so there are constantly expanded and modified (Figure 2).

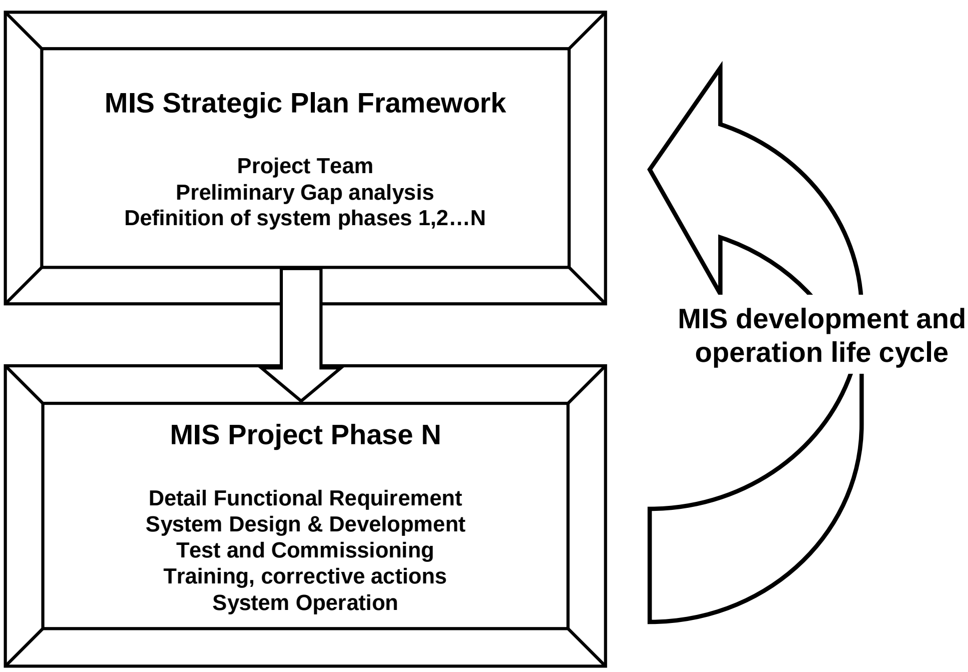

Figure 2: Methodology

The 1st Project Phase was the most important part of the project. Excellent results could convince the top and medium level management that the overall approach, design, methodology and architecture of the system was sufficient for the successful completion of the long term plan. Conversely, dissatisfied outcomes or project plan miscarriage of the 1st phase, could lead the overall project and relevant long term plan to disaster and termination. The 1st Project Phase consisted of: (a) the design and development of the system architecture; (b) the installation and customization of the appropriate hardware and software; (c) the development of software modules to control and monitor the procurement and the design related corporate processes; (d) the development of an intranet / internet site for powerful reporting, with On-Line Analytical Processing (OLAP) and multidimensional data analysis capabilities (Thierauf, 1997).

The next MIS project phases (2nd and 3rd) focused on the implementation of additional software modules to monitor and control the rest of the corporate processes, such as: construction, document management, expropriations, finance, quality assurance, quality control, health & safety and interfaces with other IT systems (ERP, HRMS, GIS, Business Plan and Primavera).

ERGOSE is a public sector company and the "resistance to change" is prominent to the working mentality of the employees and in their ability to adopt modern IT systems, that tend to modify their daily tasks and related processes. For this reason the selection of the middle, lower level managers and relevant personnel who participated in the MIS project team was very carefully designed. We gave important focus in the team characteristics, such as:

(a) To be knowledgeable about the operational processes of their organizational units.
(b) To have self-interest about their work and the MIS could be beneficial and support their workflow.
(c) To be receptive to changes and new technology.
(d) To be opinion leaders and their evaluation for the system could positively influence almost all levels of company hierarchy (upper, middle and lower level management).

RESULTS & CONCLUSION

With the operation of the MIS a lot of issues regarding the monitoring of the corporate projects progress have been solved, such as:

(a) The frequency of the management reports: prior to MIS the management reports where mainly produced quarterly and in the best case scenario monthly via batch procedures (off-line/not interactive). With the MIS the reports are available daily and on-line.
(b) The data quality: prior to the MIS the data quality was limited due to the fact that data was scattered in hundreds of Excel files between different departments of the company. With the MIS the quality of the data is almost excellent due to the centralization of data and several automated data control mechanisms.
(c) The reporting capabilities where limited in the past and very time consuming. With the MIS the management have "unlimited" options/alternatives for data analysis (multidimensional data environment etc.) and is able to take important decisions in a short time.
(d) The forecast capabilities were limited and the prevention of issues mainly concern the excess in the budget of a project were almost impossible. With the MIS we have dynamic forecast control (with relevant software modules) and at the same time we are in position to take preventive actions in order to eliminate issues due to upcoming future excess in budget of

projects (by analyzing MIS data related with the quantity surveys and pre-measurements per work category and physical structure).
(e) The control of data and information flow (Figure 3).
(f) The control and monitor public sector related bureaucracy, National and EU legislation and regulations.

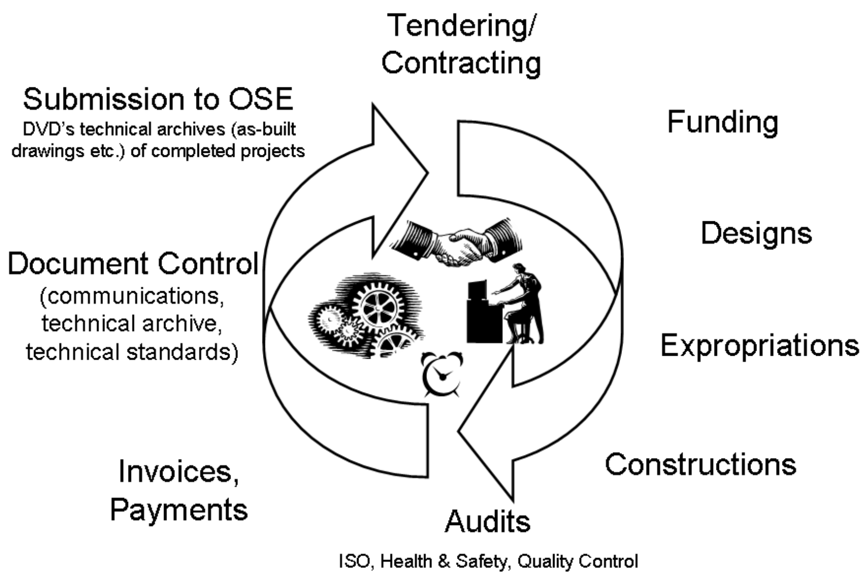

Figure 3: MIS processes

The operational results of the ERGOSE MIS project are:
(a) The corporate data are categorized and follow logical data concepts: entities, attributes and relationships (Davis and Olson, 1984) with multidimensional approach (Thierauf, 1997).
(b) Each data element is entered in the system only once by an authorized user, is stored in a specific database table and retrieved by authorized users only.
(c) An object oriented application development framework for fast and robust development of data entry software modules with On-line Transaction Processing System (OLTP) approach.
(d) Specialized statistical analysis data are extracted from MIS database, imported and manipulated with several software packages (Marques De Sà, 2007): MATLAB, SPSS R programming language.
(e) A modular system (OLTP) for data entry purposes with integrated workflow functions, which controls the following main corporate processes:
- Programming, funding, tenders & procurement etc.
- Design and construction projects: progress per work category, physical structures (tunnels, bridges, cut & covers etc.), electronic submission of payment certifications to the Finance directorate, pre-measurements, quantity surveys, change orders etc.
- Supplies (rails, ballast etc.), expropriations, finance (payments certifications, billing, budget, forecast etc.)
- Quality Assurance (QA) / ISO, Quality Control (QC) (audits, findings, Non Conformance Reports NCR's, suggested improvements, material controls, laboratory controls etc.).

- Health & safety in the construction sites (audits, findings, NCR’s etc.).
- Document Management System: corporate correspondence, library, standards and technical specifications, technical document archiving (contracts, designs, as built drawings etc.).

(f) A web-based reporting site (installed on a dedicated application server) with OLAP functions (Thierauf, 1997), with the following characteristics: (i) the predefined reports are categorized and accessed by authorized users; (ii) ad-hoc reporting for new reports (or modification on existing); (iii) the reports are easily used by upper, middle and lower level management (via an Internet Explorer browser); (iv) users can perform on-line queries with dynamic filters, extract data in various ways (tables, charts, crosstabs etc.); (v) slice-n-dice data and drill down / up / across in a multidimensional data environment.

(g) A high-end sophisticated and flexible data security mechanism: each user accesses (write or read) only the information and relevant data elements that he/she is authorized.

(h) On-line and batch interfaces with other IT systems (ERP, HRMS, GIS, Business Plan and Primavera) in order to extract data from their databases, synchronize them with the MIS data, analyze and present them through the MIS OLAP reporting site (Poe et al., 1997).

(i) An open architecture system, easily expandable to new functional requirements and adaptable to modifications in existing system processes.

The corporate benefits from the MIS operation are:

(a) Minimization of time and efforts needed for managerial and operational reporting.

(b) Best decisions, based on easy and fast accessed consolidated, categorized and accurate data.

(c) Improvement of programming and forecast capabilities based on statistical analysis in historical data.

(d) Improvement of the construction quality of the new railway structures based on: better evaluation of designs, better monitoring of construction projects and faster identification of possible drawbacks that may occur and require preventive actions.

(e) Improvement of communication and information flow between the various organizational units and with third parties (governmental authorities, EU, Prefectures, Municipalities, contractors etc.).

(f) Improvement of employee job performance and effectiveness through a well tuned workflow environment with less effort needed for controlling their daily tasks.

(g) Improvement of the corporate capability to achieve positive results in several National and EU audits, regarding the proper and effective management of the Investment Programme.

The key benefit of the system is the significant improvement of the corporate project management effectiveness, efficiency and maturity.

REFERENCES

Andersen, K.V. (2005) E-government and Public Sector Process Rebuilding. New York, Springer Science + Business Media Inc., pp. 4-44

Buttler, J.A. (2008) Designing Geodatabases for Transportation. California, ESRI Press, pp.143-160

Davis, G.B., and Olson, M.H. (1984) Management Information Systems: Conceptual Foundations, Structure and Development, 2nd ed. Singapore: McGraw-Hill International, pp. 95-130.

ERGOSE company Internet Site (2009), "Company Profile", available at http://www.ergose.gr

Kaplan, R.S., and Norton, D.P. (1996) Translating Strategy into Action: The Balanced Scorecard. Boston: Harvard Business School Press, pp. 1-42

Marques De Sà, P.J. (2007) Applied Statistics Using SPSS, STATISTICA, MATLAB and R, 2nd ed. New York: Springer

McLean, E.R., and Soden, J.V. (1977) Strategic Planning for MIS. New York: John Willey & Sons, pp. 23-27

OSE (Hellenic Railways Organization) (2009), "Company Profile", available at http://www.ose.gr

Peters, D. (2008) Building a GIS: System Architecture Design for Managers. California: ESRI Press, pp. 51-68

Poe, V., Klauer, P., and Brobst, S. (1997) Building a Data Warehouse for Decision Support, 2nd ed. New Jersey: Prentice-Hall Inc.

Pynes, J. (1997) Human resources management for public and nonprofit organizations. San Francisco: Jossey-Bass Publishers

Riley, M.J. (1981) Management Information Systems, 2nd ed. San Francisco: Holden-Day Inc., pp. 93-282

Stavrinoudakis, S.E. (2009) Management Information System: An Innovative Tool to Monitor and Control All Corporate Processes Related With the Construction of the New Railway in Greece. Proceedings of the Fifth International Conference on Construction in the 21st Century CITC-V, Florida, CITC-V, paper 149, pp. 85

Thierauf, R.J. (1997) On-line Analytical Processing Systems for Business. London: Quorum Books, pp. 3-131

Tomlinson, R. (2003) Thinking about GIS: Geographic Information System Planning for Managers. California: ESRI Press, pp. 1-199

ARCHITECTURAL PROGRAMMING:

PROVIDING ESSENTIAL KNOWLEDGE OF PROJECT PARTICIPANTS NEEDS IN THE PRE-DESIGN PHASE

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Through the increasing complexity of construction projects, the clear postulation of the planning objectives is becoming increasingly difficult for the clients and the planners equally. However, the precise definition of planning aims and goals is of crucial meaning for a positive project outcome. The precise definition and outline of the client requirements and the needs of future users can significantly contribute to the sustainable efficiency and performance improvement. While in the Anglo-American region the method is widespread in Europe it is still unconsidered. This issue is leading to immense changing costs and has a great impact on the European economy. This paper will give an overview about the standards and procedures of the programming method. The implementation of programming will be demonstrated on a case study of the Vienna University of Technology. A performance specification was being developed for an architectural program of spatial merging of three different departments.

KEYWORDS: architectural programming, design briefing, knowledge gathering, performance specification.

INTRODUCTION

Increasing complexity is one of the main characteristics of current building tasks. The construction market is segmented into numerousness relevant disciplines. The planning process however is still separated into different specializations that are working separately. The simultaneous and interdisciplinary planning is still an exception. (Achammer, 2009) Furthermore, other facts like increasing communication, diversity of solving possibilities for one assignment or the decreasing time of the planning phase contribute all to the growing complexity. The diverging disciplines concurrently develop different languages which make the interdisciplinary exchange even more difficult. Within this changing market situation the clear definition of the client's conceptions is becoming essential.

Every building task must go through the phase of the problem statement, no matter how accurately and structured it is done. At the present, knowledge about the building task is gathered within the building process and mostly in the course of major decision-making. Programming (in UK known as brief elicitation) provides knowledge that supports such decision making processes and helps to build more efficiently, adapted and sustainable. Furthermore this method can have a great impact on intangible benefits like the organisational culture or the work ethic.

The field of programming is wide spread and an accurate elaboration demands an interdisciplinary approach. Beside the technical disciplines the scope of programming reaches into the fields of sociology, political sciences, anthropology or psychology.

This paper will present programming (design briefing elicitation) as a major methodology that is still neglected. It should demonstrate the importance of clearly defined project goals and objectives and show the significance of investment in the pre-design phase. Further on, the development of programming together with an overview of the different programming phases and its different methods will be presented. It concludes with a case study on the redevelopment process of three departments of the Technical University of Vienna in order to demonstrate the application and implementation of practice-related methods.

HISTORY AND DEVELOPMENT OF THE PROGRAMMING METHOD

Every human build physical construction is originating in problem solving of a certain obstacle though structural interventions. The definition of these problems calls for the postulation of fundamental needs and goals. For example, a Stone Age-person wants to cross a river without his belongings getting wet. The problem-definition and the instructions to somebody who is trying to solve it are as old as human civilisation. The only difference compared to the current situation, is that problem statements of the past happened unconsciously.

In the United States the first documents comparable with architectural programming occurred in the 17th century within the context of self-conscious design. The development of modern programming has its roots in the post World War II era. The profound changes that occurred in many areas of our society during and after the war called for answers to questions about how we do what we do. (Cherry, 1999) In the 1960s many of the US Scientists worked in the field of "design methodologies" especially in the field of public participation in the design process. Contemporary architectural programming as a separate discipline was primarily mentioned in 1966, by a publication of the America Institute of Architecture (AIA). About the same time, the first edition of Penas book *Problem Seeking: An Architectural Programming Premier* was published. (Kumlin 1995). Architectural programming is currently a prevalent and established part of the pre-design phase in the United States. It is incorporated into standard architectural contracts and national architectural licensing examinations. Large design firms usually have specialised staff on facility programming, in other cases programming consultants are subcontracted. (Popov 2004) In Germany and Austria the definition of the needs and problems is widely unconsidered. The German architect Gunter Henn brought the Programming Method to Europe in 1987 and adapted it to the European circumstances. (Henn 2009) In 1994 the International Organisation for Standardisation published the *ISO 9699:1994 Performance standards in building – Checklist for briefing – Contents of brief for briefing design.* This standard was converted in 1996 into the German Standard *DIN 18205 Bedarfsplanung im Bauwesen*. The mentioned standard gives a detailed checklist of what should be observed, but it gives no explanation how to achieve this information.

PROBLEM STATEMENT

According to Achammer (2009), the costs for planning betray about 1,5% of the total life cycle costs. However, this relatively small amount immensely influences the performance of the following costs, which can rise up to more than 80% of the total life cycle cost.

Figure 1 shows that the costs for changes at the project start are still minimal, and they rapidly increase with the project progress. This is why the knowledge-increasing at the earliest project phase is also a crucial economical benefit.

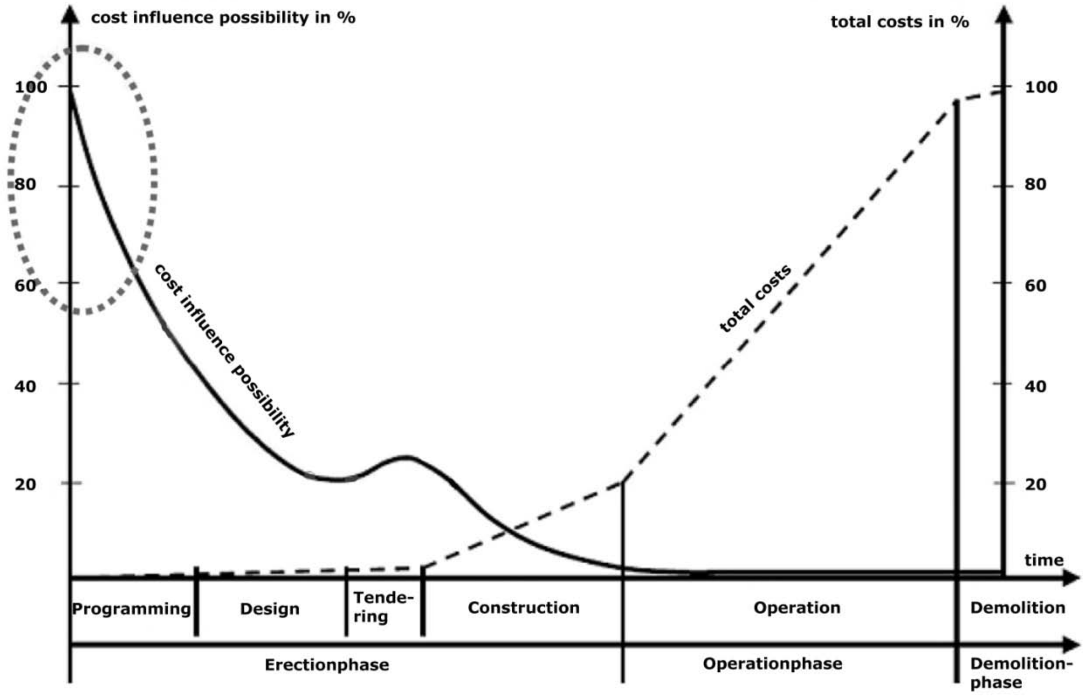

Figure 1: Cost influencing throughout life cycle adapted after Achammer (2009)

The current problem is the lacking willingness of today's clients to invest into the pre-design phase. To cause a change in such client position, the knowledge and benefits have to be communicated insistently.

INFORMATION GATHERING

The gathering of useful and important information represents the starting base of a good program. Hereby, the challenge is to separate the useful data out of the large amount of possible information. One of the main characteristics of a building is its uniqueness, therefore the information gathering methods have to be customized for each individual project. The main task of the programmer is focusing on the programming process and awareness for the relevance of the collected information. The DIN 18205 (1996) or the ISO 9699 (1994) give a detailed checklist that helps to overview the widespread field of appropriate information to be evaluated.

As shown in Figure 2, there are two different types of facts that have to be evaluated.

The first group are the hard facts or the tangible data, which can be determined through conventional data research methods like statistics. The field of these facts is wide spread and ranges from the current occupancy data to the site survey facts, if the site is known already at this early phase of the project.

The second, and maybe more important group of information are the intangible facts, which are collected through empirical social research methods. These practices include:

- qualitative techniques, like interviews or workshops;
- quantitative methods like questionnaires which can be wide spread and involve larger group of participants.

As Popov (2004) shows, qualitative methods are indispensable, as their main vantage is their openness to the different perspectives, which can provide new points of views, that could be crucial for the programmer.

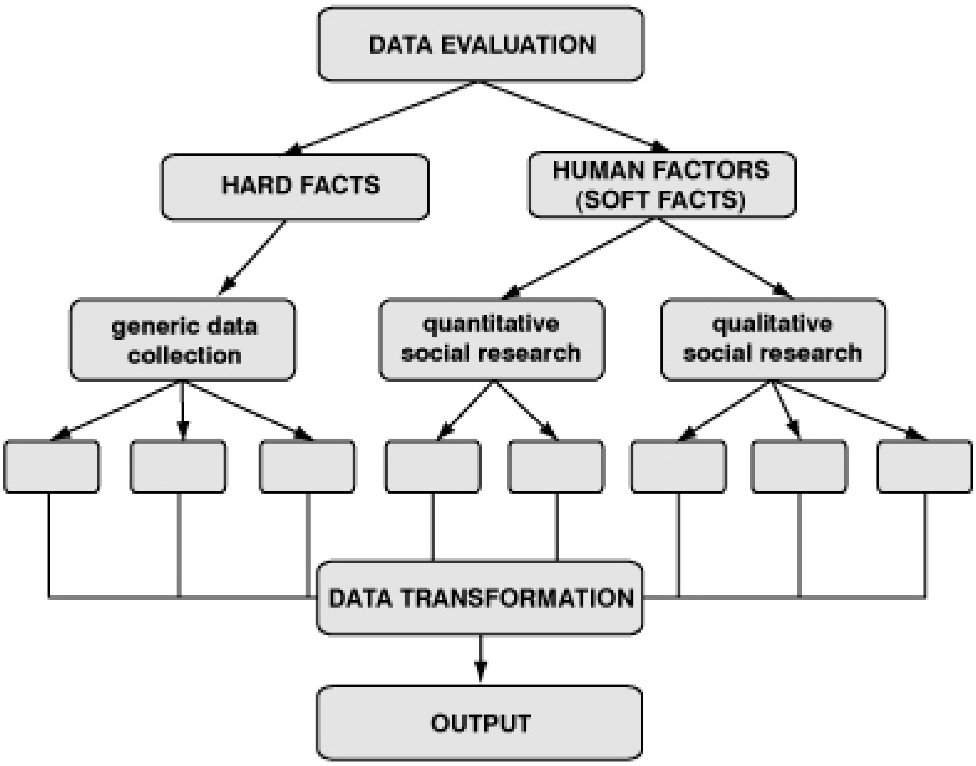

Figure 2: Information flow Structure (2009)

There is a large accumulation of different existing evaluation techniques, helping the programmer to define data that provide a maximum of relevant knowledge. Concerning this matter, the big challenge is to find methods, which maximizes the valuable data and minimizes the effort. No matter what kind of technique is used, the prearrangement must be done very accurately. The programming methods require a high level of social competence and Know-How because of the wide interdisciplinary spread of the programming team.

GOAL DEFINITION

The intention of every client is to build an excellent and unique building. However, the definition of excellence is subjective and varies within the different decision makers and the planners transforming the wishes into the build reality. *"There can´t be an excellent building without knowing what´s excellent"* The programming method makes these different pictures transparent and decreases the variety of diverse imaginations. The programming process provides the basic discussion and supports the development of clearly defined goals.

Cherry (1999) mentions, that often the client's design requirements are based on what the client wants his or her organisation to do. Therefore, she advises to establish organisational goals first, and then to transform them into facility goals and objectives. There is a wide spread field of different goals like organisational, economical, ecological, social, design-based, or facility goals, but nevertheless the clear and specific definition of project goals is one of the key aspects of the programming method.

DATA CONVERSION AND OUTPUT

The collected amount of data should be transformed into an output paper enabling a future planner to design a building according to the imaginations of the client. Various standards and literature (Din 18205, ISO 9699, Duerk, Kumlin) give checklists and hints for structuring of the output paper. Nevertheless, the output paper should primarily focus on the clear and comprehensible preparation of the essential information.

CASE STUDY

The Technical University of Vienna is going through a grand scale redevelopment. Within this process, the three different and disconnected departments for:

- Construction Economics and Management
- Construction Process and Methods
- Industrial Building and Interdisciplinary Planning

should accrete to one "Institute for Interdisciplinary Construction Process Management". For this combination, a programming study was made to provide transparency of work processes, structures and goals of the future institute for a prospective planner.

Data collecting

The first phase of the programming study was the evaluation of the main workflows and processes of the three departments with a specific focus on the similarities and the differences. Therefore, questionnaires for all employees where dispensed to evaluate the personal work habits. Also interviews with special selected employees of all three departments were held. At the same time, a large amount of the relevant data was collected, beside the direct contact to the employees. For example, the average utilisation of the lecture rooms integrated into the tree departments was evaluated by the means of statistic of the amount of students per time per semester. Generally, the gathered information could be divided into the following major groups:

- Existing work area (m^2) and their usage
- Employee statistics (quantity, where they work)
- Motion analyse
- Communication analyse
- Process analyse (separated in science and education)

In the second phase, interviews with all three department heads were arranged to establish the vision and the goals of the future institute. Therefore, parts of the analysis were already used to show the actual conditions.

Transforming information

After collecting of the all relevant information, the next step included the transformation of the data abundance into informative, clear structured and visualized outcomes. The main objective was always to create results, which can be understood and used also by outstanding users not involved in the process or the organisation. Figure 2 shows the main different processes representing the core businesses of all three departments. Education and science are the two major tasks combining all divisions.

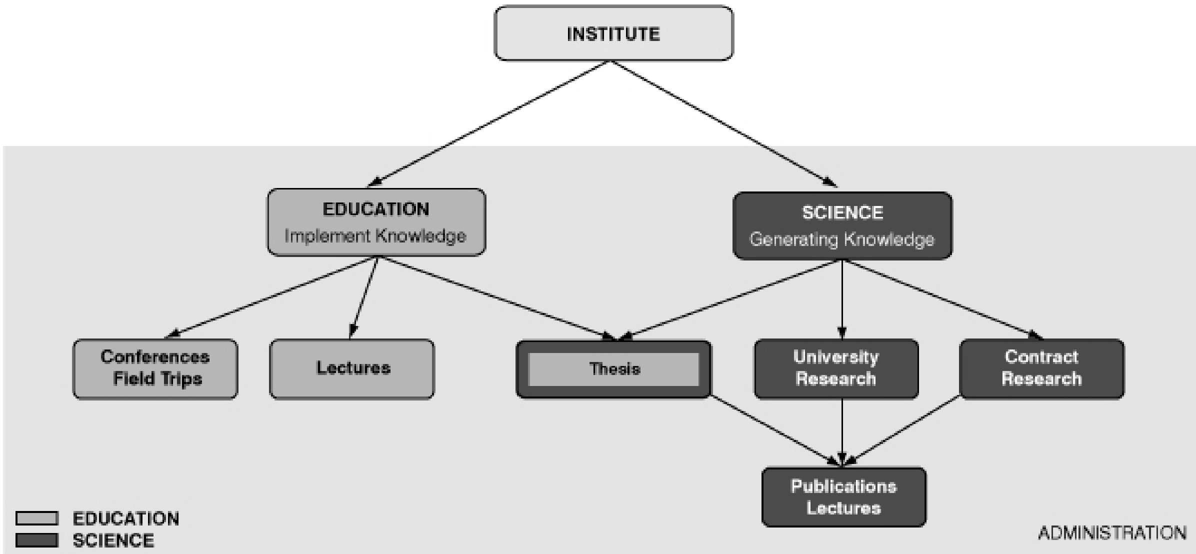

Figure 2: Institute Process Structure (2008)

The fusion of the analysis shows, that the workload could be divided in three major groups:

- about one third of the work of the staff scientists is work requiring communication
- one third of the work requires concentration and
- the last third consists of routine work.

Another key issue was the analysis of the communication structure. Every employee was asked to draw his personal communication map within the questionnaires. This method was chosen because of the fact that all of the employees are engineers, therefore familiar with the topic visualisation. These results were linked together within the communication matrix shown in Figure 3. It is obvious, that the strongest communication structures are within the departments themselves. Additionally, the communication density was evaluated within a workshop.

	Prof A	Ass A1	Ass A2	Ass A3	Prof B	Ass B1	Ass B2	Ass B3	Sekr. A/B	Prof C	Ass C1	Ass C2	Ass C3	Sekr. C	Ass D
Prof A															
Ass A1	T, P, Ko, Be		Ko, P	Ko, P	BD	Ko	Ko	Ko	BD						
Ass A2	Σ	Σ		Σ	Σ	Σ	Σ	Σ	Ko, BD, Be, T	Ko, Be	Ko, Be, T	Ko, Be	Ko, Be	Ko, Be, T	Ko, Be, T, BD
Ass A3	T	Be, T, P	Be, T, P		Be	Be, T	Be, T	Be, T	Be, T, BD						
Prof B															
Ass B1	Σ	Σ	Σ	Σ	Σ		Σ	Σ	KO, T, BD		T	T	T	Be	KO, T
Ass B2		KO	KO	KO	KO, BD, P	KO		KO	KO, BD, T		T	T	T	T	
Ass B3		KO	KO	KO	KO, Be	KO, P	KO, P		KO						
Sekr. A/B	KO, BD, T	KO, BD, T, Be	KO, BD, T, Be	KO, BD, T, Be	KO, BD, T, Be	KO, BD, T, Be	KO, BD, T, Be	KO, BD, T, Be		T	T, KO, BD	T, KO, BD	T, KO, BD	Σ	KO, BD, T, Be
Prof C															
Ass C1			KO, T	P	Be, BD				Be, T	KO, BD, Be, T		Σ	Σ	Σ	BD, T
Ass C2	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	T, KO, Be	BD, T, Be	KO, Be		KO, Be	KO, Be	T, KO, Be
Ass C3					Be					Σ	Σ	Σ		Σ	
Sekr. C	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ	T, BD	KO, BD	KO, BD	KO, BD	KO, BD		Σ
AssD	E, KO	E, KO	KO, E	E, KO	KO, T, E	KO, E	KO, E	E	KO,T,E						

A, B, C -- Different Departments

KO -- direct communication
BD -- paper flow
P -- combined projects
Be -- meetings
T -- telephone
Σ -- all

frequently (daily)
continuous (weekly)
rare (monthly)
never

Figure 3: Communication Matrix (2008)

The last step of the transformation process was the development of an effective room concept. All the collected and transformed information was linked together in order to develop a most suitable facility program for the requirements of the future organisation.

Finally a workshop with all the employees and interviews with the department heads were organised, to align the outputs and results with the staff.

Lessons learned

Within the working process, the main objective was the separation of the major and relevant information from the immense available information. This was done with respect to the future work efficiency and achievement of satisfying results. Various further insights gained within the process were:

- the importance of the preparation phase of the different evaluation methods,
- an alternation of development and reflection phases,
- the clear statement of the work-session goals

which proved to be were very gainful. Within the whole process of programming more importance was given to the questions, than to the answers.

Another important aspect was the integration of the involved persons through different feedback possibilities, in order to achieve accurate outcomes and to get a widespread acceptance of the results. Another advantage of the integration was the personal engagement and the identification of the staff with the future project, which increased the acceptance of the upcoming reorganisation.

CONCLUSIONS

With the increasing demand of our society for sustainable buildings, which have to meet economical, ecological and sociological needs, the reorganisation of the planning process is becoming urgent and essential. The investment of resources in the earliest planning phase of a future building is a major step in achievement of the upcoming goals. The clients have to be made aware of their responsibility for the development of the facility program, which occurs in the course of early planning phases serving as a preset for clearly defined design aims and objectives. The whole pre-design and design period represent an interaction between analysis and synthesis. In the past, the main focus had always been on the synthesis, as the creative part. However, this approach has to be changed, due to the rising importance of the analysis, as the aim-setting phase. This focus change in the planning process towards the analysis is crucial for handling today's increasing complexity of construction projects and for the realization of successful buildings.

REFERENCES

Achammer, C. M. (2009), Schlüssel für nachhaltige Gebäude, in Zeno 01/09, Page 46-49, München: Georg D.W. Callwey Gmbh & Co.KG

AIA, American Institute of Architects (1966), Emerging Techniques of Architectural Practice, Washington D.C.: The AIA Press

Cherry, E (1999), programming for design – from theory to practice. New York: John Willey & Sons, Inc.

Duerk, P. D. (1993), Architectural programming – information management for design, New York: John Willey & Sons, Inc.

Henn G. (2009), Methoden / Programming available at: http://www.henn.com/#en/methoden

Kumlin, R. R. (1995), Architectural programming – creative techniques for design professionals, New York: McGraw-Hill, Inc.

Pena, W. M., Parshall, S. A. (2001), Problem Seeking – An Architectural Programming Primer. New York: John Willey & Sons, Inc.

Popov, L. (2004), The Market for Facility Programming: A Study of Client Preferences and Decision-Making. FQS, Forum: Qualitative Social Research, Volume 5, No. 2, Art. 37

Standard DIN 18205 (1996), Bedarfsplanung im Bauwesen

Standard ISO 9699 (1994), Performance standards in building – Checklist for briefing – Contents of brief for building design.

IMPROVING INFORMATION SHARING ACROSS CONSTRUCTION STAKEHOLDERS: AN ORGANIZATIONAL SEMIOTICS APPROACH

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Construction projects rely on the sharing of large amounts of information between diverse stakeholders. A perennial challenge for construction is managing and coordinating these exchanges, and there is an expanding market of information management tools available to support this process. We describe how organizational semiotic concepts may be used to underpin information systems which can cater for the different requirements of multiple stakeholders. We draw especially on Eco's notion of the 'model reader' (1979). This suggests that information is produced according to the expectations and assumptions held by the producer about the actor (or model reader) who will subsequently 'read' and use it. Enhancing our understanding of this process, and of the ways that different stakeholders interpret and use information within construction contexts offers a potential foundation for information systems which are capable of representing construction information differently according to the particular 'model reader' accessing it.

KEYWORDS: organizational semiotics, information sharing, construction projects, stakeholder interaction.

INTRODUCTION

The design and construction of buildings is a highly complex process involving the creation of large amounts of information, much of which must be passed between various actors and used in multiple ways. In addition, there is often a lack of understanding about precisely what information is required further along the project process (Harty, 2005). This complexity is further increased when recent calls to better integrate the design and construction process with facility and operation management, and to shift towards integrated service provision are considered (Saxon, 2002). Coupled with this is an increasing awareness of the built environment's importance in providing the infrastructural context through which all aspects of life and work are mediated. This has led to an appreciation that construction's products must fulfil wider social, economic and environmental requirements, as well as those of the primary client (Fairclough, 2000 and Cole, 2005).

A recurring challenge for IT systems developers is to produce solutions which will better mediate the necessary information-sharing processes occurring during construction work. This paper seeks to establish how the production, interpretation and exchange of information for through-life building processes may be improved through the use of organisational semiotic concepts. We begin by outlining the challenges of integrating the heterogeneous activities of the construction sector and describe and draw on concepts from organisational semiotics, especially Eco's notion of the 'model reader' (Eco, 1979). We advocate an emerging framework which addresses the need to understand and interact with the different interpretive schemes held by different stakeholders, positioned as different 'model readers'. The implication of this is that designers must provide systems which are capable of representing information from a central repository differently according to the particular 'model reader' accessing it. Finally, we outline our approach to further developing and testing our framework, through empirical research.

The information sharing challenges of the construction sector

The activities required to build are diverse and complex. The project-based nature of construction work requires temporary and inter-organisational constellations of actors to work together. The process utilises a plethora of different skills, knowledge and disciplines, from architecture and design, through construction, to operation and maintenance. Multiple stakeholders influence the process, including clients commissioning work, planners, regulators, eventual occupiers and users, and society more broadly. Each of these actors has to create, access, share and interpret different sorts of information: specifications, visualisations, architectural plans and models, structural calculations, plans of work, bills of quantities, quality assessments and so on. In addition, there is often a lack of understanding about precisely what information is required further along the project process.

Construction projects are information-intensive fields of activity. But the sector is also characterised as lacking coherence in the way it produces, shares and uses this heterogeneous information. There is a long history of high profile reports which bemoan the quality of information and collaboration in the sector. Higgin and Jessop (1965) identified advising clients and managing information and communication within projects as particular problems. Egan (1998) called for "accelerated process improvement" to move away from approaching projects as a series of sequential, separate actions towards integration across multiple stakeholders.

Despite these calls, problems of minimal information sharing between the various construction stakeholders working on the same project remain. Incomplete or inconsistent information results in errors, expensive re-work, misunderstandings and conflict (Love et al., 1999). There are numerous factors which contribute to these problems. The disciplinary basis of construction work produces a 'silo' mentality, where the interactions between different design disciplines, or design and construction, are limited. The nature of the design process is iterative and fluid, and there is an unwillingness to disseminate design information which is still fluid and incomplete.

Long-standing and robust power structures between stakeholders (eg. clients and architects, designers and contractors) are enshrined in standard contract forms and inhibit information exchange. Organisationally-based administrative practices and issues of risk and liability distribution across projects also affect information exchange between firms (Miozzo and Ivory, 2000 and Zietsman, 2008). Emerging environmental assessment tools for monitoring such variables as operating energy usage, greenhouse gas emissions and embodied energy within structures (Cole, 2005), serve to further complicate the informational requirements of construction.

IT and the construction sector

Within this context, information technology is often positioned as able to address these problems, and provide the thread which can stitch together these disparate actors and requirements. This is the cornerstone of Egan’s call for process improvement (1998). Gann (2000) observes that contemporary building work revolves around processes and workflow activities between diverse actors more than in the past. The value of better information utilization by construction companies has been recognized as a way to develop further business. This strengthens the case for IT systems which bridge the gaps between design, construction, operation and wider stakeholders. To do so, IT systems need to be more adaptable and integrated with construction processes.

In addition, the landscape of construction does not stand still. Saxon (2002), in his assessment of the Fairclough Review (2000), points out that Integrated Solutions (IS) for clients are beginning to break down the traditional boundaries between property, construction and FM (facilities management). The need to embrace occupier needs is now a major growth niche for the sector, as industry actors recognise the potential worth of maintaining working links with a construction project following completion of their primary project activity. PFI (public finance initiative) projects, which roll together construction with concessions for operation and maintenance of public facilities, also contribute to this shift.

Construction is, in fact, sophisticated and innovative in its use of IT on projects. CAD has been a standard practice for the last two or three decades, collaboration tools such as extranets are increasingly being used and stipulated as part of contractual agreements. Document management is routinely used to coordinate information across projects. Such innovations have been incorporated into the practices of certain disciplines but few innovations have enabled better collaboration and information sharing across construction stakeholders to improve workflows and processes. Radical changes to the way information flows through projects are yet to occur:

> “ the construction industry has been quick to use technological developments as a tool to provide support for specific tasks, but has not generalized their application to integrate activities or provide communications through the construction process” (Miozzo and Ivory, 2000).

The development of such an inclusive system must meet the challenges presented by the sector’s activities. Importing off-the-shelf solutions or systems from other areas is problematic. The multiplicity of actors involved in construction projects, the often unique nature of any building and the ‘one-off’ temporary character of project teams produces a different context from more formalized and controlled industries which possess predictable and repeatable patterns of activity, such as the automotive industry. Another more tangible barrier to data exchange across project actors is a lack of inter-operability between the various information tools used within the construction process.

Whilst some commentators (Aouad et al., 2008), maintain that the business benefits of any particular information system may be difficult to determine or express in absolute terms, others argue that new innovations may bring forth more conflict and problems for the industry than solutions (Miozzo and Ivory, 2000). But it is generally accepted that the value of IT solutions which begin to successfully facilitate collaborative work for through-life building processes between construction stakeholders can outweigh any potential problems.

For the rest of this paper, we outline how concepts from organisational semiotics can begin to address the practical problems of integrating information across construction activities and move towards elucidating a framework for system design which mobilises these concepts.

Organisational semiotics and IT innovation

Semiotics may be defined as "the study of signs" or "the discipline of signs" (Peirce, 1960). It is centrally concerned with the generation and construction of meaning, encompassing the inception, analysis, interpretation and representation of signs (Liu et al., 2006). Signs are pervasive throughout human interaction; they are the medium through which information about, and understanding of objects, concepts and ideas are mobilised and shared.

Organisational semiotics (OS) is an extension of semiotics and specifically studies the utilisation of signs within organisational contexts. OS maintains that an organisation may be considered as an information system itself, which incorporates a plethora of actors, technological artefacts and activities. Within such systems, sign generation, use and manipulation is the medium through which these heterogeneous entities interact and exchange information; signs are 'all pervasive' (Liu, 2000). Organizational semiotics does not just focus upon specific information flows occurring within organisations, but allows for a holistic analysis of specific organizational scenarios, allowing all significant actors and influences affecting an organisation to be included, accounted for and explained. Importantly, this offers an approach which considers the socio-technical character of organisational contexts, thus following Stamper`s premise that only a complete understanding of both machine and human information systems will allow existing processes to be understood and improved in any tangible way (Stamper, 1973).

Compared with other information systems (IS) approaches, in drawing attention to the social processes which characterise interaction, generation and exchange of signs, organizational semiotics offers different insights than a narrower focus on technical, process-driven, information-flow processes might provide. Semiotic analysis has made significant contributions in underpinning the planning and designing of computer systems and its applicability has been demonstrated in several fields, including human-computer interactions, graphic design, and programming (Barr et al., 2004). By also incorporating the social aspects of signs generation and utilisation, organizational semiotics provides a persuasive set of concepts for understanding the complex interactions between multiple stakeholders, and analysis of the extensive production and exchange of information which characterises construction project work. It raises questions about how meaning is (or is not) constructed or shared across diverse actors, as well as accounting for flows of information. An analysis of the ways that different stakeholders interpret information in construction project contexts can provide insight into both the problems of sharing information, and into developing practical techniques to alleviate these problems.

Writing and multiple readers

To develop an understanding of the semiotic processes mobilised by stakeholders to interpret information, the potential for different groups or actors to interpret and understand the same signs or information differently is paramount. The processes through which these meanings and interpretations are produced must be considered. This is not just central to understanding the problems of collaboration in construction, but also in eliciting and reconciling different stakeholders' user requirements for any information system. It is not enough to 'know the user' (Barr et al., 2004) but to know *multiple users* and produce frameworks and tools which can simultaneously manage these different users.

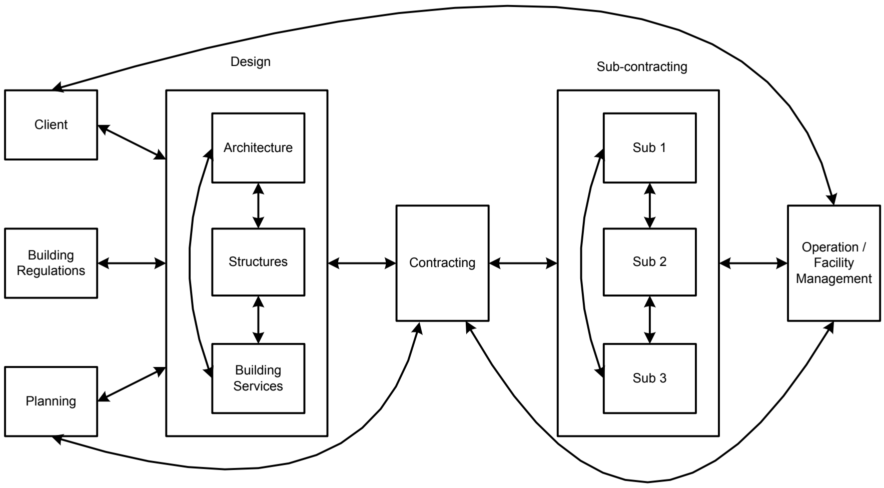

Figure 1: Stakeholders and interactions within construction projects

Fig 1. represents a simplified view of the multiple stakeholders involved, and multiple interactions occurring, within the context of construction projects. Information is passed between these stakeholders, and in doing so processes of interpretation occur. The central contribution of organizational semiotics is in positioning this interpretation of signs and information as emerging from the representational and interpretative knowledges held by different groups and individuals, and by revealing the different norms through which meaning is produced. As Liu *et al.* maintain:

> "Understanding and modelling the behaviour of members of an organisation is essentially understanding and representing norms…a norm-based theory is a good approach to derive a conceptual design for collaborative information systems" (Liu et al, 2001).

Meaning is constructed by drawing on the norms and knowledge bases of particular users. To use the terminology of semiotics, individuals (and groups) possess semantic reference models which are operationalised in particular contexts. It is through this context-specific pragmatic knowledge that the interpretation of a particular sign is produced.

If the problems of collaboration in construction projects are positioned around multiple (and potentially conflicting) interpretations of the same signs, then a potential solution is to create signs or representations of information for different users which limit the possibilities for these different meanings to be produced across stakeholders. So by aligning user-specific signs with the semantic and pragmatic frameworks held by the user, the possibilities of interpretation might be limited. This would result in less difference in interpretations across stakeholders, and hence form the basis for a better shared understanding of specific information.

The analogy of writing and reading signs is useful here. Eco (1979) suggests the notion of a 'model reader', where the author or developer generates signs which are specifically oriented to produce a ‘correct’ or desirable reading in the user. To do so requires a detailed understanding of how that potential reader might interpret the sign:

> “The author has thus to foresee a model of the possible reader (hereafter Model Reader) supposedly able to deal interpretively with the expressions in the same way the author deals generatively with them”

In other words, the pragmatic framework mobilised by the reader must be understood by the designer, and the generation of signs for that reader be aligned to it. This resonates with work on understanding the ways that users approach and utilise artefacts such as computer systems. The notion of ‘configuring the user’ (Woolgar, 1991) invokes a similar process where the artefact’s designer imagines how the potential user will utilise the artefact, and designs it so that it supports that envisaged use, and prohibits others.

The notion of having multiple readers with different interpretive schemes involved in any construction project and accessing information does complicate matters. It cannot be assumed that every actor will be a model reader, and know intuitively what a sign means (Eco, 1979). Different users must be imagined, different model readers addressed and different knowledge bases accounted for. Any system attempting to span the variety of different construction professions and stakeholders must make allowance for this reality.

In any interaction, each stakeholder will have their own knowledge base which includes semantic and pragmatic knowledge. When the stakeholder is involved in the design and production of an artefact then he may be described as a model-writer. The artefact designed or produced remains for readers to interpret or consume. The reader could be another co-worker or another project stakeholder, who in turn might use this information to author signs for other readers. This means there are multiple semiotic processes (semiosis) occurring through a building’s life-cycle. Information might be produced for one purpose - for instance for the architectural design of a building – but also used for others - for instance as a basis for producing bills of quantities or tenders for sub-contracting packages. The intentions and knowledge bases of the ‘readers’ in these different contexts could be very different, and with some ‘readings’ or interpretations lie beyond the uses foreseen by the original writer.

The basic premise is that through gaining insight into the knowledge bases of multiple stakeholders (knowing the users), and by identifying where pragmatic knowledge bases of stakeholders overlap, tailored representations of information can be developed which limit the possibilities for multiple conflicting interpretations, and hence misunderstandings across different groups.

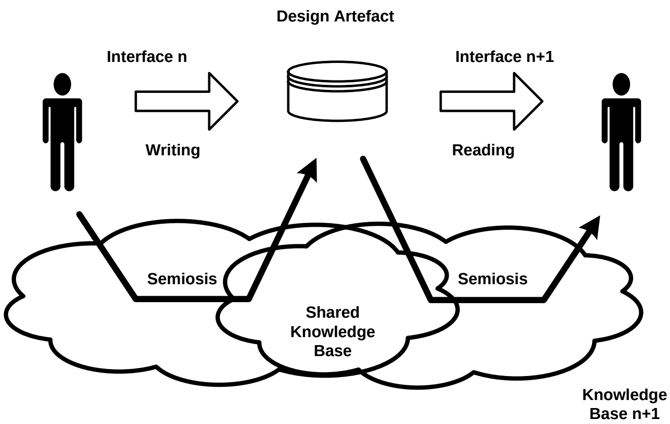

Figure 2: sharing information across knowledge bases

Figure 2 represents this concept. Different interfaces between the central source of information – the design artefact - and multiple stakeholders are developed to align with their particular pragmatic frameworks, particularly drawing on those aspects of pragmatic knowledge which are shared between them. This allows more coherence of interpretation across the stakeholders. It is in the articulation of these users, readers and frameworks that the potential to facilitate better shared understanding and enable increased collaboration resides.

Mobilising a writing / reading framework

Having outlined the problems of collaboration and information sharing in construction, and sketched out a conceptual framework to address this, attention must turn to practically mobilising this approach. To develop this, empirical work is focussing on a real and current construction project - the construction of a new office building in central Reading, UK. Using a specific project allows easier identification of stakeholders, and provides both real instances of information exchange to focus discussion and analysis and insight into the extent (and problems) of sharing information in a live context.

The central aim of the approach is to examine and clarify the complex information interpretation and exchange processes occurring between construction stakeholders throughout the entire life-cycle of the project. To achieve this firstly requires an investigation of current work processes and existing data flows and ruptures between the various stakeholders. This necessitates consideration not only of design, construction and operation activities, but also includes the project clients, local government planning, building regulation inspection, and eventual users. Secondly, the interpretive frameworks of these stakeholders need to be analysed to lay the foundations on which the development of interfaces which mobilise the ‘writing for multiple users’ concept can be based.

But gathering such data is problematic, as much of the process of interpretation is tacit and experiential, and as such difficult to make explicit. A pragmatic approach is being taken in which stakeholders are interviewed using specific instances of information interpretation and exchange as the primary focus. The interviews are oriented to reveal the sorts of information produced and required by different stakeholders, why it is needed, what it is being used for and the forms it takes. Through focussing on specific and real information and on the practical activities of participants, a more grounded understanding of how existing information is generated and interpreted can be gained.

The interviews provide a backdrop against which to position multi-stakeholder workshops. These are intended to bring together a range of stakeholders and facilitate debate around what problems and ambiguities of interpretation are being experienced on the project. Again, specific examples will be used and the workshops represent an opportunity to observe the process of interpretation and interaction across stakeholders in action. The workshops also will allow debate over areas where interactions can be improved, to which all of the participants can simultaneously contribute.

The next step is to begin to develop practical IT tools which build on the analysis of current information flow, stakeholder frameworks and areas for improvement. For this, established methods of requirement capture can be deployed. Practical analysis tools based upon organizational semiotic theory for system development processes have been developed under the MEASUR (Methods for eliciting, examining and specifying user`s requirements) programme. They include PAM – Problem Articulation Model for domain scoping, SAM – Semantic Analysis Method for domain modelling and NAM – Norm Analysis Method for capturing business dynamics. Consequently, complex problems may be de-constructed and potential solutions formulated as the basis for developing practical applications (Stamper et al., 2000).

However, there are potential problems in terms of moving between the detailed qualitative assessment of stakeholders' interpretive frameworks, and the more standardised methods of requirements analysis. A key consideration is therefore to continually check and test emerging tools with project actors. Obtaining continued stakeholder participation and co-operation in the research project process is essential if research findings or recommendations are to be valid and effective. This also mitigates against requirements capture techniques becoming separated from the analysis of stakeholders conducted previously.

CONCLUSIONS

Construction informatics is an evolving and growing field of study, with research programmes active across Europe (Turk, 2007) and the methodological approach described here is also still developing and evolving. But approaching collaboration and information sharing in construction from an organizational semiotics perspective draws attention to the different processes of interpretation and meaning creation occurring across disparate actors involved in the process. In particular, the writing and reading framework holds much potential to contribute to the field through elucidating the information exchange issues occurring during a construction project life-cycle, and the production of meaning across multiple stakeholders. We are developing a fresh analysis and perspective from which innovative IT solutions for the construction sector may be based. Such a research approach promises to focus attention upon the root cause of collaborative project problems: the generation, manipulation and exchange of information.

REFERENCES

Aouad, G., Bakis, N., Wu, S. and Osaji, E.E. (2008). Delivering full value through seamless information systems, in Barrett, P. (a.ed.) Revaluing Construction. Oxford: Blackwell.

Barr, P., Biddle, R. and Noble, J. (2004). A semiotic model of user-interface metaphor. International Workshop on Organisational Semiotics, in Liu, K. (ed.) Virtual Distributed and Flexible Organisations: Studies in Organizational Semiotics. (pp.189-215) London: Kluwer Academic.

Cole, R.J. (2005). Building environmental assessment methods: redefining intentions and roles. Building Research and Information, 35 (5): 455-467.

Eco, U. (1979). The Role of the Reader: Explorations in the semiotics of texts. Bloomington: Indiana University Press.

Egan, J. (1998). Rethinking Construction: Report of the construction task force. London: HMSO.

Fairclough, J. (2000). Rethinking construction innovation and research. Department for Trade & Industry. London: HMSO.

Gann, D.M. (2000). Building Innovation. Thomas Telford: London

Harty, C. (2005). Innovation in construction: a sociology of technology approach. Building Research and Information, 33 (6), 512-522.

Higgin, G. and Jessop, N. (1965). Communication in the building industry. London: Tavistock Publication.

Liu, K. (2000). Semiotics in Information Systems Engineering. Cambridge University Press: Cambridge.

Liu, K, Sun, L and Tan, S. (2006). Modelling complex systems for project planning: a semiotics motivated method. International Journal of General Systems, 35 (3), 313-327.

Liu, K., Sun, L., Dix, A. and Narasipuram, M. (2001). Norm-based agency for designing collaborative information systems. Information Systems Journal, 11, 229-247.

Love, P.E.D., Li, H. and Mandal, P. (1999). Rework: a symptom of a dysfunctional supply-chain. European Journal of Purchasing & Supply Management, 5, 1-11.

Miozzo, M and Ivory, C. (2000). Restructuring in the British Construction Industry: Implications of recent changes in Project management and technology. Technology Analysis & Strategic Management, 12 (4), 522.

Peirce, C.S. (1960). Collected papers of C.S.Peirce, 1931-1935. Edited by Hartshorne, C. and Weiss, P. Cambridge: MA.

Saxon, R. (2002). The industry "formerly known as construction": an industry view of the Fairclough Review. Building Research & Information, 30 (5), 334-337.

Stamper, R. (1973). Information in Business and Administrative Systems. John Wiley & Sons: New York.

Stamper, R., Liu, K., Hafkampm M. and Ades, Y. (2000). Understanding the roles of signs and norms in organisations. Journal of Behaviour & Information Technology, 19 (1), 15-27.

Turk, Z. (2007). Construction Informatics in European Research: Topics and Agendas. Journal of Comp. In Civil Engineering, 21 (3), pp.211-219.

Woolgar, S. (1991). Configuring the user: The case of usability trials, in Law, J (ed.) A sociology of monsters (pp.58-99). London: Routledge.

Zietsman, E. (2008). How can information and communication technology reduce inefficiencies in the construction sector? 5th postgraduate conference on construction industry development, 16-18 March: Bloemfontein.

INFORMATION AND KNOWLEDGE MANAGEMENT IN PLANNING PROCESS: DATABASE OF ATP-GROUP

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Innovation is considered to be one of the major driving forces of economic development within global context; a guarantee for sustainable development of a company. Innovation stands in close relationship with generation of knowledge. In the knowledge society we live in, knowledge is considered to be the true capital value of a business enterprise.
The project and real estate development are areas with constantly increasing flows of information. The international ATP architect and engineers Group has set as aim the implementation of an information and knowledge management system: a country-related Database. The Database consists of all information considering processes of development, planning, construction and delivery of real estates; systemized accordingly to the country of the Group's developing and planning activities. The Database should comply with the specific requirements of the Group's corporate policy and should be integrated in the existing CAD-software platform. The paper will present a customized country-related database model for the planning process of ATP-Group.

KEYWORDS: knowledge management, information management, innovation.

INTRODUCTION

Innovation is considered to be one of the major driving forces of economic development within global context; a guarantee for sustainable development of an enterprise. Innovation stands in close relationship with generation of knowledge – accordingly the only true capital value of a business is knowledge. Knowledge transfer occurs through communication among employees; which immediately contributes to expansion of the knowledge stock of a business; consequently to the capital value and competitiveness. The knowledge existing only in the employees' heads as well as the knowledge stashed within file folders is the useless knowledge, that should be encouraged towards exchange; which again succeeds through formal and informal communication. The management, dissemination and availability of information (knowledge) play crucial role in efficiency and development of an enterprise.

Project and real estate development is an area with constantly increasing flows of information. The international ATP architects and engineers Group has set as aim the implementation of an information and knowledge management system: a country-related Database. The Database consists of all information considering processes of: development, planning, construction and delivery of real estates; systemized accordingly to the country of the Group's developing and planning activities. The Database should comply with the specific requirements of the Group's corporate policy and should be integrated in the existing CAD-software platform.

The paper will present a model for customized country-related database model for the planning processes of ATP-Group. A requirement profile will be introduced and compared to the existing knowledge management systems from the realm of urban planning and construction.
A database model with all the modules and its functionality will be demonstrated.
The focus will lay on the three most important functionality requests:
renewal, up-to-datedness, dissemination.
The guidelines for the use of the database and its successful placement within the company will be introduced.

The paper will be structured in two main parts:
the first part presenting the theoretical background of Knowledge Management, and the second part introducing the "Country-Database" model for the ATP-Group with aims and goals, structure and implementation.

THEORETICAL BACKGROUND

Knowledge Management (KM) comprises a range of practices used in an organisation to identify, create, represent, distribute and enable adoption of insights and experiences (4managers, 2009). Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organisational processes or practice.
A Knowledge Management System (KM System) refers to a system for managing knowledge in organizations, supporting creation, capture, storage and dissemination of information. It is generally an IT based system.
The major idea of a KM System is enabling of access for the employees to the organization's documented base of facts, sources of information, and solutions. For example a typical claim justifying the creation of a KM System might run something like this: an engineer could know the metallurgical composition of an alloy that reduces sound in gear systems. Sharing this information organization wide can lead to more effective engine design and further on to creation of ideas for new or improved equipment.

A KM System could be any of the following:

1. Document based technology permitting creation, management and sharing of formatted documents such as: Lotus Notes, web, distributed databases, etc.
2. Ontology/Taxonomy based technologies: similar to document technologies in the sense that a system of terminologies (ontology) is used to summarize the document e.g.: Author, Subj, Organization etc. as in DAML & other XML based ontologies
3. Artificial intelligence-based technologies, using a customized representation scheme to represent the problem domain
4. Network maps of the organization, showing the flow of communication between entities and individuals
5. Social computing tools, increasingly deployed to provide a more organic approach to creation of a KM System.

There is a number of Knowledge Management models, meeting the above standards, while there is no single "right" model. The two most prominent one will be introduced:

- The building blocks of KM
- "Spiral of Organisational Knowledge Creation"(Nonaka, 1997)

The building blocks of knowledge management

The “building blocks of knowledge management” (Probst, 2006) is one of the most popular European models. Probst defines practice-oriented parameters, on which the model is based on:

- Compatibility
- Problem Orientation
- Comprehensibility
- Action Orientation
- Appropriate Instruments

“The building blocks of knowledge management” represent activities that are directly knowledge-related. Their arrangement in the model follows the principle of inner- and outer circle feedback cycle.

An inner cycle consists of the building blocks of:

- identification,
- acquisition,
- development,
- distribution,
- preservation, and
- use of knowledge.

An outer cycle consists of all these activities plus goal-setting and measurement.

This feedback cycle clarifies the importance of measuring the quantifiable variables in order to focus on goal-oriented interventions.

Many knowledge problems occur because organizations neglect one or more of listed building blocks and thus interrupt the knowledge cycle. For example, if the research results of the Market Research Department are not available to Product Development, this knowledge cannot be used in the process of product development. If the steps of an important problem-solving process are not documented, they may disappear from the organization’s memory, making successful repetition of the process impossible (Probst, 2003).

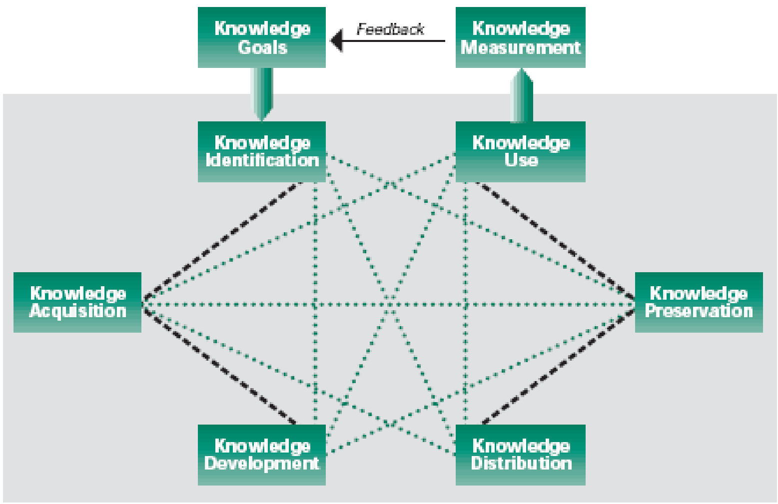

Figure1: The building blocks of knowledge management

The Spiral of Organizational Knowledge Creation

The concept of the “Spiral of Organisational Knowledge Creation” (Nonaka, 1997) originated in Japan. Nonaka and Takeuchi propose an underlying model to the knowledge creation process in order to understand its dynamic nature and to manage it effectively, consisting of three elements:

1. SECI (Socialisation, Externalisation, Combination, Internalisation)
2. Ba (a specific concept)
3. Knowledge Assets

SECI

The SECI element is based on four modes of knowledge conversion (SECImodel):

- Socialisation: Sharing tacit knowledge through face-to-face communication or shared experience
- Externalisation: Developing concepts, which embed the combined tacit knowledge and which enables communication
- Combination: Combination of various elements of explicit knowledge
- Internalisation: Closely linked to learning by doing, the explicit knowledge becomes a part of individuals’ knowledge base.

The creation of knowledge is a continuous process of dynamic interactions between tacit and explicit knowledge. The four modes of knowledge conversion interact in the spiral of knowledge creation (Figure 2). The spiral becomes larger in scale as it moves up through organisational levels, and can trigger new spiral of knowledge creation.

Ba

This difficult concept can be defined as a shared context in which knowledge is shared, created and utilized through interaction.

Knowledge Assets

Company-specific resources that are indispensable to create values for the firm can be defined as Knowledge Assets. These are the inputs, outputs and moderating factors of the knowledge-creation process.

The three elements: SECI, Ba and Knowledge Assets interact with each other originally and dynamically. The Knowledge Assets of an organisation are mobilised and shared in “Ba”, whereas the tacit knowledge held by individuals is converted and amplified by the spiral of knowledge through SECI (Socialisation, Externalisation, Combination, Internalisation).
The three elements should be integrated under clear leadership, so that the organisation can create knowledge continuously and dynamically, thus becoming a discipline for organisational members.

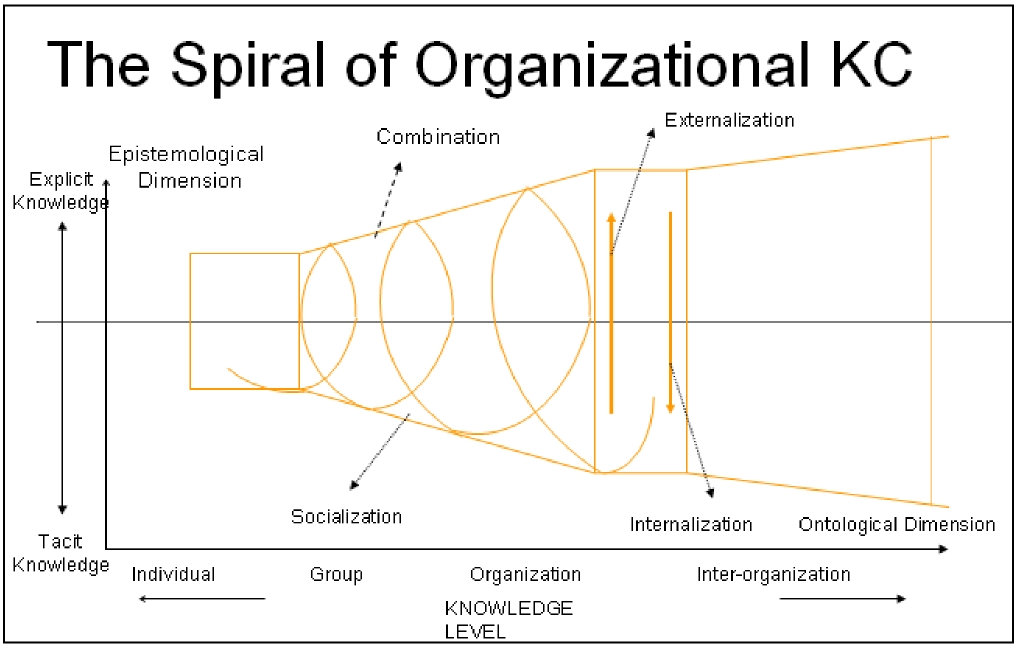

Figure.2: The spiral of organization, (GSW consulting, 2008)

DATABASE FOR ATP-GROUP

The ATP-Group is Austria's largest architectural and engineering company. With around 400 employees in its offices in Innsbruck, Vienna, Munich, Frankfurt, Zagreb and Zurich, ATP offers integrated full-service design services fine-tuned for realising complex construction projects for international clients.
As with every organisation, the management, dissemination, and availability of information (knowledge) all play a crucial role in the level of efficiency and the progressive development of an enterprise.
At ATP, the majority of the company's valuable information resides within its workforce, bound to the people and the diverse locations they work at. Additionally, a vast variety of tangible knowledge is stored within corporate file folders. In order to offer all the described types of information to each and every individual at ATP-Group, a knowledge management system was required.

The profile requirements of the database

ATP is located in different countries and is thus exposed to varying laws and regulations, processes and workflows in planning and construction. The so-called "Country Database" is the first step towards a company-wide knowledge management system. The current planning practice is highly dependable on the experience and knowledge of the persons involved in the specific project; the knowledge hardly accessible or even lost to the project co-workers.
The Database should be a well-used instrument to accumulate knowledge and to offer it to the whole company, irrespective of location, sub-organisation or type of employee.
The Database has to meet following challenges:

- Informal information structure – due to the largely differing departments and parties (architects, engineers, etc.) in most projects the knowledge resides within the employees' heads, formal documentation is restrained
- Scattered locations (Vienna, Munich, Zagreb, etc.) – knowledge is stored in local file folders and is not available for all of ATP's employees.

The main goal of the Database implementation is the efficiency increase.
Currently, most of the knowledge is spread throughout the company. Staff members generally lack the concrete guidance or information system as to where and how to access the accumulated knowledge. Therefore, despite the fact that there is a large amount of knowledge within a company, specific information is often acquired from the outside, which is cost and time consuming. In order to improve efficiency and save resources, employees should get access to the broad and general knowledge of the generated within the company.

A customised Knowledge Information System should offer a problem-solution for ATP-Group. The first step towards the realization of such a tool is a Database containing all the information about the different countries ATP is active in, and the key projects its employees are working on. ATP staff at every location should have access to the Database. The Database should be compatible and offer interface with company's CAD software (Autocad and Revit) and also with already implemented intranet platform.

The content of the database

At the point of implementation, the database should give users an informational overview of planning practice in 19 different countries. The information will be entered in the content-structure of the database, which is divided into six main areas:

1. Owner of the knowledge
    - Native Speaker
    - Know-how owner
    - Establishment

2. Main country facts:
    - Geography
    - Topography
    - Sate
    - Country and it's people
    - Real Estate

3. Economic data:
    - Policy and economy
    - Infrastructure

4. Laws and Regulation
    - Building law
    - Real estate law
    - Law of taxation
    - Criminal Law
    - Foundation of an enterprise
    - Miscellaneous
    - ATP

5. Processes
   - Development process
   - Planning process
   - Construction phase
   - Hand over process

6. Contacts
   - Partner
   - Translation offices
   - Public authorities
   - Owner of the knowledge
   - Federal economic chamber
   - Delegates
   - Mayor, contacts

Structure of the database

The database has to meet three main objectives:

- Actuality
- Knowledge transfer
- Renewability

The information system for the ATP-Group is arranged in a so-called wiki-format, again relying on a hierarchic three-pillar system.
Wiki is a piece of server software that allows the users to freely create and edit Web page content using any Web browser. Wiki supports hyperlinks and has simple text syntax for creating new pages and crosslinks between internal pages on the fly. A Wiki is unusual among group communication mechanisms in that it allows the organization of contributions to be edited in addition to the content itself. Like many simple concepts, "open editing" has some profound and subtle effects on Wiki usage. Allowing everyday users to create and edit any page in a Web site is exciting in that it encourages democratic use of the Web and promotes content composition by nontechnical users. (Schäfer, 2006)
A wiki system ensures that every employee has access to the company's knowledge. In turn, each employee is required to publish information onto the system in order to maintain its dynamic nature.

However, for quality assurance reasons, the system demands a hierarchic organisation with certain access restrictions. The Figure 3 shows a hierarchic arrangement of the three pillars and the underlying concept:

1. pillar: field of knowledge
2. pillar: field of strategy
3. pillar: field of administration

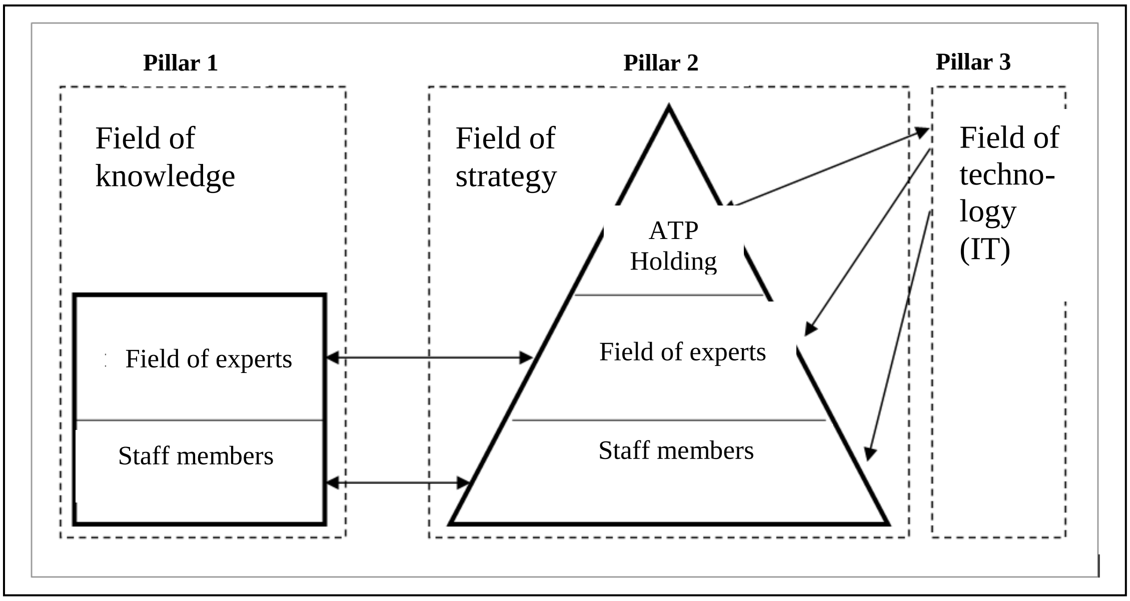

Figure 3: hierarchic three-pillar system, (Prinz, 2009)

1. Pillar: The Field of Knowledge

The field of knowledge is split into two different knowledge levels:

- The first level containing general knowledge about a country, like facts about the economy and geographical data. This information generally easy to acquire, and therefore of less importance.
- The second level, called the expert field, containing specific knowledge about laws and regulations concerning planning and building activity and special process-flows (development, planning, construction). Thus, it is higher in granularity and much more difficult to generate.

2. Pillar: Field of Strategy

This pillar represents an organisational level. It is divided into three basic categories:
staff members, experts and Holding-members.
Staff members can access and edit the previously described first level of information (country relevant data). They are also able to read entries on the second level, however, their editing rights on this more detailed and sensitive level are suppressed. Only the experts can access and edit all available information on every level of the database.
The highest level of the Field of Strategy is solely accessible for members of Holding-level. Holding-level nominates the experts.

3. Pillar: field of technology

It is the technical, IT- and system-controlling level.
Even though the general concept of a Wiki appears to be an anarchical chaos, there is a concrete and specific structure governing the information system. The structure is created and given by the IT level and has to be respected by each and every user in order to maintain its dynamic, but informative appeal.

ATP's corporate wiki is designed to be a self-sustaining system, however a central administration body will govern the adherence of the three main objectives:
Actuality, Knowledge Transfer and Renewability. These tasks include the approval and administration of user rights, continuous control of the published content, and design and usability activities. This regulatory entity has the position to delete outdated information and act as single point of contact in case of user inquiries (which are likely in the first phase of company-wide adoption).

Implementation

The implementation of the Database has to be introduced in stages, taking place in the course of longer time-period (Herbst, 2000). It should be structured in following steps:

- Analysis
- Planning
- Implementation and
- Control

The first step is to analyse the company's problems. ATP has already set the first step towards the Knowledge Management System through implementation of the intranet-platform. This form of communication and information management is not very common amongst the profession within the companies of the similar size, and is seen as an innovation. The internet platform will serve as the base for the implementation of the KM System.
However, the implementation of the intranet-platform itself was not without difficulties.
It was not accepted by the staff at the beginning. As an incentive towards increase of acceptance and use, the intranet was the set as the first site of the internet browser.
The second problem for the success of the KM System is the time and project management within the company. The project co-workers are focused on the allocated project hours, finding no time for the corporate identity activities, to which knowledge management should actually count. The use and maintenance of a successful KM System must be encouraged by management and clearly defined as a corporate goal.

Motivation of the staff

The staff has to be sufficiently motivated for the Database project before the beginning of the actual implementation. It is important that top level management acts as a role-model for the staff, through pioneering the database-entries right at the beginning.
A successful implementation of a KM System calls for changes of corporate culture.
An ambience of tolerance and confidence must be created and lived.
One of the steps towards cultural change is encouraging the will for sharing of knowledge and information in general but especially at the top level management and top positions. Often are experience, knowledge and know-how seen as status-symbols, which keep one in power.
The fear of loosing the power through sharing of information represents an obstacle for successful KM.
A further difficulty is the hierarchical corporate structure- a democratic communication beyond hierarchal boundaries is a precondition of a successful KM. A Database-entry can display that a member of lower hierarchy-level has more knowledge on a certain topic than a top level member, which must not be seen as a flaw, but as enrichment for the company as a system.
Also a shame for placing of incorrect information in the Database must be resolved, since if everyone is acting too cautiously, the Database will remain empty.
The successful implementation, use and operation of the Database should be accompanied by motivating incentive schemes.

CONCLUSION

Through implementation of the “Country-Database” the fundament of a successful Knowledge Management System for ATP-Group can be laid.
The customised Database model is developed with respect to integration in the existing IT-system as well as to enable interface with different IT-tools. The planned future implementation of building information modelling software Revit should also be possible. Thereafter, all the technical requirements for the efficient implementation are established.
The success of the KM System is largely dependable on the staff of the company.
The company itself has shown the will and interest for innovative information and communication tools through implementation of the intranet platform; therefore an encouragement for the implementation and maintenance of the Database can be expected.
The Database-project builds a base for sustainable development of the ATP-Group and can contribute to a realisation of a holistic KM System.
Knowledge stock and consequently people represent true value and capital as well as competitiveness of an enterprise. The current economic crisis makes the financing and implementation of a project such as the “Country-Database” extremely difficult - an investment in “immeasurable values” might appear as improper at the current moment. However, it is still highly recommendable since it represents an investment in the future sustainable economic development of the company.

REFERENCES

4managers, ILTIS GmbH, GF: Martin Wolf, Rotterdam; available at:
http://www.4managers.de/themen/skill-management/

GSW consulting (2008); available at:
http://www.gswconsulting.org/KC_spiral_organisational.gif

Herbst, D. (2000) Erfolgsfaktor Wissensmanagment Berlin: Cornlesen Verlag

Nonaka, I.; Hirotaka T. (1997) The knowledge creating company (dt.); Die Organisation des Wissens: wie japanische Unternehmen eine brachliegende Ressource nutzbar machen; aus dem Engl. von Friedrich Mader, Frankfurt, Main: Campus-Verlag

Probst G. J.B. (2003) Management: a model that works; available at:
http://know.unige.ch/publications/Prismartikel.PDF

Probst, G., Raub S., Romhardt K., (2006): Wissen managen, - wie Unternehmen ihre wertvollste Ressource optimal nutzen, Frankfurt (Main)/Wiesbaden: Frankfurter Allgemeine/Gabler

SECImodel, 12manage B.V. Netherlands; available at
http://www.12manage.com/methods_nonaka_seci.html

Schäfer, Y. (2006): Beteiligungsprozesse und digitale Medien, Wikis, Weblogs & Co als neue Formen des Dialogs in der räumlichen Planung Potentiale – Grenzen – Anwendungsfelder, Diplomarbeit an der Fakultät Architektur und Landschaft Universität Hannover

KNOWLEDGE MAPPING: A CONTINGENCY APPROACH

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Knowledge management has been recognised as a potentially useful approach to enhancing competence and competitive advantage of firms through efficiently managing knowledge assets. However, it has been asserted that knowledge management is still at an immature phase and furthermore, its resultant benefits and advantages have not been clearly identified or substantiated. Within this context, knowledge maps have been proposed as a useful mechanism for successful knowledge management for projects and organisations. A knowledge map concept model was developed through a single case study of a large construction project consulting firm. Further four types of knowledge maps were distinguished, including narrow-based knowledge map, strategic construction actor-based knowledge map, specific construction work process-based knowledge map and broad-based knowledge map. It is concluded that no one knowledge map model type will be appropriate for all construction project organisations and each type has its unique context, components, potential benefits and key constraints.

KEYWORDS: contingency approach, knowledge management, knowledge mapping, knowledge transfer.

INTRODUCTION

Knowledge management (KM) is recognised as a key capability to enable construction companies to capture, structure and transfer project-based knowledge to achieve effective project performance (Hoffman et al., 2005, Meroño-Cerdan *et al.*, 2007). However, in spite of the proclaimed value of KM, a number of problems and barriers have been revealed in which have eroded the actual benefits of KM. These include knowledge and KM strategy-based problems (Zack, 1999), human resource-based problems (Thite, 2004), KM technology-based problems (Koch, 2003) and process-based problems (Davenport et al., 1996).

Above all, it has been argued that the major problem is the lack of effective integration of key components and technologies for successful KM. The ‘integration view’ is consistent with the relevant literature. Robinson *et al*. (2005), for example, highlighted that people and processes must be integrated for successful KM in projects and organisations. Similarly, Kamara *et al*. (2002) and Maqsood *et al*. (2006) stressed that construction actors, processes and technologies must be considered and integrated for successful KM.

In the construction industry, there are few empirical studies which have focused on integration. This paper makes a contribution to this agenda by offering a contingency-based view of knowledge mapping.

KEY ISSUES FROM THE LITERATURE

There is a diverse range of definitions of knowledge mapping in the literature. Knowledge maps are generally seen as the processes, methods and tools to effectively visualise the sources and flows of tacit and explicit knowledge (Driessen *et al.*, 2007; White, 2002). This definition is further expanded by Gomez *et al*. (2000) who define knowledge mapping as a visual architecture of knowledge which enables users to more easily and quickly access relevant knowledge. In summary, knowledge maps are an interactive and open system for dialogue that defines, organises and builds on the intuitive, structured and procedural knowledge used to explore and solve problems (Wright, 1993).

There are a variety of knowledge map types which can be identified. First, 'procedural knowledge maps', commonly referred to as 'process-based knowledge map', are used to visualise knowledge and knowledge resources within project or business processes (Kang et al., 2003). These maps are seen as being particularly useful for process-based projects, such as in construction. Second, 'conceptual knowledge maps' are for content management of knowledge which are used as a method of hierarchically organising and classifying contents of knowledge (Caldwell, 2002). These maps can be used for content management of knowledge, for example for web-based systems with taxonomies. Third, 'competency knowledge maps' are employed to document skills, techniques, positions, job experiences and career path of individuals (Bish, 1999; Gorseline, 1996). These knowledge maps can support users to find right knowledge owners at the right time in projects and organisations (Tiwanna, 2002). Finally, a range of other knowledge maps have been proposed including wed-based knowledge maps, strategy-based knowledge maps and cognitive knowledge maps. An important question which emerges from such a diverse range of knowledge mapping types is what type of map should be used in any given context? This contingency question is explored here.

RESEARCH METHODOLOGY

A single case study approach was adopted in this research (Yin, 2003). The data collection techniques consisted of a literature review, company documentation and semi-structured interviews (Bell, 1993). Twelve interviews were conducted. The sample set consisted of two knowledge managers, nine project members and one project manager / knowledge manager. Each interview was between one and a half and two hours long. All the interviews were recorded by a digital voice recorder and then subsequently were transcribed. Each transcript was sent to each interviewee to check for accuracy. The data analysis techniques consisted of content analysis technique and cognitive mapping technique (Fraser, 1999).

KEY FINDINGS

Background of the case study firm

The case study company (here labelled as company A for confidentiality reason) is a large construction project consulting firm in the Republic of South Korea. The company was established in 1996 through a joint venture with an international engineering and construction management company based in the United States of America. The strategic aim of the joint venture is to develop its market competitiveness in the Republic of Korea and, in so doing, increase its market share.

Knowledge map concept model

A knowledge map concept model emerged from the results. This model consisted of four components: knowledge capital, construction actors, construction processes and knowledge transfer technologies (see Figure 1). In the centre, knowledge capital (e.g. Lu and Sexton, 2009) is defined as the dynamic synthesis of 'construction actors', 'construction processes' and 'knowledge transfer technologies' to enhance project-based learning and to improve project performance within temporary construction project organisations. As a consequence, these three components (construction actors, construction processes and knowledge transfer technologies) must be adopted and integrated for successful knowledge mapping.

The key findings further asserted that these three components must be configured into different types depending on the circumstance in which knowledge map model modes are formed: 'strategic' knowledge maps and 'operational' knowledge maps. Each component is presented below.

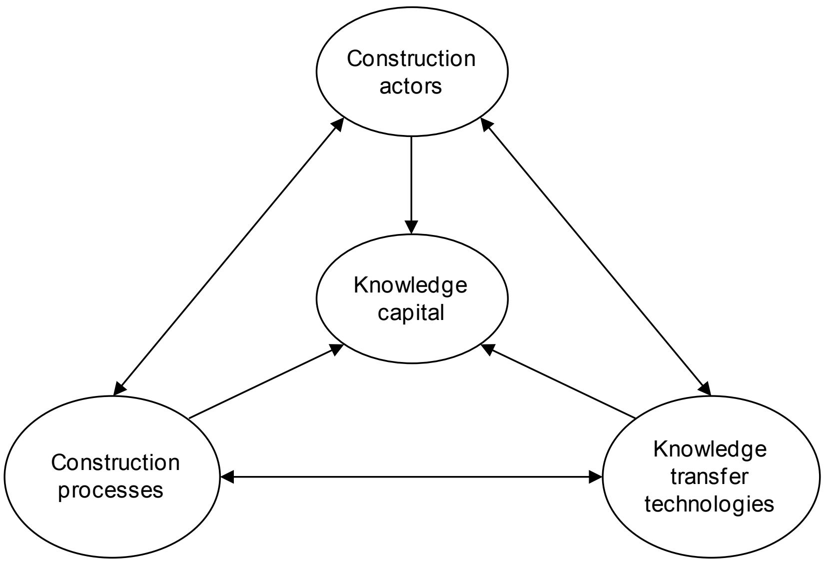


Figure 1: A knowledge map concept model

(1) Construction actors

The research results distinguished between two actor groups. First, generic actor groups who have a corresponding generic 'strategic' body of knowledge. Second, specific actor groups on a particular project who need specific knowledge within an 'operational' context.

(2) Construction processes

Two different types of construction processes were identified which need to be integrated in the knowledge mapping process: generic management system-based processes and specific construction work-based processes. Table 1 summarises the two types of construction processes.

Table 1: Types of construction processes in the knowledge mapping

	Broad-based knowledge maps	Specific knowledge maps
Key aim	• Effective management system-based process knowledge and skills sharing • Effective management system-based process performance • Effective management system-based process knowledge improvement of construction actors	• Effective specific construction work-based process knowledge and skills sharing • Effective specific construction work-based process performance • Effective specific construction work-based process knowledge improvement of construction actors
Indicated processes	• Generic management system-based processes (e.g. cost management processes, time management processes and quality management processes)	• Specific construction work-based processes (e.g. roofing work processes, piling work processes, tiling work processes and concreting work processes)

(3) Knowledge transfer technologies

The research results recognised that different technologies were appropriate to the transfer of tacit knowledge and explicit knowledge. Table 2 describes the types of knowledge transfer technologies.

Type 2: Types of knowledge transfer technologies in the knowledge mapping

Type of knowledge transfer technologies	Explicit knowledge	Tacit knowledge
Information communication technologies	Homepages, question and answer system, e-mail system, knowledge management (KM) system and MSN	Mobile phone, telephone, personal digital assistant (PDA) and radio
Internet-based technologies	Homepages, question and answer system, e-mail system, KM system and MSN	Mobile phone and PDA
Mobile environment-based technologies	Mobile phone, PDA and radio	Mobile phone, PDA and radio
Social Networks	Organisational network systems	Social gathering, meeting and mentor systems

Contingency approach to knowledge map types

No one knowledge map model type will be appropriate for all construction project organisations, and each type has its unique context, components, potential benefits and key constraints. This means that knowledge map types can be flexibly created by the knowledge mapping components determined according to the business and project needs. This position is shown in Figure 2.

The key findings identified different loci for each of the knowledge mapping components identified in the concept model: strategic construction actors and operational construction actors; generic management system-based processes and specific construction work-based processes; and, tacit knowledge transfer technologies and explicit knowledge transfer technologies. Based on the different loci, four types of knowledge maps were distinguished: type A: narrow-based knowledge map; type B: strategic construction actor-based knowledge map; type C: specific construction work process-based knowledge map; and, type D: broad-based knowledge map (see Figure 2).

Table 3 summaries the four types of knowledge map: context, components and example of each component. Each type of knowledge map is discussed below.

Type A: narrow-based knowledge map

'Type A' represents a situation in which strategic construction actor-based and specific construction work-based process knowledge transfer motivation is high. This type of knowledge map consists of strategic construction actors (e.g. architects), specific construction work-based processes (e.g. design processes) and both tacit knowledge transfer technologies and explicit knowledge transfer technologies (e.g. social gathering and meeting and mobile phones).

Type B: strategic construction actor-based knowledge map

This type is appropriate for strategic construction actor-based knowledge mapping approach in which project-based knowledge owned and used by strategic construction actors is mapped in the general management system-based processes. In this type, strategic construction actors (e.g. quantity surveyors), generic management system-based processes (e.g. cost management processes) and both tacit knowledge transfer technologies and explicit knowledge transfer technologies (e.g. telephones, e-mail systems and personal digital assistants (PDAs).

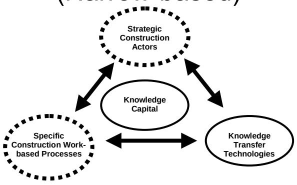
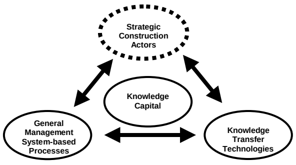
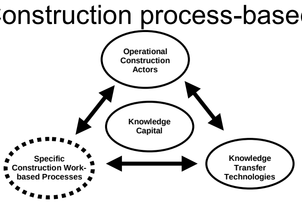
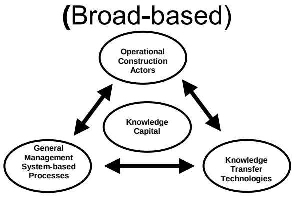
Type C: specific construction work process-based knowledge map

This type is appropriate for specific construction work process-based knowledge mapping in which specific construction work process-based knowledge owned and used by operational construction actors.

Type D: broad-based knowledge map

This type is appropriate for a broad-based knowledge mapping approach in which operational construction actors, general management system-based processes (e.g. quality management processes) and both tacit knowledge transfer technologies and explicit knowledge transfer technologies (e.g. mobile phones, social gathering and meeting, KM systems and project management information systems) are used. This type represents a context in which the general management system-based knowledge is owned and used by operational construction actors.

Table 3: Attributes, components and examples of each component for four types of knowledge map model within construction project organisation

Mode / attributes	Components	Example of each component
Type A (Narrow-based)  	Strategic construction actors	Architects
	Specific construction work-based processes	Design process
	Both tacit and explicit knowledge transfer technologies	Social gathering and meeting, mobile phones and PDAs
Type B (Construction actor-based)  	Strategic construction actors	Quantity surveyors and project managers
	Generic management system-based processes	Cost management processes
	Both tacit and explicit knowledge transfer technologies	Telephones, e-mail system and KM system
Type C (Construction process-based)  	Operational construction actors	All construction actors
	Specific construction work-based processes	Concreting work-based processes
	Both tacit and explicit knowledge transfer technologies	Telephones, e-mail systems, mentor system and radio
Type D **(**Broad-based)  	Operational construction actors	All construction actors
	Generic management system-based processes	Quality management processes
	Both tacit and explicit knowledge transfer technologies	telephones, e-mail systems, mobile phones, PDAs, social gathering and meetings, mentor system and radio, KM system and project management information system

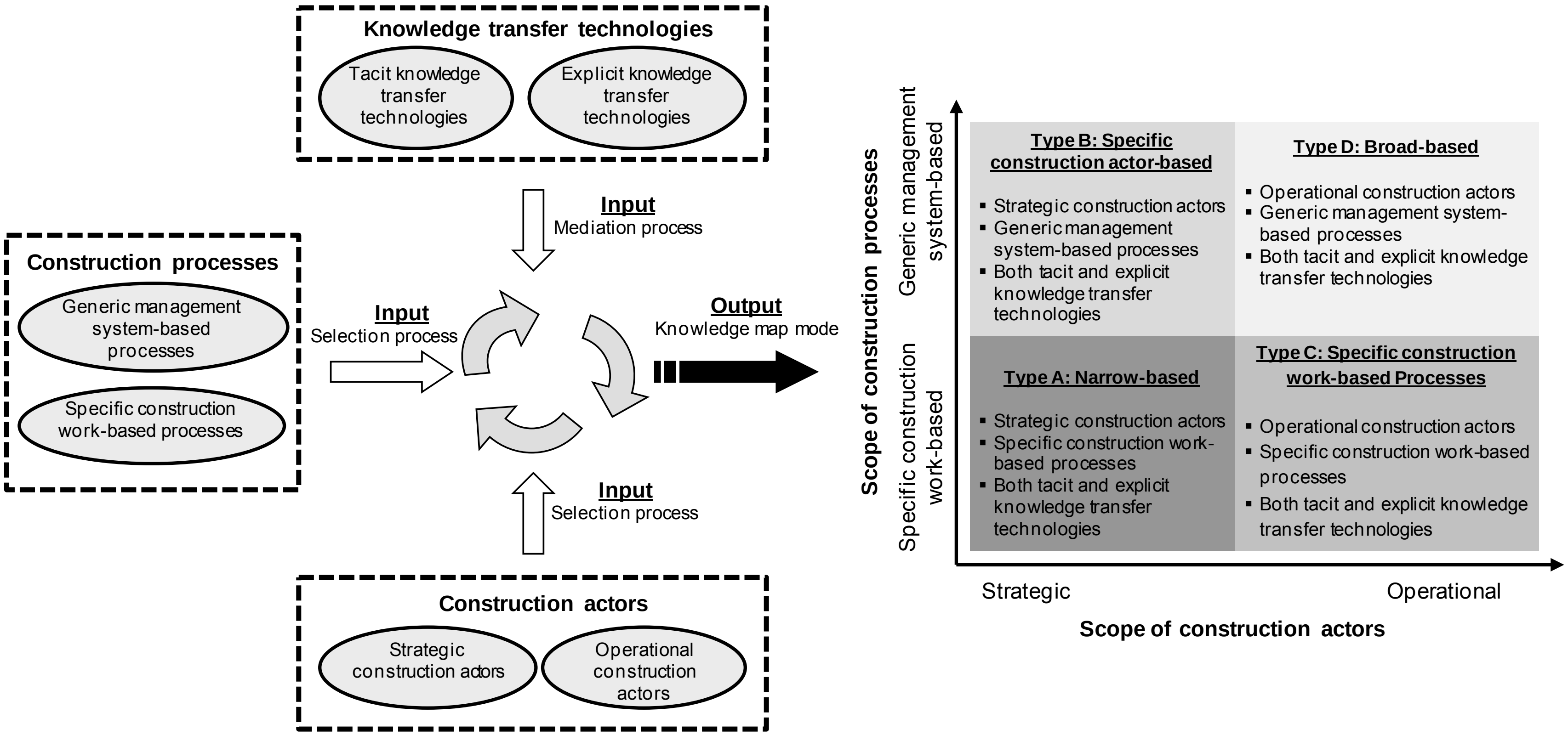


Figure 2: Fundamental principle of knowledge mapping

CONCLUSIONS

The paper has presented exploratory results and proposed a contingency approach to match knowledge map types to particular contexts. Further empirical work is required to extend this contingency-based knowledge mapping approach. This would provide nuanced guidance for future knowledge map design and operation.

REFERENCES

Bell, J. (1993) *Doing Your Research Project*, Buckingham, Open University Press.

Bish, C. M. (1999) Building competency maps. *Journal of Knowledge Management,* **7,** 10-13.

Caldwell, F. (2002) Knowledge Management Scenario: What's Next? *Gartner U.S. Symposium ITXPO.* Walt Disney World, Orlando, Florida.

Davenport, T. H., Jarvenpa, S. L. and Beers, M. C. (1996) Improving knowledge work processes. *Sloan Management Review,* **37(4),** 53-65.

Driessen, S., Huijsen, W.-O. and Grootveld, M. (2007) A framework for evaluating knowledge-mapping tools. *Journal of Knowledge Management,* **11(2),** 109-117.

Fraser, D. (1999) *NVivo Reference Guide,* Melbourne, Qualitative Solutions and Research Pty. Ltd.

Gomez, A., Moreno, A., Pazos, J. and Sierra-Alonso, A. (2000) Knowledge maps: an essential technique for conceptualization. *Data & Knowledge Engineering,* **33(2),** 169-190.

Gorseline, K. (1996) A competency profile for human resources; no more shoemaker's children. *Human Resource Management (USA),* **35(1),** 53-66.

Hoffman, J. J., Hoelscher, M. L. and Sherif, K. (2005) Social capital, knowledge management, and sustained superior performance. *Journal of Knowledge Management,* **9(3),** 93-100.

Kamara, J. M., Augenbroe, G., Anumba, C. J. and Carrillo, P. M. (2002) Knowledge management in the architecture, engineering and construction industry. *Construction Innovation: Information, Process, Management,* **2(1),** 53-67.

Kang, I., Park, Y. and Kim, Y. (2003) A framework for designing a workflow-based knowledge map. *Journal of Knowledge Management,* **9,** 281-294.

Koh, S. C. L. and Tan, K. H. (2006) Operational intelligence discovery and knowledge-mapping approach in a supply network with uncertainty. *Journal of Manufacturing Technology Management,* **17(6),** 687-699.

Lu, S. and Sexton, M.G. (2009) *Innovation in small professional practices in the built environment*, Innovation in the Built Environment (IBE) Book Series, Wiley-Blackwell Publishing, Oxford, UK.

Maqsood, T., Finegan, A. and Walker, D. (2006) Applying project histories and project learning through knowledge management in an Australian construction company. *The Learning Organization,* **13(1),** 80-95.

Meroño-Cerdan, A. L., Lopez-Nicolas, C. and Sabater-Sánchez, R. (2007) Knowledge management strategy diagnosis from KM instruments use. *Journal of Knowledge Management,* **11(2),** 60-72.

Robinson, H. S., Carrillo, P. M., Anumba, C. J. and Al-Ghassani, A. M. (2005) Knowledge management practices in large construction organisations. *Engineering, Construction and Architectural Management,* **12(5),** 431-445.

Thite, M. (2004) Strategic positioning of HRM in knowledge-based organizations. *The Learning Organization*, **11(1),** 28-44.

Tiwana, A. (2002) *The knowledge management toolkit,* Prentice Hall PTR, London.

White, D. (2002) *Knowledge mapping and management*, London, IRM Press.

Wright, R. (1993) An approach to knowledge acquisition, transfer and application in Landscape Architecture. University of Toronto, Canada.

Yin, R.K. (2003) *Case Study Research: Design and Methods, Applied Social Research Methods Series*, 3rd ed., Sage Publications, London.

Zack, M. H. (1999) Developing a knowledge strategy. *California Management Review,* **41(3),** 125-145.

AN EXAMINATION OF DECISION MAKING AND KNOWLEDGE MANAGEMENT PRACTICES IN POST DISASTER HOUSING RECONSTRUCTION PROJECTS

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Representatives from eight leading NGOs were surveyed to capture tacit, implicit and explicit knowledge and establish decision making and knowledge management practices used by their organisations during post disaster housing reconstruction. The issues of hazard risk and appropriate mitigation including increasing vulnerability due to climate change; end users and stakeholder consultation in planning and design; technological solutions; and constructing the build were all discussed, as these are challenges being faced in the pursuit of sustainable construction. The survey results presented in this paper provide insights into the decision making practices of these NGOs and establish where improvements need to be made. The results also establish that knowledge management activities need to be more focused to ensure that lessons learnt previously are implemented elsewhere; critical in hazard mitigation and meeting the challenges of increased vulnerability due to climate change.

KEYWORDS: decision making, housing, knowledge management, post disaster reconstruction.

INTRODUCTION

Housing recovery passes through four stages in the aftermath of a disaster: emergency shelter; temporary shelter; temporary housing; and permanent housing (Quarantelli, 1982); consequently reconstruction of housing stock after a disaster is not the same as providing shelter immediately following an event (Freeman, 2004). In general, research on disaster relief as it relates to permanent housing provision and associated social concerns, is still deficient (Levine et al., 2007). There is a perceived gap in the understanding the longer-term impacts of post disaster reconstruction. Implementing agencies rarely have the time and/or expertise to document properly what they have done or undertake comprehensive research on the value of their interventions.

CONTEXT

There has been a significant rise in the number of disaster events over the past decade, as well as in the number of people affected by disasters associated with natural hazards; as documented since the beginning of reliable recording in the 1960s (IFRC, 2003). Far from being under control, evidence suggests that losses associated with the built environment due to these extreme natural hazards are increasing rapidly (Spence and Kelman, 2004). As a result disaster relief work has increased substantially in the past two decades (Blacker, 2006). However questions have arisen surrounding the appropriateness of the responses made to these disasters, and how they are monitored, in order to assess their effectiveness over the short, medium and long term (Lorch, 2005).

As climate change exacerbates vulnerability, measures to mitigate increased risk need to focus on reducing built environment vulnerability in the context of development efforts;

particularly building adaptive capacity and technology transfer. Indeed the unpredictability generated by climate change places more emphasis on the need to identify and support generic adaptive capacity alongside hazard-specific response capacity (Schipper and Pelling, 2006).

As the incidents of natural disasters increase, it is imperative that NGO's and other agencies involved in disaster relief manage risk learn as much as possible from each disaster recovery and reconstruction process they are involved with; its successes and failures (Kumaran and Negi, 2006). NGO's play important roles in different stages of the 'disaster cycle' and different elements are attributed to its successful operation. For example, technical skills are important for rescue, whilst coordination is essential relief activities. These require different knowledge skills, competencies and attributes.

There is a general consensus that disaster management should shift its focus from response and recovery to sustainable hazard mitigation (El-Masri and Tipple, 2002). Hazard mitigation and planning should therefore be considered as more than an auxiliary issue and disaster risk reduction needs to be incorporated into the construction management process. The construction management decision-making process requires an in-depth integrated understanding of how to avoid and mitigate the effects of natural disasters. In order to be effective, resilience needs to be systematically 'built in' to the planning and design process and not simply added on as an afterthought (Bosher el al., 2007). It is therefore necessary to increase the participation of NGO's and the affected community within the construction process.

An appropriate response when reconstructing housing environments following a disaster is one that delivers solutions that optimise the design (its functionality and configuration) and manufacture (materials) of the build in terms of ecology, economy and social needs (Arslan, 2007), if a sustainable solution is to be found. All too often reconstruction responses are driven by technology, limiting wider engagement with cultural and social issues (Lorch, 2005). End-users must be recognised as active stakeholders; aware and conscious of their own needs and wants, rather than as passive recipients, who need to be educated as sustainability can only be achieved by using local resources (materials and labour) and cultivating skills and knowledge, thus creating micro-economies for those trying to get on with their lives post-disaster (Prasad, 2005). Ultimately, the success of any project hinges on co-ordination (organisational and managerial), both at local and regional levels, within and between organisations. The performance of housing reconstruction projects is directly related to the design and management of the project team itself (Dorrell, 2005); highlighting the importance of studying decision making in project teams and analysing organisational knowledge management processes for best practice.

There are large uncertainties associated with the future performance of the built environment due to changes in regional and local scale climatic conditions. To ensure that every house that is reconstructed following a disaster will work with or withstand future potential disasters, there needs to be an understanding and awareness of potential future risks (including climate change mitigation) alongside the development of strategies to survive or combat them.

It has been demonstrated that more research is needed on the effectiveness of longer-term development in communities where international aid and expertise have been provided. Implementing agencies rarely have the time and/or expertise to document properly what they have done or undertake comprehensive research on the value of their interventions. Therefore it both prudent and necessary to research decision making processes and in particular to establish to what extent local knowledge and technical and scientific information is exchanged between the different stakeholders (which includes the end users) and what is encouraging or constraining locally adapted solutions, particularly with respect to design, technology and materiality but also construction and building maintenance, in post-disaster housing reconstruction.

The aim of this research project, funded by the Sino-British Fellowship Trust, was to capture tacit, implicit and explicit knowledge and map the project management practices of leading aid agencies (NGOs and charities working in disaster relief) to understand decision making and knowledge management practices in the final stage of housing recovery (permanent housing).

RESEARCH APPROACH

With awareness of current practice, informed by the literature, a pilot questionnaire survey was developed. The aim of the questionnaire survey was to explore and capture both explicit and tacit knowledge in area of decision making approaches to housing reconstruction projects, when in response to natural and man-made disasters. The survey consisted of 50 questions, divided into six sections. The first section comprised of details relating to the individual being interviewed, their profession, field of expertise, and experience of working in post disaster reconstruction, in order to build up a personal profile. The following three sections dealt with decision making and knowledge management practices relating to: hazard risk and appropriate mitigation including disaster risk management strategies, increasing vulnerability and climate change; end users and stakeholder consultation in planning and design; and technological solutions and constructing the build. Sections five and six dealt with more general questions relating to organisational and management issues and knowledge and learning issues respectively.

Once the questionnaire had been trialled, a cross section of international charities and NGO’s with offices in the UK and working in disaster relief were contacted and asked to engage with the research by taking part in the survey and to form a steering committee for the project. 26 organisations were invited to take part in the survey; of the 26, eight organisations took part. The survey was conducted through in-depth interviews with project participants, either in person or by telephone, and as an on-line survey for those who preferred to complete the questionnaire in their own time. All the respondents had in depth experience of disaster response, including shelter and specifically housing reconstruction. The interviews were recorded and transcribed to ensure effective use of the shared knowledge.

FINDINGS

Preliminary results from this research, obtained through analysis of the survey responses, have been presented below in six sections, which reflect the structure of the survey.

PERSONAL PROFILES

All the respondents had experience of disaster response, including shelter and specifically housing reconstruction, naming their profession or field of expertise as disaster response, disaster risk reduction, shelter and reconstruction. All respondents had field experience and the majority of respondents had at least three years experience in the field, working on housing projects in situ. This experience validated their ability to respond appropriately to the questions asked in the subsequent sections.

HAZARD RISK AND APPROPRIATE MITIGATION INCLUDING DISASTER RISK MANAGEMENT STRATEGIES, INCREASING VULNERABILITY AND CLIMATE CHANGE

Frequently time constraints prevent what the respondents would consider to be appropriate hazard mitigation from taking place, particularly with in-country experts who are generally looked upon as less capable. Some countries/regions are perceived to be more prepared than others, dependent on the capabilities and resources available. The majority of those taking part in the survey agreed that disaster risk has tended to fall between the cracks of the wider framework of development cooperation and emergency relief, although initiatives are being undertaken to improve on this. Five of the eight organisations represented do have what is perceive to be a climate change strategy; however there were suggestions that such strategies lack capacity and strategic level commitment. Whether organisations identify and support building adaptive capacity and technology transfer together with the hazard-specific response is dependent on how donors look at transition and reconstruction and thus whether they are prepared to fund what may be considered add-ons or non-essentials.

END USERS AND STAKEHOLDER CONSULTATION IN PLANNING AND DESIGN

There was a general consensus, that self-build housing and housing built with volunteers and partner families, was the most appropriate response. There was an agreement that engagement/consultation with the community should take place as soon as feasibly possible and that keeping beneficiaries involved in the decision making process (as far as possible) were key to optimising the design (its functionality and configuration) to meet the social and cultural needs of the end users. However one contributor suggested that what is not being vigorously analysed is what community participation is actually necessary and what participation people actually want. When ensuring optimisation of the design, (its functionality and configuration) to mitigate against future hazards and potential climate change different organisations demonstrating very different approaches. No one organisation described a strategy which could be used in all circumstances and therefore a process which could be mapped.

TECHNOLOGICAL SOLUTIONS AND CONSTRUCTING THE BUILD

No one profession/individual is seen to exercise greater influence over materials/technology choice than another. Optimising the materials/technology of the build to mitigate against future hazards and potential climate change is seen as a balancing act. In order to meet social and cultural needs, it is essential to consult with end users, community planners/development committees and local trades people; and that this helps balance the technical expertise being supplied by the external organisation (and what they perceive to be the most appropriate way forward), with the actual needs of the end user. Everyone agreed that indigenous building knowledge can be devalued by outsiders and/or by local people themselves during the process. Examples were given where local people wanted concrete instead of wooden houses, clay tiles instead of thatch, reinforced concrete frame houses, brick or concrete walls, and flat slab roofs, even if these mean much hotter, wetter and uncomfortable houses; because these building materials are seen as modern and desirable even though they were considered to be less appropriate. When asked to give an example of where reconstruction work had unintentionally increased vulnerability, it was materials choices as well as the lack of knowledge and training of construction workers in new technologies that increased vulnerability. At present the organisations represented do not provide housing with a higher climatic safety level than considered necessary under the climate regime of today. However it was suggested that when undertaking reconstruction projects, where things are by definition intended to be more robust, they should be built to withstand potential climatic changes, e.g. shocks and stresses in a region subject to earthquakes.

ORGANISATIONAL AND MANAGEMENT ISSUES

Lack of resources, particularly time was seen as the key challenge when co-ordinating community-based activities in post-disaster reconstruction. In addition working alongside non-technical bureaucrats was seen as a major issue. The development of more integrated, interdisciplinary projects was restricted by competition for limited funding and by donors' separate budget lines for emergency relief and redevelopment, with donors sectionalising their funding. Not all organisations represented in this survey undertake cost benefit analysis or similar techniques on their projects. Only one organisation calculates the whole life/life cycle cost of their projects. There appeared to be no clear strategy from the organisations surveyed when considering how individual decisions made during projects are assessed.

KNOWLEDGE AND LEARNING ISSUES

Most respondents stated that their organisation does have formal procedures or guidelines for learning lessons from projects including debrief sessions after each project and through formal learning programmes and manuals. However, it was highlighted that much happens through personal experience i.e. learning something on a project and applying it the next time, but there is no significant knowledge transfer in this. In addition one respondent reported that although debrief sessions are undertaken (and documented), the outcomes of these sessions are not used by or shared with those who are newly deployed, so they inevitably make the same mistakes. In every instance, "lessons learned" activities were reported to only take place at the completion of projects; the one exception was a rebuilding programme following Hurricane Katrina, where 6 and 18 month lessons learnt activities were undertaken. Despite a lot of strategic activity there was some criticism that these lessons learnt do not filter down to field workers and the onus is on the individual to go looking for this information. The general consensus was that these activities need to be more focused and undertaken in a manner that facilitates the implementation of lessons learnt in the future. There was no mechanism mentioned in terms of capturing tacit or implicit knowledge from project members or how this knowledge could be shared with others, particularly in instances where that individual was no longer going to be working in that region or for that particular organisation.

DISCUSSION

The construction management decision-making process requires an in-depth integrated understanding of how to avoid and mitigate the effects of natural disasters. Despite this need to mitigate increased risks including climate change, to identify and support generic adaptive capacity alongside hazard-specific response capacity (Schipper and Pelling, 2006), this survey reveals that time constraints prevent appropriate hazard mitigation from taking place, particularly with in-country experts who are generally looked upon as less capable. Disaster risk has tended to fall between the cracks of the wider framework of development cooperation and emergency relief, although initiatives are being undertaken to improve on this.

Whilst five of the eight organisations represented do have what is perceived to be a climate change strategy to aid decision making; it was suggested that such strategies lack capacity and strategic level commitment. Previous research has demonstrated that the unpredictability generated by climate change places more emphasis on the need to identify and support generic adaptive capacity alongside hazard-specific response capacity (Schipper and Pelling, 2006). According to those taking part in this survey, whether organisations identify and support building adaptive capacity and technology transfer, together with the hazard-specific response, is dependent on how donors look at transition and reconstruction and thus whether they are prepared to fund what may be considered add-ons or non-essentials, demonstrating the disconnected nature of the management of disaster and development processes.

The design and implementation of any post-disaster housing reconstruction programme must find a balance between affordability, technical feasibility and quality of life. It must also recognise the end users as active stakeholders, aware and conscious of their own needs and wants, rather than as passive recipients, who need to be educated (Vatsa, 2001). Freeman (2004) and Schildermann (2004) argue that governments and agencies need to actively engage end users, building on existing knowledge, skills and capabilities within local communities, rather than rushing in to 'reconstruct' for them. On the whole, this was considered to be the most appropriate response by those taking part in the survey. Nowadays, the managers of most reconstruction projects claim that their projects are participatory, but the extent and nature of such participation is not always apparent (Twigg, 2006) and whilst community participation may be widely encouraged by NGO's, policy makers, and scholars, very little knowledge exists about how this is applied at the project level and despite often good intentions, this level of participation is rarely obtained and the capabilities of the users are often significantly wasted (Davidson et al., 2007). Indeed it was suggested that what is not being vigorously analysed is what community participation is actually necessary and what participation people actually want.

An appropriate response when reconstructing housing environments following a disaster is one that delivers solutions that optimise the design (its functionality and configuration) and manufacture (materials) of the build in terms of ecology, economy and social needs (Blacker, 2006), by applying and adapting local knowledge. All too often reconstruction responses are driven by technology, limiting wider engagement with culture and society (Gates, 2005). Indigenous building knowledge is often devalued by outsiders and indeed by local people themselves, who prize 'modern' building styles as symbols of development, and believe that they are more secure against natural hazards (Twigg, 2006). Those taking part in this survey agreed that indigenous building knowledge can be devalued during the process. For any reconstruction project to be sustainable, the building technologies need to be appropriate to local needs, resources and cultures. Indigenous technology is particularly valuable for sustaining livelihoods because local knowledge, skills and labour can be utilised during the reconstruction process. When asked to give an example of where reconstruction work had unintentionally increased vulnerability, it was materials choices as well as the lack of knowledge and training of construction workers in new technologies that increased vulnerability.

When considering the additional burden of building for unpredictable changes in climate, it has been suggested that housing with a higher climatic safety level than considered necessary under the climate regime of today be adopted. However with limited funds this approach may not be considered cost effective, although weighing cost and benefit in this context is certainly not straightforward and introduces new challenges (Lisǿ, 2006). At present the organisations represented do not provide housing with a higher climatic safety level than considered necessary under the climate regime of today. However it was suggested that when undertaking reconstruction projects, where things are, by definition, intended to be more robust, they should be built to withstand potential climatic changes.

Ultimately, the success of any project hinges on knowledge and co-ordination (organisational and managerial), both at local and regional levels, within and between organisations. Feedback from this survey suggests the development of more integrated, interdisciplinary projects was restricted by competition for limited funding and by donors' separate budget lines for emergency relief and redevelopment, with donors sectionalising their funding. This mirrors previously reported tensions which have impeded the establishment of more integrated projects (Wamsler, 2006).

When considering knowledge management as a formal process, despite numerous procedures or guidelines for learning lessons from projects including debrief sessions after each project and through formal learning programmes and manuals, there appeared to be no clear strategy from the organisations surveyed when considering how individual decisions made during projects are assessed. In addition, despite a lot of strategic activity there was some criticism that these lessons learnt do not filter down to field workers and the onus is on the individual to go looking for this information. From the results of this survey it is evident that knowledge management activities need to be more focused. This is both necessary to ensure that lessons learnt previously are implemented, but also to assist with hazard mitigation and climate contingency. An important issues that has been highlighted in this current survey is the fact that there is currently no reported mechanism in terms of capturing tacit or implicit knowledge from project members during or on completion of a major reconstruction project, nor a strategy or mechanism for how this knowledge can be successfully shared with others within that organisation who are working on similar projects. This is particularly pertinent within NGOs where staff turnover tends to be high and members of staff regularly relocate to new regions and/or new organisations.

CONCLUSIONS

NGOs play important roles in different stages of the 'disaster cycle' and different elements are attributed to its successful operation. As the incidents of natural disasters increase, it is imperative that NGOs and other agencies involved in disaster relief manage risk by learn as much as possible from each disaster recovery and reconstruction process they are involved with; its successes and failures (Kumaran and Negi, 2006). This is becoming increasingly important as the risk of repeated disasters due to climate change exacerbates the situation. For there to be a clear strategy for sustainable development post-disaster, climate change risk and adaptation must be considered and may in fact inform and contribute to an improvement of previous strategies by building in higher climatic safety during reconstruction. These insights into the decision making practices of leading aid agencies, their response to hazard risk and appropriate mitigation, end users and stakeholder consultation in planning and design, technological solutions, and constructing the build, alongside with other information gained during the interview process, have been used to develop an understanding of project management practices and where these can be improved, in order to develop future guidance.

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REFERENCES

Arslan, H. (2007) Re-design, re-use and recycle of temporary houses. Building and Environment, 42,400-406.

Blacker, Z. (2006) A matter of life and death. Building design, January 20th 2006, 8.

Bosher, L., Dainty, A., Carrillo, P., Glass, J. and Price, A. (2007) Integrating disaster risk management into construction: a UK perspective, Building Research and Information, 35(2), 163-177.

Davidson, C. H., Johnson, C. Lizarralde, G., Dikmen, N. and Sliwinski, A. (2007) truths and myths about community participation in post-disaster housing projects. Habitat international, 31, 100-115.

Dorrell, E. (2005) ‘Fears' over industry tsunami aid, Architect’s journal, 221 (3), 4.

El-Masri, S. and Tipple, G. (2002) Natural disaster, mitigation and sustainability: the case of developing countries. International planning studies, 7(2), 157-175.

Freeman, P. K. (2004) Allocation of post-disaster reconstruction financing to housing. Building research and information, 32 (5), 427-437.

Gates, C. (2005) Architects unite for rebuild effort. Building design, January 7th 2005, 4.

IFRC (International federation of the Red Cross and Red Crescent societies) (2003) world disasters report 2003, Oxford university press, Oxford.

Kumaran, T. V. and Negi, E. (2006) Experiences of rural and urban communities in Tamal Nadu in the aftermath of the 2004 tsunami. Built environment, 32 (4), 375-386.

Levine, J. N., Esnard, A-M. and Sapat, A. (2007) Population displacement and housing dilemmas due to catastrophic disasters. Journal of planning literature, 22 (1), 3-15.

Lisø, K. R. (2006) Integrated approach to risk management of future climate change impacts. Building research and information, 34 (1), 1-10.

Lorch, R. (2005) What lessons must be learned from the tsunami? Building research and information, 33(3), 209-211.

Prasad, S. (2005) Designing for disasters: look to local technology for long-term solutions. RSA Journal, 152 (5516), 40-47.

Quarantelli, E. L. (1982) Sheltering and housing after major community disasters: case studies and general conclusions. Disaster research centre, Ohio State University, Columbus.

Schildermann, T. (2004) Adapting traditional shelter for disaster mitigation and reconstruction: experiences with community-based approaches. Building research and information, 32(5), 414-426.

Schipper, L. and Pelling, M. (2006) Disaster risk, climate change and international development: scope for, and challenges to, integration. Disasters, 30 (1), 19-38.

Spence, R. and Kelman, I. (2004) Managing the risks from natural hazards. Building research and information, 32 (5), 364-367.

Twigg, J. (2006) Technology, post-disaster housing reconstruction and livelihood security. Benfield hazard research centre, disaster studies working paper 15 (January 2002/May2006).

Vatsa, K. S. (2001) Rhetoric and Reality of Post-disaster Rehabilitation after the Latur Earthquake of 1993: A Rejoinder. (available online http://www.radixonline.org/gujarat5.htm [accessed on 22/03/2007]).

Wamsler, C. (2006) Mainstreaming risk reduction in urban planning and housing: a challenge for international aid organisations, Disasters, 30 (2), 151-177.

SELECTION OF CONSTRUCTION METHODS: A PRELIMINARY MODEL

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One of construction project managers' most critical and highly influential task for construction projects is to select the appropriate construction methods to carry out the construction operations. In many occasions this task is not well made, affecting projects productivity and quality. Research objectives are to identify and understand the necessary knowledge to select construction methods and to define all relevant variables for this analysis. This article presents the main concepts from literature review and a preliminary knowledge model for construction method selection. The paper concludes that through the analysis of the knowledge used to select construction methods it is possible to improve the performance of this activity and to generate a knowledge management tool to help project managers to improve in carrying out this task.

KEYWORDS: knowledge management, construction methods, methods selection.

INTRODUCTION

Construction projects have been criticized for under-achievement, situation that has been reflected in the poor performance on time, cost and quality and the low satisfaction level of construction clients (Poon et. al, 2003; Fortune and Lees, 2003; Tapia, 2007). Several researches have indicated that problems related to productivity and rework could be associated to the following causes: inefficient management, design and planning problems, worker experience and skills, inadequate supervision, uncertainty, and poor construction method choice, among others (Sanvido, 1983; Dai et al, 2007; Love et al, 1999; Love, 2000; Serpell, 2002). This ongoing research focuses on the problem of the inadequate construction methods selection, because this is a relevant task within the construction process, but in many companies is still executed with some deficiencies, despite the critical role that plays in the achievement of the projects' objectives, because as Halpin (2006) points out, "once a project has been defined, one of the most critical questions facing the construction manager is What construction technique or method should be selected?".

To face this problem, it has been decided to use a knowledge-based approach because it has been considered that an adequate management of this organizational asset will substantially improve the performance of the construction methods selection of a project. The central idea of this research indicates that if it is possible for a construction company to capture the knowledge and experience generated by the execution of its projects, it would then be feasible to design a knowledge management structure and system for this purpose. If a construction company counts with such a knowledge management system, it will be able to obtain, store and share the methods selection knowledge and to apply it for effectively selecting construction methods for new projects.

This article presents the main concepts associated to construction methods selection and knowledge management from literature review and, also presents a preliminary proposal of a knowledge model for construction methods selection. This model, once validated, will be the base for the development of a knowledge-based system for construction method selection.

THEORETICAL CONSIDERATIONS

This section present a review of the most relevant concepts associated to construction methods selection and knowledge management.

Construction methods selection

Construction methods are the means used to transform resources into constructed products (Tatum, 1988). The selection of the most appropriate construction method for an operation is a major determinant of high productivity (Russell and Al-Hammad, 1993), but in many occasions this activity is perform without the care that deserve, with inadequate studies of alternative construction systems, just like Basha et al. (1991) find out in their evaluation of superstructure construction methods used in Egypt (cited by Youssef et al, 2005). There are different possible causes for this situation, such as (Serpell, 2002): deficiency in the use of resources, inadequate use of technologies, not considering the most efficient alternative to carry out the work, and the deficient reuse of experience from previous projects.

The selection of construction methods is a complex decision process which consider multiple attributes such as cost, time, quality, physical characteristics of the element to build, characteristics of the construction method, the environment, the risk of each alternative, and available resources, among others (Youssef et al, 2005; Russell and Al-Hammad, 1993; Soetanto et al, 2007). These criteria vary according to the reality of the project and the company. In the construction field, we could find research efforts that have narrowly focused on one class of method, as in the works of (Youssef et al, 2005; Pan, 2009; Sawhney and Mund, 2001), and also researches that addressed the issue of construction method selection in terms of approaches that have applicability to a broad range of construction methods, such as in the work of Russell and Al-Hammad (1993), who developed an expert system for these purposes, and Udairpurwala and Russell (2002) who develops a system that uses hierarchical semantically predefined representation structures, hierarchical planning and scheduling.

In the case of Chilean construction companies, the problems with the construction method selection process have been studied through a critical analysis of their construction method design and selection practices (Tapia, 2007). The main deficiencies found indicate that Chilean construction companies select and analyze their construction methods on the run as the project is being carried out, have a tendency to choose previously applied construction solutions in spite of knowing that there are other forms to carry out the work, support method selection just on the knowledge of the professionals working on site, and select the simplest methods, not necessarily the best ones (Ferrada and Serpell, 2008).

Despite the importance of an adequate construction method selection process the actual approach used in Chilean construction companies stimulates mistakes, affecting customer's satisfaction and project performance. Some of the causes of these problems are:

- People suppose that all the projects of the same company can be done in the same way because companies tend to became specialist in a certain type of construction project.

- The only way to know if a construction method accomplishes the project requirements it is executing the method, because there is not a previous period of detail analysis. Given that, the first construction units became a prototype (Tapia, 2007). Obviously, this procedure generates an important number of changes and rework, with the consequent higher cost and lower productivity of the project.

- There is not an adequate use of the knowledge and experience that the company acquire in every project. People tend to repeat the same solutions but without including any improvement or learning, repeating the same mistakes again and again. Besides, experience is not share between projects, because construction companies do not have a system to do that.

Knowledge Management

It is common that people confuse the terms data, information and knowledge, using them indiscriminately as synonyms. Within knowledge management this terms, although related, have different meanings, so serious attempts to clearly distinguish these concepts are being published (Spiegler, 1999). For example, Alavi and Leidner (2001) indicate that data are raw numbers and facts. For Davenport and Prusak (2001), data is a set of discrete and objective facts (Davenport and Prusak, 2001). Unlike the above, information is a message (Davenport and Prusak, 2001) which consists of data that have a particular meaning in a specific context (Haag et al., 2004); where data became information once is shaped by humans into a meaningful and useful form (Laudon and Laudon, 2004).

Knowledge is information possessed in the mind of individuals related to facts, procedures, concepts, interpretations, ideas, observations and judgement (Alavi and Leidner, 2001), being “a fluid mix of data, experience, practice, values, beliefs, standards, context, and expert insight that provides a conceptual arrangement for evaluating and incorporating new data, information and experiences” (Davenport and Pruzak, 2001). Nonaka and Takeuchi (1999) also indicated, that knowledge is strongly linked to people’s beliefs and commitments, essentially related to human action in a way that adds value to the enterprise (Paiva et al., 2007; Vail, 1999). Information becomes individual knowledge when it is accepted and retained by an individual as being a proper understanding of what is true and a valid interpretation of the reality (Wu et al, 2004). Then this knowledge becomes information again once it is articulated and presented in the form of text, graphics, words, or other symbolic forms (Alavi and Leidner, 2001).

Knowledge could be classified as tacit or explicit (Nonaka and Takeuchi, 1999). Tacit knowledge is difficult to express formally; an individual may not be aware that posses certain knowledge, or may not be able to present it in an explicit way (Leon, 2004). It is stored in people’s heads and is acquired through experience (Carrillo and Chinowsky, 2006), evolving through peoples’ interactions (Choi and Lee, 2003). This knowledge includes cognitive and technical elements. The cognitive elements are centered on mental models (mechanisms through which an individual tries to explain how the real world works), while the technical elements contained know-how and practical skills (Nonaka and Takeuchi, 1999). Explicit knowledge is formal, systematic and easily communicated and shared (Fernández, 2005), and could be documented and therefore physically stored in either electronic or paper format (Carrillo and Chinowsky, 2006).

To define what is knowledge management there are a variety of approaches. Hsu and Shen (2005) describes knowledge management as a systematic and organized approach to improve the organization's ability to mobilize knowledge to enhance decision making, take actions and deliver results in support of the underlying business strategy. Also, we could say that is the way that organizations create, capture and utilize knowledge to achieve organizational objectives (Sommerville and Craig, 2006), which recognizes the fact that knowledge is a valuable asset that must be managed to provide strategies for organization to retain knowledge and improve their performance (Al-Ghassani et al, 2006). Then, the purpose of knowledge management in organizations is "to ensure growth and continuity of performance by protecting critical knowledge at all levels, applying existing knowledge in all pertinent circumstances, combining knowledge in synergistic ways, acquiring relevant knowledge continuously, and developing new knowledge through continuous learning that builds on internal experiences and external knowledge" (Bourdreau and Couillard, 1999).

In a construction company, most of their knowledge is generated within each project and is usually stored on reports that few people read, or is lost because parties involved are moved to a new project, resign or retire (Kivrak et al 2008; Anumba et al., 2005), taking with them not only tacit knowledge, but also a potential source of competitive advantage. This is problematic because it is only with the benefit of hindsight that it is really possible to reflect on the true consequences of an action within a project (Anumba et al., 2005). Thus, because of the lack of methods for storing, distributing and sharing the information and knowledge generated by each project team, a vital resource is lose, which becomes a major factor that affects company business performance (Wu et al. 2004).

KNOWLEDGE MODEL FOR CONSTRUCTION METHODS SELECTION

Even though construction industry is a knowledge-based industry (Egbu et al. 2004; Carrillo et al., 2004), still exists problems with the management of the knowledge associated to methods selection. Given this, the implementation of knowledge management is particularly interesting for the construction sector (Carrillo and Chinowsky, 2006), because this approach could help the industry to innovate, improve performance (Kamara et al. 2002) (Egbu et al, 2004), and to better handle with their particular characteristics.

To implement this approach and to achieve a real improvement in the process under study, it is needed to know how to obtain, process, store and use a construction company's knowledge to select construction methods, according to specified requirements. Then, the main focus of this research is to understand and model the reasoning process and the knowledge applied by experts in performing the construction method selection activity. With this knowledge it would be possible to design and build a knowledge management system prototype for construction methods' selection that could be applied to a broad range of construction methods, helping people to make better decisions and allow them to store, share and use this knowledge.

So, every time that a company needs to select its construction methods, it would not start their work from zero, because by applying the methods selection approach, they would work on process previously used by the organization, establishing a continuous improvement and learning system. The proposed knowledge-based model for methods selection at company level is shown in Figure 1.

To structure this system, the first step of this work is to identify the available knowledge related to construction methods selection in the organization. For this it is necessary to know first which knowledge a person needs in order to do an adequate construction method selection. As Russell and Al-Hammad (1993) said, methods selection includes knowledge of available technologies and their capabilities, an ability to visualize their application on site, and knowledge of which ones can be best combined to address site and project specific conditions. This knowledge includes both procedural (knowing “how”) and declarative (knowing “that”) knowledge, and was develop through formal studies or by professional experience.

Then, knowledge acquired by a person is also tied to his/her experience, namely what this individual has done or what has happened to him in the past (Davenport and Prusak, 2001). This experience is associated with the context in which it was developed; therefore, capturing knowledge without considerer the context in which it was built can seriously affect their effectiveness (Maqsood, 2006). Indeed, Fernie et al. (2003) suggest that the context of the industry, including political, economic, social, technological, legal, environmental and structural factors of the sector may affect the transfer of knowledge between industries. The same problem could appear if we want to transfer knowledge within the same industry, but in different countries or different cultures.

Based on literature review a preliminary knowledge model for construction methods selection was develop. This model proposed an initial knowledge classification that later will be validated with experts at the end of the knowledge elicitation stage. The first level of this model identifies six major types of knowledge: about the project, available technologies, cost-benefit evaluation, risk management, project planning and project integration. In a second level each one of these categories is defined in more detailed. Knowledge about projects is associated to the technical characteristics of projects, their constraints (cost, duration, quality requirements and safety requirements) and stakeholders’ objectives. This knowledge could be obtained through revision of project documentation or in meetings with clients or other stakeholders. Knowledge about available technologies includes know about the resources required for each option, their major activities, their cost and availability, the risks associated to each option and their duration. Also, this expert needs to know how to do a cost-benefit evaluation, in order to compare different alternatives. The area of risk management is very extensive and include know how to identify, asses, and control risk. For project planning people need to know the main topics of this task, such as estimation of activity duration, planning methods, resource allocation, and cost budgeting. Project integration knowledge is related to understand how a decision made at one project level could impact the performance of activities on other levels. This model is show in Figure 2.

In the final knowledge model each one of these knowledge types will be defined in more detail, indicating their definition and scope, how people acquire that knowledge and where in the company they could find it, according to the interview results. With this answers it would be possible to structure a system that recognizes the features of the methods selection process.

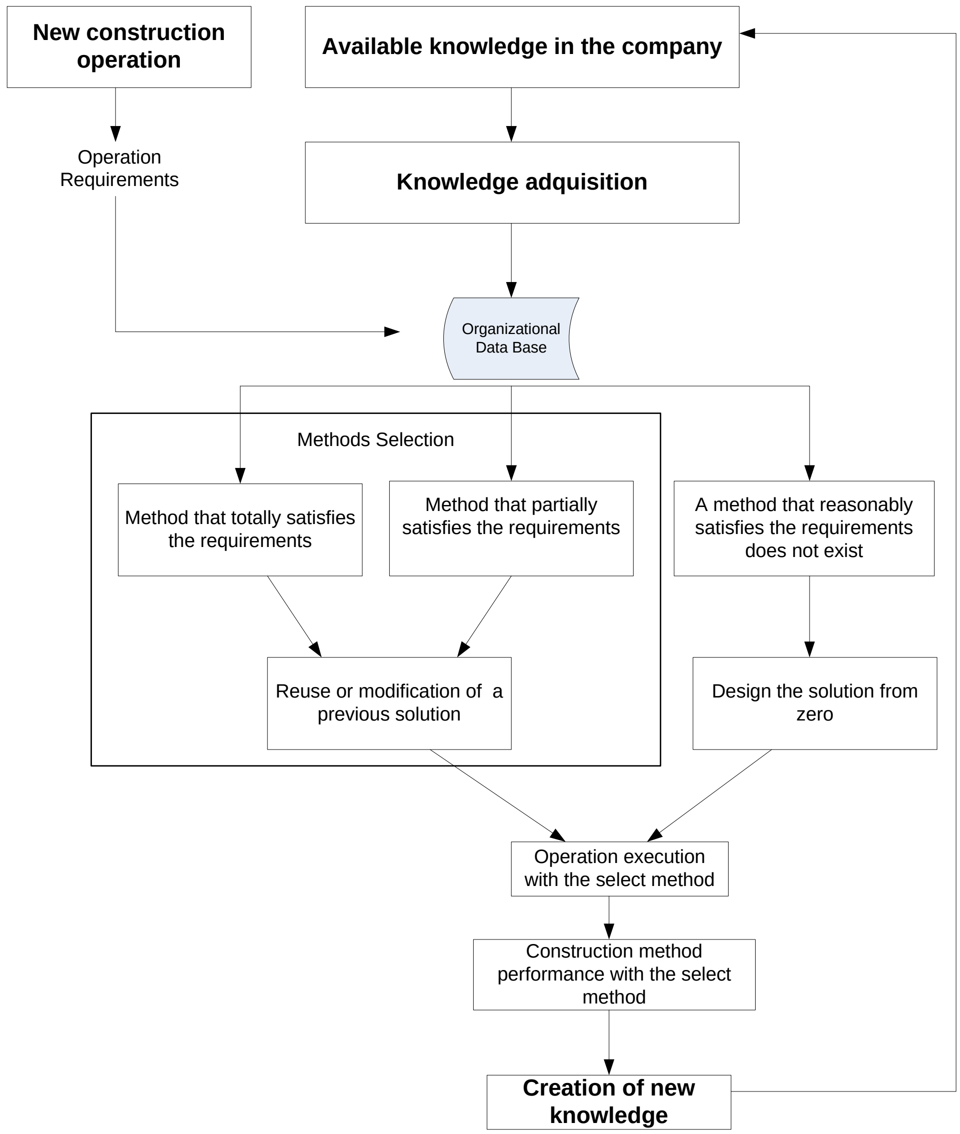

Figure 1: Knowledge-based model for construction methods selection

Then, once the knowledge elicitation phase is completed, it will be possible to answers some questions, such as:

- What knowledge is applied to select a construction method?
- What factors are evaluated during this process?
- How a method is selected?
- What information is required to select a construction method?

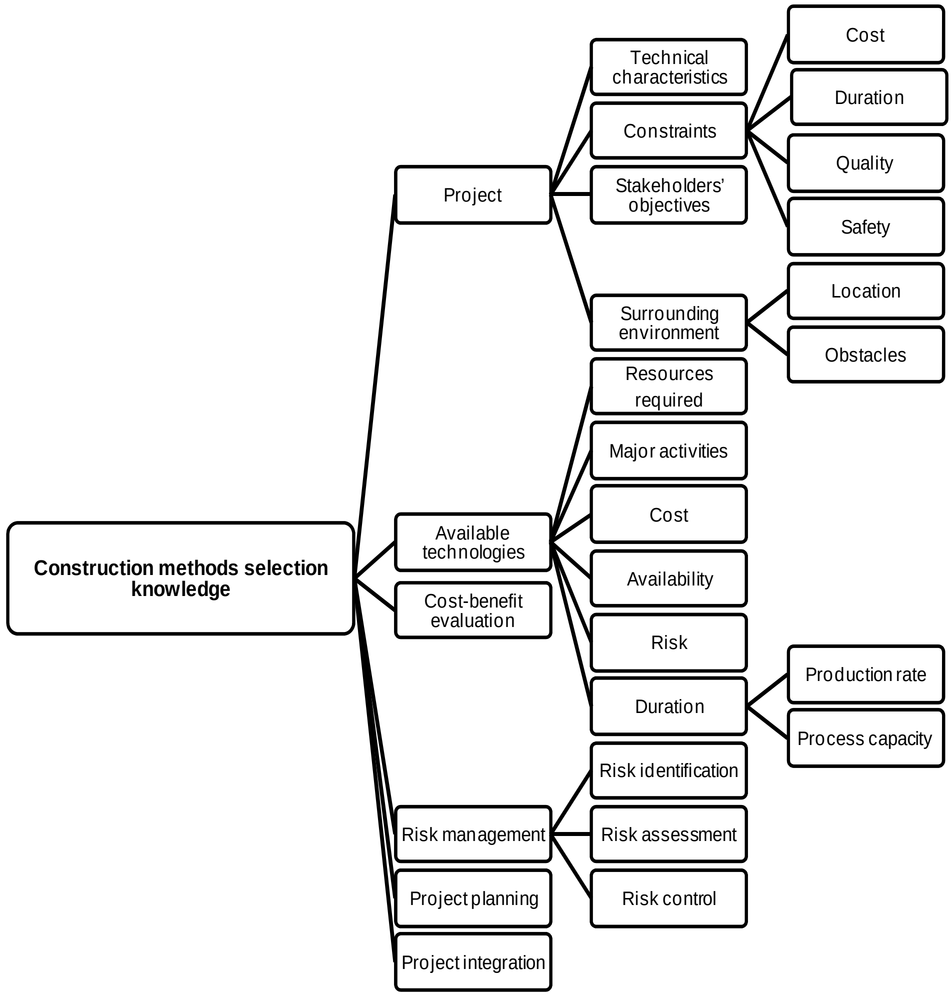

Figure 2: Knowledge model for construction methods selection

CONCLUSIONS

The proper selection of construction methods is a critical activity in order to reach the requirements of quality, time, cost and customer satisfaction. Despite its importance, is an activity which in practice does not deliver results as positive as people would like, since many projects need to change their construction methods during the construction phase, or apply methods that lead to repeat previous mistakes, given that the organization was not carried out a learning process, or because the knowledge was in the mind of a person who left the company.

The focus of this research is on how people do the selection process and what knowledge they applied, given the industry characteristics, and their environment. Through the analysis of the knowledge used to select construction methods it will be possible to improve the performance of this activity and generate a system architecture that recognizes these particularities to provide a knowledge management tool to help project managers improve in carrying out this task. To support the development of this process, this article presents a preliminary knowledge model for the selection of construction methods. Given that in Chile there is little information about the construction methods selection process, and the fact that this activity is executed with a lot of inefficiencies, this study will be an initial step to improve the performance of this process. Even though there are other researches on this topic, the final results of this study will present a different vision about methods selection based on the reality of a developing country and their particular needs.

REFERENCES

Abeysinghe, G. and Urand, D. (1999) Why use enactable models of construction processes? Journal of Construction Engineering and Management. 125(6), 437-447.

Alavi, M.; and Leidner, D. (2001) Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. MIS Quarterly, 25(1), 107-136.

Al-Ghassani, A.; Kamara, J.; Anumba, C.; and Carrillo, P. (2006) Prototype System for Knowledge Problem Definition. Journal of Construction Engineering and Management, 132(5), 516-524.

Anumba, J. C., Egbu, C. and Carrillo, P. (2005) Knowledge Management in Construction. United Kingdom: First Edition, Blackwell Publishing Ltd.

Bourdreau, A.; and Couillard, G. (1999) System integration and knowledge management. Information System Management, 16(4), 1-9.

Carrillo, P., Robinson, H., Al-Ghassani, A. and Anumba, C. (2004) Knowledge Management in UK Construction: Strategies, Resources and Barriers. Project Management Journal, 35(1), 46-56.

Carrillo, P. and Chinowsky, P. (2006) Exploiting knowledge management: The engineering and construction perspective. Journal of Management in Engineering, 22(1), 2-10.

Choi, B.; and Lee, H. (2003) An empirical investigation of KM styles and their effect on corporate performance. Information & Management, 40(55), 403-417.

Dai, J.; Goodrum, P.; and Maloney, W. (2007) Analysis of craft workers´and foremen´s perceptions of the factors affecting construction labour productivity. Construction Management and Economics, 25(11), 1139-1152.

Davenport, T.; and Prusak, L. (2001) Conocimiento en acción: Cómo las organizaciones manejan lo que saben, Buenos Aires: Prentice Hall.

Egbu, C., Hayles, C, Anumba, A., Ruikar, K and Quintas, P. (2004) Getting Started in Knowledge management: Concise Guidance for Construction Consultants and Contractors. Partners in Innovation Project (CI 39/3/709) supported by the Department of Trade and Industry, UK.

Fernández, J. (2005) Gestión por competencias: Un modelo estratégico para la dirección de recursos humanos, Prentice Hall, Madrid.

Fernie, S.; Green, S.; Weller, S.; and Newcombe, R. (2003) Knowledge sharing: context, confusion and controversy. International Journal of Project Management, 21(3), 177-187.

Ferrada, X.; and Serpell, A. (2008) Selection of construction work processes: Current practices and a new proposal. Building Abroad: Procurement of construction and reconstruction projects in the international context, pp. 223-243, Montreal, October.

Fortune, C.; and Lees, M. (2003) Exploring common practices in construction project management: a UK perspective. Proceedings of the Joint International Symposium of CIB Working Commissions: W55, W65 y W107, pp. 344-354 , Singapore, October.

Haag, S.; Cummings, M.; McCubbrey, D. (2004) Management Information Systems for the Information Age, McGraw-Hill/Irwin, United States.

Halpin, D. (2006) Construction management, Hoboken : John Wiley.

Hsu, S.; and Shen, H. (2005) Knowledge Management and its relationship with TQM. Total Quality Management, 16(3), 351-361.

Kamara, J., Augenbroe, G., Anumba, C. and Carrillo, M. (2002) Knowledge management in the architecture, engineering and construction industry. Construction Innovation: Information, Process, Management, 2(1), 53-67.

Kivrac, S., Arslan, G., Dikmen, I. and Birgonul, M.T. (2008) Capturing knowledge in construction process: knowledge platform for contractors. Journal of Management in Engineering, 24(2), 87-95.

Laudon, K.; and Laudon, J. (2004) Sistemas de Información Gerencial, Pearson Education, México.

León, J. (2004) Adquisición de conocimiento y comprensión: Origen, evolución y método, Editorial Biblioteca Nueva, Madrid

Love, P.; Mandal, P.; and Li, H. (1999) Determining the causal structure of rework influences in construction.Construction Managements and Economics, 17(4), 505-517.

Love, P.; and Li, H. (2000) Quantifying the causes and costs of rework in construction. Construction Management and Economics, 18(4), 479-490.

Maqsood, T. (2004) The Role of Knowledge Management in Supporting Innovation and Learning in Construction, Doctor of Philosophy Thesis, School of Business Information Technology, RMIT University.

Nonaka, I.; and Takeuchi, H. (1999) La Organización Creadora de Conocimiento: cómo las compañías japonesas crean la dinámica de la innovación, Oxford University Press, México.

Paiva, E.; Roth, A.; and Fensterseifer, J. (2007) Organizational knowledge and the manufacturing strategy process: A resource-based view analysis. Journal of Operations Management, 26(1), 115-132.

Pan, N. (2009) Selecting an appropriate excavation construction method based on qualitative assessments. Expert Systems with Applications, 36(3),5481-5490.

Poon, J.; Potts, K.; and Musgrove, P. (2003) CONBPS: An expert system to improve the efficiency of the construction process. RICS Research Papers, 4(21).

Russell, A.; and Al-Hammad, I. (1993) A knowledge-based framework for construction methods construction, Canadian Journal of Civil Engineer, 20, 236-246.

Sanvido, E. (1983) Productivity improvement programs in construction, Stanford : Department of Civil Engineering, Stanford University.

Sawhney, A.; and Mund, A. (2001) IntelliCranes: an integrated crane type and model selection system. Construction Management and Economics, 19(2), 227-237.

Serpell, A. (2002) Administración de Operaciones de Construcción", Alfaomega Grupo Editor, México.

Soetanto, R; Glass, J.; Dainty, A.; and Price, D. (2007) Structural frame selection: case studies of hybrid concrete frames. Building Research & Information, 35(2), 206-219.

Sommerville, J.; and Craig, N. (2006) Implementing IT in Construction, Taylor and Francis, Gran Bretaña.

Spiegler, I. (2000) KM : A New Idea or a Recycled Concept?. Communications of the Association for Information Systems. 3, Article 14.

Tapia, C. (2007) Análisis Crítico del Diseño de Procesos en Chile, Tesis para optar al grado de Magíster en Ciencias de la Ingeniería, Pontificia Universidad Católica de Chile.

Tatum, C.B. (1988) Classification system for construction technology. Journal of Construction Engineering and Management, 114(3), 344-363.

Udaipurwala, A.; and Russell, A. (2002) Computer-assisted construction methods knowledge management and selection. Canadian Journal of Civil Engineering, 29, 499-516.

Vail, E. (1999) Knowledge mapping: Getting Started with Knowledge Management. Information Systems Management, 16(4), 1-8.

Wu, S.; Kagioglou, M.; Aouad, G.; Lee, A.; Cooper, R.; and Fleming, A. (2004) A project .knowledge management tool for the construction industry, International Journal of IT in Architecture, Engineering and Construction, 2(2), 79-90.

Youssef, M.; Anumba, C.; and Thorpe, T. (2005) Intelligent selection of concrete bridge construction methods in Egypt, Proceedings of the 2005 ASCE International Conference on Computing in Civil Engineering Cancun, Mexico.

IMPLEMENTATION OF LEAN CONSTRUCTION PRINCIPLES IN PORTUGAL: "Adaptation of good practices from a Danish Case Study"

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During the post-war, the construction industry has tried to change for the better through the adoption of practices or technologies successfully applied in other sectors. Born with the Toyota Production System, the lean approach has spread to other industries. The Danish implementation of the concepts is recognised as one of the most thorough applications of lean in the sector.

To the construction in Portugal it is a good opportunity to invest in the dynamism of civil engineering segment. By implementing lean principles through the Last Planner System, the project management experienced in the Portuguese construction can now be optimised.

After having analysed the characteristics of each country's construction, the paper reports the outcomes of two case studies and compares both approaches. Factors such as costs, working environment and safety are analysed as well as today's construction critical necessities: the significance of the client's value in the construction.

The paper analyses the possibility of implementing lean concepts based in the Danish adaptation of the lean concept to construction, within the Portuguese construction sector.

KEYWORDS: **lean construction, last planner, Danish construction, Portuguese construction.**

INTRODUCTION

The construction sector has always had a major influence in a country's development. Representing up to 16% of the Portuguese GDP (Santander Totta, 2008), this industry is of main interest in the development of the nation's prosperity. Also presenting most of the times a poor performance in significant parameters, this sector should be given more attention.

The Portuguese construction sector has demonstrated to be able to make large scale projects. Now, after recovering from a crisis and with large infrastructures to construct in a near future, it should bet on the implementation of project management principles that can facilitate construction processes and improve important aspects in construction.

After WWII, a series of initiatives arose with the intention of stimulating change and development in construction. Based in the manufacturing industry and now spread in some countries around the world, the lean construction was created. Based in the value adding to the client and waste reduction, this construction philosophy has spread through various countries around the world with positive outcomes: duration and costs' reduction, safety communication between the different parties among others (Ansell *et al.*, 2007).

If the correct principles are transferred, more countries can benefit from this approach to project management. One of the successful implementations of lean construction stands out in Denmark. Having in mind the possibility of improving in various factors, the Portuguese construction sector is a potential follower of the lean construction philosophy implemented in the Danish construction.

The main focus of this paper is to analyse the possibility of implementing lean concepts, based in the Danish implementation, within the Portuguese construction sector. Also, future research to the topic development is suggested.

Research Methodology

To address the main topic, some questions emerge that act as a directive for the work research development:

- *What is Lean Construction?*
- *How is Lean Implemented in the Danish Construction Sector?*
- *Can Lean be Relevant to the Portuguese Construction Industry?*

In order to answer these questions, several research documents were analysed, interviews to experts were made and implementation cases were explored. After having responded to these and considered the varied collected information, it is much simpler to have a conclusion about the main topic.

LEAN CONSTRUCTION

Lean construction is based in management principles adopted in the manufacturing industry (specifically in the Toyota Production System) during the post-war period (Krafcik, 1988). Labelled as lean production after presenting productive results in terms of productivity, quality and product development, these principles used drew attention in other industries. The lean thinking became globally famous by changing the way work is done throughout the delivery process (Edgington *et al.*, 2002).

Contrasting with the traditional slow progression in the sector, lean construction brings a faster approach to important goals such as financial, time and quality results. In order to reach these, the lean approach focuses in maximising the workflow through the implementation of process transparency and minimisation of performance variation and the elimination of systemic waste sources. (Lean Construction Institute)

Critics concerning the lean concept in construction also exist such as the almost inexistent approach to HR aspects Green (1999, 2002), its point of focus (Thomasse *et al.*, 2003) and the oversimplified perception of value, topics that should have a further research development.

TFV

During the 1900s, Koskela (1992) proposed a new theory of Project Management, the Transformation/Flow/Value (TFV) understanding of construction. He asserted that there was an overemphasis given to transformation and that the flow and value aspect should be more taken into consideration in construction management. Koskela then stated that it is necessary to look to construction from a production point of view, focusing:

- Production as a transformation of inputs to outputs
- Production as a flow
- Production as a generation of value

He also introduced the seven preconditions necessary in order to carry out a construction work package, known as the seven flows:

- Information (construction design)
- Materials (and components)
- Workers
- Equipment
- Space
- Previous work
- External conditions
-

Last Planner System

Later, in the beginning of the 1990s, Ballard (1993) introduced a new method for applying lean in construction: the Last Planner System (LPS). This model is based in a short term planning and control of operations approach and has been one of the most used models around constructions following lean. In order to assure that the production in continuously flowing, the model assures that the necessary pre-requisites are verified before starting an activity. The LPS addresses and resolves important issues such as obstacles and coordination of subcontractors which are analysed in weekly work plan meetings; these become a fundamental key to the successful implementation of the model.

Having as a basis three main plans, the planning of schedule occurs with a satisfactory work flow control:

The Master schedule: Selects the sequence of activities and identifies all the work packages on which obstacles should be removed and is elaborated by all the parties involved in the construction; it defines what *should* be done;

Lookahead Plan: By having an outlook up to four weeks ahead, this plan controls workflow ensuring the workable backlog is sufficient for an activity to be completed; it defines what *can* be done;

Weekly Work Plan (WWP): Looks at short-term perspective and selects sequences and sizes of the work of the following week, detailing flows' verification, activities' executions and respective responsible; it then defines what *will* be done.

The control of the workflow is then made through some approaches such as the PPC (percent planned completed), an activities' weekly plan measure used in the implementation of the model which provides information related to the production productivity and planning effectiveness (Howell *et al.*,1998).

LEAN CONSTRUCTION IN DENMARK

The Danish cases of the lean principles adapted to construction are known to represent some of the most thorough lean application that can be found worldwide. This fact would not be achievable if the country did not have the current background in the sector such as the existence of highly skilled workers in the sector and the funded programmes focused in developing the construction projects (Bonke *et al.*, 1996).

By recognising some similar approaches in the sector such as the Just-in-Time logistics, in the turn of the century a new label for lean appeared in the country: *TrimByg* (Trimmed Building) is the name given to the adjustment of the lean concept within the Danish construction industry (Bertelsen, 2002). The adaptation of the Lean Construction Institute (LCI) models of lean thinking stand out from the usual application by focusing on the value (to the client) parameter and the cooperation between the trades in construction. The process moderator is also an innovation in the implementation of lean philosophy in Denmark. This new individual is the facilitator of the lean approach in construction, acting as the coach of the building site; he implements lean by concentrating in ensuring a good collaboration with and between subcontractors.

Danish Case Study

In order to analyse the practical implementation of the Danish lean principles in a construction site, this paper examines an ongoing construction where the principles are applied. The construction of an office building located in Hellerup, near Copenhagen, has been a challenge as it is attached to an existent and currently working area facility. The contractor is a large Danish contracting firm, NCC, who is applying lean principles in their projects for several years already. Through inquires, interviews elaborated to some construction intervenients about the planning and lean elements in the construction, and the attendance to a WWP meeting, some conclusions were achieved.

The Last Planner System implementation is done through a one hour weekly work plan meeting, where all the parties currently involved in the construction are present. These meetings are led by the process manager who addressed the following topics:

- *Overview of the previous weekly work plan* – checking the activities progress – PPC;
- *Obstacles list* – verifies the existent obstacles that hinder the ability to execute the activities;
- *View of the Lookahead plan* – assures that the pre-requisites of activities yet to come in the following weeks are made ready;
- *Overview of the master plan* – verifies if any activity in another part of the project needs to be paid attention and if everything is going according to plan;
- *New weekly work plan* – elaboration of each subcontractor's following week work plan;

With these complete and effective meetings, the project manager affirms that fewer obstacles exist in the activities are starting soon and the small problems existing on site are usually resolved between the site managers (due to their new communication skills taught by the process moderator).

All of the enquirees understood the relevance of planning within the production process and affirmed that the main cause of non conclusion of activities (which affects the PPC) was mostly due to information flaws (one of the seven flows). Although half of the enquirees had previously worked with lean principles before, the expectations relating to the improvement lean can give for the improvement of the construction management system varied between ‘confident’ and ‘indifferent’.

The main differences the enquirees perceived between using lean principles and the traditional way of construction were the introduction of men on site in the production planning, the increase of information available to workers and the better process flow.

Positive results concerning communication, costs and quality in the construction are also verified by the project manager, who states that the project delivery team operates in an atmosphere where relationships are equitable and members are respected, which contributes to the process transparency and positive outcomes. He is also sure that the lean principles applied already in the beginning of the planning definitely helped them winning the project concourse.

It was also observed that there was focus in optimising value for the client and users is present in the majority of processes, as well as the strategy for building continuous improvement into the process.

PORTUGUESE CONSTRUCTION INDUSTRY

In Portugal, new construction philosophies are practically non-existent. After now being slowly emerging from the recession under which it has been labouring over the last ten years, it is now time to start investing in new principles that promote and offer substantial improvement (Baganha *et al*., 2002).

Although generally the sector does not have many highly skilled workers as in Denmark, some large construction companies use to train their workers in order to achieve better results. Also, although there is not much collaboration between design and planning, problems with errors and omissions in the projects executed by these large companies are considered low.

People within the sector acknowledge that communication, bringing people working on site into the process and that design and production combination are very relevant, but these are still not well integrated in the Portuguese construction projects.

Portuguese Case Study

The case analysed to study the Portuguese approach in construction was an already completed project. Located in Lisbon, Parque das Nações, the contractor of CUF Descobertas Hospital project was Profabril S.A.. The workers at the construction site were hired by a time contract which was renovated when it expired. The costs and activities’ planning control was made monthly, but meetings with site managers took place every week (ECG, 2008).

The planning of the following weeks and also checking the seven flows was usually made during the meetings between the project manager and site managers, which lasted sometimes up to four hours. The completed planning percentage at each control was in average lower than 30% and the main causes for having a two months delay in the construction deadline and also cost deviation were caused by project changes solicited by the Client and the rough indefinitions existing on the project.

Waste causes experienced in the construction were mostly due to planning errors, project changes, failure in communication and also pre-work requisites of the activities yet to start. The activities' feedback was considered insufficient, which is also significant for the production productivity control.

When interviewed, the inspector of works was not aware of lean construction techniques, the Last Planner System implementation model and its benefits. After being clarified about it, he affirmed that it would have been possible to integrate this philosophy in the project and within the general Portuguese construction site management, resulting in positive achievements.

FINAL OUTCOMES

The Weekly Work Plan meetings are considered one of the basis for a methodical application of the lean principles through the Last Planner System. Also, the process moderator is a keystone for all the process as he is in control of the workflow and responsible for the transference of the lean principles in the meeting, on site and within the entire organisation.

The application of the lean construction principles in the Danish case revealed an accomplishment in the production of better results through the construction. The involvement of the site workers in the planning also evidences their interest in contributing for better PPC results (Arbulu *et al*., 2006). It is as well important to keep the meetings short in order to make them effective: only the relevant issues are brought up and discussed. The focus on the client value is imperative for a well adaption of the processes in the construction which is, among others, experienced through the elimination of non value-adding activities on site.

All of this description contrasts with the general Portuguese construction, where the communication between site managers is poor, the weekly meetings are too extent, the stimulation at work is low and the site workers are not that involved in the planning. On the other hand, factors such as training of workers in large firms, the verification of the flows at the weekly meetings and the understanding of how communication is vital are some of the similarities found which influence the integration of lean principles in a positive way.

Nonetheless, some conceptual changes still need to take place in the sector for the implementation of lean through the Danish principles; for instance, the insertion of an experienced process moderator with a leadership character and an effective client involvement in the process design and production phase is vital for the implementation success.

More site workers should benefit from trainings in their speciality and also a workshop in lean principles in construction must be performed for all the parties involved in the process (designers, site workers, etc).

IMPLEMENTATION BARRIERS

As the major part of Portuguese workers has never heard about lean construction, the training in this new philosophy would be necessary. Workshops made by experts on the subject and also the intervention of the process moderator during the construction can be a resolution for the problem. The company implementing lean principles should also have certain internal organisational skills leaded by top management, as they are a key figure during the important stages of the model's implementation.

Human and cultural aspects such as worker's lack of self-criticism (Alarcón *et al*., 2008) do not facilitate the successful implementation of the lean principles, but again, training can be the solution. It is also necessary to have a controlled notion of time (to execute the activities, to control the meetings, etc) and that is achieved through the experience gained throughout the implementation.

CONCLUSIONS AND REFLECTIONS

After having profoundly studied the lean construction concept, the research questions can now be answered

- *What is lean construction?*

A simplified version of lean production, a management approach based in the value adding to the client and waste reduction, the lean thinking is nowadays applied in construction. The adaptation of the concept to the sector is a new approach to the management of construction processes that have revolutionised the industry: positive outcomes such as cost reduction and safety improvement in construction. By reducing non value-adding activities and improving the communication between all the parties, the lean thinking adds value to the client through the construction. Taking different manifestations around the world when applied in practice, this philosophy has demonstrated satisfactory results.

- *How is lean implemented in the Danish construction sector?*

Based in the LCI principles of lean, the Danish implementation of lean construction has shaped itself to a more adapted version in the country. They have focused in adding value to the client through the enhancement of cooperation between trades on the project. They also implemented a key figure in the sector, the process moderator, who ensures a feasible workflow in the projects.

- *Can lean be relevant to the Portuguese construction industry?*

The opportunities the sector has at the present date to invest in new management philosophies, the will to change expressed by the sector and by having planned the construction of large projects in the near future, the construction sector can benefit from the application of philosophies. These are able to modify the acknowledged features of construction: projects with extended duration, high costs and a discontinuous workflow. After implementing some conceptual adjustments in the sector, the application of lean principles in the Portuguese construction can improve these and other poor results presented in the industry.

After having gone through an ordered exploration of the main subject, it is possible to analyse the main issue at this time. Characterised as having competitive, uncertain and complex projects in hand, the Portuguese construction sector can now experience diverse benefits by implementing lean principles within the organisations. The application of the lean principles through the Last Planner System model can be a triumph in the country if having as a basis one of the most successful implementation of lean the principles, the Danish model.

FUTURE DEVELOPMENT

Further research should be made to the implementation of lean construction principles in Portugal by actually applying it in projects. The feasibility of integrating design in the production has not been studied in the paper but some reports (Jørgensen, 2006) confirm that it leads to more interesting and positive results. Also, the quality and safety in lean construction is said to be improved, but actual studies addressing specifically this topic should be performed. Lastly, the reinforcement of the value perspective can lead to interesting outcomes, such as the analysis of sustainable solutions in the implementation of lean construction.

REFERENCES

Alarcón, L. F. (1997) *Lean construction*. A.A Balkema Publishers, Rotterdam, The Netherlands.

Alarcón, L. F. (2004) Tools for the Identification and Reduction of Waste in Construction Projects. In: *Proceedings for the 2nd Annual Conference for the International Group for Lean Construction* (IGCL-2), Chile.

Alarcón, R., Diethelm, S., Rojo, O., Calderón, R. (2008) Assessing the impacts of implementing lean construction. In: *Revista Ingeniería de Construcción* Vol.23 N°1, 26-33, Chile.

Arbulu, R., Zabelle, T. (2006) Implementation and Performance Measurement. In: Proceedings *for the 12th Annual Conference for the International Group for Lean Construction* (IGCL-14) Santiago de Chile.

Ansell, M., Holmes, M., Evans, R., Pasquire, C., Price, A. (2007) Lean Construction Trial on a Highways Maintenance Project. In: *Proceedings for the 15th Annual Conference for the International Group for Lean Construction* (IGCL-15) Michigan, USA.

Baganha, M., Marques, J., Góis, P. (2002) *O Sector da Construção Civil e Obras Públicas em Portugal*. CES, Coimbra.

Ballard, G. (1993) Lean Construction and EPC Performance Improvement. In: Proceedings *for the 1st Annual Conference for the International Group for Lean Construction* (IGCL-1) Finland.

Ballard, G. (2000) *The Last Planner System of Production Control*. PhD Thesis, University of Birmingham, UK.

Bertelsen, S. (2002) Bridging the Gaps – Towards a Comprehensive Understanding of Lean Construction. In: Proceedings *for the 10th Annual Conference for the International Group for Lean Construction* (IGCL-10) Brazil.

Bertelsen, S. (2002a) *Lean Construction in Denmark – A Brief Overview*. Denmark.

Bonke, S., Levring, P. (1996) The Danish Contracting System: Pinning Down Autonomy. *Working Paper 9 for Le Groupe Bagnolet*, DTU.

Edgington, D. W. (2002) Lean and its Limits: The Toyota Production System in Chukyo and Northern Kyushu. *Global Competition and Local Networks*, Japan.

Green, S.D. *(1999)* The Dark Side of Lean Construction: Exploitation and Ideology. In: *Proceedings for the 7th Annual Conference for the International Group for Lean Construction* (IGCL-7), Berkeley, CA, USA.

Howell, G., Ballard, G. (1998) Implementing Lean Construction: Understanding and Action. In: Proceedings *for the 6th Annual Conference for the International Group for Lean Construction* (IGCL-6) Guarujá, Brazil.

Jørgensen, B. (2006). *Integrating Lean Design and Lean Construction: Processes and Methods*. PHD Thesis, Denmark.

Koskela, L. (1992) *Application of the New Production Philosophy to Construction*. Tech. Report No. 72, CIFE, Stanford Univ., CA.

Krafcik, J. F. (1988) Triumph of the Lean Production System. *Sloan Management Review*. Fall 1988, 44-45.

Santander Totta (2008) A Banca e o Sector de Construção em Portugal e Espanha. In: *Seminar - Os Sectores da Construção e do Imobiliário em Portugal e Espanha*, Lisbon.

Simonsen, R., Bonke, S., WallØe, P. (2004) Management Innovation Brokers – The Story of Lean Construction Entering Denmark. In: Proceedings *for the 12th Annual Conference for the International Group for Lean Construction* (IGCL-12) Copenhagen.

Thomassen, M., Sander, D., Barnes, K. Nielsen (2003) Experience and Results from Implementing Lean Construction in a Large Danish Contracting Firm. In: Proceedings *for the*

11th Annual Conference for the International Group for Lean Construction (IGCL-11) Virginia, USA.

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IMPLEMENTATION OF SMART TRANSPORT CONTROL SYSTEMS IN OSTRAVA

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The feature of the development of transport is the continuous growth in the number of motor vehicles on urban roads and increasing demands on the transport of passengers and load. The growing intensity of transport necessarily entails the increasing incidence of conflict situations, the fundamental problem is the growing number of accidents and their consequences. Resolution this situation requires the need for the construction of new roads and construction works to the existing communications network, as well as the introduction of traffic management systems with minimum non-point demands.

KEYWORDS: intelligent transport system, traffic control, traffic information.

INTRODUCTION

The number of passenger cars in EU25 countries is said to increase by 25 – 35% by 2020 and number of trucks even by 55-75% (source DG TREN/2004). Such a growth needs to be eliminated at least partly by various means:

- to build capacitive communications,
- to produce "intelligent vehicles",
- to create traffic-telematic systems in a form of "intelligent" management technologies.

Time factor plays an important role with above mentioned possibilities:

- With new communication from study to realization it exceeds 20 years.
- Intelligent vehicles with many subsystems oriented on e.g. increase of safety (vehicle leading in the optimal trace, detection of obstructions, also detection of traffic signs etc.) are launched into serial production after 6 to 12 years.
- With traffic-telematic systems the innovation cycle influencing drivers is 18 - 24 months long (control of traffic in towns - info panels, variable signs etc.).

Intelligent transport system ITS of road transport has become a tool for increase of safety, smoothness of road transport, but it can also contribute to higher assessment of investment means invested into road infrastructure construction. Single applications can serve also for effective maintenance of roads and highways, control of technical means of infrastructure and technical state of the transport route. ITS collect huge amount of information with inserted added value and can become a tool of power of state transport policy. European transport routes – corridors TINA (TEN) must fulfil goals of European transport policy the way conditions for connecting national transport infrastructure with European transport process were created. ITS applications are thus an important tool of interoperability in transport processes. Therefore even single ITS application on transport infrastructure must fulfil conditions of information interoperability.

The Czech Republic has a strategic position from the transport view by its location in the heart of Europe. Its transport infrastructure must allow not only smooth connection with European industrial, business and residential centres, but infrastructure must provide the transport users adequate services. In the frame of EU currently the attention is paid to development of trans-European transport network including systems of transport control, localization and navigation systems.

PERSPECTIVE OF TRAFFIC SOLUTION IN OSTRAVA

The metropolis of Moravian-Silesian region is the second largest town in the Czech Republic by its area (214 km^2) and the third largest town from the aspect of number of inhabitants (316 670). It is located 10 kilometres from southern state border of Poland and 50 kilometres from the western border of Slovakia. 4 rivers flow through the town - Odra, Ostravice, Opava and Lučina Rivers.

The town was built on so called Amber route that has been used by merchants as the main route connecting Baltic and Mediterranean seas. The discovery of coal in the second half of the 18th century was crucial; that was followed by development of steelworks.

Urban conception of the built-up area is specific. It is a result of connection of many villages in relation to development of industry and residential housing after the 2nd world war. After 1989 there were 23 town districts set stepwise. In the town area functional connection of continuous system of three substantial residential zones occur (each counting about 100 000 inhabitants):

- city centre with Moravská Ostrava and town districts of Slezská Ostrava
- Southern town
- Poruba.

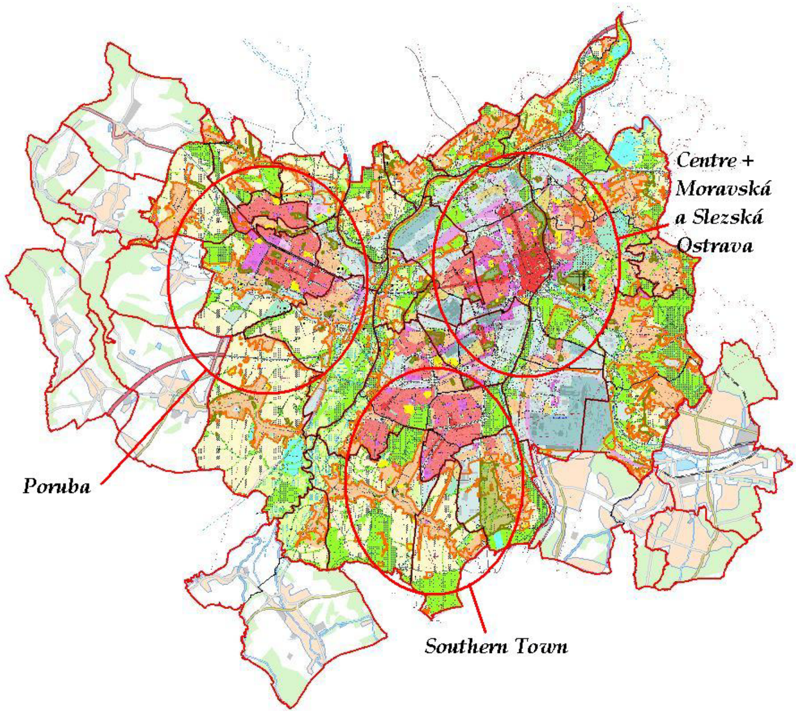

Figure 1: Determination of concentrated residential/mixed development in Ostrava

In June 2008 a semi-qualitative survey was organized in Ostrava aiming at monitoring the attitudes and satisfaction of Ostrava inhabitants between 16 and 65 with the state of car traffic and public mass transport in the town. The groups of questions follow:

1. Satisfaction of the inhabitants with living in Ostrava, reasons for satisfaction/dissatisfaction;
2. Evaluation of changes occurred in Ostrava in the past year;
3. Satisfaction with car and public mass transport;
4. Satisfaction with parking in Ostrava;
5. Satisfaction with the capacity of streets.

Although satisfaction of inhabitants with living in the town has grown with time by 3,1 percent points compared with September 2006 (survey in connection with elections) in the field of transport we can not consider this situation to be satisfactory.

Transport is represented as a factor of dissatisfaction with living in the town (it is among five most important factors). It is on the first position before the state of environment. The inhabitants mind the most the density of the traffic operations, problems with the capacity of streeets, few parking spaces and state of the roads maintenance.

- In the field of transport the inhabitants are the most satisfied with construction and opening of the highway and road repairs. Only 59% are satisfied with car transport. The inhabitants see the following items as the greatest problems: few parking places, jams, tailbacks and damaged roads.
- About 76% are satisfied with the state of the issue of public mass transport (MHD). There are only a few critical reservations and they concern the frequency of links. The matter of public mass transport acquired the best evaluation.
- Only 22,4% are satisfied with parking in town. Problems with parking occurred to 48% of the town inhabitants in the passed month. The highest number of problems appears in the town centre and in residential places. Satisfaction with parking in the centre is critical.
- About 55% of town inhabitants are satisfied with the capacity of streets. The most critical place is the town centre and frequented intersections.
- It is important to solve not only the infrastructure but also related services for inhabitants and visitors of Ostrava and awareness of these target groups.

APPLICATION OF SYSTEM CONTROL OF TRAFFIC IN OSTRAVA

The Czech Republic perceives this matter very intensively, supports all-European efforts and therefore tries to increase the share of telematic on control and management of transport and transit processes by the whole complex of arrangements the way consequent implementation of telematic systems does not fall behind the requirements of dynamically developing transport market. Interest in development of traffic telematics and support to such technologies is not shown only by Ministry of Transport but also regional and municipal authorities.

Architecture of ITS in the area of the town of Ostrava will have links onto outcomes of national and international projects solved in the fields of ITS architecture and on already built related systems or system which are introduced in the Czech Republic stepwise. They concern telematic applications, mainly the head central offices in large towns, applications for monitoring the traffic intensity, for weather monitoring, telematic applications for increase of safety in tunnels etc. Effective use of such systems is not possible without their mutual relations and links on e.g. prepared system called Cohesive system of traffic information or on integrated rescue systems.

Anticipated contributions of the application of intelligent traffic systems and services in Ostrava are:

- Increase of safety of traffic.
- Increase of operational and freight capacity.
- Improvement of services for public from the aspect of increase of mobility of comfort of travelling.
- Convenient economical impacts emerging from smoothness in transport.
- Introduction of central management will improve efficiency of exploitation of financial means.
- Implementation into transport conception in the frames of European structures.
- Environmental impact – decrease of emissions.
- Regional development.

Initial state of traffic control in Ostrava

Principal orientations of building of the traffic control system have been followed since 1993 through "Study of automation system of control of urban road traffic in Ostrava". Into building and operations of also partial parts new knowledge and technical innovations were implemented. In the first phase exchange of old controllers at crossroads occurred, which was followed by realization of the supervisory office watching the traffic on communications. The process of building depends mainly on financial means which are not sufficient and therefore current or new devices may become obsolete or incompatible.

In the framework of creation of the whole control system, following subsystems were suggested for realization:

1. Traffic control by light signalling

At the end of 2007 traffic on the town communications was controlled by light signalling in 89 nodes – of which 53 were intersections, 29 separate pedestrian crossings and 7 other places. Altogether 56 nodes are interconnected into line coordinated roads. For traffic control 71 controllers are available. Apart from 3 controllers that are semi-electronic (and the oldest ones from 1980 and 1986) all controllers are micro-processing.

2. Traffic and travel information

Information on the state of communications is important not only for road operators but also for their users. Information on closures, important situations, traffic at intersections and accidents, parking, winter negotiability and crisis situations are therefore provided at internet website of Ostravské komunikace company and statutory town of Ostrava. Cooperation with the national integrated system of traffic information provided by the Ministry of Transport of the Czech Republic is important.

3. Meteorological information

Ostrava has two external stations of meteorological indicators. They are permanently situated in two town districts – Svinov and Přívoz. They send data to the central station located at the control centre of Ostravské komunikace by wireless technology (GSM).

4. Camera supervision

Camera supervisory system (subsystem) watches traffic at 20 intersections in the town with 60 cameras. The pictures are provided to internet website of the statutory town of Ostrava and the workplace of OK, Dopravní podnik Ostrava, a. s. (DPO, a. s.), Centre of emergency calls (CTV), Police (PČR), Municipal police (MěP). Optical cable network is the transmission medium.

5. Preference of public passenger transport

The preference can be:

- *passive* **–** The technology does not distinguish actual position of the vehicle of public transport and immediate state of traffic, it comes from pre-defined signal plans which are calculated on the basis on measurements of vehicles moves and privileges their probable moves in the intersection's space.
- *active* **–** the change of the signal plan caused by public transport vehicle occurs. The public vehicle signs into the signal system with a designated detector and makes such a measure that it can go through the intersection without or with only small delay.

Currently Ostrava has active local preferences at 44 nodes for public transport vehicles, of which 24 are active and 20 passive.

All newly built or reconstructed traffic lights in Ostrava are equipped with elements for detection and preference of public transport (at the moment only for rail vehicles with active elements for detection). Technical solution comes out of the system that has been used by DPO.

6. Preference of rescue services vehicles

For vehicles of fire and integrated rescue service (HZS a IZS) an autonomous system of local preference of passage is used. The system works on the principle of wireless technology of signal emission. The devices are owned by the municipality and operated by HZS (transmitters) and OK (receivers in controllers).

7. Supervisory offices

Since 2002 supervisory offices are in operation. They monitor the controllers continually and enable their remote control – changes of signal plans, collection of acquired data on intensities of traffic or watching the operation of light signalling devices on-line.

Both supervisory centres work autonomously, mutually independent. However, the centres are incompatible, which is no acceptable for the future of central control of traffic.

Both devices are owned by the municipality. They are located at the workplace of OK that provides their operation and maintenance.

PROPOSAL OF ITS ARCHITECTURE

Growth of individual traffic in town is estimated at 3 to 6% per year. Therefore it is necessary to continue in the conception of building acc. to accepted General transport plan of the town of Ostrava from 2003 (150 nodes controlled by light signalling were considered), which would put Ostrava onto the level of motor developed countries in traffic control.

It is obvious that the speed of ITS building is not sufficient due to increase of traffic. In the future it is necessary to focus mainly on compatibility of elements of telematic subsystems and their updating in relation to serviceability and future requirements of traffic infrastructure.

Development of traffic-telematic systems in Ostrava lies in the competence of single subjects, authorities, organizations and town institutions. They must respect necessary information links with Cohesive system of traffic information for the Czech Republic or possible other systems. Local traffic information and control centre must fulfil following functions:

Collection of data

This function is solved directly through sensoric profiles and indirectly through data and traffic information receiving from the national level through National traffic information an control centre (NTICC). Data is automatically processed for further utilization.

Control

This functions is applied in connection with signal plans of light signalling, possibilities of control through installed telematic applications, mainly command and prohibitory variable traffic signs and systems of guiding. The basis of regulations and scenarios carries out the processes of control processes on the basis of evaluations of traffic data and traffic information.

Information function

It is directly applied through devices for operational information and variable traffic signs, then also indirectly through distribution of traffic information to classical and modern media.

Technological supervision

Provides continuous control and availability of technologies and systems and generates escalation procedures in case of problems.

The crucial problem is insufficient financing of construction. To eliminate this problem was prepared [2] by a large group of companies and experts and was a basic document for a proposal submitted to the Municipal Hall of Ostrava for financial support from EU.

TRAFFIC-TELEMATIC SYSTEM IN OSTRAVA

Increasing intensity of traffic and thus related increase of conflict situations require both the necessity of new communications building and construction adjustments on current communication network. However, that is a long-time and costly process, further suiting to individual car transport. Therefore it is necessary to equip the town with means that would enable doing correction interventions into complicated traffic process on the grounds of direct traffic-organizational measures the way the reserves of current communication network could be used and smooth and safe traffic could be provided.

The aims of such a system of traffic control are mainly:

- To use the reserves of existing network of roads;
- to provide optimal safety of traffic operations;
- to provide preference of vehicles of town public transport and vehicles of the right of primary run;
- to increase speed of transfers of vehicles through the traffic area and thus to lower the time losses, numbers of stopping and total time the vehicles stay in the traffic area;
- to enable strategic management in the complete town communication network and single tactical management in normal conditions as well as unpredictable and extraordinary situations.;
- automatic watching and control of all elements and immediate reporting of possible failures or breakdown.

For conditions and specific solution in the town of Ostrava following traffic subsystems were selected:

Table 1: Traffic subsystems of traffic control

Area1	Traffic control
Area 2	Traffic and travel information
Area 3	Idle traffic
Area 4	Public regular passenger transport
Area 5	Supervisory and warning systems
Area 6	Security and rescue systems
Area 7	Transport of goods and freight
Area 8	Management of traffic infrastructure

For local use of traffic data from the town system following possibilities of distribution and publication exist:

- local radio and TV broadcasting
- traffic and information services on the basis of GSM (GPRS, WAP, SMS, MMS)
- voice telecommunication information services (IVR, „living“ voice)
- internet websites

From the national level of management for town traffic control following information can be used:

- traffic accidents
- fire of vehicles and freights
- obstacles
- closures and diversions

- special use
- transportation of oversized or dangerous loads
- negotiability of communications
- limited visibility, wind, floods and other effects of meteorological situation on traffic
- information of road meteorology
- limitation by maintenance and mending works
- breakdown of engineering networks
- density, speed or intensity of traffic current
- possible limitation of idle traffic and actual availability of a system „park and ride“
- picture information from camera systems on highways and expressways.

Traffic information and data are or will be accessible from following sources:

- Police of the Czech Republic
- Fire rescue department of the Czech Republic
- medical rescue service
- road operators
- road administration offices
- Municipal police
- operators or owners of engineering networks
- Custom service
- operators or providers of tunnels
- Czech hydro-meteorological institute
- water administration offices and works of Povodí Odry
- shippers of oversized and dangerous freights
- organizers of large events
- and other similar subjects
- furthermore also from telematic applications mainly of highways and speedways
- systems of traffic current characteristics watching and traffic counts
- fond of central database (FCD) = source of traffic information (characteristics of traffic currents of vehicles, detection of tailbacks etc.)
- systems of electronic tolls
- meteorological information systems
- control camera systems
- systems of control and supervision of tunnels
- systems of devices for information providing and variable traffic signs
- systems of line control of traffic
- and possibly others.

Most of such information is or will be available through standard data distribution interface NTICC or through video-gate.

PROCESS OF REALIZATION OF TRAFFIC-TELEMATIC SYSTEM IN OSTRAVA

For satisfaction with living in the town of Ostrava transport is one of the key areas, based on the survey from 2008. Ostrava inhabitants perceive many partial improvements- mainly construction and highway opening and reconstruction of roads. With dynamic growth of transport also problems increase and on the grounds of the survey results it can be claimed that the traffic situation in town required conceptual and systematic solution:

- To finish the traffic control strategy on the basis of analysis of current traffic situation and prognosis of further trend in town development, living environment and prognosis of motorization.
- To create principle hierarchically structures architecture of traffic-telematic system for Ostrava in relation to standards created in the frames of technical committee TC278 using well-known European projects (such as KAREN or ACTIF) for every users area the way all functions that need to be realized by the systems would be described. The outcome would be the requirement saying which blocks will be parts of the town management and what must be provided by these blocks.
- To incorporate the existing 7 subsystems into above mentioned proposal (including changes of subsystems of traffic and travel information, meteorological information, control head office).
- On the basis of elaborated and approved architecture of traffic-telematic system a conception of this system building should be prepared. Part of the concept should be the process of construction in compact serviceable parts in structure of 3 and 10 years including financial costs.
- To emphasize the issue of “Traffic management and information centre of the Moravian-Silesian region and the town of Ostrava” elaborated in the frames of development EU project „CONNECT“ in the proposal of architecture of traffic-telematic system and conception of building of traffic-telematic system
- One of the predominant aspects of quality and operability of the whole system of traffic control is ownership and link-up on operations of public administration.

REFERENCES

Vondrák, I., Čeřovský, J., Svrčina, M., Soldán, P., Řezáč, M., Foltýn, P., Tomčala, J., Tkač, T., Martinovič, J., Zvara, J., Fencl, I. (2008) Audit výstavby ASŘ MSP v Ostravě. Ostrava: IT Cluster, o.s.

MAPPING SUSTAINABILITY ASSESSMENT IN RELATION TO A PPP PROJECT LIFECYCLE

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Traditionally viewed as a technical tool focused on assessing the sustainability performance of building projects, sustainability assessment is slowly evolving to provide a proactive role in support of the management of sustainability across the project lifecycle. This paper presents the findings of a mapping exercise to identify the emerging phases and activities of sustainability assessment across the lifecycle of schools project under a PPP contract. The empirical context presented explores the challenges of applying assessment in a manner that remains reactive to the requirements of the project, and maps the role of the relevant stakeholders in relation to the key phases of the assessment and in relation to the stages of the project lifecycle. Some key lessons are drawn highlighting the need to facilitate the flow of knowledge between relevant stakeholders throughout if assessment practice is to evolve in line with the suggested proactive approach.

KEYWORDS: sustainability, sustainability assessment, lifecycle, partnering

INTRODUCTION

With sustainability increasing as a consideration in the development of the built environment, emphasis is placed on establishing an effective process to identify, predict and evaluate the potential social, environmental and economic impacts associated with the way we design, build, operate, maintain and ultimately dispose of buildings and their support systems (El-Haram et al. 2007). This process is understood commonly as sustainability assessment and the nature of its evolution has been the source of much debate over the past decade (Brandon et al. 1997). Calls have emerged for the perception of assessment to move beyond the initial view of a purely technically based exercise focused on establishing sustainability performance of the building and to consider the role that assessment has in promoting engagement, mediation and learning amongst the stakeholders (Kaatz et al., 2006). Its value is to encourage stakeholders to rethink their priorities by examining in detail the potential impact of the project on sustainability through the provision of tangible information to support largely subjectively based decision making (Pope et al., 2004). Viewing the use of assessment tools as guiding decision making as opposed to determining it, enables the consideration of sustainability to be transparent and discussed in an inclusive manner with stakeholders (Mathur et al., 2008). Considering the assessment as a means for promoting discourse between stakeholders around the principles of sustainability and the implications for the project, the likes of Lutzkendorf and Lorenz (2006) argue that this provides the basis to foster a shared understanding and to apply this to the contextual requirements of the project. Enabling the relevant stakeholders to acquire knowledge and experience through involvement in the discourse that surrounds the assessment provides the potential to encourage and promote sustainability during decision making over the lifecycle of the project but also enabling its transfer to future projects (Thomson et al., 2009).

Despite the existence of over 675 assessment tools (Walton et al., 2005), practitioners commonly display a lack of awareness of tools outside the national based checklists such as BREEAM, LEED and SB Tool. Even with the volume of tools available, a lack of awareness and general confusion exists around the concept of sustainability, the nature of their application, function, and the required degree of stakeholder responsibility and involvement across the project lifecycle (Deakin et al. 2002; Cole 2005). Evidence suggests that despite the intentions of the tool developers, their application remains reactive by nature with projects merely concerned with compliance with legislative and client requirements as opposed to aspiring to deliver sustainability in practice in a proactive manner. Lee (2006) argues that other tools applied remain predominantly focused on quantifying the impact of resources intended for use within projects. He suggested that this fails to adequately support the subjective nature of decisions making surrounding sustainability within these projects. In order to aid the evolution of assessment, a better understanding of the role of assessment tools in the delivery of sustainability across the various stages of the project lifecycle is required (Kaatz et al., 2006).

This paper aims to contribute towards an emerging understanding of how sustainability assessment is applied in practice by considering an empirically based case study and to follow the assessment during its different phases across the project lifecycle. The case study selected represents an approach to assessment that is reactive by nature across a programme of schools construction projects which is managed using a Public Private Partnership (PPP) form of procurement contract (Nisar, 2007). The case study allows us to understand how sustainability assessment is being adopted in practice; enabling us to consider the impact the adoption of this form of procurement contract on the management of the sustainability assessment and the implications this has for the flow of knowledge that surrounds it. In order to understand the integration between the management of the project and the sustainability assessment, the phases and key activities of the assessment are identified and mapped in relation to stages of the project lifecycle. A methodology using knowledge mapping techniques was adopted to identify the key-decision makers and various stakeholders involved, defining their roles, establishing where the knowledge resides and the nature of its flow. It is necessary to develop this level of understanding if recommendations are to be provided to aid the evolution of sustainability assessment in line with an increasingly proactive approach.

CASE STUDY PROJECT BACKGROUND

Initiated in 2001, the projects were procured using a Public Private Partnership (PPP) contract, with the prime-contractor identified as preferred bidder in 2002, with the 'Schools Partnership' emerging from the agreed contract to oversee the delivery and operation of the schools for a 30 year term (involving the prime-contractor, facilities manager and the funder). The initial stages of the project were driven by the education department within the local authority, with sites identified in line with the council’s strategic plan representing a mix of green field sites and direct replacements on the sites of existing schools. The client body are keen to apply BREEAM for schools (Building Research Establishment Environmental Assessment Method) as a tool for sustainability assessment within these projects. They acknowledged the need within the public sector to display transparency, recognising that the sustainability performance of these projects was considered as part of this and the increasing application of assessment within such projects. Despite their inexperience in applying such tools, the authority recognised the growing expectation of its consideration in future projects.

METHODOLOGY

Focusing on an empirical example of the application of sustainability assessment offers the opportunity to examine the experience and interaction of those participating in the assessment (Yin, 2003). This aims to provide a greater understanding of the nature of its application across the different stages of the project lifecycle, its knowledge requirements and the nature of its flow. A series of semi-structured interviews (each lasting approx 2 hours) were conducted with those members of the project team involved or influenced by the application of the sustainability assessment within the project. The interviews were split in two phases, the first with the project director (prime-contractor) to develop an understanding of the project, the approach to sustainability, and the different phases of sustainability assessment across the project lifecycle. The second phase aimed to focus in detail on those who participated specifically in the sustainability assessment in order to gain a practitioners insight into the associated knowledge requirements, who is involved, what knowledge is required, who holds the knowledge, the nature of its flow and what mechanisms can be provided to aid its flow during a sustainability assessment. The interviews conducted during this phase were with the sustainability assessor, project architect and facilities manager. The interviews were conducted following the completion of four of the schools and in the final stages of construction within the other two. This provided a retrospective view of the BREEAM assessment from the perspective of the completed schools, whilst actively preparing for the final assessment with in the other two. These were valuable in identifying some key lessons for the application of assessments in future projects.

Knowledge mapping (Vestal, 2005) provides the basis for understanding the requirements associated with the individual phases of sustainability assessment. Process mapping was deployed to identify the key activities of assessment, with support of techniques such as cognitive mapping and organisational network analysis (Vestal, 2005) to understand the relationships between the stakeholders and the nature of the knowledge flow between them. Techniques deployed by the likes of Eppler (2008) (focusing on the application of knowledge during certain process stages) and Egbu (2006) (focusing on the specifics of knowledge, the processes, roles and competencies of stakeholders) were considered and a tailored approach developed. Given the context specific nature of the flow of knowledge during assessment, a mixture of representations provided a greater value than applying a single technique.

MAPPING SUSTAINABILITY ASSESSMENT

The research identified four key phases of sustainability assessment around which the key-decisions are taken i.e. identification of project sustainability issues, selection of sustainability assessment tools, implementation of the assessment, and consideration of tool outputs. The various stakeholders participating were identified in relation to each of these phases and the nature of their involvement mapped across the project lifecycle. The emerging maps illustrate how the assessment formed the basis of the projects approach to managing sustainability across its lifecycle. The interviews were conducted with those involved in the decisions taken or in delivering those phases of assessment.

Stakeholder involvement in project sustainability assessment

An initial mapping exercise identified who was involved during the different phases of the sustainability assessment and the nature of that involvement; with the findings shown in figure 1. Involved through all of the phases were the project board and client representative as they held the overall responsibility for delivering sustainability within the project. During the later two phases it was observed that the role of the client representative shifted with responsibility for delivering the desired sustainability rating for the schools passing to the project board, and the management of the assessment to the prime contractor. The others were observed to contribute during the individual phases in a manner that reflected their role, the nature of the phase and its alignment with the outlined project responsibilities.

The stakeholders were identified to play seven different roles reflective of the nature of their involvement with the assessment i.e. the key-decision maker, responsible for overseeing activity, responsible for conducting the assessment, advising, consulted, evidence provision, informed and not involved. A hierarchy was detected that required to be reflected, with ultimate responsibility lying during decision making with the client representative (during first two phases) and the project board (across all assessment phases). Whilst not involved in the detail of the assessment, these stakeholders performed the role of key-decision makers. With the project board overseeing the phases of the assessment; in line with the PPP contract the prime-contractor assumed responsibility for overseeing its delivery in practice. To assist this role, a sustainability assessor was employed to coordinate the provision of evidence by members of both the design and construction teams, in addition to specialist consultants. Significantly across the phases of the assessment it was observed that none of the various stakeholders were involved from the perspective of providing advice as an expert in the way a sustainability consultant or advisor might. A necessary distinction was observed between those who were consulted for input by the team (i.e. architect and client representative), and those who were informed of its progress (i.e. building user).

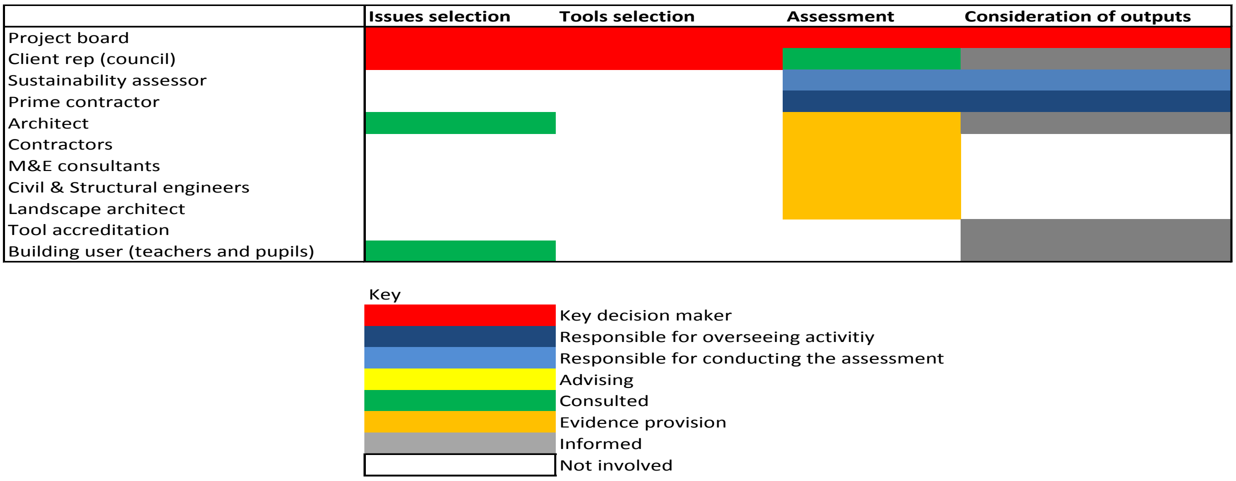

Figure 1: Project team involvement in stages of assessment

Sustainability assessment across the project lifecycle

From this the basis was provided to explore the nature of these phases in relation to the project lifecycle and to identify the nature of stakeholder involvement in relation to this. Figure 2 illustrates three representations: an interpretation of the phases of assessment, the involvement of the stakeholders, and the nature of that involvement in relation to the stages of the RIBA Plan of Works 2007 (RIBA, 2007).

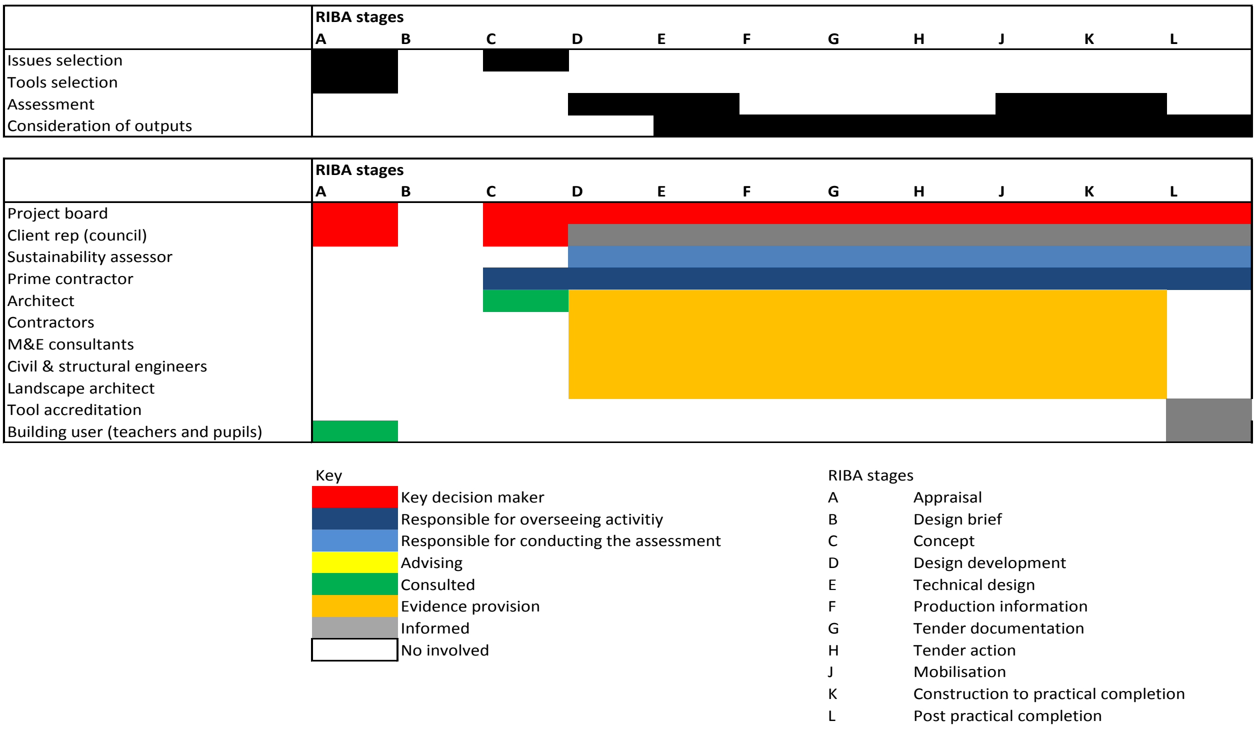

Figure 2: Project team involvement across RIBA stages in sustainability

Observed was the iterative nature of the phases of assessment and the manner in which these are revisited during later stages of the project. This is demonstrated in the selection of the sustainability issues and tool, a situation that occurred due to the client representative's desire from the outset to implement BREEAM as a tool within this programme of projects. During appraisal stage (A), the client representative introduced several sustainability issues such as energy, water, the treatment of any contaminated land, biodiversity and the quality of the teaching environment within the building as requiring consideration in the design of the building. Transport was prominent in consideration from a health and safety, congestion, air quality and from a carbon emission perspective. To an extend these were consistent with the issues displayed in the customised BREEAM version for schools, and as a result the client body were content to adopt the criteria set by the tool. The client representative acknowledged their inexperience and supplemented this by seeking the knowledge and advice informally from personal contacts from other local authorities. During appraisal stage (A), the School Partnership had not been established and the project board only involved the client body and funder. During this period, the client representative established a rough target rating of 'Good', founded on informal discussions and advice from those with experience of applying BREEAM in similar projects. The rating was established to guide the budget for the project, and to inform the development of the client expectations outlined in the contract. However, it was clear that the project board and the client representative displayed an inability to critique the tools and placed complete trust in the appropriateness of the tool for the context.

It was not until concept stage (C), when the prime-contractor was appointed as preferred bidder that questions regarding the sustainability issues were again raised, forcing the client representative, project board, prime-contractor and the architect to review the achievability of the target and its practical implications. The establishment of the Schools Partnership marked a series of meetings where it became apparent of the increased emphasis placed on energy and water consumption, and its influence on the overall cost of running the building. Although, individual targets were set reflecting the increased focus on long-term considerations, a 'Good' rating remained the overall target. Members of the design team were consulted to ensure the achievability of the rating and to check that the expectations for the emerging design were understood. At this stage, the appointment of a sustainability assessor led to the development of a pre-assessment report outlining the implications for practice and presented to the project team during a workshop in addition to the approach for gathering the data and evidence for the assessment.

The assessment tool was implemented across stages C, D, E, F, G, H, J and K with the final assessment being delivered and submitted to the BRE for accreditation at the end of the construction stage. At various points during the design stages, the design team and relevant consultants fed data and evidence through the prime-contractor to the appointed sustainability assessor. This process allowed the assessor to monitor the implications of the emerging design against the criteria required to achieve the set rating and therefore permitted adjustments should they be required. Much of the assessment criteria could be handled by the expertise of the design team through their standard practices although additional consultants were appointed to model both energy performance and transport implications required through the assessment.

The prime-contractor acted as the main point of contact for both the assessor and those providing the data and evidence, although limited communication was possible through e-mail. Apart from an initial workshop, a general lack of contact between the assessor and the design team reduced the potential for the agreed rating to be re-evaluated as the design progressed. The ease, at which the project was delivering its agreed rating, highlighted a general lack of feedback resulting in a failure to realise that it would be possible to improve the sustainability performance of the buildings in line with a 'Very Good' rating without much trouble. This is a traditional failing of assessments of this timeframe, and it is clear the management structure adopted by the prime-contractor restricted the level of contact and information flow between these groups.

The intention was for the assessment outputs to provide the benchmark against which the post-design activities are considered, however due to delays in the provision of data and evidence the formal outputs were not available, although a pre-assessment report acted as a guide. This ensures that decisions taken for the construction activities and the procurement of suppliers conform to the assessment requirements, and these delays permitted the inclusion of these in the final assessment rating. The reason the prime-contractor retained control of the information flow between the sustainability assessor and design team was to ensure that the construction activities were delivering in practice the assessment rating of the agreed performance. This is a necessary aspect of ensuring that the later stages of the project lifecycle deliver the agreed sustainability performance within practices on site, in the completed building and finally in its operation. This was significant due to the long-term responsibility for the schools through the PPP contract and the desire to minimise operational costs and reduce environmental impacts. This was highlighted by the presentation of the formal assessment report to the project board, during post practical completion stage (L) in order to inform the schools facilities management.

Figure 3 illustrates the sustainability issues that emerged during the project against the main RIBA Plan of Works stages, detailing in the first level those described by the project team as the priority considerations, second level those assessed as part of the project process, and third outlining the BREEAM criteria assessed by the team. It is necessary to point out that the BREEAM criteria are not presented in any order or in relation to the stages of the RIBA Plan of Works. As discussed, the overall criteria selected for assessment was centred predominantly on the criteria for the BREEAM assessment of schools. The additional assessments conducted, were largely supportive of the BREEAM criteria and addressed in increased detail the priority concerns of the client representative and project board.

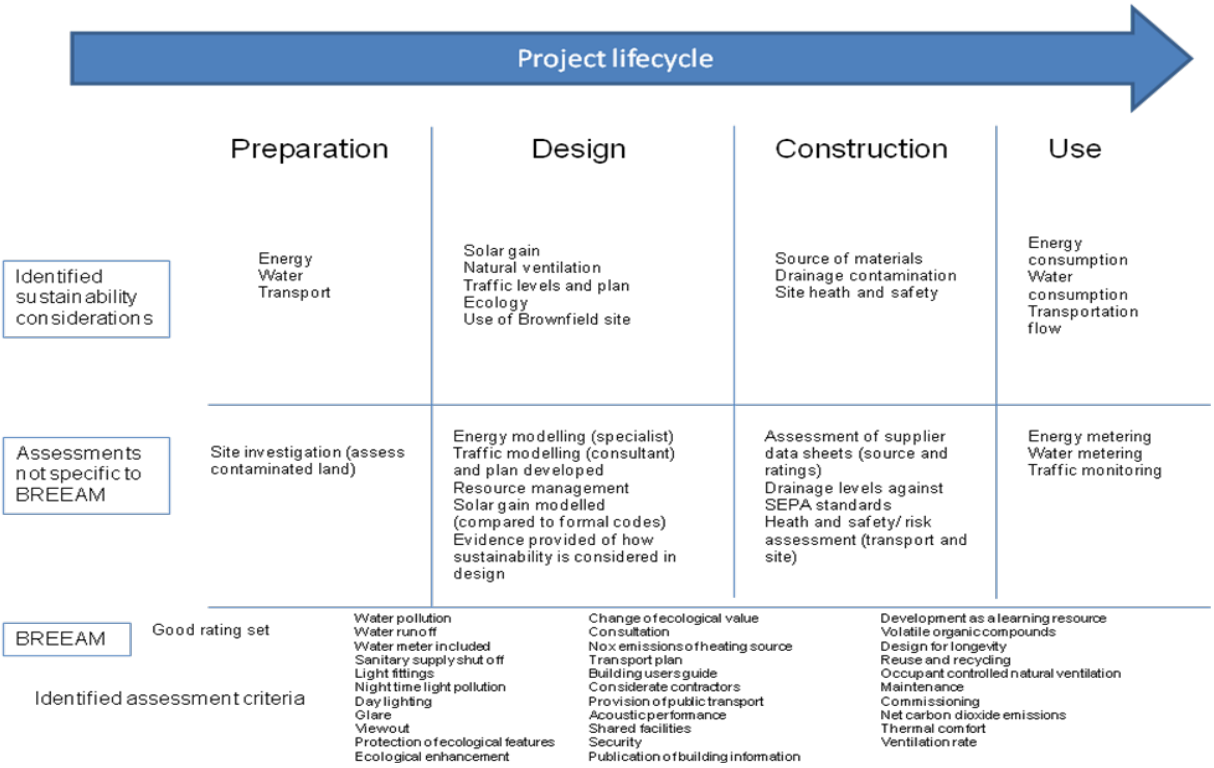

Figure 3: Sustainability considerations for assessment identified across the project lifecycle

KEY FINDINGS

During the analysis six key lessons were drawn which require to be addressed if sustainability assessment is to evolve as a proactive tool to guide sustainability within projects in an approach that promotes discourse between stakeholders. These were informed by observations made by team members regarding problems in the approach and potential improvements.

Need to promote the flow of knowledge between the stakeholders

Channelling the flow of data and evidence between the design team and the sustainability assessor through the prime-contractor clearly restricted the ability of the team to recognise the opportunities that were presented to improve the targeted rating. This structured approach lacked the flexibility and degree of contact between these parties required to realise this potential. Although both sides acknowledged the opportunity, the project management structure did not permit informal contact nor did it encourage the issue to be raised with the prime-contractor. The design team commented that by not meeting or communicating with the assessor directly, the opportunity to ask questions and learn more about the tool and its implications was significantly restricted. This significantly restricted the teams' ability to benefit from 'social learning' or 'learning by doing', which is necessary to improve practice.

Dangers of a reactive approach to sustainability

The case study demonstrates an approach to sustainability that is reactive with the client body being guided by both legislative requirements and market expectations. This reflects a common trend within the industry as clients and project teams look to the government and industry bodies for direction regarding how to approach sustainability within their projects. Such a culture contributed to the general failure within this project to set a higher BREEAM rating and to recognise the potential offered to improve it. A lack of aspiration was observed, requiring a quest for a cultural shift within the project team in line with those displayed in projects by Bioregional Quintain such as the BEDZED or Greater Middlehaven which are being developed in line with One Planet Living Principles (Desia and King, 2006). These projects place sustainability at the core of the project's vision, and view tools like BREEAM within a wider suite of assessment tools that support the quest for aspirational targets that are set far above legislative demands and incorporate a broader coverage of sustainability issues.

Need for leadership to promote sustainability

Over the course of the project's lifecycle a lack of leadership was observed in order to promote sustainability. Part of this problem is connected to the shift in responsibility for delivering the project over the lifecycle due to the nature of the PPP contract. The client body initiated the project, and provided the context around which sustainability was considered including the selection of the tool and the target rating. In shifting responsibility to the prime-contractor for the delivery of the schools in line with this target, the potential to improve the rating was partly removed as such a change would require the involvement of the client representative to drive it forward. In many such projects the architect often provides leadership towards delivering sustainability within the buildings design, however due to the nature of the PPP contract within this project the architect felt removed from the necessary channels of communication and decision making to influence this.

Lack of expert guidance to support the assessment

The limited experience of the team in both sustainability assessment and in the practical use of the tool was observed to result in a limited ability to critique the tools available, to identify a suitable rating and to ensure that the assessment informed the development of the project through feedback. Increasingly similar projects are employing a sustainability advisor to supplement the knowledge base of the team, and to ensure that expert guidance is available when required. In this case the lack of expert guidance, resulted in advice being sought from informal sources with the knowledge gained being un-contextualised for the requirements of the project.

Challenge of chasing moving targets in long term contracts

Initiated back in 2000-1, this programme spanned a lifespan of nearly 8 years as it moves through its planning, design and construction phases. Over this period, sustainability has continued to emerge as an important issue for building projects and assessment has continued to evolve in response. The use of sustainability assessment as a tool to guide design, construction and operation of building projects is a role that is increasingly being appreciated within the industry. This project was initiated at a time when priorities for sustainability were less prominent in the minds of the key-decision makers and demonstrated an inability to update their approach over the projects lifespan. This example illustrated the challenge faced by development projects in setting rigid targets across long term contracts, and whilst acknowledging the problems of chasing a moving target and agenda, the team acknowledged that greater consideration for flexibility in targets required in order to future proof such projects.

Risk adverse culture promoted by the PPP contract

It is possible to argue that the nature of the PPP contract potentially acts as a barrier to achieving a higher rating, as it is unlikely that unless stipulated by the client body in the contract that the prime-contractor or architect would want to commit themselves to a higher rating than they are required. The interviews revealed a feeling that although they were responsible and even accountable for delivering the desired rating, a set budget exists, and to raise the level above that agreed within the contract places risk on themselves, as opposed to the client body. A shift in culture is required where those involved to view adjustments in sustainability targets in terms of potential benefits such as savings in energy, water and carbon-dioxide emissions and to communicate these to client bodies more effectively.

CONCLUSIONS

If sustainability assessment is to evolve as a proactive tool in the promotion of sustainability within building projects, a need exists to greater understand how it is currently applied in practice. It is argued that assessment needs to guide decision making and support the necessary pathways of discourse that surrounds the consideration of sustainability across the lifecycle of the project. Greater understanding is required of the flow of knowledge between the relevant stakeholders and the nature of their involvement with the assessment across the project lifecycle. This research intended to contribute through the consideration of an empirically focused case study and presented are the findings of a mapping exercise of the phases of the assessment and their integration with the stages of the project lifecycle.

An number of key lesson were observed, many of which related to the influence of the adoption of a PPP contract on the flow of knowledge between the stakeholders and the limitations potentially placed on the adoption of a proactive approach to sustainability in this context. The mapping revealed the iterative nature of the decision making regarding the selection of sustainability issues and tools, with particular focus in this case on how the client representative's intention to use a particular tool, predefined many of the issues selected. Notably the team displayed an inability to critique the tools available and once selected a failure to effectively monitor their implementation due to a lack of experience and reluctance to seek expert advice to compensate for this. The appointment of a sustainability advisor had the potential to support the knowledge base of the team surrounding the assessment process and ensure it is structured through a methodology, in addition providing its integration with the project. Stressed was the need to support decision making within each stage by facilitating the flow of knowledge regarding sustainability and its assessment as widely within the project team as appropriate. This was demonstrated partly through the team's failure to recognise the opportunity to raise the targeted BREEAM rating during the design process.

ACKNOLWEDGEMENTS

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REFERENCES

Brandon, P.S., Lombardi, P.L. and Bentivegna, V. (1997) Evaluation of the built environment for sustainability, London: E & FN Spon.

Cole, R. (2005) Building environmental assessment methods: redefining intentions and roles. Building Research & Information, 33:5, 455-467.

Deakin, M., Huovila, P., Rao, S., Sunikka, M. and Vreeker R. (2002) The assessment of sustainable urban development. Building Research & Information, 30:2, 95-108.

Desai, P. and King, P. (2006) One Planet Living – A Guide to Enjoying Life on Our One Planet, Bristol, UK: Alastair Sawday Publishing

Egbu, C.O. (2006) Knowledge mapping and bringing about change for sustainable urban environments: a report of a transition project research funded by the EPSRC Sustainable Urban Environment Programme (EP/C009649/1), BNE No. 25, Glasgow Caledonian University.

Eppler, M. (2008) A Classification of Knowledge Maps, in: Lytras, M D, Russ, M A, Naeve Maier, R (Eds) Knowledge Management Strategies: A Handbook of Applied Technologies, Idea Group, 117-143.

Kaatz, E., Root, D.S., Bowen, P.A., and Hill, R. (2006) Advancing key outcomes of sustainability building assessment. Building Research & Information, 34:4, 308-320.

Lee, N. (2006) Bridging the gap between theory and practice in integrated assessment,. Environmental Impact Assessment Review, 26:1, 57-78.

Lutzkendorf, T. and Lorenz, D.P. (2006) Using an integrated performance approach in building assessment tools. Building Research & Information, 34:4, 334-356.

Mathur, V.N., Price, A.D.F. and Austin, S. (2008) Conceptualizing stakeholder engagement in the context of sustainability and its assessment. Construction Management and Economics, 26:6, 601-609

Nisar, T.M. (2007) Value for money drivers in public sector partnership schemes. International Journal of Public Sector Management, 20:2, 147-156.

Pope, J., Annandale, D, Morrison-Saunders, A (2004) Conceptualising sustainability assessment. Environmental Impact Assessment Review, 24, 595-616

RIBA (2007) Outline plan of works 2007, RIBA publications.

Thomson, C.S., El-Haram, M.A., and Hardcastle, C. (2009) Developing a KMS supportive of urban sustainability assessment. Engineering Sustainability, 162:ES1, 35-44.

Vestal, W. (2005) Knowledge mapping- the essentials for success, Houston, US:APQC publications.

Walton, J.S., El-Haram, M., Castillo, N.H., Horner, R.M.W., Price, A.D.F. and Hardcastle, C. (2005) Integrated Assessment of Urban Sustainability, Engineering Sustainability, 3: 7, 57-65.

Yin, R K (2003) "Case study Research: Design and Methods", 3rd edition, Applied social research methods series Vol 5, London: Sage Publications Ltd.

METHODS FOR SUSTAINABLE RECONSTRUCTION OF VIENNA UNIVERSITY OF TECHNOLOGY

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The year 2015 is 200th anniversary of the Vienna University of Technology. This occasion will be marked through general redevelopment of University's inner city location into a modern city campus, mainly through general building restoration and spatial grouping of individual faculties. The newly found interdisciplinary Research Group for Energy and Environment has set as an aim the implementation of the newest energy-efficiency methodologies and technologies currently developed at the Vienna University of Technology into the reconstruction process.
This paper proposes methods and standards for the intended integrated, interdisciplinary planning process for maximal energy-efficiency building. Life cycle oriented planning, benchmarking through international standards defining sustainability and building performance evaluation will be introduced. A strategy for integrated process for implementation of planning objectives will be proposed.

KEYWORDS: sustainability, energy-efficiency, integrated planning, building performance evaluation.

INTRODUCTION

Vienna University of Technology is celebrating its 200-anniversary in year 2015, the celebration marked by the flagship project: *TU Univercity 2015*. The project is based on the conversion of the existing University buildings, situated in centre of Vienna, into a unique modern city campus, but it also includes a number of scientific activities.
The Research Group for Energy and Environment represents interdisciplinary and interfaculty scientific activity within *TU Univercity 2015*, offering know-how transfer as well as consulting service for the professionals and students. One of the Group's major tasks is the implementation of the newest methodologies and technologies currently developed at the Vienna University of Technology into the redevelopment of the University through interdisciplinary planning. The intended redevelopment should eventually serve as University's own laboratory for testing of systems such as solar cooling and heating, geothermal energy, lightning and monitoring. One of the planning goals is a realisation of a building that can completely outcome without heating or cooling; and even produce instead consume energy. Due to the complex property and investor-client-management situation the project is still on hold.

The paper will address following topics together with proposal of problem-solutions:

- setting of performance goals for sustainability and energy-efficiency of buildings,
- introduction of different international standards with purpose of benchmarking for sustainability parameters,

- proposal of strategy for integrated planning process and implementation of energy-efficiency planning objectives and indicators

PROBLEM IDENTIFICATION

The realization of the energy-efficient showcase building should be conceptualised and adduced through the interdisciplinary work of the Research Group consisting of several departments from different faculties. Some of them are:
Institute for Thermodynamics and Energy Conversion, Faculty of Mechanical and Industrial Engineering;
Department for Building Physics and Acoustics, Department for Industrial Building and Interdisciplinary Planning, both Faculty of Civil Engineering;
Institute of Power Systems and Energy Economics**,** Faculty of Electrical Engineering and IT;
Department of Project Development and Management, Faculty of Architecture and Urban Planning and others.

The project is facing several major problems.
For the planning and construction process itself a planning team has already been appointed (architecture, structural and services engineering, building physics). There is also a number of different stakeholders involved in management, coordination and commissioning process, such as steering committee, project leader, project marketing and public relations, formal-aesthetic consultant and project coordinator. On the other hand, there is a heterogeneous and ambitioned scientific group, involving a large number of participants that should implement the newest energy-efficiency expertise and prove it as innovation through technology-transfer.
Until now there has been almost no communication between the “planning” and “scientific” teams. There are also communication difficulties within the teams themselves, since the project involves a complex planning and construction activity; whereas many of the experts involved have hardly had experience with planning and construction of buildings. The roles of stakeholders with their competences and responsibilities have not yet been clearly defined and communicated. So far no project handbook has been issued; the aims have not been defined or benchmarked – so clearly one of the main problems is the lacking of commissioned project management.

Lessons Learned

According to the study of the US National Renewable Energy Laboratory there are several crucial criteria for success of highly ambitioned energy-efficient projects (Torcellini et al, 2006). These are: integrated, life-cycle (LC) oriented planning, setting of measurable aims, clients acting as main motivators for realisation of energy-efficient buildings, monitoring of operation-phase.

As most important criteria integrated, LC-oriented planning process, involving design, construction and operation phase - so called “whole-building” design can be identified. (Gauzin-Müller, 2002) The traditional planning process is a reactive process, where the architect develops a spatial and functional plot in accordance with the client (investor). Structural and mechanical engineering follow consecutively - in this way, the energy or material performance cannot be optimised, since they only react to the preset architectural design.

The “whole-building” design requires an interdisciplinary work of a team, due to the high level of complexity of planning goals. Everyone involved must be included at the earliest stage of the design in order to set and understand the required building performance. Only in this way, all the aspects and interdependencies can be considered from the beginning, when the change potential is still almost indefinite. All later changes are costly and work intensive (Achammer, 2007). This approach requires the commitment of an entire team to the set goals (in this case energy-efficiency) since a building works only as a system, and not a sum of the parts. Each team member must be encouraged to search and contribute to the final solution, as well as to benefit from other disciplines. An ambience of confidence and trust is necessary for interdisciplinary planning – organised and encouraged communication supports and empowers information flow and know-how transfer.

A precise definition of performance goals in the pre-design phase before any design concepts have been developed, is a precondition for desired and optimal performance of a building. In this way, energy-efficiency will be incorporated in the design as the inherent quality, instead of an add-on value. Basically, all the planning processes can be split into two major parts: analysis and synthesis. The analysis results with the definition of performance aims; the synthesis is the actual design. (Pena, Parshall, 2001). Analysis is always standing in the shade of the more creative synthesis - design phase, however when seen as major determinant for the final project-success, it gains on importance.

Energy-efficient and sustainable design underlies to higher investment cost due to its innovation and often prototype character, however investor decisions are driven mostly by minimisation of cost or financial risk. (Intrachooto, 2005) The hypothesis is, that main motivation for realisation energy-efficient buildings is provided by owners (investors), who act as driving force throughout the course of the project in their role of decision maker.

Further on, energy-efficient buildings do not operate the way they were designed –
transparent information management, monitoring and repeated post-occupancy evaluation are necessary to improve the performance. (Mendler, et al, 2006)

BENCHMARKING THOROUGH RANKING-SYSTEMS

Throughout the last decade a number of international standards – ranking systems for evaluation of sustainability and energy-efficiency of buildings emerged, based on different national aims and policies.
LEED, DGNB and Minergie Standards have been chosen for closer examination of used indicators and target values, because of their prevalence or increasing relevance for the Central and East European real estate market. Some of the indicators and target values will be adapted and used for the Building Performance Evaluation for *Univercity 2015*.

LEED: Leadership in Energy and Environmental Design is The United States Green Building Council’s rating system, “*a voluntary, consensus based national standard for developing high-performance, sustainable building*” (LEED, 2005) It is a point based system, with certification levels of Certified, Silver, Gold or Platinum. This standard has become the accepted standard for measuring “green” design in the United States, but also in the Arab Countries such as Emirates. It differentiates the project typologies into: New Construction, Existing Buildings, Operations and Maintenance, Core and Shell, Commercial Interiors, Schools, Healthcare, Retail, Homes and Neighbourhood Development.

New Construction Project Check List totals with 69 possible points (PP); and is structured as follows:

- Sustainable Sites 14 PP
- Water efficiency 5 PP
- Energy and Atmosphere 17 PP
- Materials and Resources 13 PP
- Indoor Environmental Quality 15 PP
- Innovation and Design Process 5 PP

DGNB is German Sustainable Building Council Certificate. It is a relatively new certificate from 2008, however its fundamentals are in much older Handbook for Sustainable Building dating from 2001 (BMVBW, 2001), where basic indicators and benchmarks have been set. This standard is adapted to the German and European building tradition and stands in narrow connection to the European Energy Certificate, obligatory from 2009.
The grading is in percentages, categorising in rankings:
Gold (from 80%), Silver 65 – 79,9%) and Bronze (50 – 64,9%).
For new construction and administrative buildings it is differentiated in (DGNB, 2008):

- Ecologic Quality 195 PP/Weighting 22,5%
- Economic Quality 50 PP/Weighting 22,5%
- Socio-cultural and Functional Quality 280 PP/Weighting 22,5%
- Technical Quality 100 PP/Weighting 22,5%
- Process Quality 230 PP/Weighting 10%
- Location separate evaluation!

Minergie is a Swiss concept; it is a registered trademark of Cantons Zurich and Bern. It supports rational energy consumption, use of renewable energies, life-quality improvement and reduction of emissions. The concept defines the performance goals through limiting of the weighted maximal supplied energy: set limit for new construction housing is
38 kWh/m²/year; for offices 40kWh/m²/year. Supply through fossil end-energy is differently weighted from renewable source. Even stricter energy consumption limits are set for Minergie-P (30 kWh/m²/year housing; 25 kWh/m²/year offices) or Minergie-P-ECO, which are based on passive house standard. (Minergie, 2008).

METHODS FOR SETTING OF PLANNING GOALS

The main problem with designing and planning of energy-efficient buildings is that the planning focus often exclusively lies upon the energy-saving targets, technologies and facilities. Often, many sacrifices are done in the course of planning process on account of building functionality, spatial and aesthetic quality, in order to keep up with the pre-set performance goals. Buildings as systems are more than large consumers of energy and resources –
modernist definition of building as a system of form-function-construction, expanded by the aspect of economy (monetary flows) reflects more precisely the importance of the built structures for society.
A **holistic building performance evaluation** (BPE) is based on the triangle of sustainability, where features of form, function and construction are analysed in their coherence with economic, ecologic and societal issues (Figure 1). Every energy-efficient building must still fulfil its primary function – providing of living or working space and function as such.

Therefore, a clear specification of processes and spatial requirements is necessary, next to the performance target definitions. Relatively new issue in dealing with design processes of sustainable buildings is the issue of the use of buildings in time. Through the internet and communication technologies and changed global economy, buildings are mutating in fast changing structures – a change in use of a building occurs up to three times throughout the lifecycle. British architect Frank Duffy describes: *"The unit of analysis...isn't the building, it's the use of the building through time. Time is the essence of real design problem"* (Brand, 1999). Time is represented through projected 3rd dimension in the cob-web diagram (point).

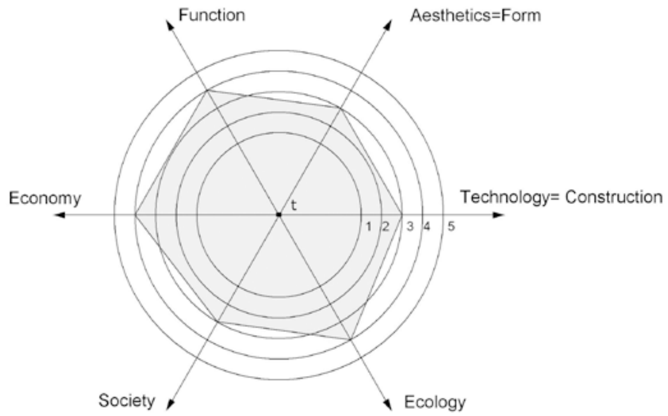

Figure 1: Cob-Web Diagram of holistic BPE (Kovacic, 2008)

Next to the BPE, as crucial method for performance goal-setting within integrated planning processes is participatory planning. This method involves maximum number of stakeholders and benefits from their expertise at project definition phase, which is especially important when setting sustainable design as target for projects serving to the community, such as *TU Univercity* is.

Analysis of requirements and needs of: users, researchers, municipal officials, citizens and local stakeholders, exploring consensus-based concepts on how a sustainable reconstruction might evolve, should be organised in a charrette – a growth plan reflecting the solicit input from community.

Another charrette should be held early in the process for planning team, supporting the integrated multidisciplinary collaboration. Included disciplines should involve at least: architects and engineers (construction, civil, mechanical, electrical and plumbing, environmentsl), client and their representatives, interior designer, cost consultant, users and other for the project relevant experts. Prior to this charrette, preliminary analysis carried out by individual participants should be done, consisting of:

site evaluation, massing studies, energy and day lightning analysis, development of cost model. (Mendler et all, 2006).

An early phases charrette supports interdisciplinary involvement of the planners, users and other stakeholders, their communication, contribution and commitment to the project.

STRATEGY FOR PLANNING OF ENERGY-EFFICIENT BUILDING

For potential redevelopment of the intended showcase energy-efficient building within the *Univercity 2015* a STRATEGY will be proposed.
The strategy is based on implementation of:

- Holistic building performance evaluation (BPE) through model of sustainability indicators (Kovacic, 2008)
- Worksheets for setting of planning objectives and measurable goals
- Development plan for integrated interdisciplinary process through workshops and charrette

Sustainability indicators model

A holistic BPE reflects the sustainability issues on the one side, and the modernist approach of form-function-construction on the other.
The BPE parameter-model is structured in three levels.
Primary level differentiates among three KEY ISSUES (Table 1):

- ecology,
- economy
- socio-cultural

aspects of building performance.

Each key issue is subdivided into planning OBJECTIVES, which again are described by sustainability INDICATORS on the third level.

KEY ISSUES ⇨
PLANNING OBJECTIVES ⇨
Indicators

Sustainability indicators reflect the ambivalent nature of a building, as the set of tangible and intangible characteristics. Therefore, some indicators are measurable through monitoring and benchmarking, some are immeasurable and to be evaluated through interviews/answers. Both tangibles and intangibles can be graded through means of scale-rating (1-5), resulting with a final absolute value of sustainability performance potential.

KEY ISSUES	PLANNING OBJECTIVES	INDICATORS
ECONOMY	Innitial Investment	Construction cost, Return of investment
	Following Costs (LCC)	Cleaning, Waste, Heating, Cooling, Electricity, Utilities, Inspection, Maintenance
	Functionallity	Fungibility, Flexibility, Economic Life Duration, Risk analysis
	Formal Criteria	Impact on econ. growth, Iconographic design, Corporate Identity, "Thematic identity"
	Construction/technolgy	Tech. Durability, Maintenance methods, Fire protection, Noise protection
	Econ. power and competetivness	Improvement of innovation, Technology transfer, Regional products, Recycled Materials, Certificates, Branch diversity, Business diversitiy, Corporate Awareness
ECOLOGY	Building Demand	Construction demand, Further use/optimisation of existing buildings possible?
	Land	Reduction of land consumption (Landrecycling), Reduction of land use for traffic, Reduction of sprawl, Integration in the landscape, Protection of green land, Maintenance of soli regeneration Reduction of excavation of materials
	Emission reduction	Reduction of: CO2 emissions, individual car traffic, AIR and SOIL pollutants, Noise and Light emissoins protection, Heath island effect prevention
	Water	Protection and care of ground water Rainwater use on the site Reduction of drinking water consumption
	Materials/Recycling	Durability of building elements, Dismantling possibilities Recycling of the building elements, Modular construction, Use of recycled materials, Regenerative/Regional/Emission-free building materials
	Energy Consumption	Primary energy consumption Energy-efficient construction Standards: Low-energy,Passive House, Plus Energy, Energy consumption for: heating, cooling, ventilation, lightning Integrated energy management system
	Waste Management	Cleaning Effort, Maintenance (Material flow) Sewage water/Conduct in ground Waste accumulation
SOCIO-CULTURAL	Urban Identity	Urban identity and quality, Architectural identity
	Equality	Equal rights for: disabled, minorities, gendermainstreaming, integration
	Fulfillment of individual needs	Provision of housing or working space, Acessibility of: infrastructure, of workplace, to public transport, bycicle comfort, Satisfactory regional life, Health: Interior climate, Comfort
	Social Stability	Protection of social stability (transgenerationliving, playgrounds), Communal communication/participation Balanced income, Stabilisation of public budget

Table 1: Holistic BPE with indicator-system (Kovacic, 2009)

Work sheets for Goal Definition

Each project dealing with sustainability and/or energy-efficiency should define an overall **Vision Statement**, in order for the planning team to be able commit to the common aim. Vision Statement is defined through a number of planning objectives, described in the **Work Sheets** (Figure 3), where the proposed goals, indicators and the applied metrics are defined.

PLANNING OBJECTIVE 1	ENERGY CONSUMPTION
Proposed Goal:	Minimize source energy consumption for building operations
Indicators:	Minimize energy consumption for building operations: heating, cooling, ventilation, lightning
Design objectives:	Reduce energy consumption compared to the best practice (BP) by 20% BP Energy consumption benchmarks: Heating < 15 kWh/m²year Cooling+Ventilation < 8,5 kWh/m²year Lightning< 8,0 kWh/m²year
Performance Metrics:	Energy consumption benchmarks: Heating kWh/m²year Cooling+Ventilation kWh/m²year Lightning kWh/m²year per Gross Floor area Percent Savings compared to Benchmarks

Figure 2: Work Sheet for goal definition (Kovacic, 2009)

Development Plan

The main planning objective of the *Univercity 2015* is the realisation of the maximum performance energy-efficient building. The building should reach the highest certificates through the ranking-systems and even outreach those; it is not a certain technology that should be specified, but performance aims and goals through integrated planning.
A **Development Plan**, based on a number of workshops and a charrette resulting with defined deliverables for specification of energy-efficiency objectives will be proposed (Figure 4),
Within the first workshop relevant planning objectives and indicators will be chosen from a holistic BPE indicator-model. For each proposed planning objective a **worksheet** with indicators and/or design objectives and performance metrics should be created.
In the course of the second workshop on hand of the worksheet-specifications the concepts for design, form, technology, construction and functional programme should be discussed. The individual preliminary-analysis tasks for each team-member (planner) will be specified, such as: site-analysis, formal concept, functional programme, simulation of cost-calculation resulting in a simulation of the **pre-design baseline model** (basic inputs of function, size and location). Finally, a charrette, a multi day event which continues the work of workshops in more detail will be launched. It is organised as a sequence of plenary work and design sessions with final open house presentation (Grünberger, 2008). The final outcome of the

charrette will be a **master plan**, with massing, functional programme, building orientation, and a base-line model proposing energy performance of the building and a cost model.

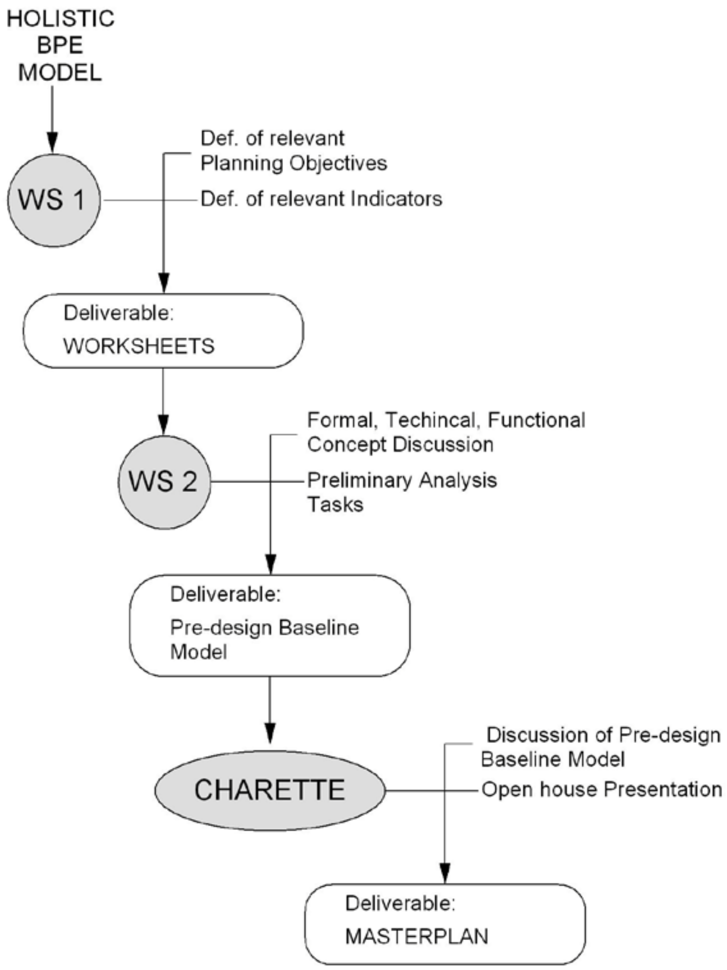

Figure 3: Development plan for integrated planning process (Kovacic, 2009)

CONCLUSION

The proposed strategy for the implementation of the maximum energy-efficiency for the redevelopment of *Univercity 2015* project could not have been implemented yet.

The immediate cause for the postponement of the *Univercity 2015* project was the disability of the owners and investors (being users) to negotiate financing and leasing models, partly due to the lack of transparency of the planning aims and contracting models, resulting in scepticism towards the cost of new technologies and their later economic performance. This circumstance supports the hypothesis of role of investors as major determinant in realisation of energy-efficient buildings.

As underlying causes the lack of the assigned project management and of the integrated planning process-knowledge can be identified. The tasks of Vision Statement and measurable performance goals definition should have been assigned to the clearly appointed project management as the first planning step, which was not the case.

The early definition of clear planning aims enables more accurate cost estimation and contracting transparency for investors, proprietors and facility managers in preparation of financing construction and change management, which is especially important when planning energy-efficient buildings that are often cost intensive in primary investment through their innovative character.
The interdisciplinary team was not able to make progress in planning process, since they lacked the contracted assignment, defining aims and non-aims, process-definition and accorded communication.

It can be concluded that *Univercity 2015* project offers large innovation potential for ”whole” building design through:

- gathering of large amount of LC-data (knowledge),
- development of new models for LC-oriented planning
- optimisation of building performance through knowledge-transfer from planning into operation.

Integrated, interdisciplinary planning requires a high level of organized, educated, very intense and in front of all transparent communication, that still needs to be learned amongst the profession.

REFERENCES

Achammer, C. (2008) , Neue Prozesse des Planens und Bauens für nachhaltige Gebäude, Vienna, Ökosoziale Forum, in: "Klimaschutz konkret: Büro- und Gewerbegebäude"

BMVBW Bundesamt für Bauwesen und Raumordnung, (Publisher) (2001),
Leitfaden für Nachhaltiges Bauen, Technical Report

Brand S. (1994), How buildings learn, USA: Penguin Books USA, pg. 13

DGNB (2008), „Das Deutsche Gütesiegel Nachhaltiges Bauen: Aufbau-Anwendung-Kriterien“, available at: http://www.dgnb.de/

Gauzin-Müller D. (2002), Nachhaltigkeit in Architektur und Städtebau, Basel-Berlin-Boston: Birkhäuser, pg. 99

Grünberger S. (2008), Sustainable Urban Planning in Canada, Technical Report, Vienna University of Technology

Intrachooto S., Horayankura V. (2005); Energy efficient innovation: Overcoming financial barriers, Building and Environment 24 (2007) 599-604

Kovacic I. (2008), Developing Strategies for Sustainable Planning: Building Performance Evaluation in Terms of Sustainability, Saarbrücken: Verlag Dr. Müller

LEED (2005), “LEED® for New Construction & Major Renovations”, available at: www.usgbc.org/leed

Mendler S., Odell, W., Lazarus M.A. (2006), The HOK Guidebook to Sustainable Design USA: John Wiley and Sons

Minergie (2008), available at: http://www.minergie.ch/

Penna W., Parshall S. (2001), Problem seeking: an architectural programming primer, USA: John Wiley and Sons

Torcellini P., Pless S., Deru M., Griffith B., Long N., Judkoff R. (2006), Lessons learns from Case Studies of Six High-Performance Buildings, Technical Report, Golden, Colorado, USA: National Renewable Energy Laboratory

ENVIRONMENTAL CRITERIA IN PUBLIC PROCUREMENT OF CONSTRUCTION WORK IN PORTUGAL

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The construction, use, maintenance and demolition of a country's infrastructures consumes energy, natural resources, produces unacceptable noise, emission, waste and traffic on a large scale. Building more intelligently, efficiently and respectfully begins with the procurement phase. The new EU and national procurement directives offer various possibilities for integrating environmental considerations into public procurement, namely in the technical specifications, selection and award criteria. Integrating environmental criteria in the procurement of construction goods and services is essential for improving the environmental performance of the construction sector. Presently, the award of public contracts can be based on the "most advantageous tender" criteria that entail various pondering factors such as quality, price, technical merit, aesthetic and functional characteristics, running costs, period of completion, etc. This paper presents the results obtained from a research carried out aimed at identifying environmental criteria used in contract notices for construction work in Portugal. The research revealed that very few types and clear criteria are used and that the contracting authorities that consider green criteria in contract notices always seem to be the same ones.

KEYWORDS: sustainable, construction, procurement, criteria.

INTRODUCTION

Steps to promote sustainable development have gradually been taken by governments worldwide. This action has been motivated by the fact that in the last decades, specially in developed countries, societies have adopted a standard model of development that privileges the immediate well-being without considering the social, environmental, energetic and economic sustainability. The recent signs of unsustainability have made it clear that this conventional model will have to be reformulated (MOPTC, 2007).

In Europe, for instance, the primary objective of the European Commission (EC) is to promote the integration of sustainable development with policies that foster the European Union's (EU) competitiveness (EC, 2008_a). One of the most recent action plan adopted was the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) that intends to tackle a broad range of environmental challenges by boosting demand for resource-efficient and manufacturing of eco-friendly products at a larger scale, so that such products become cheaper and mainstream production. It also aims at encouraging the industry to invest in eco-design, resource-efficiency and eco-innovation, that is to say the markets of the future, including eco-technologies and environmental industries (EC, 2008_a, EC, 2008$_b$). Environmental industries are those industries that provide solutions for measuring, preventing and correcting environmental damage to water, air and soil, and for problems such as waste, noise, and damage to eco-systems. They include sectors such as waste and waste water management, renewable energy sources, environmental consulting, air pollution, and eco-construction. The global market for environmental industries was estimated to be €1000 billion in 2005 and could reach €2200 billion in 2020 (EC, 2008$_c$).

Construction sector

The construction sector can seriously contribute to sustainable development as it is a sector of high relevance in terms of economic, social and environmental responsibilities. At the economic level, construction activities represent major investments and demand large quantities of resources (labour, materials and plant resources). At the social level, the sector has a huge impact on the quality of the built environment as well as on working and living conditions (for instance health and safety risks on work sites and for building occupants). By being more socially sustainable, the construction sector can improve the living context and the relationship between citizens and their environment; contribute effectively towards social cohesion and job creation and the promotion of cultural tourism and regional economic development (EC, 2001). Finally, this sector impacts the environment with emissions of harmful substances that pollute the air, land and water; energy consumption, resource consumption and waste generation which represent a major contribution to climate change, resource depletion and pollution at a global scale; noise disturbance from machinery and transport of material by heavy vehicles influencing local communities and eco-systems.

Fortunately, Sustainable Construction has been identified by the EC in the Lead Market Initiative as one of the six markets[1] with potential in becoming a Lead Market (EC, 2007$_a$). The initiative calls for urgent and coordinated action plans for these markets to rapidly bring visible advantage for Europe's economy and consumers (EC, 2007$_b$). Furthermore, it has identified Public Procurement[2] as an instruments that can help foster the Construction Lead Market. In other words, a more environmentally sustainable construction can be pursued through Green Public Procurement.

Green Public Procurement

Green Public Procurement (GPP) can be defined as the approach by which contracting authorities integrate environmental criteria into all stages of the procurement process, thus encouraging the spread of environmental technologies and the development of environmentally sound products, by seeking and choosing outcomes and solutions that have the least possible impact on the environment throughout their whole life-cycle (TAKE5, 2006).

The first initiatives promoting GPP were studies that assessed the level of GPP across Europe, identified environmental criteria best practice examples, prepared recommendations and guidelines for integrating environmental considerations into public procurement practices and disseminated readily usable criteria. These studies included: Buying Green handbook on environmental public procurement published by the EC in 2004; Procura+ Manual - A Guide to Cost-effective Sustainable Public Procurement produce by the Procura+ campaign

[1] The six markets which have been identified for the initial stage of the Initiative are eHealth, protective textiles, sustainable construction, recycling, bio-based products and renewable energies.
[2] Other policy instruments include: legislation, standardisation, labelling and certification.

coordinated by the International Council for Local Environmental Initiatives (ICLEI); Green Public Procurement Network (GPPnet, 2002-2004) funded by the EC within the LIFE Environment programme framework; Local Environmental Management Systems and Procurement (LEAP, 2003-2006) funded by the EC within the LIFE Environment programme framework; Greening Public Procurement in Mediterranean Local Authorities project (GreenMed, 2003-2006) funded by the LIFE Environment III programme and the Green Public Procurement in Europe (Take-5 Consortium Project, 2004-2006), financed by the European Commission's Directorate-General for the Environment (DG-ENV).

Benefits, barriers and overcoming barriers

Applying GPP has a number of benefits. For instance, energy, water and resource efficient products, services and buildings can significantly reduce utility bills and operating costs. The procurement of environmentally preferable products can lower waste management fees, and reduce spending on pollution prevention. Contracting green electricity or using low-emission buses and fleet cars can improve local air quality and help achieve climate protection targets (EC, 2004$_a$; EUROCITIES, 2005; EC, 2007$_c$; ICLEI, 2007$_a$). Public authorities can implement strategies to motivate various economic sectors to develop new technologies and innovative products. They can also encourage suppliers, service providers and contractors to gain perspective on the advantages of green contracts (PLMJ, 2007; RCM, 2007). Moreover, the promotion of greener products and benefits of green procurement facilitates environmental awareness within the various sectors.

Unfortunately, barriers to GPP do exist. These include for instance, low awareness of the importance of GPP; lack of management support (including money and time), strategic focus and organisational policy strongly promoting GPP; lack of general political support in the country, province or municipality; lack of interest from procurement department/teams; lack of knowledge about the environmental impact of goods/services; lack of knowledge on how to develop environmental criteria; lack of training, lack of technical and legal expertise to apply sustainable procurement standards; lack of practical tools and information (e.g. handbooks, internet-tools); perception that environmentally friendlier products would be more expensive, i.e higher initial investments and tight budgets; perception that environmentally friendlier products would not be readily available; perception that legislation is not clear about taking into account environmental criteria; concerns about legality of green public procurement (TAKE5, 2005; GREENMED, 2005; TAKE5, 2006; EC, 2007$_c$; EC, 2007$_d$).

National Procurement Legislation

Currently, the most important legal document concerning public procurement in Portugal is Decree-Law nº 18/2008 of 29th January 2008 that approves the new National Public Procurement Code (NPPC)[3]. This new code regulates the preparation and implementation of public contracts by defining all the procedures and elements necessary to carry out a contract for services, goods and works procured (DL 18.2008).

[3] In PT: *Código de Contratos Públicos* (came into force on the 30th July 2008). Transposes the European Directives for Public Procurement 2004/17/EC and 2004/18/EC both adopted on the 31st March 2004.
Adjacent Decrees linked to this Decree-law and published so far include: Decree-law nº. 143-A/2008 of 25th July 2008; Decrees nº. 701-A/2008; 701-B/2008; 701-C/2008; 701-D/2008; 701-E/2008; 701-F/2008; 701-G/2008; 701-H/2008; 701-I/2008 and 701-J/2008 of 29th July 2008 and Official Communication Standard n.º 35-A/2008 of 29th July 2008.

Furthermore, it is an important implementation instrument of the National Strategy for Green Public Procurement 2008-2010 (NS-GPP) approved by the Resolution of the Council of Ministers nº 65/2007 of 7th May 2007. This strategy constitutes the guiding document of the National Public Procurement System [4] managed by the National Agency for Public Procurement (ANCP)[5]. It aims at encouraging public entities to implement environmental purchasing practices by incorporating green criteria into their public procurement procedures, and thus contributing to the Sustainable Development Strategy.

Green Criteria

Contracts are awarded on the basis of the award criteria, after the suitability of tenderers (personal and professional situation of the tenderer) has been verified in accordance with the economic/financial and technical capacity criteria (selection criteria) indicated by the contracting authority. Linked to the aims of the contract, the nature of these criteria are the corner stone of the tender programme which makes their description and publication of undisputable importance for both the contracting authority and the tenderers (DL 18.2008). Contracting authorities should define the criteria in a clear and precise manner enabling the submission of appropriate tenders (the tenderers outline their strategy and present their bid arguments based on these criteria). On the other hand, non-discriminatory and transparent criteria substantiate a fair and effective tender evaluation procedure and a successful contract award based on the 'most economically advantageous' bid.

Accordingly, the NPPC aims for: (i) criteria and sub-criteria and their weightings be expressed and publicised according to the principals of equal treatment, competition, fairness, adequacy, transparency, publicity and good will (parameters that dominate the legal requirements of procurement procedures); (ii) these principles be assured throughout the tender evaluation procedure, including prior and subsequent procedures.

Aims

Given that the European Directives and the new National Code for Public Procurement recommend that environmental issues be considered throughout the public procurement procedure, specially in the technical specifications, selection and award criteria (duly publicised), this paper reports the results obtained from a research carried out aimed at identifying environmental criteria used in contract notices for construction work in Portugal. The research was carried out according to the methodology described below.

METHODOLOGY

Green criteria (selection and award) in Contract Notices (CN) regarding construction work in Portugal have been measured by consulting the electronic CN on the Government Internet Portal for Public Procurement (http://compras.gov.pt) which accesses the data-base of the Electronic Official Gazette (DRE[6]) (http://dre.pt).

[4] In PT: *Sistema Nacional de Compras Públicas* (SNCP), as stipulated in Decree-Law nº 37/2007 of 19th February 2007.
[5] In PT: *Agência Nacional de Compras Públicas, E. P. E.* (ANCP) approved by Decree-Law nº 37/2007 of 19th February 2007.
[6] In PT: *Diário da República Electrónico* (governmental internet portal).

To search for these specific CN, each Official Gazette (DR[7]), from 1st January 2006 to 31st March 2008 was accessed. The first step consisted in measuring the number of CN regarding construction work in the DR nº 1 of 2006. This was done by selecting "construction" in the CPV Code section and by introducing 2006 in the year section of the advanced search tool panel (results in the third column of Table 1).

Table 1: Sample of the table used for collecting data in 2006.

Date	Nº DRE	Nº of CN concerning "construction work"	Nº of CN with "ambient" (possible green criteria)	Nº of CN with valid green criteria
02-01-2006	1	4	0	0
n…..	…..	…..	…..	…..
29-12-2006	249	8	1	0

The number of CN regarding construction work with green criteria were then measured by introducing pre-selected keywords regarding environmental issues (e.g environment, environmental management, etc) into the advanced search panel. As a result the website would deliver all the CN that have been categorized in its database as "construction" and containing the word "environment" (to be precise, in PT: "ambient" for ambiente or ambiental). These CN were classified as 'possibly' green (results in the fourth and fifth column of Table 1) and downloaded to thoroughly check for "valid" green criteria (summarised in Tables 2 and 3). A total of 379 'possible' Green Contract Notices (GCN) were analysed (182 CN in 2006, 148 CN in 2007 and 49 CN in 2008). These steps were repeated for every gazette up to DR nº 63 of 31st March 2008 and the overall assessment constitutes a 27 month (or 9 trimesters) database of gathered information.

Some CN were dismissed during the assessment due to the fact that the word "environment" was part of a name of an Entity or Division, for instance, *Urbanism and Environment Division of a City Council*. An additional CN was also put aside as it mentioned the implementation of an Environmental Management System (under the heading 'Quantity or Scope of the Contract') but did not mention the criteria that would be used to consider or evaluate such system.

Special attention was also given to the Common Procurement Vocabulary (CPV) [8] in order to verify if work contracts were actually being dealt with. Examples of CPV for work contracts include 45000000, 45100000, 45200000. Strangely enough, during the search for construction work CN, the online governmental portal supplied a small cluster of CN regarding medical equipment. These CN were immediately put aside and none appeared during the assessment of the downloaded CN.

[7] In PT: *Diário da República*

[8] Commission Regulation (EC) Nº 2151/2003 of 16th December 2003 amending Regulation (EC) nº 2195/2002 of the European Parliament and of the Council on the Common Procurement Vocabulary (CPV). The CPV establishes a single classification system for public procurement aimed at standardising the references used by contracting authorities and entities to describe the subject of procurement contracts.

In addition to the search for selection and award criteria, attention was also given to the titles of the Contract Notices to see if any "green" titles were used. Unfortunately, no green title was found. Moreover, some titles lack transparency and don't reflect the actual objective of the contract notice. For instance, some titles would suggest a work contract when in reality they turned out to be a supply contract. Some titles would merely be a code, for example, "Process xxxx/2007".

RESULTS

The green selection criteria for qualifying tenderers are usually found in the 'Conditions for Participation: Technical Capacity sub-section'. Table 3 summarizes the type of green selection criteria found in CN for construction work in Portugal. Green selection criteria were found in 40 CN (18 CN had only green selection criteria while the other 22 CN had both green selection and green award criteria). Requests were mainly for documental proof of the environmental certification of the tenderer and proof of academic and professional qualifications of the person responsible for dealing with the environmental issues of the construction work being procured.

Table 2: Green selection criteria found in the Conditions for Participation Section in 40 CN (PIRES, 2008).

Nº of CN (Total 40)	Description of the green selection criteria found in Contract Notices
24	Proof of academic and professional qualifications of person responsible for implementing / coordinating the Environmental Management System of the construction work. (Some CN would be more specific and ask for proof of technical qualifications in the area of Environmental Engineering or Specialist with more than five years experience in Environmental Management).
12	Proof of technical and professional qualifications of person responsible for the environmental function with the minimum competencies stipulated in the tender dossier. (Some CN would be more specific and ask for a Graduate in Engineering with minimum two years confirmed experience in environmental management of similar construction work in terms of complexity and size).
2	Documental proof emitted by an independent body that officially recognizes the environmental certification of the tenderer. If the tenderer does not possess certification by an independent body, statements on how the applicable legislation will be fulfilled must be provided.
2	Tenderers must prove their professional and technical capacity by providing the documents listed in the tender dossier as well as fulfilling the terms of the following criteria: Possess a Graduate in Civil Engineering, Environmental Engineering or in Sanitary Engineering, or other graduate engineering course with a Post-graduate Course in Sanitary Engineering and with a minimum five years confirmed professional experience in construction management.

Table 3 summarizes the type of green award criteria found in CN for construction work in Portugal. Unfortunately, it was impossible to measure the exact weight given to the green award criteria. Most of the time the environmental aspect of the work procured is grouped with other aspects, namely, Health & Safety and Quality aspects which makes the real percentage value of just the environmental issue unclear.

Table 3: Types of Green Award Criteria and weightings (PIRES, 2008).

Main Non-price Criteria		Sub-criteria		% Final Weighting Non-price Criteria	% Final Weighting (Price & Non-price Criteria)	Nº CN (46 total)
Description	%	Description	%			
Guarantee of good execution	: 45% : 50% : 60%	Proposed methodology for Health & Safety Management System, Environmental Management System, Quality Management System	10%	: 22,22% : 20,00% : 16,67%	: 10%	4
	: 25%	Environmental Management System	6%	: 6%	: 1,5%	1
	: 30%	Health & Safety Management / Quality Management System / Environmental Management Manual	15%	: 15%	: 4,5%	2
	: 35%	Environmental Management Manual	5%	: 14,3%	: 5%	2
	: 40%	Risk Analysis, Health & Safety Prevention and Environmental Protection Analysis	25%	: 25%	: 10%	1
Technical Value	: 35% : 45% : 50%	Environmental Management System	5%	: 5%	: 1,75% : 2,25% : 2,5%	6
	: 50%	Environmental Management (Compilation of the environmental documental system; Environmental Management Preliminary Programme).	5%	: 10%	: 5%	21
	: 25%	Environmental Management System	2,5%	: 10%	: 2,5%	1
	: 25%	Environmental Management System	10%	: 10%	: 2,5%	2
	: 40%	Quality, Safety and Environmental Management System	10%	: 25%	: 10%	1
Technical Quality of the tender and Safety, Quality and Environmental Management System	: 40% : 50%	Technical Quality of the tender and Safety, Quality and Environmental Management System			: 40% : 50%	4
	: 50%	Technical note on the Environmental Management of the construction work	10%	: 10%	: 5%	1

From the 1433 construction work CN made available in the 249 gazettes published in 2006, only 40 CN presented valid green criteria (which represent 2,79% of GCN). Five CN presented only 'selection criteria', 13 only presented 'award criteria' and 22 had both 'selection and award criteria'. Seven CN were for 'Design and Build' and 33 were for 'Build' of construction work. The results of 2007 and the first trimester of 2008 may be found in Table 4.

Table 4: Assessment results (PIRES, 2008).

Year	Nº DR	Total Nº of CN (construction work)	Nº CN with valid green criteria				Type construction Work (Open Proc.)	
			Total GCN	Selection	Award	Selection & award	Build	Design-Build
2006	249	1433	40	5	13	22	33	7
2007	365	1369	22* (18)	9	9	0	15	3
2008 (until 31/03)	91	525	6	4	2	0	3	3
Total	705	3327	68* (64)	18	24	22	51	13

*The 68 green contract notices found were 'Open Procedures' except for four CN found in 2007 regarding 'Restricted' procedures. These four represented the same contracting authority for the same project (competition for four different sections of the project). The only criteria present in these CN regarded the selection of the limited number of candidates: Environmental Management Coordinator (weight 2,5%). No environmental concerns were present in the Award Criteria (Technical value (weight 25%) and Price (weight 75%)).

A total of 64 CN containing environmental issues were found. All CN concerned construction work contracts using 'Open Procedures' where 51 CN were for 'Build' contracts and 13 CN were for 'Design & Build' contracts. The average estimate value of the database is 6.567.807 €, the minimum estimate value is 145.000 € and the maximum estimate value is 120.000.000 €.

Furthermore, only twelve contracting authorities seemed concerned with greening their procurement. One contracting authority was responsible for 32,8% of the results (and another was responsible for 18,8%). In addition, only 7 CN stated that variants were allowed (one CN in 2006, five CN in 2007 and one CN in 2008).

CONCLUSIONS

From the results of the research, it may be concluded that very few types and clear criteria are used. The green selection criteria for qualifying tenderers were mainly for documental proof of the environmental certification of the tenderer and proof of academic and professional qualifications of the person responsible for dealing with the environmental issues of the construction work being procured. As for the green award criteria, only one aspect was covered: the Environmental Management System to be adopted by the tendering contractor.

Furthermore, the contracting authorities that consider green criteria in contract notices seem to be always the same ones. The selection and award criteria found are quite similar due to the fact that two of the main contracting authorities are responsible for more than half of the results. Additionally, these criteria only apply to construction work with a certain dimension that cause environmental impacts that require qualified personnel to manage the environmental issues of the work being procured. Smaller construction projects do not need an environmental expert onsite or an environmental impact assessment.

The lack of precise and transparent criteria (including weightings) was found to be unacceptable as the principles of transparency, non-discrimination and equal treatment depicted in national and international legislation concerning public procurement are not fulfilled. Consequently, the large majority of the contract notices were dismissed because the award criteria were not specified. Instead, the contract notices would state that the criteria 'are those specified in the programme and in the specifications' which does not meet the principle of transparency. Most of the time, the environmental aspect of the work procured is grouped with other aspects, namely, Health & Safety and Quality aspects which makes the real percentage value of just the environmental issue unclear. Therefore, measuring the green award criteria in the contract notices also proved to be a difficult task.

REFERENCES

DL (18.2008) Decree-law n. 18/2008, approves the New Portuguese Public Procurement Code (Código de Contratos Públicos, 29th January 2008.

EC (2001) Competitiveness of the construction industry. An agenda for Sustainable Construction in Europe, 20th May 2001, Brussels. Accessed 25th January 2007 at European Commission: < http://ec.europa.eu/enterprise/construction/compcom/comp com.htm >.

EC (2004_a) Buying green! A handbook on environmental public procurement, ISBN 92-894-8117-x. Luxembourg. European Commission's Handbook on Environmental Public Procurement SEC(2004)1050, August 2004. Accessed 28th January 2007 at European Commission: < http://ec.europa.eu/environment/gpp/guideline_en.htm >.

EC (2004_b) Directive 2004/18/EC of the European Parliament and of the Council of 31st March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

EC (2007_a) LMI Lead Market Initiative for Europe, COM(2007)860final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, Brussels, 21st December 2007

EC (2007_b) Lead Market Initiative for Europe, COM(2007) 860final, {SEC(2007) 1729}, {SEC(2007) 1730}, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, Brussels, 21st December 2007. Accessed 14th June 2008 at European Commission: < http://ec.europa.eu/enterprise/leadmarket/doc/com_07_en.pdf >.

EC (2007_c) Green Public Procurement. Accessed 3rd September 2007 at European Commission: < http://ec.europa.eu/environment/gpp /index_en.htm>.

EC (2007_d) Accelerating the Development of the Sustainable Construction Market in Europe. Report of the taskforce on Sustainable Construction. Composed in preparation of the Communication "A Lead Market Initiative for Europe", COM(2007) 860 final, 21st December 2007. Accessed 14th June at European Commission: < http://ec.europa.eu/enterprise/lead market/doc/sustainableconstruction_final.pdf >.

EC (2008a) Sustainable Industrial Policy. Accessed 1st August 2008 at European Commission: < http://ec.europa.eu/enterprise/environment/index_en.htm >.

EC (2008_b) Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, COM(2008)397/3, {SEC(2008)2110}, {SEC(2008)2111}, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, Brussels, 16th July 2008.

EC (2008_c) Action Plan for sustainable consumption, production and industry, MEMO/08/507, Brussels, 16th July 2008. Accessed 1st August 2008 at European Commission: < http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/507 >.

EUROCITIES (2005) Responsible Procurement – Green Procurement. CARPE Cities as Responsible Purchasers in Europe. Accessed 28th June 2007 at Eurocities: < http://www.eurocities.org/carpe-net/site/article.php?id_article=28 >.

GREENMED (2005) Green Public Procurement Report. Green Public Procurement in Greece and in Portugal. Version 2.0, March 2005. Project LIFE 03/ENV/GR/000221, GreenMed: Greening Public Procurement in Mediterranean Local Authorities, 2003-2006. Accessed 7th May 2007 at GREENMed: < http://www.greenmed.net >.

MOPTC (2007) Construção sustentável: desafios para a indústria, Ministro das Obras Públicas, Transportes e Comunicações, Communication of 14th September 2007. Accessed on the 1st August 2008 at Portal do Governo: < http://www.portugal.gov.pt >.

PLMJ (2007) Nota Informativa: Estratégia Nacional para as compras Públicas Ecológicas 2008-2010, 14th May 2007. Accessed 23rd January 2008 at PLMJ Sociedade dos Advogados: <http://plmj.com/xms/files/newsletters/2007/ESTRATEGIA_NACIONAL_PARA_AS_COM PRAS_ PUBLICAS_ECOLOGICAS_(2).pdf >.

RCM (2007) Resolution of the Council of Ministers nº 65/2007 of 7th May 2007 that approves the National Strategy for Green Public Procurement 2008-2010 (Estratégia Nacional para as Compras Públicas Ecológicas 2008-2010).

PIRES B. R. (2008) Environmental criteria in public procurement of construction work in Portugal. Master Thesis, University of Minho, Portugal

TAKE5 (2005) Green Public Procurement in Europe 2005 - Status overview. Take-5 Consortium – Bouwer M. et al, Netherlands. Accessed 1st April 2007 at European Commission: http://europa.eu.int/comm/environment/gpp/media.htm#state.

TAKE5 (2006) Green Public Procurement in Europe 2006 - Conclusions and recommendations. Take-5 Consortium – Bouwer M. et al, Netherlands. Accessed 1st April 2007 at European Commission: < http://europa.eu.int/comm/environment/gpp/media.htm# state >; < http://www.gpp-europe.net/GPPdata/ >.

RIJEKA’S TORPEDO LAUNCH PAD STATION PRESERVATION

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From the middle of 19th century till the middle of 20th century Rijeka’s industrial developments were known world wide. One such unique and genuine development for sure is a torpedo. Every torpedo had to pass very difficult testing processes therefore it was necessary to build such facility which enabled simulation of all launch positions. Today, Torpedo launch pad station facility has attribute of cultural good although is rather devastated. Consequently, this paper will give an overview of what should have been done and was not, and an overview of what is being done to salvage and preserve such an important and unique monument of technological activities of Rijeka and its citizens that endures time.

KEYWORDS: industrial heritage, maintenance management, preservation, reuse.

INTRODUCTION

City of Rijeka is situated on the shore of Kvarner bay, the northernmost part of Adriatic Sea, where the Mediterranean is closest to the countries of middle Europe. As being in background of Kvarner, Dinaric Alps are at lowest altitude therefore is the easiest crossover from sea side deeper into land towards European countries. Good geographical position of Rijeka provided good communication post, which was first noticed by Romans and Greeks, and can be found in charts of famous chart maker Claudius Ptolemaeus.

Industrial developments in Rijeka are strictly connected with developments which followed the Industrial Revolution such as development of steam engine. In the late years of 19th century town grew rapidly and good geo-communication position helped Rijeka to become industrial centre and important sea port of that time.

One of many technical and technological developments of that time for sure is torpedo. Torpedo idea was born and developed in Rijeka. When the retired officer of Austrian Marine Artillery captain Giovanni Luppis returned to his home town Fiume (Rijeka) he tried to achieve his many years evolved idea of “Salvacoste” (Coast saver), a new long distance self remote navy weapon. As captain Luppis had no technical knowledge as well as resources for development and improvement of his idea, introduction to Robert Whitehead made him one step closer to its fulfilment. Robert Whitehead was British machine engineer and manager of the local factory and iron foundry in Rijeka. He developed Luppis’ idea and made completely new product called torpedo which was the most advanced navy weapon of that time. From the middle of 19th century till the middle of 20th century the highest class torpedoes were designed, build and tested in Rijeka. According to the factory's available documents during that period of time there were build 20.383 torpedoes, 1.053 launch tubes and 1.368 high pressure compressors. Before explosive filling and final use, every torpedo had to pass very difficult testing processes which included launch of every torpedo at least four times. For such complex testing processes facility for launching torpedoes logically arises as necessary. Torpedo launch pad station in Rijeka was and is first facility of such kind.

Torpedo launch pad station

Torpedo launch pad station was used for torpedo final testing purposes and became crown achievement of this revolutionary invention. Facility was used for torpedo launching in order to test horizontal and vertical movements and adequate redesign if necessary. Facility provided simulation of torpedo launching below, from and/or above sea level.

Launch pad station in Rijeka was conducted in two phases. First phase started at 1929 when the eastern part of this facility was build. In the period from 1936 till 1945 the western part was build and the whole facility took the shape which we know today. Facility stayed in use until 1966, when factory sold torpedo construction rights to other factories around the world.

Building of launch pad station was made of reinforced concrete, steel, stone, wood and glass. Whole bearing structure was made of reinforced concrete and steel, while wall fillings and facade walls were made of stone blocks and hollow bricks with vertical cavities in combination with glass. Roof structure was made of wood. On the south side of the roof structure was constructed wooden observation post which was enhanced in relation to remaining roof structure. Torpedo launch pad station main parts are shown on Figures 1 and 2:

1 – passage between factory and launch pad station,
2 – access to the launch tubes,
3 – movable launch tubes,
4 – derricks,
5 – observation post.

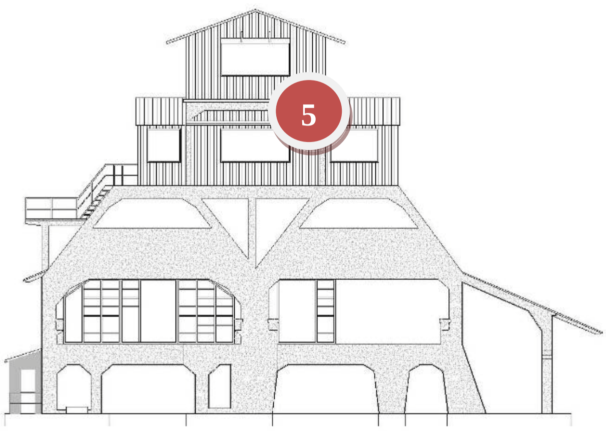

Figure 1: South facade of torpedo launch pad station

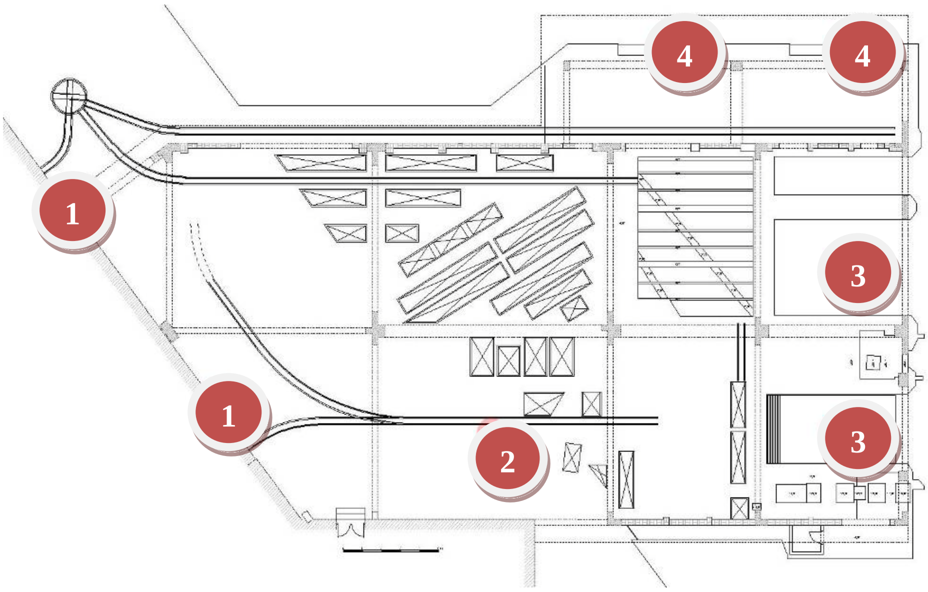

Figure 2: Torpedo launch pad station ground plan

Figure 1 gives an overview of the facility from position of working platform upwards. Foundations are not shown. Facility was founded in very specific conditions; partly on shore and partly on piles and piers in the sea. Most part of the facility lies just above the sea level. The average sea depth in the area of launch pad station is ten meters.

Present state of facility

Today, Torpedo launch pad station is rather devastated. All structural elements experienced specific amount of damage. Considering proportion and type of reinforced concrete structural damage, rehabilitation can be performed by structural elements reparation or their complete removal and production of new elements exactly the same dimensions. It is of great importance to act quickly because of the years of none maintenance will lead this unique facility to structural collapse (Marović, Završki, Car-Pušić, 2009).

Figures 3 to 5 present the general state of Torpedo launch pad station today.

Figure 3: East view of the facility

Figure 4: West view of the facility

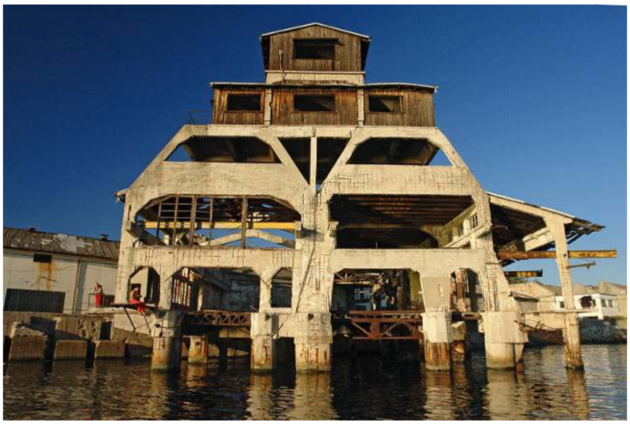

Figure 5: South view of the facility

In the present maritime conditions the steel reinforcement in the concrete structure has been subject to corrosion induced by chloride ions which caused progressive decay of the reinforced concrete structure during such long period of time. The harmful effects of corrosion can be seen in the reduction of the effective cross-sectional area of the reinforcement bars and their ductility, longitudinal fracturing and flaking of the concrete protection, the loss of adhesion between the concrete and the reinforcement.

Conducted examination of facility

Engineering methodology of estimating the current condition of structure was used, which included studying the existing documentation, visual inspection of the structure, field and laboratory testing on specimens taken from the structure, preliminary classification of damage and calculation of residual bearing capacity (Bjelanović et al, 2007; Grandić et al, 2008).

The aim of laboratory tests was to define the condition of structure materials, which included material properties of the concrete and the corroded reinforcement, permeability of the concrete as well as the amount of chloride ions in the concrete in order to estimate influence of its age and the effect of aggressive maritime environment to general durability of the facility. In his work Kovačević (2007) gave the results of laboratory tests detail damage classification of main structural elements of Torpedo launch pad station.

Reinforced concrete elements, due to corrosion overgrow, cast out protective concrete layer making the reinforcing bars directly exposed to impacts of surroundings especially under the working platform. Concrete construction framework which use to be a support for entire roof truss and derrick girders, cast out protective concrete layer because reinforcement is well saturated with sea salt chlorides. Most damaged frames of this facility are positioned in the middle of the construction near the shore boundary where the load is most significant.

Regarding the type and quantity of structural element damage, it is possible to approach the rehabilitation of facility by reparation and/or substitution of damaged structural elements. Table 1 gives an overview of reparation and/or substitution proportion of certain element groups divided into west and east part of the facility (see Fig. 5: west part – left, east part – right).

Impact of sea salt chlorides penetration into concrete elements can be seen on Figure 6 and 7, while the power of sea waves can be seen on Figure 8 and 9.

Figure 6: Working platform (front facade detail)

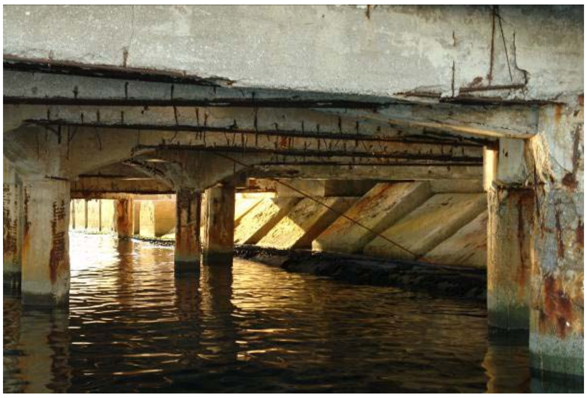

Figure 7 : Working platform (shore boundary detail)

Figure 8: Working platform (inside facility)

Figure 9: Damaged pier (cavitation impact)

There is no constructive element which wasn't damaged due reinforcement corrosion. On most structural elements major part of reinforcement cross-section has been partly corroded, while on some other parts the reinforcement is completely corroded and missing. Most damaged frames are positioned in the middle of the construction near the shore boundary where the load is most significant. Whole construction is exposed to extreme loading conditions (wind pressure and breaking waves) during south and south-east winds called Oštro and Jugo (Marović, Završki, Car-Pušić, 2009). Especially jeopardized and very high risk zones are concrete beam supports where the lack of mechanical connection can cause the collapse of facility.

Table 1: Overview of the reconstruction work

Structural elements	West part		East part	
	Reparation [%]	Substitution [%]	Reparation [%]	Substitution [%]
Frame columns in axis 1-1	50	50	25	75
Frame beams in axis 1-1	30	70	50	50
Frame columns in axis 2-2	40	60	0	100
Frame beams in axis 2-2	100	0	100	0
Frame columns in axis 3-3	0	100	100	0
Frame beams in axis 3-3	0	100	100	0
Frame columns in axis 4-4	50	50	0	100
Frame beams in axis 4-4	100	0	0	100
Frame columns in axis 5-5	100	0	100	0
Frame beams in axis 5-5	100	0	100	0
Reinforced c oncrete c onstruction in working platform level	80	20	80	20
Reinforced c oncrete c onstruction under working platform level	70	30	70	30
Longitudinal beams	100	0	100	0

Maintenance and reuse of facility

Results of Bjelanović (2007), Grandić (2008) and Kovačević (2007) inspection of the Torpedo launch pad station show that the facility is in bad shape. All structural elements experienced some specific amount of damage (see Table 1). Facility was not used for the last four decades and because of unsolved legal asset relationships, maintenance of Torpedo launch pad station in Rijeka was neglected for years. Today, facility requires complete reconstruction, but first there has to be an idea of exploitation of facility as well as facilities surroundings.

So far there were few initiatives, efforts and suggestions of Torpedo launch pad salvage, reassembling (Smokvina, 1993) and reusing but the time and ignorance overrun them. Glimmer of hope for Torpedo launch pad station occured when the Ministry of Culture of the Republic of Croatia brought a resolution in June 2008 concluding that the Torpedo launch pad station and adjacent compressor station for torpedo air injection, both as part of ex "Torpedo" factory in Rijeka, have attribute of cultural good and have to be renewed.

The level of awareness of the importance of industrial heritage, its preservation and conversion has been raised in Europe in the last 30 years. In order to save them from desertion and devastation, numerous mines, factories and manufactures have been listed as World Heritage of UNESCO. Many examples of world heritage are no other then examples of industrial heritage from the time of the beginning and growth of the Industrial revolution (Ratković, Bačić-Jelinčić, 2007). Reconstruction helped with preservation of facilities as well as converting the locations into top tourist destinations. Concerning Torpedo launch pad station history value, facility has all attributes and potential to become one interesting tourist destination.

In the work (Buha, Car-Pušić, Marović, 2009) the cost estimation of reinforced concrete Torpedo launch pad station reparation is given which can be considered as starting point which enables cost estimation for partial recovery of certain constructive elements.

CONCLUSIONS

From brief overview of this facility, which was not used for the last four decades, one can conclude that the maintenance of Torpedo launch pad station in Rijeka was neglected for years. It is very interesting that the 80-year old facility in aggressive surrounding with absolutely no maintenance for last 60 years is still standing and rather devastated defies the time. Once important part of the torpedo production plant, launch pad station in Rijeka today, although rather devastated, is important and valuable monument of Rijeka’s rich industrial heritage and should be saved, preserved and reused. According to Ministry of Culture of the Republic of Croatia resolution the Torpedo launch pad station have attribute of cultural good and have to be renewed. It is of great importance to act quickly because of the years of none maintenance will lead this unique facility to structural collapse.

Facility will be reconstructed according to Rijeka’s present urban and space planning schemes in order to achieve appropriate cultural purpose. Idea of reusing this facility as museum area is under consideration of local authorities. Rehabilitating and rearranging Torpedo launch pad station into museum, the value of genuine ambient and the content of all torpedo’s equipment will be saved.

REFERENCES

Bjelanović, A., Marović, I., Ribarić, D., et al. (2007) Inspection of the Torpedo Launch Pad Structure in Rijeka and Analysis of the Possibilities of its Repair and Conversion, In Proc. of 3rd International Conference on Industrial Heritage, Rijeka (*in Croatian*)

Buha, L., Car-Pušić, D., Marović, I. (2009) Cost Estimation of Reinforced Concrete Torpedo Launch Pad Repairment, In Proc. of 12th Faculty of Civil Engineering Book, University of Rijeka, Rijeka (*in Croatian*)

Grandić, D., Jelenić, G., Kovačević, D., Šćulac, P. (2008) Situation Report about Condition of Torpedo Launch Pad Station Construction in Rijeka and possibilities of its preservation, University of Rijeka, Rijeka (*in Croatian*)

Kovačević, D., Brnelić, M., Lustig, N., Grandić, D., Bjelanović, A. (2007) Ex Torpedo Launch Pad Structure in Rijeka – Damage Estimation Procedure, In Proc. of 3rd International Conference on Industrial Heritage, Rijeka (*in Croatian*)

Marović, I., Završki, I., Car-Pušić, D. (2009) Battle with time – Rijeka's Torpedo Launch Pad Station Rehabilitation, In Proc. of 12th International Scientific Conference, Brno, 103-106

Ratković, D.L., Bačić-Jelinčić, K. (2007) Protection of Industrial Heritage by Conversion into Cultural-Tourist Products, In Proc. of 3rd International Conference on Industrial Heritage, Rijeka (*in Croatian*)

Smokvina, M. (1993) Suggestion of Torpedoes Museum Collection Reassembling in Rijeka, Rijeka (*in Croatian*)

ENHANCING CAPACITIES FOR DISASTER MITIGATION AND RECONSTRUCTION IN THE BUILT ENVIRONMENT

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Throughout the recent decades, natural and man-made disasters have demonstrated the fragility of the built environment and its vulnerability to hazards. The destruction of the built environment caused by disasters impedes the regular functioning of the society while hindering all the other activities due to its strong linkages with other sectors. The role played by the built environment in determining the casualties and monetary costs of disasters emphasises the need of reducing its disaster vulnerabilities and achieving disaster resilience within the built environment through enhancing capacities for disaster mitigation and reconstruction. Capacity enhancement within different sectors in the society such as governments, institutions and communities, in relation to the built environment enables to identify constraints and to plan and manage construction activities of the built environment effectively, efficiently and sustainably. Understanding existing capacities in the context of disaster mitigation and reconstruction in the built environment is vital to identify any required capacity enhancement. In this context, this paper reviews literature to discuss the existing capacities in international community, national and local governments, non state actors and the private sector, local communities, policy and regulatory environment and human resource development in relation to disaster mitigation and reconstruction in the built environment and to identify its capacity gaps in combating disasters. The paper expands its scope to compare capacity gaps between developed and developing countries and attempts to identify the reasons behind higher capacity gaps in developing countries.

Keywords: built environment, capacities, disaster mitigation, reconstruction.

INTRODUCTION

Recent natural and human-induced disasters have highlighted the fragility of the built environment and its vulnerability to hazards (Bosher *et al*., 2007a). Disasters are not the necessary result of hazards but occur only when these hazards intersect with the built environment, particularly poorly located and poorly constructed development (UNDP cited Duque, 2005). The built environment comprises the substantive physical framework for human society to function in its many aspects—social, economic, political, and institutional (Geis, 2000, page 8). Thus, due to its linkages with other sectors, the destruction of the built environment by disasters hinders the regular functioning of any social and economic context.

Since the ability of the built environment to withstand the impacts of hazards plays a direct role in determining the casualties and monetary costs of disasters (Mileti, 1999), it is important to reduce the vulnerabilities within the built environment and enhance its capacity for disaster mitigation and reconstruction to achieve resilience to disasters. It is indicated that the hazards cannot be managed and it is the characteristics of the built environment that can be managed (Duque, 2005). Therefore, it is essential to improve the capacities of the built environment in order to make it is less vulnerable to the impacts of disasters. Capacity enhancement within different sectors in the society such as governments, non state and private institutions and communities, in relation to the built environment enables to identify constraints and to plan and manage construction activities of the built environment effectively, efficiently and sustainably. However, it is important to identify the existing capacities in the built environment in the relevant context in order to bridge the capacity gaps.

The capacities needed for effective disaster mitigation and reconstruction in general could be listed as comprising a society with local non-governmental organisations particularly deal with disaster issues, well-developed disaster plans and preparedness, coping mechanisms, adaptive strategies, memory of past disasters, good governance, ethical standards, local leadership, physical capital, resilient buildings and infrastructure that cope with and resist extreme hazard forces, etc. (Benson et al., 2007). Accordingly, the institutions, strategies, frameworks, policies, laws & regulations, projects and programmes, which have been developed towards disaster risk reduction in the built environment, are considered as the relevant capacities in the paper. However, since the built environment largely contributes to the overall development goals of the world and the built environment is a major component of almost every development activity, the key disaster management capacities, which link development as a whole with disaster risk reduction, are also indicated in the paper.

The subsequent section of the paper briefs the method used for the paper followed by the section which categorises literature on existing capacities in the relevant context. Then the paper moves to discuss the capacity gaps in disaster reduction in the built environment and the differences of capacity gaps between developed and developing countries prior to its conclusions.

METHOD

As understanding existing capacities in the context of disaster mitigation and reconstruction in the built environment is vital to identify any required capacity enhancement, this paper reviews literature to discuss the existing capacities in international community, national and local governments, non state actors and the private sector, local communities, policy and regulatory environment and human resource development in relation to disaster mitigation and reconstruction in the built environment and to identify its capacity gaps in combating disasters.

EXISTING CAPACITIES

Understanding existing institutional level and individual level capacities is very important for understanding the potential impact of future disasters and deciding how to intervene and enhancing the capacities (Benson et al., 2007). The relevant existing capacities are discussed under the following categories.

a. international community
b. national and local governments
c. non state actors and the private sector
d. local communities
e. policy and regulatory environment
f. human resource development

a. International community

International level capacities and experiences in the field of disaster reduction are vital mainly because in many developing countries, the lack of knowledge, resources and expertise can be overcome by adequate global cooperation in tackling natural disasters (El-Masri and Tipple, 2002). The supportive role of international agencies can assist countries in building mitigation programmes by applying their existing knowledge and resources (El-Masri and Tipple, 2002). In this context, the capacities which are applicable at international level and have been developed by international institutions as United Nations are considered in this section.

According to Schipper and Pelling (2006), there are three key domains which should be integrated in order to achieve sustainability in disaster risk management. Those are climate change, natural hazards and development. Changes in climate affect changes in the frequency and magnitude of hazards since factors as rising greenhouse gas emissions may lead to increasing temperatures and changing rainfall patterns (Schipper and Pelling, 2006). According to Schipper and Pelling (2006), there are three main global policy agendas, which govern the aforementioned realms. Climate change policy is based on a specialised UN convention that requires global cooperation in order to function, The United Nations Framework Convention on Climate Change (UNFCCC); disaster risk reduction is mainly guided by an international framework called Hyogo Framework for Action 2005-2015 (HFA) that governed by United Nations secretariat of the International Strategy for Disaster Reduction (ISDR); and development aims to meet a set of internationally agreed goals by 2015 (United Nations Millennium Development Goals- MDGs) which were introduced in the United Nations Millennium Declaration.

In the context of disaster mitigation and reconstruction, all the above three policies have a great impact on the built environment, since construction and use of the built environment could increase disaster risks through, carbon emission leading to climate change; improper planning and construction leading to increased vulnerabilities and deficiencies of buildings and infrastructure leading to slowed down development.

In addition to the above three main international agendas there are several other capacities which have been developed to implement at international level and relevant to disaster reduction and reconstruction in the built environment. United Nations Development Programme’s (Bureau for Crisis Prevention & Recovery Disaster Reduction Unit- UNDP) guidelines for post disaster recovery, Capacity for Disaster Reduction Initiative (CADRI) by the United Nations Development Programme´s Bureau for Crisis Prevention and Recovery (UNDP/BCPR), the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), the United Nations secretariat of the International Strategy for Disaster Reduction (ISDR) and SAARC Comprehensive Framework on Disaster Management are few examples among these capacities. However, most of these capacities are aligned with the HFA’s priorities and ISDR’s objectives.

b. National and local governments

UNDP (2004) identifies governance as the exercise of economic, political and administrative authority to manage a country's affairs at all levels through bringing together the actions of state, non-state and private sector actors. Therefore, the characteristics of good governance i.e., participation, rule of law, transparency, responsiveness, consensus orientation, equity, effectiveness, efficiency, accountability and strategic vision become key capacities of a country for sustainable development and disaster risk reduction (UNDP, 2004). Further, Mitchell (2003) divides his disaster risk reduction mainstreaming framework which is an operational framework for application at national level into four main sections, namely, politics and legislation, policy, knowledge and practice.

In addition to the aforementioned general factors, most of the countries have their own country specific capacities for disaster management irrespective of whether they are developed countries or developing countries. Commonly, acts, policies, frameworks and centres/institutions for disaster management become the national level capacities and they have been developed and implemented by the national and local governments. However, in some instances international bodies such as United Nations assist certain countries in disaster management by building country oriented capacities like United Nations Assistance Mission in Afghanistan (UNAMA). Further, as these capacities incorporate country's development activities into their objectives, they are closely linked with the activities of the built environment.

From this point onwards, the paper focuses on the disaster reduction and reconstruction capacities which are more specific to the built environment. They are discussed under four main categories, i.e., non-state actors and the private sector, community level, policy and regulations and human resource development.

c. Non-state actors and the private sector

There are many disaster reduction and reconstruction capacities within the built environment such as guidelines, frameworks and projects/programmes that have been developed and implemented by the non state actors and the private sector. Some of these capacities offer technical assistance for reconstruction while some are targeted at raising awareness of people on disaster reduction and reconstruction. Some examples for this type of capacities are given below.

- CABE (Commission for Architecture and the Built Environment), UK has set eight objectives to be achieved within three years, (2007-2009) targeting sustainable designs which facilitate disaster mitigation (CABE, 2007).
- Disaster Management Process Protocol (DMPP) - The Royal Institution of Chartered Surveyors (RICS) and the School of the Built Environment have developed Disaster Management Process Protocol (DMPP), which provides a structured framework for supply chain integration of disaster management. This could be integrated to construction/reconstruction projects as it could be used by any participant to the disaster management and reconstruction supply and recovery chain (RICS and the School of the Built Environment, 2009).
- Safe, Secure & Sustainable Built Environment' Project (S3BE) - A research team from the Department of Civil & Building Engineering, Loughborough University, UK has formulated an Integrated Strategic Framework to integrate

the Construction Industry to the emergency management framework in the UK (Bosher et al., 2006).

- Rebuilding Homes and Livelihoods in Sri Lanka aims to assist individuals, local and international development organisations and other agencies as a guide to the natural, social, institutional and operational issues in housing and housing services reconstruction sector in Sri Lanka.

d. Local community level

Many studies have recognised the need to include community's participation into disaster management (Pardasani, 2006; Owen and Dumashie, 2007; Jayaraj, 2006) specially in reconstruction since disaster reconstruction is about building back homes and infrastructure to become more resilient to the next disaster, and fit for purpose for the community (Owen and Dumashie, 2007). A study on hurricane Katrina illustrates that leadership at local level can provide flexible and faster decision making than bureaucratic disaster responsive systems in existence (Kapucu, 2007) and that community based initiatives are much faster than national and local governmental response (Bradshaw, 2001). Thus, the capacities of the local community are vital in disaster reduction and reconstruction in the built environment.

The capacity of a community represents the internal strengths of these communities and their external opportunities. Garlick (1999 cited McGinty, 2002) identifies five major elements of capacity in a study on community capacity building. They are knowledge building, leadership, network building, valuing community and supporting information. Similarly, local community's capacities can be identified under these categories within disaster mitigation and reconstruction contexts. Garlick (1999 cited McGinty, 2002) describes knowledge building as the capacity to enhance skills, utilise research and development and foster learning. Leadership is the capacity to develop shared directions and influence what happens in regions and network building is the capacity to form partnerships and alliances (Garlick, 1999 cited McGinty, 2002). Further, valuing community is about recognising the community and the capacity of the community to work together to achieve their own objectives.

e. Policy and regulatory environment

As Bosher et al. (2007b) state, the most common types of natural hazards mitigation in relation to the built environment could be divided into two as structural and non-structural. In addition, legislation is needed to support technical programmes, such as strengthening existing buildings against loads, while insurance schemes have the potential to contribute significantly to mitigation efforts (Bosher et al., 2007b). With a similar approach, Deegan (ca2004), identifies three general mitigation policy types in relation to his model for identifying stakeholders and preferences for natural hazard mitigation policies in the USA as follows.

- **Structural Mitigation:** These policies usually result in the strengthening of building and public facilities/infrastructure (via building codes, engineering design and construction practices, etc.). The primary stakeholder groups for structural mitigation are home owners and other building owners in hazard prone areas.
- **Non-structural Mitigation:** These policies are designed to prevent development in hazard prone areas (via maintaining and enhancing functions of wetlands, dunes and forests that reduce hazard impacts, and acquiring

property or development rights in hazard areas by the state and local government to limit development). The primary stakeholder group for non-structural mitigation includes land developers and business entrepreneurs in potential hazard areas.

- **Hazard Insurance:** Insurance policies connect structural and non-structural mitigation policies to assign risk to structures in hazard prone areas. In order to maintain accurate assessments of potential damage and risk, it is necessary to provide the proper tools of implementation for building code enforcement and zoning policies.

The above classification highlights the importance of building codes and land use planning policies in disaster mitigation and reconstruction in the built environment. As Mileti (1999) shows, engineering codes, standards, and practices have been promulgated for natural hazards and traditionally, it is the local governments who have enacted building codes. Similarly, Nateghi-A (2000) states that design standards, building codes and performance specifications are important in improving the design and construction of buildings, agricultural structures, infrastructure and other facilities to reduce their susceptibilities. Further, it is indicated that building codes are the critical frontline defence for achieving more strongly engineered structures, including large private buildings, public sector buildings, infrastructure, transportation networks and industrial facilities.

Moving to the policies which govern usage of land, it could be identified that there is a widespread failure to recognise and address connections between changes in land use, settlement policies, population distributions and the accompanying degradation of habitats on the one hand and dramatically increased levels of hazard exposure and vulnerability on the other (Comfort et al., 1999). According to Nateghi-A. (2000), the adverse effects of disasters can be greatly reduced if it is possible to avoid the hazardous areas being used for settlements or as sites for important structures. Most urban masterplans involving land-use zoning attempt to separate hazardous industrial activities from major population centers (Nateghi-A., 2000).

f. Human resource development

Education, professional training and competence and political will are necessary aspects of institutionalising disaster mitigation (Nateghi-A, 2000). Nateghi-A (2000) confirms that the professional training of engineers, planners, economists, social scientists and other managers to include hazards and risk reduction within their normal area of competence is gradually becoming common. Accordingly it is important to enhance professional training and competence of built environment professionals to enhance disaster management within the built environment.

The following list exhibits where property and construction skills can add value to disaster management and recovery (Max Lock Centre, box 30 Main Report, page 30 cited Lloyd-Jones, 2006).

- Assessing disaster-related damage
- Land surveying, GIS and rapid mapping of disaster impacts and risks
- Monitoring funding
- Valuation, cost planning and spending priorities; development finance
- Procurement and project management
- Sourcing construction materials and equipment

- Building quality audits pre- and post-disaster, particularly resistance to disaster risks
- Aiding logistical planning
- Aiding local government land administration, cadastral mapping
- Knowledge of land and property legislation, providing support on land rights and claims
- Knowledge of local regulatory frameworks and ways they could be improved
- Training and knowledge transfer
- Disaster risk assessment
- Links with other built environment professions; inter-disciplinary and team working
- Contacts with local business and industry; networking
- Knowledge of appropriate forms of disaster-resistant construction and engineering

Accordingly, it could be seen that education and training are vital in developing human resources in disaster reduction and reconstruction. Therefore, training programmes/workshops for professionals and other workers in the built environment, and study modules and university courses on disaster management become capacities in this context. In addition, the initiatives that are taken by the professional institutions and other relevant bodies in the built environment to develop human resources can be categorised under this capacity group. The RICS President's Commission on Major Disaster Management (MDMC) which was convened after the 2004 Indian Ocean tsunami in response to members concerns on what they and the RICS could do to help is a similar initiative. This Commission, made up of members of the RICS and other built environment professionals, has explored the strategic and practical ways it could bring the skills of RICS members and others involved in the built environment to provide help in the return to normality for those affected by disasters each year (Lloyd-Jones 2006).

The capacities which were discussed under the above six categories are the main capacities for disaster reduction and reconstruction within the built environment. However, there are gaps in these capacities that need to be improved in order to achieve disaster resilience in the built environment. The next section of this paper is allocated to discuss the major capacity gaps in the relevant context and their differences between developing and developed countries.

DISCUSSION: CAPACITY GAPS AND THEIR DIFFERENCES BETWEEN DEVELOPED AND DEVELOPING COUNTRIES

The capacity gaps of the field of disaster management in general are common to the disaster reduction and reconstruction within the built environment as well. The most common capacity gaps in disaster management can be mentioned as lack of necessary policies, regulations and technology, poor implementation of regulations, problems in disaster management planning structures and coordination between different parties, lack of disaster management related awareness, education and training, deficiencies in information management, and lack of community involvement.

While emphasising that meeting development goals, responding to climate change and reducing risk of natural disasters should be undertaken in an integrated manner, Schipper and

Pelling (2006) state that on a policy level, these three spheres of influence have become three realms of action. “Unfortunately, action often remains segregated both institutionally and from a disciplinary standpoint, thus not taking advantage of the interrelated nature of the realms” (Schipper and Pelling, 2006, page 19). As Mileti (1999) elaborates, to facilitate sustainable disaster mitigation, all policies and programs related to hazards and sustainability should be integrated and consistent.

Jigyasu (2002) indicates five main issues and challenges that are evident in the context of rural communities in South Asia for reducing their disaster vulnerability through building local knowledge and capacities. These are,

- Loss of material and land resources from rural communities
- Loss of traditional skills
- Cultural incompatibility of external interventions
- Increasing social and economic inequity
- Weakening of local governance

The above list implies that there are additional problems in disaster management capacities in the developing countries specially within the rural communities which arise mainly because of poverty and cultural aspects. It has been indicated that disaster resilience requires an appreciation of the cultural context of the relevant community. Also, poverty becomes an enormous barrier for building and improving capacities for disaster management since it brings day to day living to a higher priority than disaster planning (Martin, 2002). However, according to Martin (2002), disaster management planning within the economic constraints of developing countries would greatly reduce the extra burden caused by disasters.

Further, different levels of authorities—local, provincial, national and international need to promote cooperation between them in order to complement each others’ activities to ensure sustainable and equitable development (El-Masri and Tipple, 2002). To promote effective cooperation, the different organisations should redefine and readjust their roles in order to establish adequate communication networks and warning systems; to disseminate existing and new knowledge; to help in effective technology transfer; and to mobilize adequate resources (El-Masri and Tipple, 2002). Further, inadequately defined roles between local and national levels can have serious implications on effective disaster management and this is more common in developing countries. One of the most common problems in developing countries is the centralised systems, which make it impossible for the decision makers to be closer to communities because of spatial and socioeconomic distance (El-Masri and Tipple, 2002). Therefore El-Masri and Tipple (2002) suggest a comprehensive decentralisation of decision making to sub-national and local levels to enhance local initiatives, maximize the use of resources, respond to the real needs of the people, and build appropriate systems for defining responsibilities and accountability in the administrative system. Although this decentralisation is not a simple task it could be acheived by building consensus and capacity at different levels (El-Masri and Tipple, 2002).

In addition to the above common capacity gaps, there are some capacity gaps that are specific to the built environment. Among them, lack of disaster resilient buildings and infrastructure, lack of appropriate technology, lack of regulations including land use policies, building codes and construction standards, deficiencies in implementation of regulations, and lack of disaster management related knowledge and training among professionals and other workers are the key capacity gaps. However, as Nateghi-A. (2000) states, disaster management requires certain organizational and procedural measures to regulate the activities. As the changes in physical planning in the built environment, upgrading structures and changes in the characteristics of the building stock are processes which need a long time scale, the above measures or the objectives and policies that guide the disaster management processes have to be sustained over a number of years and have to survive the changes in political administration that are likely to happen within that time (Nateghi-A., 2000). Apropos, both the above common and specific capacity gaps are further highlighted through the following built environment related cases that emerge through literature.

Carthey et al. (2008) in their assessment of adaptive capacities of hospital facilities to cope with climate related extreme weather events, emphasise that it is necessary to ensure that healthcare infrastructure can cope with climate change. Further it is stated that there is a requirement to determine not only the impact of increasing incidences of extreme weather events on the health of the community that may increase the demand for healthcare services, but also to consider how to prevent health facilities failing under the loads placed on the building fabric due to these same events (Carthey et al., 2008).

According to le Masurier et al. (2006), in New Zealand, whilst routine construction processes have proved adequate for small-scale disasters, the greater degree of coordination required for programmes of reconstruction following a larger disaster has not been adequately addressed in policy and legislation. On the other hand, Nateghi-A (2000) emphasises that disaster-resistant building codes are, unlikely to result in resistant buildings unless the engineers who have to implement the code accept its importance and endorse its use, understand the code and the design criteria required of them and unless the code is fully enforced by authorities checking and penalising designs that do not comply. “A code has to fit into an environment and there has to be the establishment of an effective administration to check code compliance in practice: the recruitment of ten new municipal engineers to enforce an existing code may have more effect in increasing construction quality in a city than proposing higher standard building codes” (Nateghi-A., 2000, page 207). Similarly, Mileti (1999) indicates that investigations after disasters have revealed shortcomings in construction techniques, code enforcement, and the behaviour of structures under stress. Codes, standards, and practices for all hazards must be re-evaluated in light of the goal for sustainable mitigation while communities must improve adherence to them (Mileti, 1999).

Further, as Nateghi-A. (2000) states, urban planning needs to integrate awareness of natural hazards and disaster risk mitigation into the normal processes of planning the development of a city. However, as El-Masri and Tipple (2002) suggest, if land use policies are to be sustainable for the mitigation of natural disasters, they should be complemented by appropriate housing design, construction methods and use of building materials as well.

In the context of capacity gaps in human resources, Bosher et al., (2007b) state that risk and hazard training should be systematically integrated into the professional training and professional development of architects, planners, engineers, developers, etc. Further, it is important to encourage cross disciplinary training for construction professionals and emergency managers (Bosher et al., 2007b). Lloyd-Jones (2006) admits that chartered surveyors with appropriate training have key roles to play during all disaster phases from preparedness to immediate relief, transitional recovery and long term reconstruction. In the context of professional development, RICS and other built environment professional institutions have a responsibility to work together to promote the development of a worldwide network of trained professionals, ready to join recovery and reconstruction teams with local people (Lloyd-Jones, 2006). In this context, there is a significant issue pertaining to disaster management practiced in South Asian subcontinent that it has become a highly specialised discipline and various professionals and decision makers perceive various approaches for mitigation and rehabilitation within their own disciplinary field (Laverack, 2005).

The post windstorm damage surveys carried out by Henderson and Ginger (2008) in Australia have shown there were examples of houses designed and built that did not conform to the relevant standards, because of the use of unconservative design parameters, poor or faulty construction practices such as inappropriate use of materials for durability requirements and use of products that have not been designed, tested or installed for appropriate wind region. They suggest that education and awareness of the consequences in making inappropriate design assumptions, and of faulty construction is required in every step of the building process (regulation, design, construction, certification and maintenance) and by all parties (designer, builder, certifier, and owner) are required to overcome the problems.

On the other hand, it is not only the professional development necessary for the disaster reduction and reconstruction in the built environment but developing skills and knowledge of non professionals in the built environment including workmen in different construction trades is vital as well. National Earthquake Risk Mitigation Project (NERMP) in India proves this by identifying faculty members of engineering colleges, engineers, architects, contractors, construction supervisors, and lead masons and masons as the various stakeholders whose capacity should be built in achieving their objectives.

CONCLUSIONS

There are many capacities that could be found in the context of disaster reduction and reconstruction in the built environment. The paper considers the institutions, strategies, frameworks, policies, laws & regulations, projects and programmes which have an orientation towards disaster reduction and reconstruction as the relevant capacities and groups them under six categories; namely, international community, national and local governments, non state actors and the private sector, local communities, policy and regulatory environment, and human resource development.

Since the built environment is strongly linked with all the other sectors and all development activities, integration of built environment with any disaster reduction and reconstruction policies, frameworks and guidelines is almost inevitable. Specially the disaster management capacities that emerge at international level and national and local governmental level targeting the overall development activities are directly or indirectly applicable for the built environment. Therefore, the global agendas which focus on reducing disaster vulnerabilities with an international scope such as Hyogo Framework for Action and Millennium Development Goals become capacities that are applicable in the built environment. However, regulations like building codes, construction standards and land use policies, and the skills and knowledge of the stakeholders of the built environment including local communities on disaster mitigation and reconstruction are the key capacities that could be highlighted as the built environment specific capacities in the given context.

Although there are many capacities that are available for disaster reduction and reconstruction in the built environment, there are number of capacity gaps existing in this context. Lack of disaster resilient buildings and infrastructure, lack of appropriate technology, lack of regulations including land use policies, building codes and construction standards, deficiencies in implementation of regulations, and lack of disaster management related knowledge and training among professionals and other stakeholders are the key capacity gaps in the built environment in combating disasters. Thus, there is a need for bridging the gaps and enhancing capacities in the built environment. This becomes more critical in developing countries as they are the worst hit by disasters. However, issues such as poverty, cultural constraints, less developed technology, lack of disaster management related knowledge and training, bureaucratic management and administrative structures which were discussed in the earlier section hinder the developing countries achieving disaster reduction and reconstruction effectively at the same speed as developed countries.

REFERENCES

Benson, C. and Twigg, J. with Rossetto, T. (2007) Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations. Switzerland: ProVention Consortium.

Bosher, L., Dainty, A., Carrillo, P. and Glass J. (2007a) Built-in resilience to disasters: a pre-emptive approach. Engineering, Construction and Architectural Management, 14 (5), 434-446.

Bosher, L., Dainty, A., Carrillo, P., Glass, J. and Price, A. (2006) The Construction Industry and Emergency Management: Towards an Integrated Strategic Framework. Proceedings of the Information and Research for Reconstruction (i-Rec) Third International Conference on 'Post-disaster reconstruction: Meeting stakeholder interests, May 2006, University of Florence, Italy.

Bosher, L., Dainty, A., Carrillo, P., Glass, J. and Price, A. (2007b) Integrating disaster risk into construction: a UK perspective, Building Research and Information. 35(2), 163-177.

Bradshaw, S (2001). Reconstructing Roles and Relations: Women’s participation in reconstruction in post-Mitch Nicaragua. Gender and Development, 9(3), 79 – 87.

CABE (2007) Sustainable design, climate change and the built environment. London: Commission for Architecture and the Built Environment.

Carthey, J, Chandra, V and Loosemore, M (2008) Assessing the Adaptive Capacity of Hospital Facilities to Cope with Climate-Related Extreme Weather Events: A Risk Management Approach. In: Dainty, A R J (Ed) Association of Researchers in Construction Management, 1-3 September 2008, Cardiff, Wales.

Comfort, L., Wisner, B., Cutter, S., Pulwarty, R., Hewitt, K., Oliver-Smith, A, Wiener, J., Fordham, M., Peacock, W. and Krimgold, F. (1999) Reframing disaster policy: the global evolution of vulnerable communities. Environmental Hazards, 39-44.

Deegan, M.A. (ca2004) Extreme event policy analysis: Identifying stakeholders and preferences for natural hazard mitigation processes. New York: State University of New York.

Duque, P. P. (2005) Disaster Management and critical issues on disaster risk reduction in the Philippines. International Workshop on Emergency Response and Rescue, 31October -1 November 2005.

El-Masri, S. and Tipple, G. (2002) Natural disaster, mitigation and sustainability: The case of developing countries. International Planning Studies, 7(2), 157-175.

Geis, D., E. (2000) By design: The disaster resistant and quality-of-life community. Natural Hazards Review, 1 (3), 151-160.

Henderson, D. and Ginger, J. (2008) Role of building codes and construction standards in windstorm disaster mitigation. The Australian Journal of Emergency Management, 23 (2), 40-46.

Jayaraj, A. 2006. Post disaster reconstruction experiences in Andhra Pradesh, in India. In: IF Research Group (ed.), International conference on post-disaster reconstruction meeting stakeholder interests, 17-19 May 2006, University de Montreal, Florence.

Jigyasu, R. (2002) From Marathwada to Gujarat – Emerging challenges in Post earthquake rehabilitation for sustainable eco-development in South Asia. Proceedings of the Conference on Improving Post Disaster Reconstruction in Developing Countries, 23-25 May 2002, Organized by the Information and Research for Reconstruction and IF Research Group, University of Montreal, Canada.

Kapucu, N. (2007) Building Community Capacity to Respond. The Public Manager, Fall 2007, 21-23.

Laverack, G. (2005) Evaluating community capacity: Visual representation and interpretation. Community Development Journal, 41 (3), 266–276.

le Masurier J., Rotimi, J. O.B. and Wilkinson, S. (2006) A comparison between routine construction and post-disaster reconstruction with case studies from New Zealand. 22nd ARCOM Conference on Current Advances in Construction Management Research, Organised by Association of Researchers in Construction Management (ARCOM), 4th -6th September, Birmingham, U.K.

Lioyd-Jones, T. (2006) Mind the Gap! Post disaster reconstruction and the transition from humanitarian relief. UK: Royal Institution of Chartered Surveyors.

Martin, B. (2002) Are disaster management concepts relevant in the developing countries: The case of the 1999-2000 Mozambican floods. The Australian Journal of Emergency Management,16 (4), 25-33.

McGinty, S (2002) Community Capacity Building. Australian Association for Research in Education Conference in 2002, Brisbane.

Mileti, D. S. (1999) Disasters by design. The Changing Risk Landscape: Implications for Insurance Risk Management, In: Britton, N.R., Proceedings of a Conference sponsored by Aon Group Australia Limited.

Mitchell, T., (2003) An Operational Framework for mainstreaming disaster risk reduction. Disaster Studies Working Paper 8, Benfield Hazard Research Centre.

Nateghi-A., F. (2000) Disaster mitigation strategies in Tehran, Iran. Disaster Prevention and Management, 9(3), 205-211.

National disaster management authority of India, “National Earthquake Risk Mitigation Project (NERMP)”, available at: http://ndma.gov.in/wps/wcm/resources/file/eb57670c05506f0/EOI_%20NERMP.pdf

Owen, D. and Dumashie, D. (2007) Built Environment Professional’s Contribution to Major Disaster Management. Strategic Integration of Surveying Services, FIG Working Week, 13-17 May 2007, Hong Kong.

Pardasani, M. (2006) Tsunami reconstruction and redevelopment in the Maldives. Disaster Prevention and Management, 15 (1). 79-91.

RICS and the School of the Built Environment of the University of Salford (2009) Disaster Management Process protocol. RICS / University of Salford.

Schipper, L. and Pelling, M. (2006) Disaster risk, climate change, and international development: scope for and challenge to integration. Disasters, 30(1), 19-38.

UNDP (2004) Reducing disaster risk: A challenge for development. Geneva: UNDP.

WOMEN IN DECISION MAKING AND DISASTER REDUCTION IN THE BUILT ENVIRONMENT-A WAY TOWARDS SUSTAINABLE DEVELOPMENT

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Women have been portrayed as more vulnerable to disasters than men due to their social values. Accordingly, there is a need to adequately incorporate women's needs and concerns into disaster risk reduction activities in reducing their vulnerabilities. Enhancing women's status in disaster reduction decision making contributes towards reducing women's disaster vulnerabilities as it will help to identify their specific needs and concerns more effectively. Improving women's role as decision makers in the built environment is vital in this context as the built environment performs a major role in disaster risk reduction. Gender mainstreaming, a concept targeted at empowerment of women through gender equity could be adopted to address this issue of improving women's role as decision makers in the built environment. Mainstreaming brings the perceptions, experience, knowledge and interests of women and men as necessary to a particular situation to bear on policy-making, planning and decision-making. Achieving gender equality in the decision making roles in the built environment facilitates social equity, one of the three main components of sustainable development. Attempting to reduce disaster vulnerabilities and the susceptibilities of the built environment, paves a way towards more sustained development as the development within the built environment facilitates all key components of sustainable development, namely; environmental protection, social equity and economic growth. In this context, this paper reviews literature to discuss the importance of enhancing women's role in higher level decision making process in the built environment through gender mainstreaming in reducing disaster vulnerabilities, while demonstrating how this could ultimately facilitate sustainable development.

KEYWORDS: built environment, decision making, disaster reduction, gender mainstreaming, women.

INTRODUCTION

According to Childs (2006), gender is one of the main factors which determines the capacity and vulnerability to disasters. In this regard, it has been illustrated that women are more vulnerable to disasters than men due to their social values and they are more affected by disasters (UN/ISDR, 2002). According to Enarson (2000), following are the main reasons for their higher vulnerability.

- Women have less access to resources.
- Women are victims of the gendered division of labour.
- Women are primarily responsible for domestic duties such as childcare and care for the elderly or disabled and they do not have the freedom of migrating to look for work following a disaster.
- Housing is often destroyed in the disaster; many families are forced to relocate to shelters.
- When women's economic resources are taken away, their bargaining position in the household is adversely affected.

Therefore, as Hyogo framework for action 2005-2015 (UN/ISDR, 2005) states it is vitally important to integrate a gender perspective into all disaster risk management policies, plans and decision making processes aiming at reducing women's vulnerabilities. UN/ISDR (2002) highlights gender mainstreaming as a way of bringing a gender perspective into disaster reduction as it could translate into identifying the ways in which women and men are positioned in society and their varying vulnerabilities. Further, involvement of women in decision making is important as an effective way of bringing their perception into disaster reduction policies and measures. Thus, subsequently to the method section, the paper gives an account of the concept of gender mainstreaming followed by a section which discusses the importance of women's involvement in decision making to bring a gender perspective to the disaster reduction decisions.

On the other hand, the role played by the built environment in determining the casualties and monetary costs of disasters emphasises the need of reducing its disaster vulnerabilities to achieve a disaster resilient built environment. The decision-making process in the built environment thus requires integration with disaster risk reduction. In this context, improving women's role as decision makers in the built environment is vital to bring their perception and to identify women's needs and concerns. Apropos, the last section explains how attempting to minimise the susceptibilities of the built environment whilst trying to reduce women's disaster vulnerabilities, paves a way towards more sustained development prior concluding the paper.

METHOD

This paper reviews literature with the aim of highlighting the importance of enhancing women's role in decision making in the built environment through gender mainstreaming in reducing disaster vulnerabilities, whilst demonstrating how this could ultimately facilitate sustainable development.

WHAT IS GENDER MAINSTREAMING?

As mentioned earlier, gender mainstreaming could be adopted to bringing a gender perspective into disaster reduction decision making. Accordingly, this section gives an account of what is gender mainstreaming and how it can be applied to improve women's role in decision making.

Evolution of the idea

According to a report on gender mainstreaming by the Council of Europe (1998), gender mainstreaming, as a new concept, appeared for the first time in international texts after the United Nations Third World Conference on Women in Nairobi in 1985. It was seen as a means of promoting the role of women in the field of development and of integrating women's values into development work. At the United Nations Fourth World Conference on Women, in Beijing in 1995, the strategy of gender mainstreaming was explicitly endorsed by the Platform for Action (PfA) which was adopted at the end of the Conference (Council of Europe, 1998). The conference and the PfA provided new impetus for governments and civil society organisations to address gender inequalities in society at all levels (Commonwealth Secretariat, 1999) while promoting its underlying objective as empowerment of all women (Murison, 2004).

Defining gender mainstreaming

Gender mainstreaming has been defined in different ways by different authors and institutions. However, as Council of Europe (1998) exhibits there is little consensus about a definition of gender mainstreaming or on how to mainstream the gender equality perspective in practice and what this implies. Figure 1 was formulated based on the explanation given by Council of Europe (1998) on the composition of different definitions of gender mainstreaming.

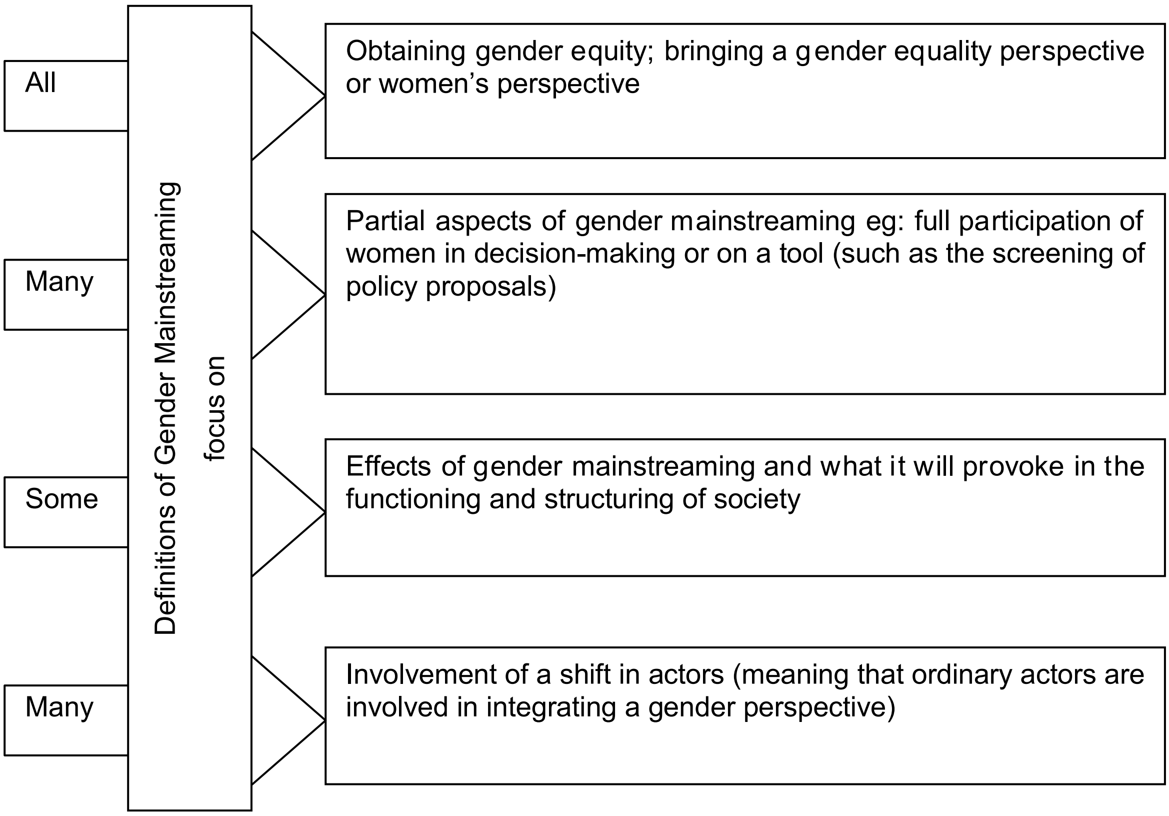

Figure 1: Composition of the definitions of gender mainstreaming

However, Council of Europe (1998) suggests that a comprehensive definition of gender mainstreaming shall include most of the aspects mentioned in various definitions such as the main goal that has to be achieved i.e. gender equality; the functional and structural implications of gender mainstreaming i.e. the reorganisation, improvement, development and evaluation of policy processes; various techniques and tools required for gender mainstreaming in a particular circumstance i.e. full participation of women in all aspects of life as well as the analysis of all proposals concerning general or sectoral policies and programmes from a gender equality perspective. Accordingly, the definitions of gender mainstreaming could vary from one to another depending on the characteristics of the organisation or the environment in which gender mainstreaming has to be achieved.

In the context of disaster risk reduction, gender mainstreaming is defined by the UN/ISDR as fostering awareness about gender equity and equality etc., to help reduce the impact of disasters and to incorporate gender analysis in disaster management, risk reduction and sustainable development, to decrease vulnerability (Inter-agency Secretariat for the ISDR, 2002). Further, UN/ISDR (2002) views gender mainstreaming as a means of promoting the role of women in the field of development, integrating women's values into development work. This confirms the importance of gender mainstreaming in reducing disaster vulnerabilities of women.

Achieving gender mainstreaming

Since gender equality is the key goal of gender mainstreaming, a strategy for mainstreaming gender must be laid to achieve equality, which is however not the simple objective of balancing the statistics of males and females (European Commission, 2004a). As UN/OSAGI (2001) elaborates, mainstreaming involves more than increasing women's participation and it is not about adding a "women's component" or even a "gender equality component" into an existing activity. "Mainstreaming entails bringing the perceptions, experience, knowledge and interests of women as well as men to bear on policy-making, planning and decision-making." (UN/OSAGI, 2001).

As the definition could vary depending on the environment, the way to mainstream gender may also differ according to the characteristics of a particular situation. However, European Commission (2004b) suggests that the basic feature of mainstreaming as the systematic consideration of the differences between the conditions, situations and needs of women and men in all policies and actions in the relevant environment. Carolyn Hannan, Director of the UN Division for the Advancement of Women (cited ILO), outlines the basic principles of mainstreaming as follows:

- Establishment of adequate accountability mechanisms for monitoring progress
- Initial identification of issues and problems across all area(s) of activity to diagnose the gender differences and disparities
- Not assuming that issues or problems are neutral from a gender-equality perspective
- Gender analysis (According to (IFAD, 2000), Gender analysis helps to identify where and what kind of inequities may exist between men and women with regard to legal rights, opportunities for personal development, access to productive resources, political participation, etc.)
- Clear political will and allocation of adequate resources for mainstreaming, including additional financial and human resources if necessary for translation of the concept into practice
- Widening women's equitable participation at all levels of decision-making

As the last point emphasises, on principle, widening women's equitable participation at all levels of decision-making is necessary for integrating a gender perspective. Commonwealth secretariat (1999) states at each stage, a successful process of gender mainstreaming in organisations involves decision makers at senior levels representing gender equality interests.

WOMEN’S ROLE AS DECISION MAKERS IN DISASTER REDUCTION

According to UN/ISDR (2002), the promotion and implementation of a comprehensive and sustained policy for disaster reduction has numerous elements and strategic components that need to be looked upon from a gender perspective. Integrating a gender perspective to disaster reduction strategies, policies and practices has been identified as a key issue by the international community through different global agendas. The Hyogo framework for action, which was adopted by 168 countries at the World Disaster Reduction Conference in Kobe, Japan in 2005 includes this under the general considerations for its priorities of action. The framework says that a gender perspective should be integrated into all disaster risk management policies, plans and decision making processes, including those related to risk assessment, early warning, information management, and education and training (UN/ISDR, 2005).

However, women are in a better position in identifying the specific needs of women that to be integrated into the disaster risk reduction planning in order to decrease women’s higher vulnerabilities. On the other hand, women’s subordination in male led decision making processes has been shown as a reason for women’s higher vulnerabilities for disasters (Groots International, 2008). Therefore, women’s involvement in decision making is vital in reducing women’s disaster vulnerabilities and achieving disaster reduction. Inter-agency secretariat for the ISDR (2002) emphasises this stating that gender equality in disaster reduction requires empowering women to take an increasing role in leadership, management and decision making positions to ensure a participatory approach. Further, as literature exhibits, having shown a central involvement to the development of their communities throughout history, women have an enormous capacity to engage in disaster risk reduction planning.

WOMEN IN DECISION MAKING IN THE BUILT ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

It has been shown that disasters are not the necessary result of hazards but occur only when these hazards intersect with the built environment, particularly poorly located and poorly constructed development (UNDP cited Duque, 2005). Further, the ability of the built environment to withstand the impacts of hazards plays a direct role in determining the casualties and monetary costs of disasters (Mileti, 1999). Therefore, the decision-making process in the built environment is necessary to be integrated with disaster reduction (Bosher et al., 2007). In this context, ensuring women’s involvement as decision makers in the built environment is vital to bring their perception and to identify women’s needs and concerns leading to disaster reduction specially through reducing women’s disaster vulnerabilities. However, women’s involvement in decision making in the built environment is insufficient as the representation of women in the mainstream management is significantly low. According to Construction Skills (2004) women account for approximately 9% of the total employment in the construction industry, the hard core of the built environment and only 5% of them are engaged in mainstream management.

Therefore, it is important to ensure the participation of women in the decision making process in the built environment to identify women's varying needs and concerns and to reduce women's disaster vulnerabilities. Then, the equality of gender specific needs and concerns related to disaster reduction could be more effectively taken into consideration in decision making in the built environment leading to reduce women's disaster vulnerabilities.

It has been demonstrated that the severe damages caused by disaster events are a significant threat to sustainable development (UN/ISDR, 2003). Thus, attempting to reduce disaster vulnerabilities and the susceptibilities of the built environment, paves a way towards more sustained development as the development within the built environment facilitates all key components of sustainable development, namely; environmental protection, social equity and economic growth. On the other hand, achieving gender equality in the decision making roles in the built environment facilitates social equity, one of the three main components of sustainable development. Further, a balanced and equal participation of both women and men in formulating and implementing policies and programmes allows utilizing the maximum talent available and can help in identifying different needs, perception and roles and facilitating public policy that is effective and sustainable to help promote gender balanced disaster reduction strategies, plans and programmes (UN/ISDR, 2002).

Further, in September 2000, the United Nations General Assembly adopted some specific tasks to be achieved by 2015 as Millennium Development Goals (MDGs) in the areas of poverty, education, gender equality, child morality, maternal health, HIV/AIDS, environment and development cooperation (UNDP, 2004) and all these goals are targeted at redusing vulnerabilities of people to achieve sustainability in the world. Apropos, it has been identified that DRR has a significant role to play in the MDGs. Several of the goals have close linkages to vulnerability to natural hazards, such as eradicating extreme poverty and hunger, achieving universal primary education, promoting gender equality, and ensuring environmental stability and partnerships for development (UN/ISDR Secretariat, 2004). Under its goal of promoting gender equality and empowering women, it emphasises the need of facilitating the participation of women and girls in the development process, including efforts to reduce disaster risk, while highlighting the importance of bringing women's skills and knowledge for decision making in disaster risk reduction (UNDP, 2004). Therefore, it is clear that achieving disaster reduction in the built environment whilst ensuring gender equality in decision making significantly contributes to sustainable development.

CONCLUSIONS

Women's needs and concerns should be necessarily integrated into disaster reduction policies and practices as women are more vulnerable to disasters. Gender mainstreaming is an effective concept in fulfilling the above need since it has been introduced as a successful way of integrating gender perspective to all decisions. Gender mainstreaming always promotes enhancing women's role in relevant decision making process as a key necessity for successful integration of women's perspective to decisions. Enhancing women's involvement in decision making in the built environment through the concept of gender mainstreaming becomes important since the built environment plays a major role in disaster reduction.

Acting towards reducing disaster vulnerabilities of women through promoting women's involvement in decision making in the built environment facilitates sustainable development in two ways. It aims to achieve gender equality in one hand and disaster reduction on the other hand.

REFERENCES

Bosher, L., Carrillo, P., Dainty, A., Glass, J. and Price, A. (2007) Realising a resilient and sustainable built environment: towards a strategic agenda for the United Kingdom. Disasters, 31(3), 236−255.

Childs, M. (2006) Not through women's eyes: photo-essays and the construction of a gendered tsunami disaster. Disaster Prevention and Management, 15(1), 202-212.

Commonwealth Secretariat (1999) Gender management system handbook. London: Commonwealth Secretariat.

Construction Skills (2004) Altogether stronger- Skills needs analysis for construction executive summary. United Kingdom: Construction Skills.

Council of Europe (1998) Gender mainstreaming- Conceptual framework, methodology and presentation of good practices. Strasbourg: Council of Europe.

Duque, P. P. (2005) Disaster Management and critical issues on disaster risk reduction in the Philippines. International Workshop on Emergency Response and Rescue, 31 October -1 November 2005.

Enarson, E. (2000) "Gender and Natural Disasters, IPCRR Working Paper no.1, International Labour Organization" [online]. available at: http://www.ilo.org/public/english/employment/recon/crisis/publ/index.htm.

European Commission (2004a) "Gender Mainstreaming" [online]. available at: http://europa.eu/Gender Mainstreaming\gms_en.html.

European Commission (2004b) "Incorporation of equal opportunities to Community Policies" [online]. available at: ://europa.eu/scadplus/leg/en/cha/c10921.htm.

Groots International and Fundaction Guatemala (2008) "Latin American women promote resilience through grassroots organizing & development" [online]. available at: http://www.huairou.org/assets/download/guatemala_press_release.pdf.

Inter-agency Secretariat for the International Strategy for Disaster Reduction (2002) Women, disaster reduction and sustainable development. Geneva: UN/ISDR.

International Fund for Agricultural Development (IFAD) (2000) An IFAD approach to gender mainstreaming. IFAD.

International Labour Organisation (ILO), "Gender equality tool- Definition of gender mainstreaming" [online]. available at: http://www.ilo.org/public/english/bureau/gender/newsite2002/about/defin.htm.

Mileti, D. S. (1999) Disasters by design. The Changing Risk Landscape: Implications for Insurance Risk Management, In: Britton, N.R., Proceedings of a Conference sponsored by Aon Group Australia Limited.

Murison, S. (2004) Gender Mainstreaming in the United Nations System. The Capacity Development Group, Inc.

UN/ISDR Secretariat (2004) The Millennium Development Goals and Disaster Reduction as relevant to the Early Warning Conference II (EWC-II). Geneva: UN/ISDR.

United Nations Development Programme (2004) A global Report- Reducing Disaster Risk, A Challenge for Development. New York: UNDP.

United Nations International Strategy for Disaster Reduction (UN/ISDR), (2003), "Disaster Reduction and Sustainable Development", available at: http://www.unisdr.org/eng/risk-reduction/sustainable-development/DR-and-SD-English.pdf.

United Nations International Strategy for Disaster Reduction (UN/ISDR) (2005) Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, Final Report of the World Conference on Disaster Reduction. Geneva: UN/ISDR.

United Nations International Strategy for Disaster Reduction (UN/ISDR) (2002) Gender mainstreaming in disaster reduction. Geneva: UN/ISDR.

United Nations Office of the Special Adviser on Gender Issues and Advancement of Women Department of Economic and Social Affairs (UN/OSAGI) (2001) "Gender mainstreaming-Strategy for promoting gender equality" [online]. available at: http://www.un.org/womenwatch/osagi/pdf/factsheet1.pdf.

United Nations Office of the Special Adviser on Gender Issues and Advancement of Women Department of Economic and Social Affairs (UN/OSAGI) (2007) "Concepts and Definitions" [online]. available at: http://www.un.org/womenwatch/osagi/gendermainstreaming.htm.

COMPARATIVE ANALYSIS OF THE WHOLE LIFE COST FOR REFURBISH OR RENEWAL ASBESTOS ROOFING

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In the UK, there is increasing pressure, particularly in the public sector, to make investment decisions on the basis of "best whole life value". As a result, there is a growing awareness of the need to conduct whole life costing (WLC) appraisals in the design and management of buildings. Whole life costing provides the means of determining the total financial implications of options selection based on both initial and future costs over their predicted lives. However, it is important that WLC estimates consider alternative solutions not just in terms of direct costs, but also in terms of other costs and performance measures such as sustainability (e.g. waste and energy consumption) and productivity (e.g. loss of availability).
This paper reports the outputs of a case study to compare the relative merits from a whole life cost point of view, of two approaches to dealing with asbestos roofs that are in a poor state of repair. The first option is to remove the existing roof and replace it with a new, Profiled Steel Cladding (PSC) with pvc coating. The second option is to encapsulate the existing roof in a liquid applied waterproof membrane. The paper demonstrates how the Net Present Value of the two options is calculated and how issues such as energy savings and availability are taken into account. It demonstrates the sensitivity of the outcomes to changes in the discount rate and assumed lives of the components, and show how newly developed software can radically simplify and speed up the calculation of whole life costs.

KEYWORDS: **whole life costing, net present value, asbestos roof covering, sustainability.**

INTRODUCTION

Whole Life Costing (WLC) has assumed increasing importance in recent years, partly as a result of government policy (HMSO, 2003 and OGC, 2007a), partly as a result of new forms of contract such as PFI and Prime Contracting (OGC, 2007b) and partly as a result of the demands of enlightened clients who wish to assess the whole life sustainability of the work they commission. Whilst economics is but one of the three dimensions of sustainability, it is often seen as creating the principal constraints. However, whilst sustainable buildings may well incur higher initial costs, there is increasing evidence to suggest that these are often more than offset by the reduction in operating and maintenance costs that sustainable designs bring about.
. Whole Life Costing is defined in the draft International Standard, ISO 15686 Part 5 as: "economic assessment considering all agreed projected significant and relevant cost flows over a period of analysis expressed in monetary value. The projected costs are those needed to achieve defined levels of performance, including reliability, safety and availability" (BSI, 2008).

Whole life costing is important not only in complete buildings, but in the choice of components too, though in building design, it is important to ensure that the whole life costs of the complete building rather than the whole life costs of any single component or system are minimised. Recognising this, manufacturers and supplier are increasingly turning their attention to the competitive advantage of their products when viewed from a whole life perspective.

This paper reports a study undertaken by Whole Life Consultants Ltd in collaboration with the University of Dundee on behalf of a roofing contractor offering a proprietary system for re-furbishing asbestos roofs. It demonstrates how whole life costing is carried out in real circumstances, and the difficulties it presents. It also illustrates how newly designed, unique software can reduce the amount of effort and cost required to calculate whole life costs.

WLC METHODOLOGY

The WLC process has the following steps.

1. *Identify all anticipated project phases and activities that will generate cost in the life cycle*

A typical life cycle of a building consists of three phases: capital, facilities management and disposal. WLC can be implemented at different phases of the building' life cycle.

2. *Create or adopt WLC breakdown structure*

Once the anticipated project phases are the identified, the next step is to create or adopt the WLC data structure. The WLC data structure, whether new or adopted is the key to successfully implementing WLC. For the UK construction industry, BCIS has developed a Standardised Method of Life Cycle Costing for Construction Procurement – UK Supplement to ISO 15686 Part 5 which can be used as WLC breakdown structure..

3. *Identify requirements, constraints and alternatives*

The next step is to identify the requirements and constraints of each WLC element. This should be established through discussion between the project team stakeholders; client, designers, constructors, facilities managers, and other members of the team. The relevant constraints may be budgetary (e.g. affordability), technical (e.g. legal, environmental) and other project's specific constraints.

4. *Determine the data required to estimate each alternative option*

Reliable, consistent data and information is the key to successfully implementing WLC. In this step the WLC team will establish assumptions related to each alternative option of WLC elements and determine the data and information which is needed to estimate the cost of every WLC element identified in the structured WLC breakdown.

5. *Estimate WLC of each alternative option*

In this step each WLC element of each alternative option is estimated. WLC element including (BSI, 2008):

- Construction costs

- Maintenance costs (e.g. planned preventive maintenance costs, reactive maintenance costs, life cycle replacement costs, etc)
- Operating costs (e.g. cleaning, utilities costs, etc)
- End of life costs (e.g. disposal costs)

The above cost elements are estimated for each alternative option in terms of undiscounted cash flow and/or net present value (NPV) based on the specified economic life and discount rate.

6. *Compare various alternatives for each WLC element*

The primary aim of WLC is to evaluate and optimise whole life costs of the project while satisfying the user and the projects requirements. This step provides an equitable comparison on a quantitative basis amongst competing designing options of WLC elements in order to select the lowest WLC (NPV) option.

7. *Evaluate results for uncertainty and risk*

WLC deals with the future and the future is unknown. There are many factors such as expected physical life, expected economic life, discount rate, inflation etc., to which WLC analysis is very sensitive. Therefore there is a need to critically review uncertainty associated with the selected discount rate, economic life and physical life.

8. *Report findings and conclusion*

The WLC report includes outcomes, assumptions, limitations and uncertainties for every WLC element used in the analysis. It includes WLC elements and their distribution over the period of analysis. The data should be presented in a variety of forms for each alternative, including cumulative WLC (NPV), cash flow of WLC (NPV), contribution of each cost (e.g. construction, maintenance, operation etc.) to total WLC or WLC (NPV)/m2.

CASE STUDY BACKGROUND

In light of the widescale use of asbestos in the UK prior to 1999, it is likely that the amount of asbestos waste produced annually is substantial. In 2002/3 some 361,000 tonnes of asbestos were disposed of to several hundred landfill sites in the UK [http://www.aranovus.co.uk/index.htm]. Asbestos roofs pose particular hazards when they need cleaning, maintaining or fall into disrepair. Inhalation of asbestos fibre can lead to asbestosis, mesothelioma, and lung cancer (IIAC, 2009). Even if it is decided to entirely replace an asbestos roof, extreme care must be taken during demolition and removal, which may only be undertaken in the UK by licensed contractors using licensed disposal facilities (EA, 2009). Aranovus Ltd has developed a system of cleaning asbestos roofs while controlling the release of asbestos fibres. Following any necessary repairs, refurbishment is effected by the application of an encapsulating liquid waterproof membrane.

Whole Life Consultants Ltd was asked to compare the whole life costs of the Aranovus system with those of a complete replacement system. The replacement system chosen was Profiled Steel Cladding, which was considered to be the most competitive solution.

Option Description

Option 1. The Aranovus Roof Refurbishment System The work is carried out in three stages.

1. Site set up and preparatory work including roof assessment and repair works.

2. Roof cleaning – controlled, safe cleaning and removal of deleterious matter with monitoring for airborne asbestos fibres.
3. Roof coating – application of a first coat primer using an airless spray technique followed by a liquid applied waterproof membrane of Aranovus encapsulent.

Option 2. A complete roof renewal system with a manufacturer's guarantee of 25 years comprising Profiled Steel Cladding (PSC) coated in PVC (Plastisol) 120 microns thick insulated steel decking designed to achieve a U value of 0.25 w/m^2- ^0C. The work is carried out in three stages.

1. Site set up.
2. Removal of existing asbestos roof coverings including allowing for temporary tarpaulins to keep the building weatherproof during the roofing works.
3. Installation of profiled steel cladding roof covering system including insulation levels as required by the current building regulations.

In both cases a typical roof area of $2000m^2$ was assumed

WHOLE LIFE COSTING

Assumptions and Constraints

To carry out the Whole Life Cost analysis for the two options, the following assumptions were made. Comments on these assumptions are provided in a later section of this paper.

Costs included: Construction; Planned Maintenance; Life Cycle Replacement; disposal; operation (energy savings).
Costs excluded: VAT;
Period of analysis: 40 years (Assumed lifespan of asbestos sheeting)
Evaluation method: Net Present Value (NPV) of Whole Life Costs
Base date: Q1 2009; Year zero - 2009
Real discount rates: 0%, 3% and 6% (Three rates are used to check the sensitivity of the results to changes in the discount rate. The real discount rate takes into account both the cost of borrowing money and inflation).
Intensity of use: For the purposes of energy calculation, the property is assumed to be occupied for 5 days a week on a single 8 hour shift basis.
Life expectancy: Aranovus system 15 years; PSC system 25 years (corresponding to the current guarantees).
Costs: The sources of cost data are shown in Table 1.

Data required to estimate whole life cost

Table 1 shows the data and information used in the calculation of whole life costs for both options, together with the sources from which they are derived.

Table 1 Data required and sources of data

Cost Elements	Option 1: Aranovus System	Option 2: PSC
Refurbishment/ Renewal Cost (£/m^2) including site	40 (Aranovus Ltd, 2009)	82 (BCIS Wessex, 2009) and (Roof Cladding and Building Ltd, 2009)

set up and temporary works		
Life expectancy (years)	15 year guarantee (25 year guarantee available in 2010) (Aranovus Ltd, 2009)	Manufacturers 25 year guarantee for plastisol coating to steel cladding (Roof Cladding and Building Ltd, 2009)
Life cycle replacement	High pressure wash and application of membrane, £7.00/m^2. (excludes site setup and support costs e.g. scaffolding (Aranovus Ltd, 2009)	Cost of new plastisol coating £23.00/m^{2,} 25 year life expectancy (excludes site setup and temporary works e.g. scaffolding) (The National Green Specification, 2009)
Planned maintenance	PM task is clearing gutters and twice yearly inspection. (Aranovus Ltd, 2009)	PM task is clearing gutters and twice yearly inspection. (Aranovus Ltd, 2009)
Disposal cost of Asbestos removal (£/m2)	0	£6 (BLS Group Ltd, 2009): BLS Group, Bradford; Asbestos tipping charges from Bradford local authority waste disposal depot)
Contract period	4 weeks (Aranovus Ltd, 2009)	8 weeks (BLS Group Ltd, 2009)
Energy savings (£/year)	0	Savings accrue from the increase in insulation which is a statutory requirement for replacement cost. These are calculated to be £2740 per annum (see later calculation)

WLC ESTIMATION

In order to estimate the WLC of each option, it was necessary to identify the tasks such as refurbishment/renewal, replacement, planned maintenance, and operation that generate costs. These calculations and results are illustrated in the following sections.

Initial Cost

The initial cost is the cost of roof refurbishment in the case of option 1 and the cost of roof renewal in the case of option 2.

Option 1: Aranovus system	**£/m^2**	**Total cost for 2000m^2**
Total cost including site set up, cleaning and coating	**40**	**80,000**

Option 2:PSC	**£/m^2**	**Total cost for 2000m^2**
Strip existing asbestos roof coverings, battens & felt; allow for temporary tarpaulins and keeping building weatherproof during roofing works, including site set up	13.50	27,000
Roof covering: Profiled steel cladding, insulated decking, PVC	68.60	137,200

coating >50 degree pitch		
Total cost	**82.10**	**164,200**

Life Cycle Replacement Cost

Option 1: Aranovus system

The method of life cycle replacement after 15 years for the Aranovus system (providing the condition of the asbestos sheeting has not deteriorated) would be a high pressure wash and the application of one coat of membrane. Over a 40 year period of analysis this task will be carried out twice. The cost of this process at today's prices is £7.00/m^2 or £28000 in total.

Option 2: PSC

The method of life cycle replacement after 25 years for the PSC option would be a high pressure wash and the application of one coat of plastisol membrane. The cost of this process at today's prices is £23.00 /m2 or £46,000 in total

Planned Maintenance Cost

The planned maintenance for both roofing options is a simple task of inspecting the roofing system and clearing gutters. This task should be carried out twice yearly to prevent the collection of deleterious matter. The cost per visit is assumed to be £200. The planned maintenance cost for both options is therefore £400/yearInitial

Disposal Cost

The initial disposal cost for the asbestos containing roofing material was separated from the renewal/refurbishment costs in this analysis since they are quite variable depending upon the weight of the roofing material, location of the building structure and its proximity to an approved disposal site. A limited number of sites is available to take hazardous waste and therefore transport costs may also be an issue.
Option 1: Aranovus The disposal cost for the Aranovus roof refurbishment option is zero. The installation of this roofing option encapsulates the existing asbestos containing roof.

Option 2: *PSC* For this analysis we assumed the disposal costs for the asbestos containing roofing material to be £40/tonne or £6/m^2 (**source data: BLS Group, Bradford; Asbestos tipping charges from Bradford local authority waste disposal depot*). The disposal cost for the roof renewal option is therefore £12,000.

Operation Cost: Energy Saving Cost

For this analysis we assumed that the building was at least 15 years old (otherwise the roof would not need refurbishing), and therefore that there was no insulation in the original roof structure.
Option 1: Aranovus Although the insulation properties of the Aranovus option have not been tested, it is unlikely that the encapsulating material will have significant insulating properties. We therefore assumed no energy saving for this option.

Option 2: PSC This option incorporated insulation and therefore would produce energy savings. These savings would be significant if no insulation were present within the original roof structure. For a lightweight factory building heated by fossil fuel, the annual energy benchmark consumption is 107KWh/m2 (Source: Energy Conservation Guide 81 www.energy-efficiency.gov.uk). For a 2000m2 building, the annual heating cost is therefore £8560 assuming a cost of gas of 4p per KWh. Heat loss through the roof is likely to be 32% of the total loss (Source: www.colorcoat-online.com), at an annual cost of £2740. If we assume that without insulation, the heat demand is twice the benchmark, and that the application of insulation reduces it to the benchmark figure, then the annual savings accruing from insulation will be £2740. Clearly, a more accurate calculation than this would be possible and necessary if the precise circumstances were known Whole Life Costs

Table 2 below illustrates the NPV of the Whole Life Costs for the Aranovus and PSC options for discount rates of 0%, 3% and 6% for 40 years.

Table 2: NPV of whole life costs

Cost element	Aranovus 0%	PSC 0%	Aranovus 3%	PSC 3%	Aranovus 6%	PSC 6%
Initial cost	80,000	164,200	80,000	164,200	80,000	164,200
Life Cycle replacement cost	28,000	46,000	14,754	21,970	8,279	10,718
Planned maintenance cost	16,000	16,000	9,246	9,246	6,019	6,019
Initial asb estos disposal cost	0	12,000	0	12,000	0	12,000
Energy saving	0	-109,600	0	-63,334	0	-41,227
Total £	124,000	128,600	104,000	144,082	94,298	151,710

These costs are illustrated graphically in Figures 1, 2 ,3 & 4.

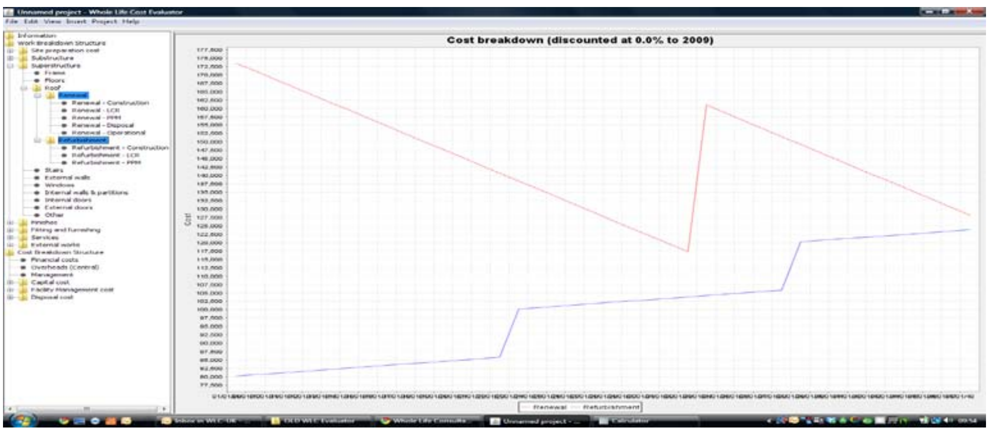


Figure 1: Comparison of total Whole Life NPV for Aranovus and PSC - 0% discount rate

Disruption Cost

It is necessary to take account of disruption costs if there is a loss in operational performance as a result of the roofing works. The cost of disruption may include the cost of lost production and/or decantation of the existing occupants/plant/machinery.

Option 1: Aranovus The installation of the Aranovus system will not interfere with the operation of the building. The disruption cost for this option would therefore be zero.

Figure 2: Comparison of total Whole Life NPV for Aranovus and PSC - 3% discount rate

Option 2: PSC. For this option, we assumed that on average there will be 10 days (for a roof area of 2000m^2) when the performance of the temporary sheeting is insufficient and the hazards associated with asbestos removal are too great to allow operations inside the building to continue. This assumption depends very much on the context of the work and the way it is carried out. Equally, the cost of the loss of productivity is an unknown factor, and depends on the type of operations that are carried out inside the building. However, by way of illustration, if the value of goods output per year were £1m, a loss of ten days' production would represent a loss of some £40,000 in cash terms. It would be necessary to add this cost to the initial and Whole Life Costs of Option 2**.**

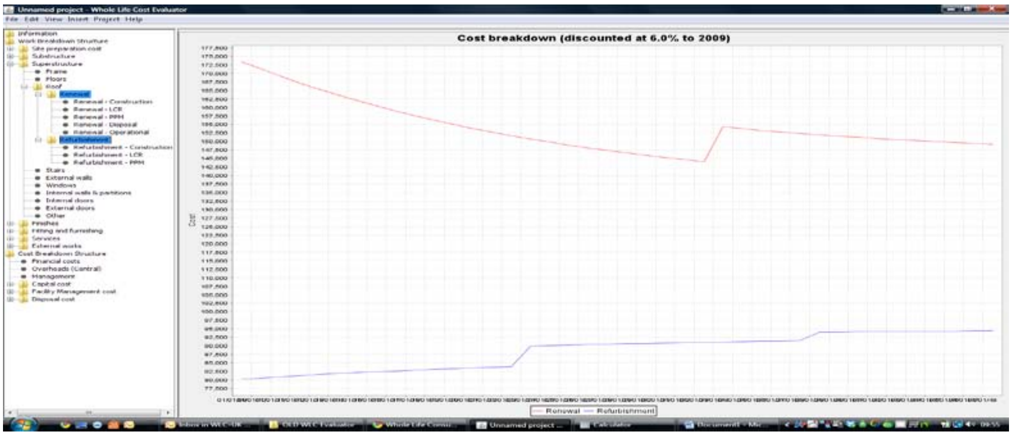
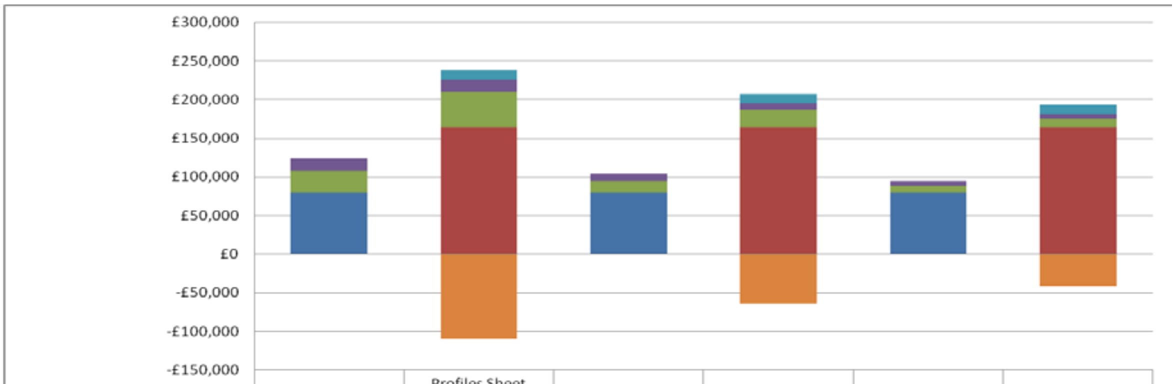


Figure 3: Comparison of total Whole Life NPV for Aranovus and PSC - 6% discount rate

DISCUSSION

Whole Life Costing is finding growing application in the comparison of competing products. However, considerable difficulties exist in forecasting costs which are context specific such as disruption costs and energy savings. If these are to be included with a reasonable level of accuracy, it is necessary to carry out sophisticated calculations which take account of the detailed design and operational conditions relating to the asset. It is also necessary to recognise that the results of whole life cost analyses are heavily dependent on the assumptions made particularly about discount rates and life expectancy. Sensitivity analyses should always therefore be conducted.



	Aranovus WLC (Undiscounted)	Profiles Sheet WLC (Undiscounted)	Aranovus WLC-NPV at 3%	Profiles Sheet WLC-NPV at 3%	Aranovus WLC-NPV at 6%	Profiles Sheet WLC-NPV at 6%
Energy saving	£0	-£109,600	£0	-£63,334	£0	-£41,227
Initial Disposal Cost	£0	£12,000	£0	£12,000	£0	£12,000
Planned Maintenance Cost	£16,000	£16,000	£9,246	£9,246	£6,019	£6,019
Life Cycle Replacement Cost	£28,000	£46,000	£14,754	£21,970	£8,279	£10,718
Renewal		£164,200		£164,200		£164,200
Refurbishment	£80,000		£80,000		£80,000	

Figure 4: Comparison of Whole Life Cost elements for Aranovus and PSC - 0%, 3% and 6% discount rate

CONCLUSIONS

Whole Life Costing is an imprecise science. It depends on our ability to predict future costs, discount rates, operational conditions and life expectancies. As a result, it is always necessary to conduct sensitivity analyses to determine the margin of error in the results. For this purpose, it is helpful to use software to carry out the calculations. Whole Life Cost Evaluator has been designed specifically to increase the efficiency and accuracy of whole life cost calculations whilst allowing maximum flexibility and functionality. If carefully and wisely used, it can serve as a useful tool for comparing the whole life performance of competing products.

REFERENCES

Aranovus Ltd, http://www.aranovus.co.uk/index.htm, accessed March 2009.

BCIS Wessex (2009) Estimating Price Book SMM7, 13th Edition, RICS, London, UK

BLS Group Ltd, http://www.bls-group.co.uk, accessed March 2009

BSI (2008) BS/ISO Standard 15686, "Buildings and constructed assets - Service life planning", Part 5; Whole life costing, British Standards Institution/The International Organisation for Standardisation

Corus Group, www.colorcoat-online.com, accessed March 2009

Energy Conservation Guide 8, http://www.energy-efficiency.gov.uk , accessed March 2009

HMSO (2003) The Green Book – Appraisal and Evaluation in Central Government: treasury guidance. HM Treasury, Her Majesty's Treasury Stationery Office, London

Office of Government Commerce (OGC) (2007a) Achieving Excellence in Construction Procurement Guide – No. 7; "Whole Life Costing and Cost Management", Crown, UK

Office of Government Commerce (OGC) (2007b) Achieving Excellence in Construction Procurement Guide – No. 6; "Procurement and contract strategies", Crown, UK

Roof Cladding and Building Ltd, Southampton, UK http://www.roofingcladdingbuilding.com accessed March 2009

The Environment Agency (EA), UK, http://www.environment-agency.gov.uk accessed March 2009

The industrial injuries Advisory Council (IIAC), Position Paper 22, Laryngeal Cancer and Asbestos Exposure www.iiac.org.uk, accessed March 2009

The National Green Specification, http://www.greenspec.co.uk/html/durability/steelclad.html, accessed March 2009

SUSTAINABLE PROCUREMENT ISSUES IN THE GREEK CONSTRUCTION INDUSTRY

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Construction procurement is a key factor of the whole construction process contributing to overall client satisfaction and project success. The selection of the most suitable procurement method is critical for both clients and project participants, and is becoming an important and present-day issue within the construction industry. The aim of the present paper is to investigate the awareness level and the constraints of sustainable procurement practices, and record the procurement practices implemented in the Greek construction industry. A questionnaire survey of twenty seven experts (construction managers, industrial and academics) was carried out in order to obtain experience of the above issues concerning procurement practices in the Greek construction industry. The findings indicate that although sustainability criteria are recognised as essential their use is limited.

KEYWORDS: construction industry, sustainability, procurement practices, questionnaire survey.

INTRODUCTIO N

The fundamental principles generally applied in the field of public procurement in Greece, include those laid down in the EC Treaty, and relevant secondary Community legislation (public procurement Directives). Among those are the principles of equal treatment, non-discrimination, transparency, proportionality and mutual recognition.

The following Community Directives on public procurement have been implemented in the Greek legal system:

- Supplies Co-ordination Directive 93/36/EEC which is actually amended by European Parliament and Council Directive 97/52/EC and Commission Directive 2001/78/EC

- Works Co-ordination Directive 93/37/EEC amended by European Parliament and Council Directive 97/52/EC and Commission Directive 2001/78/EC

- Services Directive 92/50/EEC amended by European Parliament and Council Directive 92/57/EC and Commission Directive 2001/78/EC

- Sectoral Directive 93/38/EEC amended by Directive 98/4/EC of the European Parliament and of the Council

- Remedies Directive 89/665/EEC and Sectoral Legal Remedies Directive 92/13/EEC

Public procurement Directives have been implemented in Greek legislation by Presidential Decrees 370/95, 105/2000 334/2000 and 336/2002, 346/1998, 18/2000, 101/2003 and 2854/2000

In the Greek legislation there are also specific laws regulating works and design contracts below the threshold of Council Directives 93/37/EEC and 92/50/EEC. The main legislation in question is:

For works: Law 1418/1984 as amended by Law 2229/1994, and Presidential Decree 609/85

For design contracts: Law 716/1977.

For design contracts and relevant consulting services: Law 3164/2003

In cases of contracts below thresholds of the Directives and where there is no other particular law provision, the framework set in the Directives is implemented in substance.

Institutional framework

The institutional framework for public procurement in Greece consists of three Ministries each one responsible for one sector according to the division of the classical Directives:

- Ministry of Economy and Finance which is responsible for public procurement of services (Directive 92/50/EEC), and Ministry of Environment, Physical Planning and PublicWorks which is responsible especially for design studies services;

- Ministry of Development which is responsible for public procurement of supplies (Directive 93/36/EEC);

- Ministry of Environment, Physical Planning and Public Works for public procurement of works and construction contracts (Directive 93/37/EEC);

For the utilities sector (Directive 93/38/EEC), the above competent Ministries by sector of responsibility.

The above mentioned Ministries co-ordinate their action for the government of procurement policy and for the preparation of the legislative framework as well as the incorporation of Community legislation in the Greek legal system.

Sustainable procurement

Recent awareness for the scarcity of resources in Greece has emerged the adoption of green products and Sustainable Procurement services. Around 95 million euros will be disseminated in sustainable products and services in the 4th framework of the EC. Sustainability as a concept is most widely known in relation to sustainable development. According to the United Nations World Commission on Environment and Development sustainable development is defined as “development which meets the needs of present generations without compromising the ability of future generations to meet their own needs”. Sustainable development provides a framework for the integration of environmental policies and development strategies. It recognises that development based on the efficient and environmentally responsible use of all of society's scarce resources is essential to satisfy human needs and improve the quality of life.

Sustainability is important for every sector of industry but merely in the construction industry because the facilities we construct have a huge impact on the environment. These facilities make use of natural resources during the construction stage and leave man-made footprints in the ecological environment and they are also our interface to the natural environment, protecting us from the elements and meeting the needs of humanity for shelter, status, and other functions.

As a result there is a pressure in order to make these facilities more sustainable, through sustainable construction, is the demand to meet the needs of society without compromising the needs of others or jeopardizing the future survival of humanity on earth.

Sustainable construction is defined as (Chan et al 2001)‘the set of processes by which a profitable and competitive industry delivers built assets: building structures, supporting infrastructure and their immediate surroundings, which:

- Enhance the quality of life and offer customer satisfaction,

- Offer flexibility and the potential to cater for user changes in the future,

- Provide and support desirable natural and social environments,

- Maximize the efficient use of resources while minimizing wastage'.

Sustainable construction comprises construction procurement (i.e. new construction, refurbishment work and maintenance), operation and demolition of constructed work. It encircles such matters as tendering, site planning and organization, material selection, recycling and waste minimization (Chan et al 2001)

The general framework for implementing sustainability in construction has to deal with the procurement selection with respect to materials and services. It is claimed that the correct choice of a construction project delivery method will lead to the success of the project and as a result selecting an appropriate procurement system is an essential step in any construction project process (Love et al 1998). A construction project may be regarded as successful if it fulfils the following requirements: it is delivered at the right time, at the appropriate price and quality standards, and provides the client with a high level of satisfaction. The most important influence on the above requirements is the type of procurement method implemented which determines the overall framework and structure of responsibilities and authorities for participants within the whole construction process. The selection of the most suitable procurement method consequently is critical for both clients and project participants, and is becoming an important issue within the construction industry Watuka and Aligula (2003).

This paper sought to answer the following questions:

- Are sustainable procurement practices implemented in the Greek construction industry?

- What constraints exist to hinder the achievement of sustainable procurement and how these constraints be can overcome?

Particularly, the paper aims at identifying potential drivers of change in all the stages of the procurement process considering the development of the 'business case' for sustainability (i.e. how environmental and social sustainability contributes to economic sustainability).

The paper is organised as follows. In the next section issues of sustainable procurement are presented followed by the stages of the procurement process are outlined. In the following section the methodological framework concerning the preparation of a questionnaire survey in developing procurement selection criteria in the case of Greek construction industry is presented. The results are presented in the next section. The final section draws the conclusions of the paper.

BACKGROUND

The procurement process

The procurement process is viewing as a cycle (IDALG, 2003) in order to emphasise the development of a business case. The stages of the procurement cycle are (IDALG, 2003)

- Identifying needs

- Development of business case

- Definition of procurement approach

- Supplier selection

- Tender evaluation

- Award and implementation of contract

- Management of contract

- Closure/lessons learned

The first stage of the procurement cycle is to identify needs. Identifying needs has to do with the alternative options for satisfying the needs of a user group which can be significantly different from the current solution.

The business case deals with the identification and appraisal of alternative options and the establishment of value for money. The business case can be summarised as: achieving strategic objectives; complying with environmental law; controlling costs; managing risk and reputation; creating markets; ensuring security of supply; ensuring maximum community benefits.

The definition of procurement approach comprises the specification of requirements and the update of the business case.

The supplier selection has as outcome the short-list of suppliers, though tender evaluation comprises bids evaluation, confirmation of successful supplier and updating of the business case.

The stage of award and implement contract includes the preparation of service delivery. Management of contract deals with the serviced delivered, benefits achieved and, value for money maintained.

The final stage (Closure/lessons learned) deals with the preparation for future arrangement and review and updating of the business case.

Challenges for green procurement

Challenges for green procurement have emerged as a result of the international and national The challenges for green procurement selected for consideration are presented in Table 1 (IDALG, 2003).

Price

Green products are deemed to be more expensive than conventional alternatives, which is true in some cases, particularly where development costs are reflected in the price. However, very often there is no significant difference between green products and conventional alternatives because a green product may have a higher up-front purchase price, but will cost less over its liftime.

Lack of corporate commitment

The implementation of a green procurement programme, requires commitment from all levels of an organization, including senior management and purchasing agents.

Insufficient knowledge

It is essential for an organization to have an understanding of concepts and relevant terms.

Availability

Delays in obtaining green products may occur because distributors do not stock them or else they stock only small quantities of them due to low market demand.

Table 1: Challenges for green procurement.

Category	Challenges for green procurement.
1	Price
2	Lack of corporate commitment
3	Insufficient knowledge
4	Availability
5	No acceptable alternative
6	No specifications
7	Purchasing habits
8	Strategy development

No acceptable alternative

Lack of acceptable alternatives to a present product can be a barrier. construction industry's response to sustainable construction.

No specifications

On one hand purchasers must clearly define their needs and requirements, though on the other hand suppliers must be asked to provide the environmental specifications of their products.

Purchasing habits

Purchasing habits have to do with change management, which is important in order to overcome existing relationships between purchasers and suppliers that make it difficult to switch to alternatives and change the purchasing process.

Strategy development

It is essential in order to implement a green procurement programme and aims to identifying changes, suitable products and services, and evaluating the environmental performance of suppliers.

Definition of criteria for evaluating tenders and awarding contracts

The public procurement Directives contain two options for the award of contracts: either the lowest price or the ‘most economically advantageous tender’. In order to define which tender should be considered the most economically advantageous, the contracting organization/authority has to indicate beforehand which criteria will be decisive and will be applied.

Comprehensive approaches to Green Procurement at national level

Comprehensive approaches to Green Procurement in various countries, include Japan (i.e. Green Purchasing Network at national level conducts purchasing and provides advice to consumers, companies and government organisations); Canada, the USA and Austria have also put in place formal requirements for green public procurement; The UK has some specific green procurement commitments (e.g. on timber, renewable energy and recycled paper) and also has a well established sustainable development strategy at the national level 'A better quality of life ' to drive forward the sustainable development agenda, but there has been no clear commitment to green government procurement more broadly as has been in other countries (Green Procurement, 2008)

Existing environmental and other legislation at Community or national level compatible with Community law, is binding upon contracting authorities and may have an influence on the choices to be made and the specifications and criteria to be drawn up by contracting authorities. The main possibilities for "green purchasing" are to be found at the start of a public purchase process, namely when making the decision on the subject matter of a contract. These decisions are not covered by the rules of the public procurement directives, but are covered by the Amsterdam Treaty rules and principles on the freedom of goods and services (principles of non-discrimination and proportionality). The public procurement directives themselves offer different possibilities to integrate environmental considerations into public purchases, notably when defining the technical specifications, the selection criteria and the award criteria of a contract. In addition, contracting authorities may impose specific additional conditions that are compatible with the Treaty rules (it depends on national law whether contracting authorities have further possibilities for "green purchasing"). For contracts not covered by the public procurement Directives, Community law leaves it to the Member States to decide whether or not public procurement not covered by the Community Directives should be subject to national procurement rules. Within the limits set by the treaty and Community law, Member states are free to adopt their national legislation (CEC, 2001).

In Greece national legislation on procurement refers only to public procurement compatible with Community law. The existing legislative framework offers possibilities to integrate environmental considerations into public purchases, notably when defining the technical specifications, the selection criteria and the award criteria of a contract (e.g. Directive 93/96-14-4-1993 and Presidential Decree 370/1995, Presidential Decree 394/1996) (Karanastasis 1998).

RESEARCH METHODOLOGY

Research Design

Survey research adopted for this paper in order to obtain information on procurement practices in Greece by asking people (i.e. persons employed in firms, organizations/authorities) about their perceptions. The target population in survey was 27 firms and their distribution is presented in Table2

Table 2. Target Population

Type of Firm	Number
Industrial	7
Educational	4
Construction	16
Total	27

The response rate was 66 %, i.e. 18 questionnaires were returned, representing and these were used in the analysis presented in the following section.

Development of the questionnaire

The questionnaire refers to the challenges for green procurement that have emerged as a result of the international and national construction industry's response to sustainable construction. The challenges for green procurement selected for consideration are those presented in Table 1.

Persons employed in target population (i.e. firms, organizations/authorities) were asked to answer the following questions:

Question 1. Do you think that green products are more expensive than conventional alternatives? (Yes, No)
Question 2 . Do you think that the knowledge in a use of a green product is sufficient? (Yes, No)
Question 3. Can you purchage green products easilly as for instance local distributors or you face delays in purchaging green products Easily_ difficulties_
Question 4. Did you find lack of acceptable green product alternatives to the present products? (Yes, No)
Question 5. Do the suppliers provide the environmental specifications of the products they are offering? (Yes, No)
Question 6. Do you think that purchasing habits and relationships between purchasers and suppliers that make it difficult to switch to alternative green products? (Yes, No)
Question 7. Is it in your business goals a systematic review of the green procurement programme to be carried out? (Yes, No)
Question 8. Where do you find more difficulties in implementing green products procurement? Select one of the following:

1. Organizational support (Implementing a green procurement programme means changing policies and procedures).
2. Self-evaluation: An important step in implementing green procurement is conducting an evaluation of present purchasing practices
3. Set goals: A broad policy should be established, and specific priorities and targets set.
4. Develop a strategy: It is now to time to identify and implement changes, both short and long-term, identify suitable products and services, and evaluate the environmental performance of suppliers.
5. Assignment of accountability, plan addressing employees, customers, investors, suppliers and the public.

RESULTS

Table 3 shows the outcomes of participants' perceptions in response to the survey questions.

Table 3. Response to survey quastions

	Yes	No
Question 1	100%	0%
Question 2	66%	33%
Question 3	77%	22%
Question 4	61%	39%
Question 5	72%	28%
Question 6	72%	28%

Question 7	50%	50%

All the participants think that green products are more expensive than conventional alternatives. A percentage of 66.6% think that the knowledge in a use of a green product is sufficient. Only 27% think that green products easily can be purchase from local distributors while the rest 78% think that purchasing is having difficulties. A percentage of 61% find lack of acceptable green product alternatives to the present products all the participants say that suppliers provide the environmental specifications of their products they are offering. A percentage of 78% think that purchasing habits and relationships between purchasers and suppliers that make it difficult to switch to alternative green products.

Difficulties in implementing green products procurement are ranked as follows:

1. Develop a strategy
2. Set goals.
3. Organizational support
4. Self-evaluation
5. Assignment of accountability, plan addressing employees, customers, investors, suppliers and the public.

CONCLUSIONS

In order to investigate the awareness level and the constraints of sustainable procurement practices, and record the procurement practices implemented in the Greek construction industry a questionnaire survey of eighteen experts, mainly consultants and contractors, was carried out in order to obtain experience of the above issues concerning procurement practices in the Greek construction industry. The findings indicate that although there is a sufficient knowledge in the use of green products associated with sustainable procurement practices implemented in the Greek construction industry the use of green products is limited due to barriers such as product price, purchasing habits and relationships between purchasers and suppliers.

The results of this research indicate that the most important factors concerning the implementation of procurement practices in the Greek construction industry were strategy development, goal setting and organizational support.

Based on the findings of this paper, a number of measures could contribute in initiating the process of entrenching green procurement in the Greek construction industry. These measures can be classified into two broad categories related to general or specific policy (i.e. construction policy): a) General policy measures and b) Construction policy measures

The general policy measures should focus on the development of existing legislative framework for integrating environmental considerations into public procurement.

Construction policy measures should include an appropriate legislative framework regarding sustainability in construction. The legislative framework regarding sustainability in construction should be revised in order to encourage the use of green products supporting not only the procurement process but all the stages of the whole procedure towards sustainability.

We conclude that future research should be conducted using the same or other more extended questionnaires and should involve a comparison of the results with those of other methodological approaches. Alternative methodological approaches for identifying the above factors towards green procurement would be the Delphi technique and/or the analytical hierarchical method using pairwise comparison.

REFERENCES

Chan, Albert P. C., Yung, Esther H. K., Yam, Patrick T. I., Tam and C. M. Cheung, S. O. (2001) “Application of Delphi Method in Selection of Procurement Systems for Construction Projects“, Construction Management and Economics, Vol. 19, No 7, pp 699-718.

Love, P.E.D., Skitmore, M. and Earl, G. (1998): “Selecting a suitable procurement method for a building project“, Construction Management and Economics Vol. 16, pp. 221- 233

Watuka J. and Aligula EM. (2003) Sustainable construction practices in the Kenyan construction industry: The need for a facilitative regulatory environment

Improvement and Development Agency for Local Government IDALG (2003). Sustainability and local government procurement, London

Green Procurement (2008), Business and sustainable development: A global guide, available at: http//www.bsdglobal.com/tools/bt_green_pro.asp

Sustainable Procurement Group SPG (2003).Report and recommendations of the sustainable procurement group, January 2003, available at: http//www.sustainable-development.gov.uk/ documents/publications/report03.pdf

Commission of The European Communities CEC (2001). Commission Interpretive Communication Communication on the Community law applicable to public procurement and the possibilities for integrating environmental considerations into public procurement, Brussels, 4.7.2001, COM(2001) 274

Karanastasis, M. (1998) 'The new legislation on public procurement (public legal entities, public authorities and public enterprises), Athens (in Greek)

ASSESSMENT, REVIEW, AND EVALUATION OF THE PROJECT MANAGEMENT EDUCATION AND TRAINING PORTFOLIO

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The paper presents a portfolio approach that facilitates strategic planning for education programs and trainings, and guides the operational activities. The portfolio approach assure a holistic view of all education programs, and trainings delivered by the organizer, assuring that all education programs are aligned with the strategy and the selection and assessment of the new and ongoing education investments are made properly. The roles and responsibilities, and other organizational issues related to the portfolio management are presented, An important part of the paper deals with the education programmes evaluation. The paper address this issues using a case study developed for the Academy of Economic Studies is finally discussed.

KEYWORDS: project management, education, training, portfolio.

INTRODUCTION

The Academy of Economic Studies (AES) is a national university. The education and training programmes are delivered based on a public budget, coming from the Education and Research Ministry, and also on its own resources. It also has freedom and autonomy according the law. AES is considered a remarkable representative of superior economic studies in Romania. The university has 10 faculties, over 49.000 students and course attendants; 35500 - graduation cycle, 9400 - master programmes, 2500 - PhD enrolled, over 1600 in academic schools and post-graduation courses and 2000 didactic staff and technical and administrative personnel.

In 2009-2010, AES will deliver more than 192 education & training programmes, 12 of them having Project Management as specialization ([AES 2009]). More than 80% of the education & training programmes have PM topic included as disciplines or modules (see Table 1).

Table 1: AES Education & Training portfolio for 2009-2010

AES Education &Training Programmes	Total Number	PM Programmes
Bachelor's degree in Economics	13	0
Continuing education (Trainings)	75	6
Scientific Master's degree	29	1
Professional Master's degree	46	4
International Master's degree	9	0
Online Professional Master's degree	10	1

Doctor's degree	10	0
Total	**192**	**12**

AES mission

AES promotes the economic values, the administrative and judicial ones, together with the science and universal culture values. Its commitment is to achieved excellence in economic education, and so to ensure the next generation of economists and administrative specialist is fully prepared for success on the workforce market. Based on competencies high level and responsibilities that AES has for the Romanian nation, it has the following goals in his mission:

a) to educate and train qualified and high qualified personal for the economic, administrative and social domain;
b) to promote free mind and critic spirit and the spirit of economic, juridical, and administrative knowledge;
c) to continue develop the scientific research within economic, judicial and administrative domain, being connected with institutions of the same kind from the country and from all over the world;
d) to develop programs regarding entrepreneurial activity;
e) to promote the human culture and civilization;
f) to defend the democratic academic framework based on fundamental liberties and human rights within a democratic state;

AES wants take a leading role in increasing the interest in economic, juridical, and administrative sciences, as few other academies and organizations can through its unique mission, workforce, facilities, research and innovations. AES is also taking a leading role to make significant impacts in engaging underserved and underrepresented communities in economy.

AES Education & training portfolio management – the framework

The success of AES's education portfolio depends upon *strategic planning* across the University. To succeed in his mission, the University tries to ensure that workforce requirements are identified and met and the education efforts are aligned and focused on building the future workforce in the specific domain. That's why it reaches the following *priorities*:

- to train specialists in economy having the specializations: business administration, cybernetic economics, accounting and management information, agro food economics, commerce economics, general economics, enterprise economics, environment economics, finances and banks, applied mathematics, management, marketing, international business, economic statistics and previsions, public administration and other according to national economy needs;
- to train specialists using programs that are using for teaching foreign languages;
- continuing education through programs like: master programs, PhD programs and postgraduate programs;
- developing fundamental scientific research and applied through faculties, research centers, laboratories and departments;
- entrepreneurial activities that contain consulting programs, special assistance, business incubators;

- recalling scientific performances of the academic community members by having organized reunions at national and international level;
- offer education for foreign students.

The AES charter contents the coordination framework that aligns the University's total education portfolio with a strategic plan, provides a coordination structure, and creates a wide strategic planning implementation and evaluation framework for the investment in types of education of the University. The document builds on the education goals. Three of most important *goals* are:

a) *strengthen AES leading role in promoting economist profession in Romania* – University will identify and develop the critical skills and capabilities needed to achieve the vision for its specific domains. To help this demand, the University will continue to contributing to the development of the nation's economy workforce of the future through a diverse portfolio of education initiatives that target Romanian's students at all levels.
b) *attract and retain students in economy, judicial and administrative disciplines* – to compete effectively for the minds, imaginations, and career ambitions of Romania's young people, AES will focus on engaging and retaining students in its education programs to encourage their pursuit of educational disciplines critical to University's future, economic, judicial and administrative missions;
c) *engage Romanians interested people in University' missions* **–** AES has already and will build more strategic partnerships and linkages between economic, judicial and administrative formal and informal providers. Through hands-on interactive, educational activities, AES will engage student, educators, teachers, specialists, families, the general public and all University external stakeholders to increase Romanian's economy, judicial and administrative literacy.

In addition to the university values and strategic management priorities, the AES education portfolio is established upon some *operating principles* to ensure programs alignment and excellence. The principles are integral to the conduct of, and apply collectively to, all AES education programs. They form the foundation for evaluation of both new and existing education investments. The AES applies the following operating principles:

- *Relevance:* To effectively strengthen the nation's economic, judicial and administrative workforce, AES must implement activities that are useful to the education community and that strengthen their ability to engage students in the University activities and programs and in the future in the economic life of the society.
- *Content:* Education investments use University content, people or facilities to involve educators, students, and/or the public in AES activities and plans, technology, business experts, lawyer and people with a vast experience in practice.
- *Diversity:* AES strives to ensure that underrepresented and underserved students participate in University education and research programs to encourage more of these students to embrace a carrier in economic domain.
- *Evaluation:* Education investments document their intended outcomes and use metrics to demonstrate progress toward and achievement of these outcomes and annual performance goals. Evaluation methodology is based on models and techniques appropriate to the content and scale of the targeted activity, product, or program.
- *Continuity:* Projects and activities draw from the obtained results that have already demonstrated the efficiency of the programs University. Many projects and activities encourage continued young people affiliation with AES throughout their academic career.

- *Partnerships/Sustainability:* Education investments achieve sustainability through their intrinsic design and the involvement of appropriate local, regional, and/or national partners in their design, development, or dissemination. Key aspects of projects and activities are replicable, scalable, and demonstrate potential for continuation beyond the period of direct AES funding.

The AES Education Outcomes and Operating Principles can be mapped onto the Education Strategic Framework Pyramid (Figure 1). It can be found here the planning, implementation, and assessment of framework of the AES Education Portfolio.

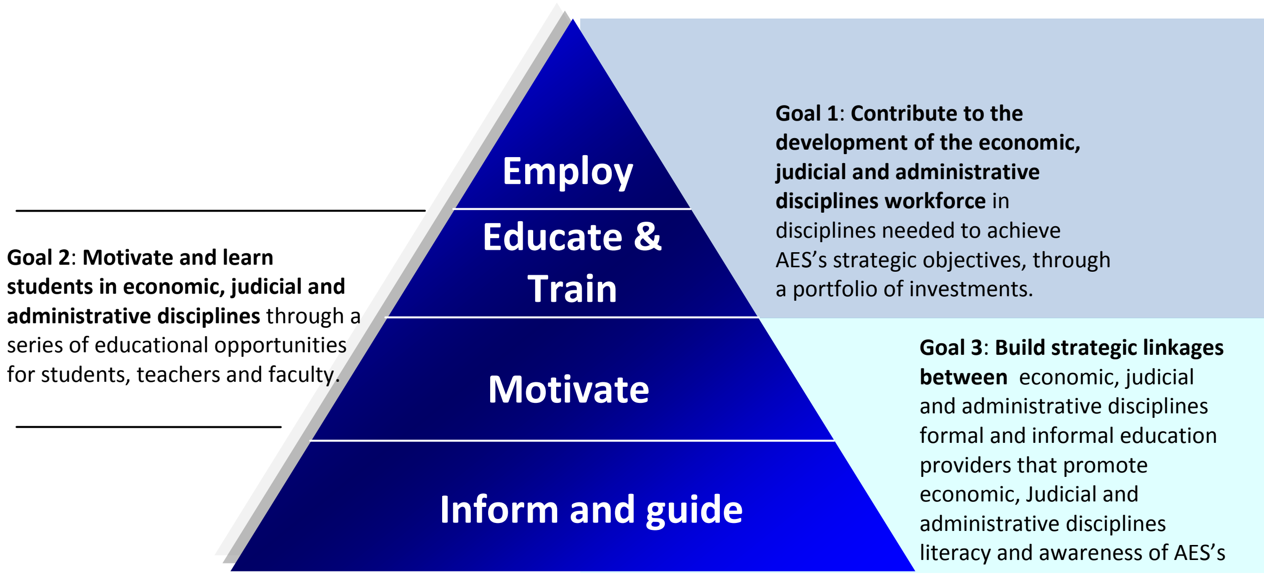

Figure 1: The Education & Training goals

The management of AES's education efforts allows through the portfolio approach a holistic view of all University education programs, projects, products, and activities as:

- Ensures that all education programs, projects, products and activities are aligned with the university strategic plan.
- Coordinates programs, projects, products, and activities in a broader context so that they work together to achieve AES's education goals.
- Guides selection and assessment of new and ongoing education investments.
- Facilitates performance evaluation, assessment, and accountability reporting, as well as communication of program status within AES and to external stakeholders.
- Identifies programmatic gaps and/or redundancies and guides investment strategies.
- Aids in development of annual performance goals.

Mechanisms for Education & Training Portfolio Management in a Distributed System

Strategic management of the AES education portfolio requires the participation of the Educational Programs Department (EPD), faculties and departments of the University. This extensive participation provides broad education engagement with the economic content, people, and facilities. Close and effective consultation, coordination, and cognizance among all entities are critical to the optimal fulfillment of AES's objectives relative to its education investment. A coordinated and effective university education portfolio requires clear roles, responsibilities and a very well-defined management processes.

Different authors addressed the education & training portfolio management issue, most of them proposing multi-criteria decision-making processes. In (Mustafa and Goh, 1996) we can find a comprehensive analysis of literature recommendations. (Politis and Siskos, 2004) proposed an educational portfolio evaluation model for enhancing the educational quality and internal organization of an engineering department inside of a Greek university. In (Caballero et al, 2001), a goal programming approach is proposed in assigning financial resources within a university system.

Education & Training Portfolio Management - Roles and Responsibilities

Vice-Rector (VR) is responsible for the Education Portfolio, reporting to the Senate and to Rector. The VR for Education supervise the Educational Programs Department. and ensures the overall planning, coordination, and integration of the University's entire education portfolio. According to results received from EPD the VR submit to University Senate proposals for decision. Based on these proposals, the senate provides integration and evaluation support to external stakeholders. EPD maintains a centralized database of all University education activities and coordinates the evaluation and assessment of education portfolio.

The Educational Programs Department (EPD) and Business Environment Relationships Department (BERD). The Educational Programs Department is responsible for ensuring compliance with external requirements and laws, processes, procedures, standards, audits, and accounting related to education. It also provides the leadership for coordinating education strategic framework, implementation approach, and policies. BERD assures that the programs are according to market needs and advises the EDP what must be changed. BERD also has relationships with External Stakeholders. The EPD and BERD provide national partnership networks and infrastructure to disseminate AES education content and activities developed by the faculties, commissions, PRS, programs directors, departments and other education partners and collaborators. The integration and evaluation results are aggregated to demonstrate the total impact of AES education efforts and assessed to provide data to the stakeholders to improve the effectiveness of the overall education investment strategic framework.

Other university departments and internal stakeholders are responsible for embedding education components into their research and development programs.

Educational Suppliers: Faculties and Continuing Education Department (F&CED). Faculties and Continuing Education Department (CED) are responsible for implementing the university education programs, projects and activities. They plan and implement education programs that are unique and funded by their Pro-Deans, Deans and Program Directors. They are also responsible for execution of programs and projects and for institutional assets, provide expertise in state standards and requirements in their area of geographic responsibility and provide valuable field-based input into education program planning.

Education & training Programme Directors and Deans. Programme Directors and Deans are responsible for making and executing decisions within their authority. Accordingly, they have authority over the budgets, schedules, and human and capital assets for their programs.

External Education Implementing Partners. External Education Partners include organizations that implement education activities for the University. The implementing partners include contractors, academic institutions, business organizations, business centers and other outside entities. Most external education implementing partners are competitively selected and offer specific areas of expertise of use to the University (for example SIVECO Company).

External Audit Bodies (EAB). These institutions are used to perform regular performance evaluation at each level. They try to identify the problem areas and to discover opportunities for better management. Their actions lead the university to greater organizational effectiveness and guiding investment strategies.

University Senate and Specialized Committees. The university senate is a collaborative structure that maximizes university's ability to maintain an integrated education portfolio and strategically manage the implementation of numerous programs, projects and activities in a distributed system. They receive from external Reviewers information about what they have to change in their program. They also send a feedback to Educational Suppliers according to information received from External Reviewers.

Education & Training Portfolio Management - Processes

Figure 2 presents the main processes of the education & training portfolio management.

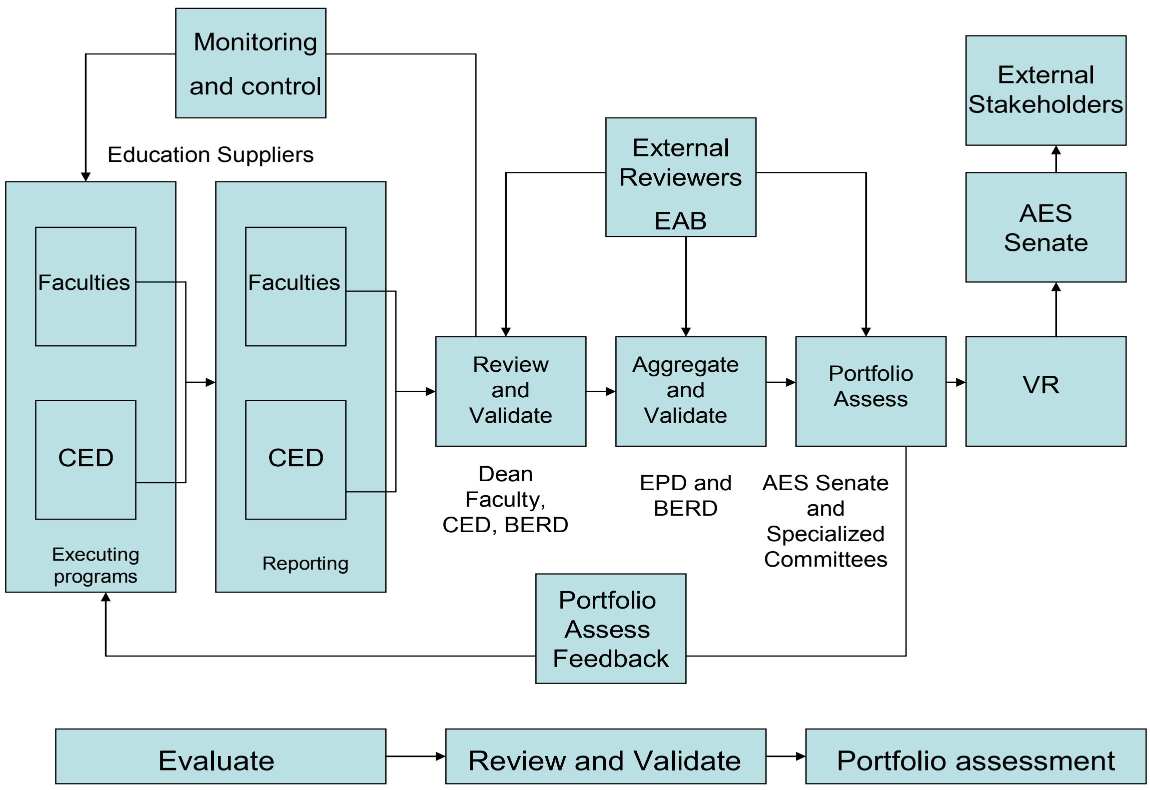

Figure 2: The main processes of the Education & Training Portfolio Management

AES success in implementing its education portfolio is determined by the university management ability to accomplish the proposed goals. It uses performance metrics, regular review processes, and defined tools to assess its performance at all level—portfolio, goals, and the individual program. It will be a direct connection between “Review and Validate” position, represented by the Faculty leader (Dean, Pro-Dean) and Educational Suppliers that handle the “Executing programs”. “Review and Validate” sends information based on information received from External Reviewers. This fact optimized the results send to Educational Suppliers. Effectual consultation, coordination, and cognizance among all entities are critical to the optimal fulfillment of AES’s education investment.

Education & Training Programmes Evaluation

AES’s education portfolio is evaluated in some steps from the beginning of the process. First, an external reviewer evaluates the results of internal reviewer and valuator, then the activity of ADP, then the Senate and specialized commissions. After that, the last one sends a feedback to Educational Suppliers.

The management of education programs/projects complies with current AES directives on program and project management, processes, and requirements. The evaluation plans will measure intended impact and be scaled appropriately to the size of the investment— “one size does not fit all.” The Programmes Directors regularly monitor and evaluate the programs, and report the results of those evaluations to their funding organizations. The main tool for the education programmes evaluation is the student opinion survey.

The figure 3 presents some examples taken from *Computerized Project Management*, one of the PM master degree programme (MIP 2008).

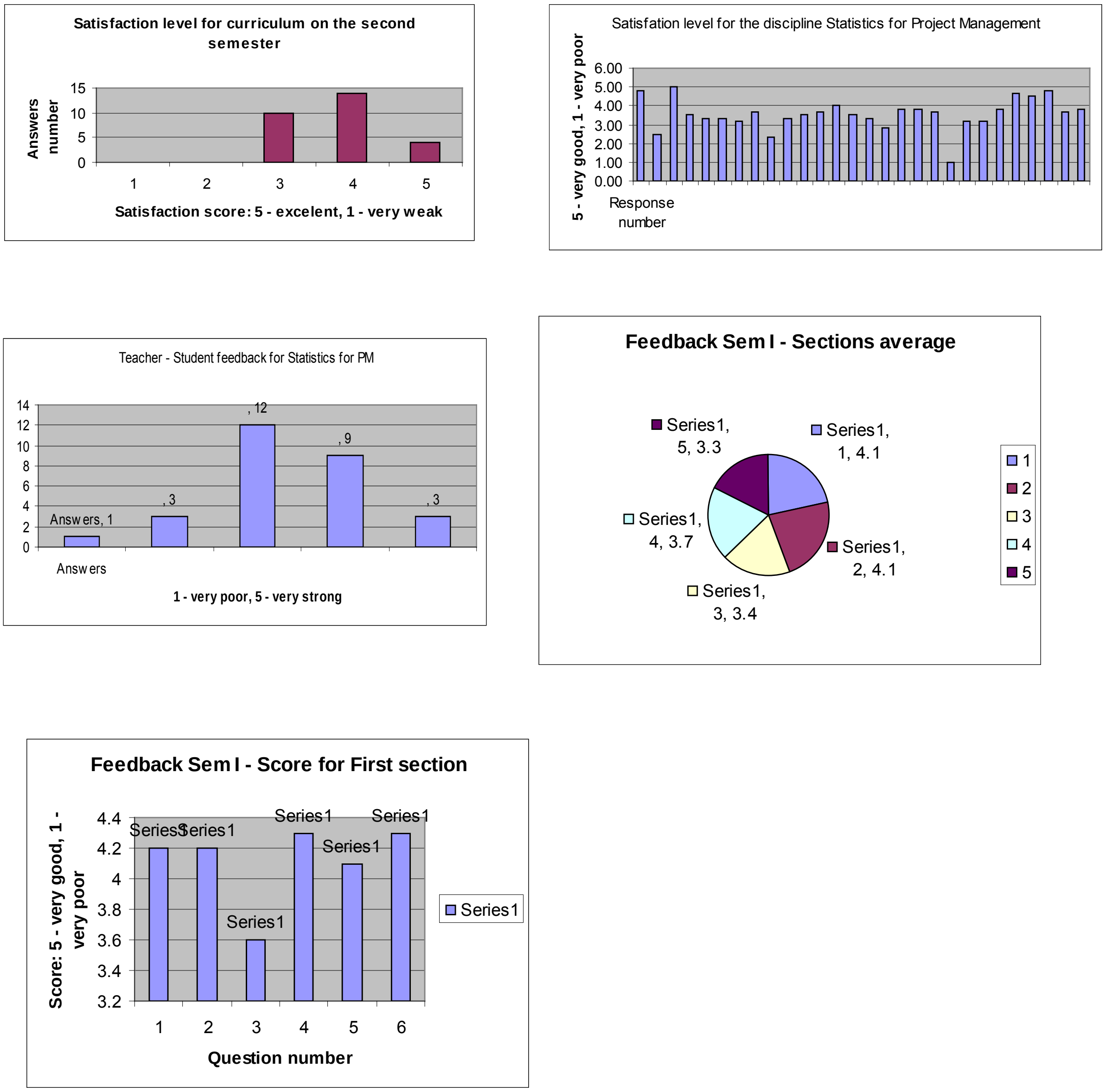

Figure 3: Evaluation of the *Computerized Project Management* master degree programme.

Review and Validate

The review and validation are made by the Educational Programmes Department. The tools used are:

- A common database and format used with a very detailed information about the content of the education & training programmes (see figure 4) and required resources (academic staff and software). This database is used for the results interpretations and for further decisions.
- The ability to trace budget and actual costs from a single project up through the university education. It is very important to know how much the University can spend with a program/project/activity.

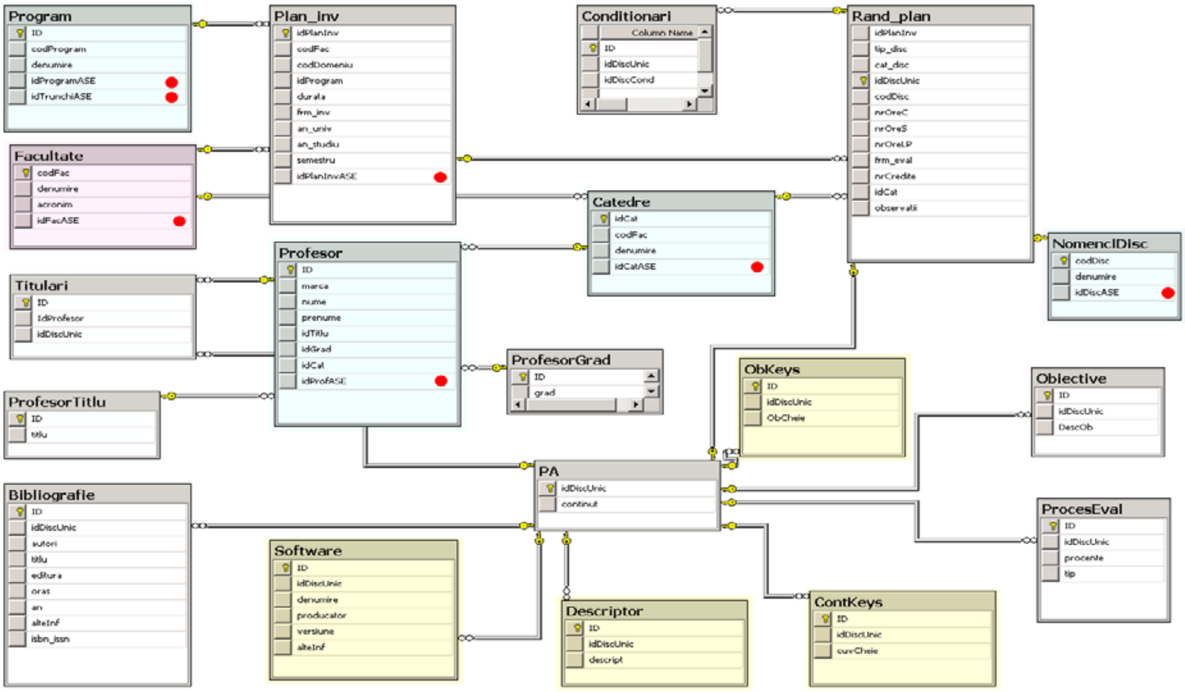

Figure 4: The structure of the database used by Educational Programmes Department

Portfolio Assessment

In carrying out its role of assessing and guiding the total portfolio, the Senat and its committees have the ability to:

- Measure performance, including key performance indicators and metrics.
- Monitor ongoing status of operations, events, and resources.
- Set overall performance goals for the University.
- Establish measures and criteria for monitoring progress.
- Ask input from external reviewers on the status of the overall portfolio and future trends/needs in economic education related to AES's workforce needs.

CONCLUSIONS

The success of AES's education portfolio depends upon *strategic planning* across the University. Strategic management of the AES education portfolio requires the participation of the Educational Programs Department (EPD), faculties and departments of the University. This extensive participation provides broad education engagement with the economic content, people, and facilities. Close and effective consultation, and coordination among all entities are critical to the optimal achievement of the AES's objectives relative to its education investment. A coordinated and effective university education portfolio requires clear roles, responsibilities and a very well-defined management processes.

REFERENCES

AES (2009) Public information, available at: www.ase.ro

Caballero R., Galache T, Gomez T., Molina J., Torrico A. (2001), Efficient assignment of financial resources within a university system. Study of the University of Malaga, in: European Journal of Operation Research. No. 133, pg 298-309.

MIP (2008) Student Survey Results, available at: www.mip.pm.org.ro

Mustafa A, Goh M. (1996). Multi-criterion models for higher education administration, Omega, in: International Journal of Management Science, no. 24, pg. 167-178.

Politis Y., Siskos Y, (2004). Multicriteria methodology for the evaluation of a Greek engineering deparment, in: European Journal of Operation Research. No. 156, pg 223-240.

INSIGHT OF THE CURRENT STATE OF APPLICATION AND DEVELOPMENT OF IT IN THE CONSTRUCTION AND PROJECT MANAGEMENT FIELDS IN CROATIAN CONSTRUCTION AND CONSULTANT FIRMS

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The development and implementation of information technologies (IT) in project management enables a qualitative shift in the construction and project management field. Regarding the quick development of IT there is a constant need for education in specialized software application for users which are employees of construction and consultant firms. The Polytechnic of Zagreb e.g. its Department of Civil Engineering is conducting a Polytechnic graduate study, the only one of its kind in Croatia. The fore mentioned study is organised for additional education and the continuation of study for the engineers that are already employed – more than 90% of the students are employed in the Civil Engineering profession. To get a better insight on the education of employees in the application of IT in the construction and project management field we will conduct a survey among students studying on the mentioned study. In that way we will get an insight of the current state of application and development of IT in the construction and project management field. We will also get guidelines for future research in the methods of enhancement and implementation of IT in Croatian construction and consultant firms.

KEYWORDS: IT, survey, construction management, project management.

INTRODUCTION

IT in construction and project management

In the last 30 years or more, there is a large development of IT and its application in various areas of human activity, and so in the area of construction engineering. In the beginning the application of IT in construction engineering was mainly concentrated on CAD and large number-crunching software. Other aspects of IT application were left in the domain of special application which had no larger impact on construction engineering as a whole. With quick development of computers (PCs, notebooks, handhelds, etc.) and drastic increase in their computing capabilities, it was possible to introduce IT in more or less every area of construction engineering, thus in construction and project management.

Regarding the quick development of IT in general, and IT in construction and project management, there is a constant need of investment in education and training in the application of specialized software tools. These tools help employees (managers, consultants, engineers, etc.) to easier plan, track and organize projects. Currently there are many software solutions available on the market, and they differ in their capabilities and the amount of user knowledge needed for their application. It is important to mention that these tools cannot replace human knowledge in construction and project management fields, and that they are solely used as auxiliary tools. Their biggest advantage is to ease those parts of the process which are mathematically or graphically difficult.

Polytechnic graduate study

The Polytechnic of Zagreb e.g. its Department of Civil Engineering is conducting a Polytechnic graduate study – Construction engineering specialization, the only one of its kind in Croatia. The fore mentioned study is organised for additional education and the continuation of study for the engineers who completed the six semester polytechnic graduate professional study programme and are already employed – more than 90% of the students are employed in the Civil Engineering profession. The duration of the study is 4 semesters, but because of the fact that the vast majority of the students are employed and that they are studying whilst working full time, the duration of the study is extended to 3 years instead of the usual 2 year period needed to complete the 4 semesters.

The age of the students varies from approximately 25 to 50 years of age, and their working experience varies from as little as 1 year to a 30 year long period. The average age of the students is about 30 years and the working experience is about 10 years. Because of their working experience the students can give a valuable insight on the situation regarding the general state of application of IT in Croatian construction and consultant firms. For that reason we conducted an electronic survey among the students in which we tried to collect the data about the general state of application of IT and the data needed to get guidelines for future research in the methods of enhancement and implementation of IT in Croatian construction and consultant firms

Bearing in mind that the students are, among other knowledge, involved in the education regarding PM subjects, the purpose of the survey was to get their opinion about the general state of application of IT in Croatian construction and consultant firms. The survey idea was to analyse the IT parameters regardless of the variability of the company’s core business; because of the relatively small Croatian construction and consultant market.

THE SURVEY

The survey conduction

The survey was conducted among the first and second year students of the fore mentioned study. They were given a questionnaire in which they had several types of questions divided into three main groups. The first group of questions was about the general aspects of the firm in which they are currently employed (number of employees, ownership structure, main activities of the firm, geographical area of operation, and organizational structure). The second group of questions was about the general state of application of IT in the construction and project management field in their firm. The third group of questions was about the potential of future application and development of IT in the construction and project management field in their firm.

Some questions had offered answers from which the students had to choose the most appropriate one; the offered choices were written in such a way that they covered the most probable answers the students could give. Regardless of the offered choices there was a possibility for the students to answer with an answer of their own but as it turned out very few answers were given in that way.

There were a few examples where there were two or more students from the same firm. In that case we separately analyzed their questionnaires, but the analysis showed no great discrepancy in the student's answers that was significant to the survey results.

The distribution of the questionnaire to the students and their replies were all done by e-mail.

The survey results

General aspects of the firm

We sent the questionnaire to approximately 200 students. Majority of the students are studying on the second year of study, and some on the first year. A total of 105 students replied to us, those students working in 96 different firms. About 87% of these firms were dominantly private owned and the rest (13%) were dominantly state owned.

More than 95% of the firms reported more than two main business activities; their main business activities were building construction (60%), building design and planning (47%), engineering (46%), consulting (40%), building maintenance (20%), machinery and transport (13%) and building materials manufacturing (7%). Their average number of employees is approximately 370, but it is important to mention that 85% of the firms have less than 200 employees, 10% have between 200 and 1000 employees and only 5% have more than 1000 employees.

Regarding the geographical area of operation; 73% of the firms operate only in Croatia, 20% operate only in their local district, and only 7% operate in Croatia, neighbouring countries, South-eastern and Eastern Europe and other continents. None of the surveyed firms currently operates in the area of Central and Western Europe.

The last question regarding the general aspects of the firm was about the organisational structure, and the results were as follows; 13% of the firms have a functional organisational structure, 33% have a matrix organisational structure, 33% have a project oriented organisational structure and 21% have a business process oriented organisational structure. To better comprehend the question about the organisational structures, the questionnaire contained an appendix with a detailed explanation of the structures so that the surveyed students could give an exact answer.

General state of application of IT

With the second group of questions we tried to determine the current state of application of IT in the construction and project management field in the surveyed firms. Unlike the first group of questions, the second and third group of questions required a more personal opinion while answering them, and for that reason the answers given reflect the employees' view of the general state of application of IT.

The surveyed students had to give a grade from 1 to 5 about the current state of application of IT in the construction and project management field in their firm, 1 being the worst and 5 being the best grade. The average grade given was 2.9, and the grades were given in the following percent; 1 – 20%, 2 – 13%, 3 – 27%, 4 – 40%, none of the students gave grade 5 (Figure 1).

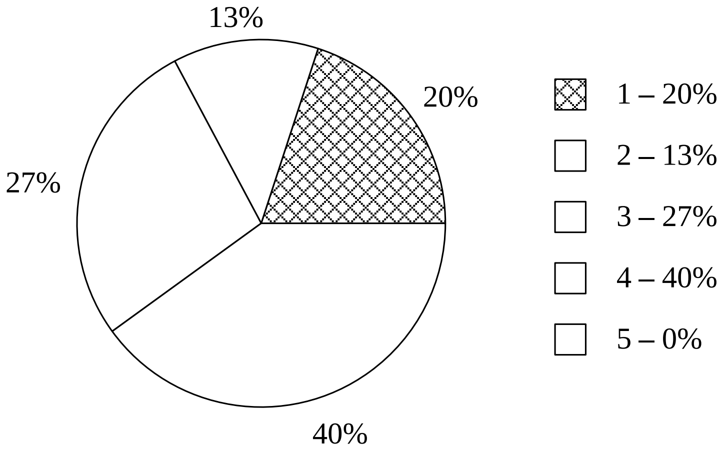

Figure 1: With a grade from 1 to 5 (1 being the worst and 5 being the best grade) how would you grade the current state of application of IT in the construction and project management field in your firm?

Some of the main questions were those regarding the use of specialized software in the management process. We asked what kind of specialized software if any is used in their firm and what is the extent of application of those specialized software. The dominant software which is in use is Microsoft Project 2003 (71%) and in certain extent Microsoft Project 2007 (18%), the rest of the software used are some of the Oracle Primavera tools (3%) and some very specialized custom made software specific to the firm for which it was produced (5%). The rest of the surveyed students (3%) said that their firms are not using any specialized software at all, but they would like to use it (Figure 2). They also said that they think it would be of great help to start using the software, because they have seen in it perform in their classes and in various partner firms.

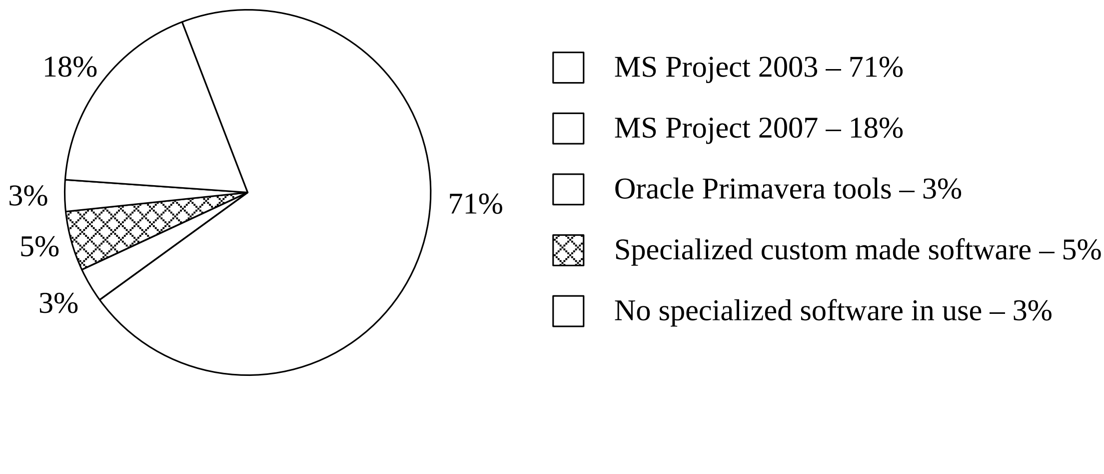

Figure 2: What kind of specialized software if any is used?

Other than the specialized software like the MS Project and Primavera tools, almost all of the surveyed students (92%) use software packages like the MS Office and Open Office for various purposes in the management process. The most common IT subsystems used are those concerning accountancy (80%), financial assets management (67%), CAD – Computer Aided Design (60%), biddings and bill of quantities (53%), and project management (47%), with a large use of internet/intranet in more than 80% of the firms. The least used IT subsystems used are those concerning work orders (7%), material assets management (13%), GIS – Geographic Information System (13%), and machinery and transport management (20%).

Unfortunately on the 1 to 5 scale all surveyed students graded theirs and their colleagues' knowledge of the software that they use with an average grade of 2.5. Many of them (70%) say that they are self taught and that they would like to get professional education.

One of the reasons for the rather poor application of specialized software is that the investors are rarely demanding project planning and tracking (33%) and that they often do not demand any project planning and tracking at all (67%). Most of the students (80%) say that their firms do not take services from professional firms which are engaged in project planning and tracking.

According to the surveyed students, 73% of them say that their firms are using all of the following ways of official communication; by phone, by mail, by fax, by e-mail or orally by personal contact. The rest of the 27% say that their firms use communication mainly by phone, by fax or by e-mail.

In the aspect of market efficiency, only 27% of the students think that the IT application in their firm is one of the critical factors of their firm's market efficiency in the past year and in the year to come. Regarding long term strategy, 60% of the surveyed students said that the long term application and development of IT and specialized software is a part of the long term strategy of general development in their firm.

Potential of future application and development of IT

At the end of the questionnaire we asked the students some questions about the future application and development of IT in their firms. All of the questions offered more than one possible answer. Regarding the fact that a vast majority of the firms are using the specialized software like the MS Project, we asked the students questions what would happen if their firm would more efficiently use them.

The surveyed students think, that if their firm would more efficiently use specialized software like the MS Project, that it would get the next strategic advantages: more efficient monitoring and control (73%), competitiveness enhancement (46%), better communication between project teams (33%), better relations between the firm and its suppliers/subcontractors (33%), and company image enhancement (27%) (Figure 3).

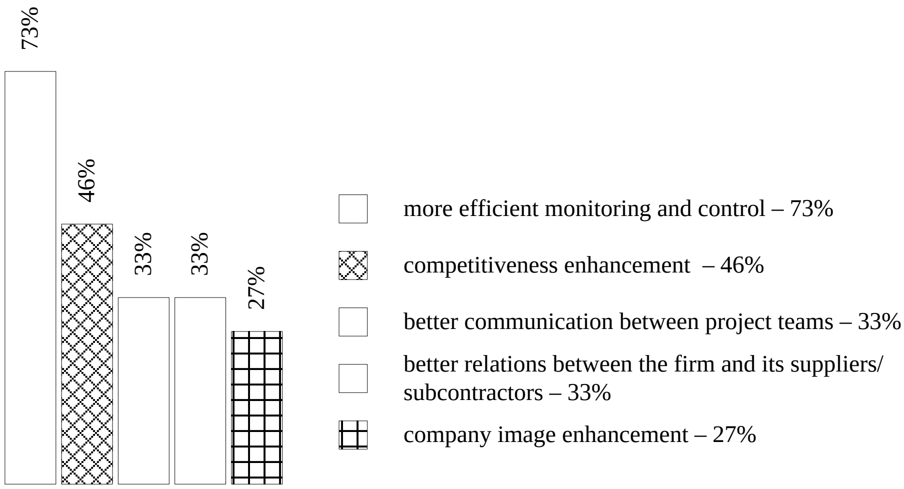

Figure 3: What strategic advantages would your firm get if it would more efficiently use specialized software like the MS Project?

More than 80% of the students think, that if their firm would more efficiently use the specialized software, it would generally help improve the compliance with the contracted deadline in a way that it could help them to easier monitor the activities of the project, 67% of the students think that bottleneck reduction would occur, and 53% think that it would ease the procedure of regular reporting.

When it comes to cost savings, 80% of the students think it would improve financial tracking, 47% think that it would greatly reduce the amount of paper documentation, 40% think that it would reduce the work needed for paper administration, and around 17% think that it would reduce phone, mail and travel expenditures (Figure 4).

From the business quality improvement aspect, 80% of the students think that it would help to easier identify and track mistakes, 60% thinks that it would decrease unnecessary redundant work, 60% thinks that it could ease the process of coordination with contracted procedures, and 47% thinks that it would increase the quality of documentation (Figure 5).

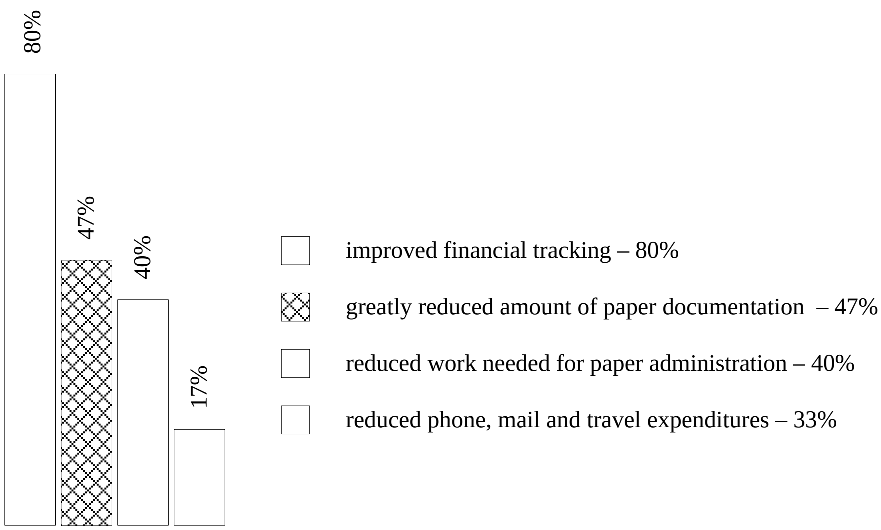

Figure 4: How would a more efficient usage of specialized software like the MS Project affect your firm from the cost savings aspect?

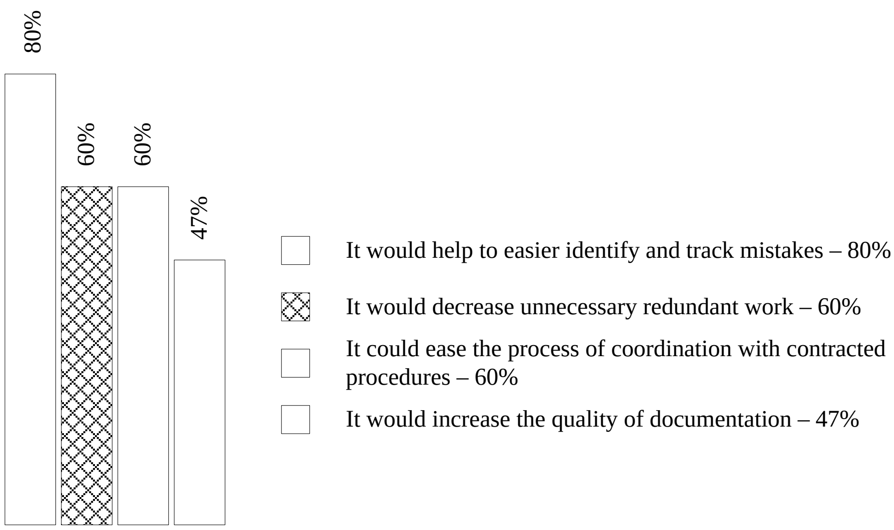

Figure 5: How would a more efficient usage of specialized software like the MS Project affect your firm from the business quality improvement aspect?

CONCLUSIONS

After summarizing the given answers and opinions the following conclusions could be rendered.

Although a large number of firms use specialized software and IT in general, the general state of IT usage still needs improvements. For example, large numbers of firms use specialized software like MS Project but they use only a small portion of the software features and capabilities. Employees use powerful planning and tracking software as a mere replacement for a drawing board and pen. It is mainly used to quicken the process of drawing large diagrams and plans like the gantt chart or network diagram, while tracking capabilities or resource levelling options are not used at all.

The employees need constant education and training, because the IT area is evolving rapidly it is hard to keep pace with it. That education and training can be provided in various ways like the lifelong learning process, which is important for every employee, from the lowest ranking worker to the top managers.

Large numbers of firms use some kind of standard software packages like the MS Office and Open Office for various purposes in the management process, which is very commendable, but again the employees are usually self taught and lack adequate education and training through specialized seminars and workshops.

The employees embraced some of the new communication technologies and it is very good that the firms are providing them with internet access, mobile phones or faxes, because it greatly helps to improve team communication.

The investors should also be more demanding regarding project planning and tracking, because they don’t insist on the project tracking procedures which can greatly reduce project setbacks and cost savings.

One of the most satisfying facts is that all of our surveyed students realize the importance of education, training and learning, and they also realize that lifelong learning process are very important for them in their career advancement. They also realize the importance of specific software solutions which can greatly improve all of their project planning and tracking processes, and which can become one of the biggest business quality movers in the future.

In the end this survey provided us with great insight about the current state of IT implementation in Croatian building construction and consultant firms, and it will be a great starting point for future research in the subject.

REFERENCES

Žerjav V. (2009), “Znanstveni projekt – Razvoj informatičke tehnologije u hrvatskom graditeljstvu – anketni upitnik”, available at: http://moodle.srce.hr/mod/questionnaire/view.php?id=6439

Izetbegović J., Orešković M., Bandić M. (2003) Application and development of information technology in the civil engineering sector in Croatia, GRAĐEVINAR 56 (2004) 8, 481-488

Pauše Ž. (1988) Vjerojatnost, Zagreb, Školska knjiga

Pauše Ž. (1993) Uvod u matematičku statistiku, Zagreb, Školska knjiga

Izetbegović J., Žerjav V. (2009) Organizacija građevinske proizvodnje, Zagreb, University of Zagreb – Faculty of Civil Engineering ; Croatian Association for Construction Management

Marmel E. (2006) Microsoft Project 2007 Bible, John Wiley & Sons

THE MBA IN CONSTRUCTION SPECIALIST MASTER PROGRAM

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The MBA in Construction program launched at the University of Zagreb is specially designed and adapted to the specific needs of the construction industry, as “general” MBAs are not always suitable for engineers holding managerial jobs in companies and/or in construction projects. The program is the result of research conducted at the University of Zagreb and in the Croatian construction sector. How to sustain the continuity of quality university education while taking into account the reality of the lack of time for education is a problem that faces not only students and their future employers, but in the first place university teachers who are expected to pass on knowledge.

KEYWORDS: MBA, construction sector, postgraduate course.

INTRODUCTION

One hundred years ago, in 1908, the Harvard Business School was established as the first school for business administration. For decades the MBA qualification was offered only in the US. Later, from the 60-ties, European business schools also started to offer MBAs and MBA programs and curricula have gone a long way and are today taught all around the world. The last fifteen years have seen a massive expansion of providing Master of Business Administration (MBA) degrees around the world, with virtually every university-level business school having one, and some having more than one.

The supply of venues largely exceeds the demand as the market is flooded with a range of MBA programs offering different modes of delivery (there are one-year and two-year degrees, full-time and part-time degrees, campus-based versus distance learning MBAs, general MBA versus “specialized “) and, which is even more important, with different quality of knowledge offered to the students.

Knowing all this, one may wonder if it makes any sense to start yet another specialised MBA program? Is the MBA a global qualification? Does one size fit all? Are we in fact doing students a disservice by offering them an MBA in Construction?

WHY AN MBA?

The objective of an MBA course, according to Kempner (as cited in Kretovics, 1999), is “to develop managers who will run efficient, profitable enterprises in a competitive world for the creation of wealth in society”. Boyatzis (et al., 2002) sees the objective of graduate management education as preparing people to be outstanding managers and leaders.

MBAs are expanding, and are proclaiming their individuality and distinctiveness. According to Purcell (2005), the European MBA market has grown by almost 40 per cent over the last ten years. Examining the UK MBA market, Armstrong (2005) states that there has been a 31 per cent rise in part-time students during the last decade, a 23 per cent rise in distance learning and a 57 per cent rise in full-time student numbers over the same period. Burnson, 2003, reports a “significant rise” in MBA students from Europe going to study in the USA. Ters (2003) reports a significant increase (“several hundred students”) in the number of Russian students studying for MBAs at Western business schools. There has also been an “MBA boom” in China Hulme (2004) with 10,000 students enrolled in MBAs in 2001 (contrasting with 100 enrolled students in 1991.).

Basically MBAs have developed along “capitalist” market principles and represent a Western interpretation of management and leadership. They were always perceived as an “elite” business qualification for potential leaders and senior managers.

An MBA specialization is the most highly respected qualification in business. The knowledge of how to manage western-style organized companies effectively is of paramount importance and very much in demand for all kinds of managers-to-be in Croatia. Thus the huge need for “western-style” business education and the growing demand for MBA courses in our part of the world.

To conclude, the aims of all MBA programs are very clear - to prepare their graduates for managerial roles, help them gain a better understanding of the industrial and business world and its needs, enrich their skills and provide them with competences relevant to their careers. So there is no doubt that we need the kind of education provided by an MBA. But the best method of delivering knowledge to MBA students is yet to be decided.

MBA IN CONSTRUCTION

When it comes to the construction industry, the MBA programs offering “general managerial training” have to be modified, as they are not completely appropriate for the needs of construction managers. Construction differs fundamentally from all other industries because in a “normal” industry the product changes its place and the production factors (people and machinery) are static. In construction it is the opposite – the product (the site, the building under construction) is static and does not change its place. When the “production process” is finished “the product” stays where it was made, while the production factors (people and machinery) move on to the next location – to the “next product”.

Croatian civil engineers, for years have been successfully heading building and construction companies and various large-scale projects all over the world. They proved their technical knowledge, skills and expertise while working in different economic and political environments. However, very often they had problems in managing companies and projects (particularly in efficiently managing time and costs/finances), as they had no formal knowledge or training in management and/or project management.

Every manager knows well that the higher his/her position in the managerial structure is, the less he/she has “to do” with solving technical/professional problems and the more time and energy he/she spends in solving “all the other” problems in the company.

A survey Katavić, Đukan (1989) was carried out among engineers, graduates from the Faculty of Civil Engineering, University of Zagreb (generations from 1955 to 1985), to identify the specific managerial features and “the most important” knowledge and skills for a construction manager. The respondents’ evaluations resulted in a rank list of the ten most important skills and knowledge for the construction manager, the first being „command of technical knowledge and professional skills”. They firmly expressed the view that ***to be a good manager a person must in the first place be a good engineer***. They placed the ability to control expenses last of the ten most necessary kinds of knowledge.

In 2001, field research Katavić, Cerić (2002) about the essential knowledge and skills needed by the successful manager in the construction industry was repeated. Respondents ranked ***topmost knowledge in management science*** (analysis, planning, organization, motivation, control)***.*** Project management (planning methods, resource management, risk analysis etc.) was considered the second most important knowledge by 91% respondents, and economics came third (accounting, marketing, finances, international economic relations etc.).

Obviously the perception of the manager’s functions has changed. Increasingly civil engineers and other technical graduates are becoming aware that they need additional education in the “management field” and the demand for multidisciplinary and interdisciplinary knowledge is growing.

MBA IN CONSTRUCTION AT THE UNIVERSITY OF ZAGREB

The International MBA in Construction started in February 2003, as a TEMPUS project. Teachers from Dundee University, Reading University, Salford University, Technische Universität München, American College of Management and Technology from Dubrovnik and University of Ljubljana taught together with colleagues from the University of Zagreb, creating an environment of different business and cultural approaches.

In June 2003 the University of Zagreb Senate approved the proposed program, making MBA in Construction one of the two academically verified business management studies in Croatia and also recognizing it as an international post-graduate study course.

Due to the Bologna reform postgraduate studies for further scientific training have been abolished and specialist post-graduate studies introduced as a key element of lifelong education. Thus the existing postgraduate course had to be modified to meet the new requirements.

In May 2009 the Ministry of Science, Education and Sports Republic of Croatia and in June 2009 Zagreb University Senate gave a final approval of the modified international interdisciplinary university specialist program MBA in Construction and we are now announcing the enrolment of the third generation of students.

The MBA in Construction specialist program given at the University of Zagreb is a program that focuses on construction with the purpose of providing present and future construction managers with knowledge in various non-engineering fields necessary to understand and master complex management processes. Educating civil engineers to be successful managers, as proposed in our program, widens the circle of knowledge “consumers” by providing engineers with new multidisciplinary and interdisciplinary competencies and knowledge.

The program is intended for all participants in the building process (such as investors, designers, builders, consultants, project managers) as well as for those from corporate management (future managers and /or construction company owners).

It targets professionals who want to improve their knowledge, gain access to new information and to master skills that improve their professional efficiency .

The program lasts three semesters: two semesters of lectures and one semester for the final paper. The curriculum is based on 90 ECTS credits (for more details visit www.grad.hr/mba). It consist of :

- 10 mandatory courses
- 4 elective courses
- 3 case studies
- 2 critical analysis
- final paper.

On completion of the program a candidate is obtaining an academic degree - university specialist in MBA in Construction.

The program consists of three groups of subjects Katavić, Matić (2006):

- <u>general business-management subjects</u> (organisational behaviour and organisation design, business strategy, business ethics, human resource management, decision-making theory, negotiating and business protocol)

- <u>economic subjects with a special accent on construction</u> (business statistics, marketing strategy, international marketing, accountancy and finances)

- <u>construction subjects</u> (project planning and control, project management, legal regulations in construction, building maintenance, environmental protection management).

Two teachers teach each subject, one of them Croatian and the other from a European institution, creating a synergy of knowledge and experience as they demonstrate recent national and international practice.

Even when they speak of general subjects, the teachers adapt their lectures to the specific requirements of the construction industry. The material (especially in the group of economic subjects) has also been modified for students of a technical profession, making it easier for them to follow and understand the non-engineering material.

The teaching is held in weeklong modules of all-day teaching, at the Centre of advanced academic studies of Zagreb University in Dubrovnik. The students’ “isolation” and all-day intensive work greatly increased their commitment and allowed them to completely focus on internalising new knowledge.

Intensive socializing with colleagues and teachers creates a background for abundant, direct, formal and informal communication where problems and their solutions are aired, presented and discussed publicly and without hesitation. This is leading to the development of group synergy, which besides a positive feeling of belonging is also achieving group intelligence and group reasoning, thus creating a network of people who think about the problems of Croatian construction in a similar way.

It is this inter-relationship - quality, time and money - that should be crucial in harmonizing study effectiveness and efficiency. A serious analysis along these lines is also important because the students' previous efficiency (the number who got their master's degree within the given term) was very low. Obviously a correlation must be established between the efficiency of a study such as MBA in Construction and the choice of methodology for knowledge transfer.

EVALUATING THE METHODOLOGICAL FORMS OF STUDY

If we start, in addressing this problem, from rationalizing resources, in the first place time, we must consider the introduction of *e-learning* (learning from a distance) as a possible solution. *E-learning* is a radical structural change "from above" and requires the complete re-engineering of classical studies. The most usual reason for structural changes in the system is re-engineering resulting from the introduction of information technology. When studies are re-engineered to accommodate information technologies, then it is not the exchange of information in itself that is decisive but the synergy of contacts and the interactive work and relationships between the participants in the process, in this case of students and teachers, which encourages structural transformation and which is designed to result in certain improvements and advances.

However, it is not yet quite clear whether this is the best way. Professional circles do not yet agree about the desirability of *e-learning* as an extremely flexible method of knowledge transfer. We show below the SWOT-analysis of *e-learning* as demonstrated by Kathawala et al.(2002) We have compared traditional MBA study methods and *e-learning* as a new method. Many elements of the analysis can be generally applied to all *e-learning* methods because they are not specific to MBA programs only.

S – Strengths - comparative advantages of *e-learning* vs. traditional methods

- the global increase in the use of *e-learning* for MBA programs **–** the main advantage of introducing the new technologies is considered to be the possibility for the mass dissemination of knowledge to dislocated students, combined with rationalisation of absence from work;
- rationalization of teachers' time, who do not have to take frequent trips but can transfer knowledge from any place where they dispose of the necessary equipment;
- easier adaptation to the specific needs of every student.

W – Weaknesses – comparative disadvantages of *e-learning* vs. traditional methods

- terms of enrolment: the possibility that some universities may change enrolment requirements (will they still require GMAT or will some other kinds of knowledge be necessary for enrolment, e.g. knowledge of IT);
- financial aspect: *e-learning* is as a rule cheaper than classical studies, but not in institutions that insist on high-quality programs and teachers;
- institutions that want a top program must invest a lot in equipment (fast computers, the necessary software, technical support for the entire system and, of course, especially for teachers and students);
- quality: one of the main arguments against *e-learning* is the somewhat lower quality of the existing distance MBA studies, because they are not on the quality level of the recognised traditional-method MBA studies.

O - Opportunities – what can institutions do to emphasise the advantages of *e-learning*

- according to some sources, world companies and governments spend about US$40 billion a year on the education of their employees, with growing *e-learning* participation (from US$1.8 billion and 700,000 students in 2000 it grew to US$5.5 billion and 2.2 million students is 2002);
- universities with a weaker tradition have the opportunity of securing a larger part of the MBA *e-learning* market from the peak universities, which decide to introduce new methods only sporadically.

T -Threats - are the warnings that must be taken into account less they become shortcomings that can completely "destroy" the MBA program that uses *e-learning*

- changes in teaching form: there is a great difference between the traditional and virtual teaching of students. The American university teachers' association finds teaching by *e-learning* more time-consuming and intensive for the teacher because an unavoidable and mandatory part of the teaching process includes individual written communication with each student;
- change of data base: traditional data bases, such as books, will give way to new combined data bases, which provide teachers with incomparably greater possibilities of creating coherent study courses;
- change of teaching place: it is a great change to replace a classical classroom with a virtual class in which people communicate by *e-mail* and similar communication tools;
- changes in student characteristics: greater emphasis is placed on ethics (plagiarizing, having others write papers), personal motivation (no one and nothing forces the student to fulfil certain obligations and tasks), self-discipline, organisational and analytical abilities.

One of the main objections to *e-learning* is the lack of personal student-teacher contacts and the non-existence of personal contacts among students. In this sense the research of Ponzurik et al.(2000) shows that various methodological forms can be used to achieve a consistent structure of lectures, however, some educational adaptations are necessary in the case of *e-learning*.

If the above SWOT analysis is applied to our MBA in Construction program several other specific problems/weaknesses appear.

Given that making studies cheaper is an objective acceptable to the students, this will be difficult to realise on the national market because MBA in Construction targets a small population, on the relatively small Croatian market and is held in small groups (maximum 25 students) so the overall effects of a price reduction would be negligible, but work quality might suffer.

At the same time, the measure to which Croatian teachers are ready to accept new technologies is a question, and in this context it is also objectively possible that quality might suffer. It is not unimportant to point out that other specialist university studies show no intention of introducing *e-learning*, so classical teaching should not be rejected without careful consideration. Technology means nothing without a "brain" – it is not possible to teach a computer to lecture well, only a good teacher can do this. Lectures in the form of direct communication are the quintessence of studies, they are their most creative part, the personalisation of knowledge in the creative choice of material, manner of presentation, synthesis of experience and standpoints which can be influenced and which therefore have a motivating and inspiring effect on both associates and students. This effect cannot be achieved in a mechanically-based relationship in a virtual environment. It is therefore certain that the exclusive use of *e-learning* for MBA in Constriction under Croatian conditions would not answer its purpose, at this moment, because it would bring the existing quality into question.

It is completely certain, however, that the future of a program such as MBA in Construction definitely depends on the possibility of finding new ways of knowledge transfer that will require less absence from work. Our target market are young ambitions managers who desire new knowledge and are ready to invest in fulfilling their wishes and needs. Their greatest problem in the realisation of this goal is lack of time, so management studies are faced with the task of finding optimum solutions that will retain and even advance study quality and at the same time shorten the time of absence from work.

CONCLUSION

To summarise, there is no doubt that the classical concept of MBA studies demands a certain degree of re-engineering through a careful and gradual introduction and combination of traditional and new technologies of knowledge transfer, such as for example *e-learning*. However, it is also certain that the time resource should be optimised through structural adaptation based on continuous organic growth, not on sudden leaps.

Part of this adaptation process is the introduction of information technologies geared at creating a fast, efficient and expense-acceptable model of managing the information necessary for the study process, in an environment of full electronic connection. This is relatively easy to achieve and at the same time saves time because it is incomparably easier to follow the flow of information than the flow of physical documents (applications, seminar papers, exams, literature, chosen courses). A prerequisite is creating an IT infrastructure and system of organised approach to and storage of data.

Many world universities have introduced so-called hybrid models of study at some post-graduate level courses (especially specialist studies), which combine traditional methods (direct contacts between students and teachers) and *e- learning*. One of the options in the further development of MBA in Construction lies along these lines, towards the gradual introduction of *e-learning* in some subjects whose contents and accompanying literature are such as to satisfy the criteria of excellence.

Direct communication between each individual student and teacher, among students and between the students as a group and the teacher must be made possible and simple. This will give communication using information technologies a synergic effect of creating a group intelligence, if not as a substitute, then as a supplement and catalyst for the original communication directly realised during lectures and the formal and informal personal communication between teachers and students. Therefore, what we are looking at is adapting the studies by introducing IT technology as a necessary and desirable first step in the modification and advancement of the existing MBA in Construction programme.

REFERENCES

Armstrong, S., 2005. Postgraduate management education in the UK: lessons from or lessons for the US model?, Academy of Management Learning and Education, 4(2), 229-234.

Boyatzis, R.E., Stubbs, E.C., Taylor, S.N. (2003) Learning cognitive and emotional intelligence competencies through graduate management education, Academy of Management Learning & Education, 1(2),150-162.

Burnson, P. (2003), "International business education: shaping future global vision", *World Trade*, No.June, pp.52-4.

Hulme, V.A. (2004) The MBA boom, The China Business Review, 1, 24-36.

Katavić, M., Đukan, P.(1989) The Civil Engineer as a Manager, 3rd Yugoslav Symposium in Building Organisation, Cavtat, University of Zagreb, 767-779.

Katavić, M., Cerić, A.(2002) In Pursuit of the Perfect Project Manager, 2nd SENET Conference on Project Management, Cavtat, University of Zagreb, 73-85.

Katavić, M., Matić, S.(2005) MBA in Construction, 11th Joint CIB International Symposium, Helsinki, Finland, 328-340.

Katavić, M., Matić, S.(2006) Business Education for Construction Managers, Conference: Contemporary problems in construction, 2-3 June, Subotica, Serbia, 49-58.

Kathawala, Y., Abdou, K., Elmuti, D.S., 2002. "The global MBA: a comparative assessment for its future", Journal of European Industrial Training, 26 (1), 14-23.

Kretovics, M. (1999) Assesing the MBA, What do our students learn? The Journal of Management Development, 18(2), 125-136.

Purcell, J. (2005) Euro MBAs have a unique appeal, Business Education, 1, 13.

Ters, K. (2003) Weighing MBA study: home or abroad?, St. Petersburg Times, 9

Ponzurik, T.G., France, K.R-L., and Cyril, M. (2000) Delivering graduate marketing education: an analysis of face-to face versus distance education. Journal of Marketing education, 22(3), 180-187.

DEVELOPMENT OF CURRICULA IN HIGHER EDUCATION FOR THE NEEDS OF CONSTRUCTION INDUSTRY

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Higher education for the needs of construction industry experiences its transformation according to market and economic environment. The request from interested parties (construction companies, public services, institutions dealing with investments) is increasingly present to harmonize the existing curricula with modern trends in business. Therefore, the tendency to enrich the curricula of higher education institutions with modern topics (i.e. project management, investment management, planning - construction procedures, integrated quality management system, leadership, human resource management, entrepreneurship, safety and health protection at work, communications, negotiation, supply chain management) is quite logical. The study programmes are being improved more and more in accordance with the requirements of the economy. Many higher education institutions form or harmonize their curricula in order to be successfully applied for training courses in engineering chambers and chambers of commerce, management bodies or for the needs of inhouse courses in construction companies aimed at lifelong education. Therefore, the sustainable partnership with construction companies and public services is being developed in higher education institutions aimed at harmonization with construction practice.

KEYWORDS: construction industry, training, construction companies, public services.

INTRODUCTION

The objective of this paper is to point to the significance of development strategy for partnership improvements among educational institutions in the field of construction and economic entities. Moreover, this partnership results in improving practical aspect of instruction so that students become qualified to solve practical assignments in construction companies immediately after graduation. In addition, the paper is aimed at perceiving the need to conduct training programmes for employees in companies and administrative bodies.

Higher education for the needs of construction industry experiences its transformation according to market and economic environment. The request from interested parties (construction companies, public services, institutions dealing with investments) is increasingly present to harmonize the existing curricula with modern trends in business.

Sustainable development of the partnership among educational institutions and companies and public services for the purpose of harmonization with construction practice first of all implies the improvement of business communication, planning-construction procedures through normative activities and business informatization in each segment of planning and building through all the lifecycle of a project.

Economic and non-economic activities set greater and greater requirements and challenges before individuals according to the changes in global environment. In order to respond to the challenges of business life, a key issue is to combine professional and social competence. Business competence presents the basis in creating values of product and services towards business success of a corporation (enterprise). Taking into consideration that a large number of enterprises operate in international surrounding, there is a need for a competitive life-long education of people in each country, as a prerequisite for investments and development of every national economy. Business, technical and other institutions of higher education consider opportunities to improve partnership among educational institutions, economic and non-economic activities emphasizing training arrangements.

EDUCATION AS A FUNCTION OF BUSINESS COMPETENCE OF ECONOMY AND PUBLIC SECTOR

Based on the achieved contacts and conversations led with the representatives of enterprises dealing with economic and non-economic activities, successful activities have been started on developing educational programmes, predominantly through team work for education, evaluation and certification from different fields, for example: micro- and macro-economy, management, finances, accounting, banking, control and auditing, technical-technological field, construction, public sector and other scientific-business analytic fields. The improvement of partnership among educational institutions and economy should be run with mutual engagement of the staff from educational institutions, from economy, non-economic activities and certified training experts from Europe and Serbia. The result should be business certificate („diploma“ or the similar; e.g. professional competence for a specific field), including the possibility to gain and develop certificate of social competence, offering enterprises (companies) and others competitive advantages of educated personnel on labor market. Thus business competence would be created for personnel all over Europe, i.e. Europe Union (EU).

Through joint team work of all participants an *„educational network“* for acquiring business competence would be created all over Europe, especially Serbia, thus focusing our education towards economy requirements. Mutually organized application of the acquired knowledge, skills and abilities would constantly be directed towards economy and simultaneously, new standards for life-long education of adults would be established. Prospective clients would be offered possibilities for success in performing business activities and meeting the demand of international companies for standardized, European educational programmes. The programme would be intended for professionals with high qualifications interested in further education, e.g. graduate students of colleges and faculties, as well as prospective managers without formal education and specialized training in business practice. The objectives of this project are:

- to develop strategy for partnership improvement among colleges of vocational studies and economic entities in the region;
- to improve practical aspect of the instruction at colleges of vocational studies, in such a way that students are being trained to solve practical assignments in companies immediately after graduation;
- to conduct training programme for employees in companies and administrative agencies.

This project will consider the following issues:

- Project management
- Quality management
- Human resources management
- Business communications
- Entrepreneurship
- Services and supply
- Normative activities
- Business informatization
- Business risk management
- Operations with EU.

BIBLIOGRAPHY REVIEW

As Brujin and Tukker (2002) noted, sustainable development has become a central perspective in environmental strategies around the world. The focus is in describing and understanding various formats of collaboration and critically evaluating its effects and prospects. A learning – action network is defined as a set of relationships which lay over and complement formal organizational structure linking individuals together by the flow of knowledge, information and ideas. These networks are embedded in the complex of organizational and social relationship, management structures and processes that constitute business and its social context. Companies that seek to develop knowledge and action through learning – action networks which span their internal and external stakeholders have been termed "meta – textual" organization.

Aaker (2008) has mentioned that a successful business strategy enables managers to provide organizational vision, monitor and understand a dynamic business environment, generate creative strategic options in response to environmental changes, and base every business effort on sustainable competitive advantages. Developing business strategies provides the knowledge and understanding needed to generate and implement such a strategy.

To succeed in an increasingly competitive world, individuals and businesses alike need to come up with new takes on old business models, fight commoditization and find unconventional avenues to growth, as suggested by Forester and Kreuz (2008). Different thinking presents practical tools and strategies that can be used to help you drastically increase the value of your business.

In high-tech industries research and development are the most important origin of competitive advantage, assigned by Wiethaus (2008). The underlying investment decisions are notably complex. First high-tech industries are highly concentrated such that mutual observation and reactions among competitors need to be taken into account. Secondly the knowledge created through research and development may not only benefit its originator but may spill over to competitors.

In the book by Rainey (2009) it has been mentioned that there were some topics of substantial interest for sustainable business development, such as:

- Enterprise thinking
- The strategic logic
- Crafting sustainable business strategies and solutions
- The driving forces of social, economic, and environmental related change

- The forces driving market and stakeholder connectedness
- Crafting a sustainable enterprise through leadership and capabilities.

ORGANIZATION OF PRACTICAL ACTIVITIES IN COMPANIES, PUBLIC SECTOR AND ON LABOR MARKET

In principle, institutions of higher education develop partnership with many companies and institutions aiming at students' practice and employees' training. In order to improve partnership among educational institutions and economic entities within the region, these educational institutions and a certain number of distinguishable companies and institutions are prepared to participate in this project with all their available capacities (personnel and material).

The representatives of the mentioned companies and institutions are ready for mutual work, provided that all of them together invest a lot of energy, time, patience and above all concern to help in project completion within their competence and possibilities. In a word, it is a process which will last; it is neither simple, nor impossible to be completed.

It is necessary to mention here that many capabilities and knowledge are recognized by diplomas gained after the education completion, but evidently there is a difference between the awarded diplomas and what is required during business operating in companies, due to the constant change of learning content and volume needed for practical work related to the acquired knowledge. In addition, according to their diplomas, a lot of employees have particular mantle and capability but recently there has been a need to harmonize the acquired licenses with the requirements set by market, namely the volume and the description of the job which the license has been issued for.

It is necessary to reform licenses according to:

- the reform of higher education
- the list of professions from the appropriate fields and abbreviations of professional academic and scientific titles
- market requirements.

EXPERIENCE AND PRACTICE

Some world experience has been cited in obtaining business competence.

European Business Competence* Licence, EBC*L:

- it has been established as a certificate of business knowledge
- it enables the highest degree of standards approved by economy – numerous companies have included it into internal educational standard of the staff.

The European Business Competence* License, EBC*L is a Europe wide established business qualification certificate attesting the holder the core competence needed:

- to take part in economic life
- to be able to run a department and make managerial decisions
- to control and manage the financial aspects of a project

- to start up a new business.

The EBC*L certificate demonstrates business management expertise on an internationally recognized level. The EBC*L is currently established in 28 countries (Austria, Albania, Azerbaijan, Belarus, Bulgaria, China, Croatia, Cyprus, Czech Republic, Germany, Greece, Hungary, Italy, Kosovo, Kenya, Macedonia, Nigeria, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Switzerland, The Netherlands, Turkey, Ukraine) and is available in 23 languages. Due to its high degree of transparency the European Business Competence* License is accredited by international economy. A huge number of well known companies (including Siemens, T-Mobile, Xerox, Bayer, Uniqua, Samsung) have successfully integrated EBC*L into their in-house staff development programs. The EBC*L is established in several projects financed by the European Union.

ABET – Technology Accreditation Commission, Baltimore (USA)

Programme criteria for Construction:

- The curriculum – The course of study should prove that graduate students possess: skills in mathematics, likelihood and statistics, and basics in physics, as well as in engineering design; comprehension of professional procedures in construction and processes in structure construction, communication, methods, materials, systems, equipment, planning, timing, safety, cost analysis, cost control; comprehension of theme entities management, such as: economics, business operations, accounting, law, ethics, management, decision-making and optimization methods, analysis and design process, engineering economics, engineering management and financial management.
- Teaching staff – The programme must show that teaching staff is qualified to teach the subject by professional worthiness (license) or education and experience in designing.

California State Personnel Board – The description and specification of jobs, e.g. supervisory body for work completion, construction inspector... :

- Definition
- Habitual work assignments
- Minimum qualifications
- Knowledge and capability
- Special personal qualities
- Additional desired qualifications.

PROGRAMMES

Various seminars can be organized intended for engineers and experts dealing with investment realization and investment projects in construction.

Project management

The course should enable to study project management, time, cost, quality, communications, risk and supply management from the aspect of investors, contractors and interested parties. The content of the seminar should involve:

- Concept and types of project.

- Basic concepts of project management.
- Administrative and procedural flows of certain time stages in project completion (from the initiative to use permit).
- Project management according to American PMI (Project Management Institute).
- Investment management.
- Management of negotiating construction works execution.
- Tender procedures i contract documentation of FIDIC (International Federation of Consulting Engineers).
- Construction designing, modern methods and techniques in project management.
- Software packages for project management.
- Management of Changes.
- Marketing.
- Re- engineering in construction.

Investment management in construction

The objective of the seminar is that civil engineers master procedures for an efficient investment project management. The course should enable investment management to be studied from various aspects: technical-technological, legal, economic. The content of the seminar includes:

- Financial, legal and technical aspects of investment management. Investment definition. Investment classification. Investment projects. Finance and economy. Impacts on an investment. Indicators of construction production. Evaluation of construction production. Business operations in construction. Business relations investor – contractor.
- Value of structure construction. Production value. Price. Costs. Investment programme. Price structure. Participations. Preparation. Equipping. Design and construction. Accompanying costs. Calculating structure construction costs / cost analysis. Calculating factor. Market value.
- Negotiating construction works performance. Process of submitting and valuating offers. Contracting. Bidding documentation. Conditions of contracting – general and special. Choice of contractor. Contract on structure construction and equipment. Methods of contracting in our and world practice, tender procedures and contract documentation of FIDIC and international financial institutions. Basic contract regulations. Financial guarantees. Guarantee terms.
- Investments. Business plan. Business plan content. Prefeasibility study and feasibility study. Financial investment indicators. Practicability study. Compensation of invested funds with structure area. Contraction documentation on assigning land to a purpose. Financial flow control in construction industry. Plan, programme and structure of investment management. Cash flow. Financial plan. Plan of funds investing dynamics. Reimbursement of the performed works.
- FIDIC. Forms of contracts. General and specific terms of contracting.
- Regulations related to finances in construction industry.
- Investment management structure. Information system. Feasibility analysis and investment realization dynamics.

Planning in construction industry

The objective of the seminar is that civil engineers master the problems of investment project completion planning, monitoring and control, as well as determining necessary construction resources and costs. The content of the seminar:

- Planning in construction industry.
- Principles. Methods of planning. Technology of building and planning.
- Construction norms.
- Network diagram. Structure analysis. Time analysis.
- Gantt chart. Cycloramas planning.
- Peculiarities of plans related to structure types. Needed resources bill of quantities. Financial plan. Periodical operative plans.
- Construction completion control. Data collecting. Re-planning.
- PERT method.
- Network plans optimization.
- Computer implementation in designing. Software packages (PRIMAVERA, MS PROJECT...).

Safety and health protection in construction industry

The objective of the seminar is that civil engineers master the principles and methodology of safety and health protection at work in construction industry and introduce relevant legal regulations. The content of the seminar:

- Up-to-date approach to safety and health protection at work in construction industry.
- Domestic legal regulations. The law on safety and health at work. By-law on protection at work at construction work performing.
- Draft of the Regulation on safety and health at work on temporary and mobile construction sites. The review of works with increased risks from injuries at work and professional diseases. Construction site registration. Measures of safety and health at a construction site. Content of the plan for safe and healthy work at a construction site.
- Professional instructions on elaboration of work equipment inspection and testing methodology and examination of work environment.
- Other regulations. The decision on forming safety and health at work council. The Code on the content and method of issuing report form on injury at work, professional disease and the disease related to work. The Code on measures and norms for protection at work from noise in work premises. The Code on means of personal protection and personal protection equipment. The Code on keeping a record from protection of work. The Code on protection at work at loading and unloading into/out of freight vehicles.
- Foreign regulations. Directive 89/391/ecc – introducing measures for safety and health at work improvement. Guidelines on risk evaluation in the European Union – Agency for public health and safety at work.
- Manual on risk evaluation – European agency for safety and health at work. Stage of designing. Organizational stage. Control lists of a construction site.
- Implementation of the measures of safety at work. The Code on the method and procedure of expert monitoring during structure construction. The Code on the content and method of structure technical inspection and use permit issuing.
- Obligations of construction firms arisen from the law.

- Safety and protection of product and services in construction industry.
- The system of safety and protection at work as an integrated management system: QMS, EMS, OHSAS, RMS, AA 1000, SA 8000.

Quality management in construction industry

The objective of the seminar is that civil engineers master the problems of establishing and keeping up quality, as well as the basics of quality management system in construction industry. The course is not aimed at introducing quality management system into construction and related organizations according to the series of standards ISO 9000, but this course should serve those interested in introducing quality management system into their firms as a source of information in this procedure. The content of the seminar:

- Quality providing. Quality management. Total quality management (TQM).
- Quality system and quality control.
- Quality control and evaluation. The Law on standardization. Harmonized and non-harmonized product. Certification. Accreditation.
- Process control.
- Revision of standards ISO 9000:2000. Quality management system – QMS. Environment protection system – EMS.
- QMS and the European Union. Integrated system of quality and environment management.
- Structure construction quality management.
- Quality management according to American Project Management Institute – PMI.
- Costs of quality establishing and keeping up.
- Methods and techniques related to business operations quality. Model SIX SIGMA. 5-S Technique.

Construction structures evaluation

The objective of the seminar is that civil engineers master the principles and methodology of evaluation and revalorization of financial resources invested into investment project completion. The content of the seminar:

- The complexity of investment projects in physical and financial view. Product price counting. Methodology of product pricing. Data needed in pricing. Investment programme.
- Regulations and practice of revalorization estimate during investment project completion. Clause on contracted price revision. The conditions influencing the price revision. Advance payment treating. Some possible cases.
- Evaluation of the invested funds in a particular time section during investment duration. Financial construction control.

CONCLUSION

Partners performing practical activities of the students at higher education institutions are companies, management bodies, public utility companies, educational institutions and labor market (employment exchange).

Besides the acquired knowledge, companies and institutions especially stress that it is necessary for students and the employed or those from labor market to be really interested in getting to know the business operations of each company separately.

Academic knowledge is necessary, but it must be fitted into the requirements and needs of the companies according to modern business processes and changed roles of agents on the market where a consumer is in a dominant role.

Practice can be improved, refreshed or it can even discover innovations that students and other potential staff can reach during their studying, carrying out different business activities or on labor market while expecting changes of qualification and work place.

From this aspect, students and other candidates should pass all the instances in companies, both in the headquarters where the product is created and developed, as well as the completion of the product on the market.

Based on practical activities and the acquired knowledge during studying, the needs for changes in curricula and in the sheer education system will take a more definite shape.

REFERENCES

Aaker, D.A., *Developing Business Strategies*, Sixth Edition, John Wiley & Sons, 2008.

Brujin, T.J.N.M., Tukker, A., (Eds.), *Partnership and Leadership: Building Alliances for a Sustainable Future*, Springer, 2002.

Forerster, A., Kreuz, P., *Different Thinking Creative strategies for developing the innovative business*, Kogan Page EPZ, 2008.

Rainey, D. L., *Sustainable Business Development Inventing the Future through Strategy, Innovation, and Leadership*, Cambridge University Press India, 2009.

Wiethaus, L., *Research and Development - Business Strategies towards the Creation, Absorption and Dissemination of New Technologies*, VDM Verlag, 2008.

WHAT DO WE KNOW ABOUT USE OF PROJECT EVALUATION METHODS IN CIVIL ENGINEERING?

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Research done in late decades of past century and later has shown that use of discounted cash flow based project evaluation has increased. However, theoretical findings about discounted cash flow methods show that they have numerous limitations, and ignorance of these limitations can lead to false results as well as false conclusions about investment projects.

The theoretical part of the present article describes some limitation of discounted cash flow methods. It focuses on the deficiencies of the internal rate of return method, since unfamiliarity with the deficiencies under discussion can lead to erroneous conclusions.

The empirical part presents results of the research, which was carried out among members of the Slovenian Project Management Association and among managers in selected Slovenian companies about their familiarity with the methods of project evaluation and their use in practice. Their personal opinions about investment project evaluation methods and knowledge of their faults were studied in the research. During analysis of the results the situation in the field of civil engineering was treated separately and compared with other technical and non-technical sciences.

KEYWORDS: project evaluation, civil engineering, discounted cash flow, internal rate of return.

INTRODUCTION

Increased use of financial calculators and electronic spreadsheets in last decades caused an increase in multi-periodical methods of project evaluation. In the era before common use of financial calculators and electronic spreadsheets the multi-periodical methods for project evaluation (e.g. internal rate of return and other discounted cash flow methods) were more or less domain of mathematicians. With the state-of-the-art electronic support this methods became usable by other professionals and also by the common public.

Research done at the end of last century shows that the use of discounted cash flow methods for investments and projects evaluation has significantly increased. Among these methods, the internal rate of return method (IRR) and the net present value method (NPV) were the most common. Klammer and Walker (1984) state that in the USA the use of discounting grew from 19 % in 1960 to 57 % in 1970, and their research establishes that the use of discounting in 1980 grew to 75 % in projects dealing with expansion of existing capacities. Similar conclusions for the UK are drawn by Pike (1988), who established that the use of internal rate of return method or net present value method in large UK companies grew from 58 % to 84 % between 1975 and 1986; the exclusive use of the internal rate of return method grew from 44 % to 75 % and the exclusive use of net present value grew from 32 % to 68 %. It is interesting, that Ho and Pike (1996) established very similar percentages in their analyses, and, also Pšunder and Ferlan (2007) found quite similar findings for companies in Slovenia in their research: The net present value method were most commonly used discounted cash flow method with a percentage of over 70 %, followed by the internal rate of return method with a percentage of slightly less than 70 %.

Deficiencies of discounted cash flow methods

Since the net present value and the internal rate of return methods are very generally used, we can not overlook their deficiencies. Numerous of authors point out the misleading simplicity of this methods and lack of understanding of their use; Lumby and Jones (1999) focus mainly on flaws in the internal rate of return method that result from its polynomial foundation. Above all they stress out the meaning of multiple internal rate of return, non-existent internal rate of return, and, in connection with the net present value method, also a non-existent positive net present value along with existing internal rate of return.

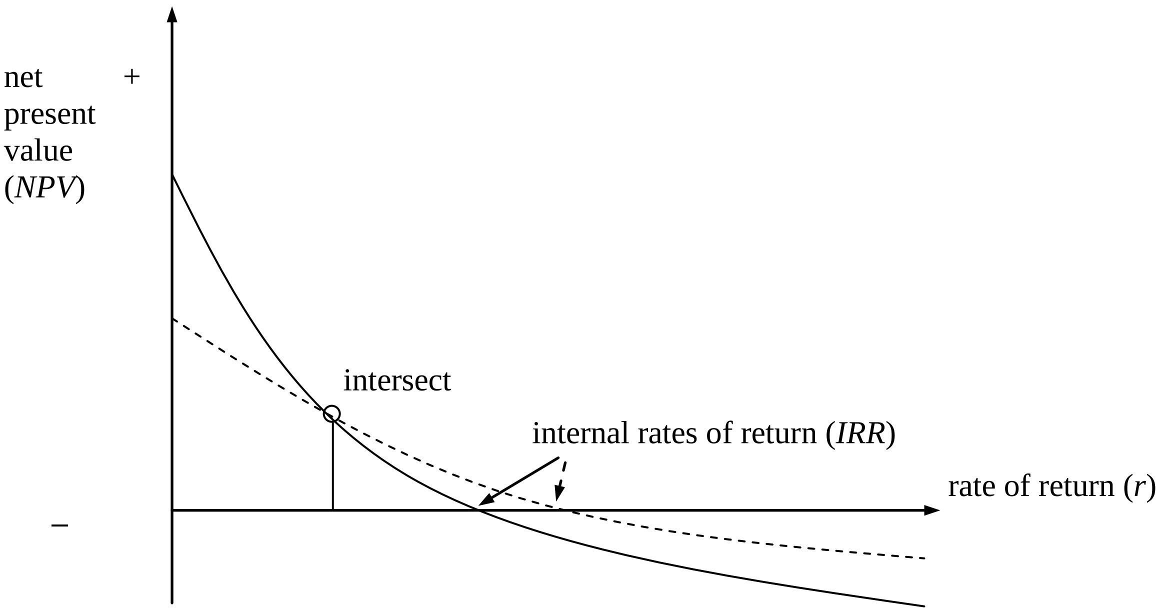
All these faults are, if they appear, expressed in false or at least inexact results (indications). Holmes (1998) discusses particularly the problem of potential for conflicting results (indications) when using methods of internal rate of return and net present value in comparing two mutually exclusive projects.

Apart from the theory the biggest problem in using discounted cash flow method is lack of adequate data. Analysts usually anticipate approximate or even incorrect data. According to Mauboussin (2006) analysts also use too short forecast horizon or inadequate capital cost. Čibej (1999) additionally points out that some projects deal with a residual value at the end of life cycle, and suggests that the residual should be treated as increased cash flow in the last year of evaluation. The residual value problem is particularly significant in civil projects.

Use of the internal rate of return

Lumby and Jones (1999) explain that unlike the net present value method, the internal rate of return method makes the analyses using the decision rule: does the project yield a greater or lesser return than the capital market? Thus, the internal rate of return methods gives the best result when comparing a single project with the capital market. However, even in a single project – especially in civil engineering – the cash flows can be so volatile that the method results in multiple internal rates of return. This arises out of the mathematics of computation, as the internal rate of return is the root of a polynomial equation. According to the Descartes' rule of signs, there are so many possible solutions as there are changes of sign in the polynomial equation. However, we can overcome the problem with discounting of all negative cash flows to the first period of negative cash flow in the equation. With this procedure we eliminate changes in sign. When a computer of financial calculator is used for solving such problem, the solution will be found by guessing the correct internal rate of return.

When evaluating two projects by using internal rate of return, the method can give false indication. According to Medanić et al. (2005) we can encounter a conflicting advice from the net present value method and internal rate of return method, as shown in the Scheme 1.



Scheme 1: Conflicting indication from net present value method and internal rate of return method (Medanić et al., 2005)

Holmes (1998) explains that for conflicting advice in this type of situation the net present value curve must intersect, the point of intersection must be at discount rate or higher and the intersection must be in the positive quadrant.

The abovementioned theoretical findings have raised questions about the familiarity with project evaluation methods in Slovenia.

THE RESEARCH AND THE METHODOLOGY

The research was carried out among members of the Slovenian Project Management Association and among managers in selected Slovenian companies about their familiarity with the methods of project evaluation and their use in practice. Their personal opinions about investment project evaluation methods and knowledge of their faults were studied. By interpreting the results we focused on discounted cash flow methods. A special stress was placed on experts in civil engineering and civil engineering companies, as civil projects are due to their specifics especially exposed to the described “pitfalls” of the discounted cash flow methods. Among the methods we dealt with the net present value method and above all with internal rate of return method.

The goal of the research was to establish the level of knowledge and use of investment evaluation methods. Besides knowledge and frequency of use of discounted cash flow methods, we were also interested in any relation between the level of education degree and knowledge of investment project evaluation methods.

We gathered data by the questionnaire method. Data acquired from the questionnaires were systematised and analysed statistically. We calculated the dependence of method and faults knowledge from individual variables.

RESULTS

Analysis shows that most companies use discounting cash flow methods as well as single-period methods, e.g. payback period method. The Table 1 shows the usage and the knowledge of discounted cash flow methods among Slovenian companies.

Table 1: Usage and knowledge of discounted cash flow methods for projects evaluation

	Use	Know	Don't know
Net present value method	70,45 %	13,64 %	15,91 %
Internal rate of return method	68,18 %	15,91 %	15,91 %

As shown in the table, among discounting cash flow methods, the net present value method and the internal rate of return method are equally well known, but the net present value method is more frequently used in the practice. Among Slovenian project managers there are slightly more than 15 % of those who don’t know the net present value method and the internal rate of return method, respectively. More then half questioned also know net present value index and modified rate of return method, but only 40 % of questioned use the first one and less than 30 % use the second one.

Project managers in civil engineering companies according to their answers on the questionnaire know better discounted cash flow methods than project managers in other engineering companies. Project managers in civil engineering companies also use the methods more frequently than project managers in other engineering companies. The most frequent users of discounted cash flow methods are project managers in financial holdings, tourism and consulting.

Analyses also show that 58 % of all companies bring decisions about the project considering only one method. Those who combine more methods prefer to combine discounted cash flow methods with single-period methods (e.g. payback-period). Over 72 % of the questioned professionals do so, but only 6,5 % of questioned professionals combine two discounted cash flow methods (e.g. internal rate of return and net present value index).

As net present value method does not have any significant deficiency which can lead into erroneous conclusions, we have asked Slovenian project managers about knowledge of deficiencies in internal rate of return method. Although the results of internal rate of return method are easy to understand and to compare with capital market rate of return (which is not the case in interpreting the results of net present value method), the internal rate of return include some major deficiencies. Ignoring them can lead into erroneous conclusions. As described in the theoretical part of the article, the two most common deficiencies are multiple internal rate of return and conflicting advice of the internal rate of return method and net present value method. Slight inaccuracies of results can also arise from assumption that all cash inflows form the project will be reinvested at the same rate of return as the internal one. Such a rate is in practice very hard to achieve; the reinvestment rate is usually lower. However, it is quite unlikely that this assumption will be a reason for erroneous (opposite) conclusions, but that can be a reason for slightly overrated (or rarely underrated) results. In the Table 2 we present the knowledge of Slovenian project managers about deficiencies of internal rate of return method.

Table 2: Knowledge about deficiencies of internal rate of return method

Deficiency	Knowledge
Multiple internal rate of return	43,18 %
Conflicting indication of internal rate of return and net present value	15,91 %
Assumption, that reinvestment rate of return equals internal one	34,09 %

In establishing the level of knowledge about faults, we focused on the internal rate of return method, because the authors quoted at the beginning of this article ascribe most faults to this method. We established that in Slovene companies less than half (43.2 %) of experts are familiar with multiple internal rate of return, and only 16 % know the problem of conflicting results (indications) between the internal rate of return method and the net present value method. This is not surprising, since only 6,5 % use two or more discounted cash flow methods for project evaluation and decision making. On the other hand many of those who know multiple internal rate of return most probably encountered them by using financial calculators or electronic spreadsheets on computers. Also, more than one third of questioned are aware that by using internal rate of return method it is presumed that reinvestment rate of return equals internal one.

Dependence of knowledge about deficiencies of discounted cash flow methods by level of education degree

The connection between the knowledge of investment project evaluation methods and the level of education degree was established by calculating the contingency coefficient.

In establishing a connection between knowledge of discounting cash flow methods and level of education (over 34 % of questioned had a PhD or an MSc degree, almost 39 % a university degree, more than 20 % a college degree and less than 3 % had a secondary-school degree), we found that the knowledge about the faults of the net present value method is highly dependent on the level of education of respondents (the correction of contingency was 0.866), but according to our results there is only a weak connection between knowledge of deficiencies in the internal rate of return and the level of education (the correction of contingency is 0.256). However, we established that there is a strong connection between knowledge about flaws in the internal rate of return method and the *field* of education, since the calculated correction of contingency coefficient is 0.91.

DISCUSSION AND CONCLUSION

Our research project investigated the use of investment project evaluation methods in Slovenia. The results show that the use of investment project evaluation methods in Slovenia is fully comparable by the situation in other countries. However, due to lack of comparable research we could not compare knowledge about deficiencies of the subject methods.

The research show that the discounted cash flow methods are less popular that single-period methods. This finding is contrary to our expectations, as functions for solving internal rate of return of net present value are standard on Excel or similar programs and also on many financial and engineering calculators. On the other hand, the single-period methods are still easier to calculate and also very easy to interpret and understand.

If we link the research results with theoretical findings, we can conclude, that for reliable results we should combine at least two methods. Thus is advisable to combine internal rate of return method with net present value method or any other discounted cash flow or even single-period method.

Research results leads us to the conclusion that, in the light of actual economic changes, the topics about project evaluation methods will gain in significance. Consequently we can identify a need to compare conditions at different time periods, which represents a guideline for further research work.

REFERENCES

Čibej, J. A. (1999) Matematične metode: Gradivo za izobraževanje za pridobitev strokovnega naziva preizkušeni ocenjevalec vrednosti nepremičnin. Ljubljana, Slovenski inštitut za revizijo.

Ho S., Pike R. (1996) Computer decision support for capital budgeting: some empirical findings of practice. Journal of Information Technology, 11, 119-28.

Holmes P. (1998) Investment Appraisal, International Thomson Business Press, London.

Klammer T. P., Walker M. C. (1984) The continuing increase in the use of sophisticated capital budgeting techniques. California Management Review, 27 (1), 137-48.

Lumby S., Jones C. (1999) Investment appraisal & Financial Decisions, 6th edition. London, International Thomson Business Press.

Mauboussin M. J. (2006) Common Errors in DCF Models. Available at: http://www.leggmason.com/funds/knowledge/mauboussin/CommonDCFErrors.pdf.

Medanić B., Pšunder I., Skendrović V. (2005) Neki aspekti financiranja i financijskog odlučivanja u građevinarstvu. Osijek, Građevinski fakultet.

Pike R. H. (1988) An empirical study of the adoption of sophisticated capital budgeting practices and decision making effectiveness. Accounting and Business Research, 72 (18), 341 – 51.

Pšunder I., Ferlan N. (2007) Analysis of the knowledge and the use of investment project evaluation methods in the field of mechanical engineering. Journal of Mechanical Engineering, 53(9), 569-581.

LANGUAGE NEEDS OF CONSTRUCTION PROFESSIONALS

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There is an increasing necessity to improve communication skills of construction professionals by vocational and professional training programmes which enhance the linguistic and cultural knowledge of the graduates and/or professionals. The outcomes of LANCAM (Languages for Contract Administration and Management in Construction) fulfilled these requirements for teaching and learning in English, German and Spanish together with the working cultures in UK, Germany and Spain. The methodology and the results of LANCAM project are used to develop new learning materials that will focus on the construction industry related work culture/ practice issues in Turkey, Greece, Austria and UK, while focusing on Turkish, Greek, German and English language learning and teaching. Main objectives of the project EVLAC (Enhancing Vocational Language Skills and Working Culture Awareness of European Construction Professionals) are to; increase the mobility of construction professionals throughout Europe, decrease the misunderstandings between nationals due to cultural differences, introduce different work cultures and practices to vocational students while increasing their language abilities, provide an e-learning material which is user friendly, easy to access and can be further expanded for both different languages/ cultures and for changing working practices.

Two questionnaire surveys have been undertaken during the initial stage of the project. The aim of these questionnaires has been to determine the vocational foreign language needs of construction professionals. The questionnaires have been completed by 173 construction professionals/company managers working in international construction projects. The results were then used to structure the content of EVLAC e-learning material. The aim of this paper is to present some of the findings of the questionnaire surveys.

KEYWORDS: construction industry, Europe, vocational language.

INTRODUCTION

It has been increasingly important for construction companies to develop both intercultural and linguistic competence in order to succeed in multinational European projects. However, the inability to operate effectively in markets with different working cultures and practices together with different languages has been an important barrier to the mobility of construction industry professionals/ contractors within European Union. There has been, in turn, an increasing necessity to improve communication skills of construction professionals by vocational and professional training programmes which enhance the linguistic and cultural knowledge of graduates and /or professionals. LANCAM (Languages for Contract Administration and Management in Construction) project fulfilled these requirements for teaching and learning in English, German and Spanish. EVLAC (Enhancing Vocational Language Skills and Working Culture Awareness of European Construction Professionals) (LLP- LDv-TOI-2007-TR- 048) project, on the other hand, adopted the methodology and the results of LANCAM project to develop new vocational language learning/teaching materials in Turkish, Greek, German and English which furthermore focuses on the construction industry related work culture/practice issues in Turkey, Greece, Austria and UK. Two different questionnaire surveys, one with construction company managers and other with construction industry professionals have been undertaken in all partner countries in order to determine vocational language needs. The aim of this paper is to present some of the findings of these questionnaire surveys.

LITERATURE REVIEW

Literature review shows that various researchers have been working on vocational language needs of professionals where most of them focused in the use of English. Bertin and Bertin (1993) undertook a small sized questionnaire survey with transportation companies in France. Their survey results showed that English was most frequently required for reading and writing telexes and forms. Talking and listening English on the phone formed the second major need. Meanwhile, for Haissinski and Maury (1990) oral expression in English was the main problem for business people and reading was the least important problem (Dechesne, 1998). They reported that English language usage requirements of business people did not vary according to the sector they were working (like engineering, computing science, food industry) or type of business their companies undertook (like multinational, export, non export). In a similar research, Furuya (1998) found out that oral communication skills are the most problematic area for Japanese engineers. Various other questionnaire surveys (Garcia-Mayo (1995), Sinhanetti (1994), Moody (1993), Pennington (1993), Wongsothorn (1992), Holden (1995)) related with the use of English by business people from all over the world have also been reported ((Dechesne, 1998). However, literature showed no evidence related with any research which focused on the vocational foreign language requirements other than English except a pilot study (LANCAM) undertaken by Rogerson- Revell, 2003.

The LANCAM project responded to a recognised need to facilitate the mobility of construction industry professionals within the European Union, by encouraging construction business which crosses national borders. This pilot project was funded within the language stream of the Leonardo Da Vinci training programme of the European Commission and took two years to complete, from 1999 to 2001. De Montfort University, Leicester, was the project contractor working with educational, Professional and industrial partners from Denmark, Germany, Ireland and Spain. (Rogerson- Revell, 2003).

RESEARCH METHODOLOGY AND FINDINGS

The aim of the current project (EVLAC) has been to adopt the methodology and the results of LANCAM project to Turkish, Austrian, Greek and English cases. Two questionnaire surveys in 4 partner countries have been undertaken in order to determine the vocational foreign language needs of construction companies and professionals working in international projects. While Questionnaire 1 was aimed at individuals who needed language training themselves, Questionnaire 2, was aimed at people who could give an overview of a company's language needs. Collected data helped EVLAC project team to identify the communicative needs of construction industry professionals, and to gather useful information about working in construction project management in Europe. This information was then used to ensure that developed e-learning materials were both relevant and useful to European construction industry professionals.

Profile of Respondents

Number of respondents is given in Table 1. The questionnaires were completed by construction professionals (civil engineers, architects, mechanical engineers or electrical engineers) and company managers who currently work in international construction projects. While Austrian and British contractors undertake/plan to undertake construction projects mainly in European (like Germany, Italy, Switzerland, Spain, Bulgaria, Czech Republic, Romania, Croatia and Slovenia) and Arabic (like Dubai and Saudi Arabia) countries, Turkish contractors focus on undertaking work in former Soviet Union, Balkan, Middle East and North African countries besides European and Arabic countries.

Table 1: Number of Respondents

	Turkey (P1)	Austria (P2)	Greece (P3)	UK (P4)
1st quest.	34	12	46	40
2nd quest.	16	10	7	7
Total	50	22	53	47

Priorities in Hiring Professionals for Projects Abroad

Table 2 shows company managers' priorities while hiring professionals for projects abroad. Managers were asked to scale their priorities on a Likert Scale from 1 (high) to 5 (low). The results show that company managers' priorities are similar for Turkish, Greek and Austrian companies. The managers prefer professionals with right specialization to the project needs and with high communication skills in the required foreign language. The coefficients of variations for these two factors show that managers in each country are in good agreement with each other. While "company's broader staff needs" is observed to be the second priority of Turkish construction companies (with mean value of 1.71), coefficient of variation (0.75) shows that the managers' opinions vary considerably.

Table 2: Priorities While Hiring People for Projects Abroad

		A*	B	C	D	E
TURKEY	Mean	1	2	1.71	2.43	2.86
	Std. Dev.	0	0.76	1.28	1.45	1.60
	Var. coeff.	0	0.38	0.75	0.60	0.56

GREECE	Mean	1.5	1.14	2.86	3.86	3.71
	Std. Dev.	0.50	0.35	0.83	1.36	0.88
	Var. coeff.	0.3	0.31	0.29	0.35	0.24
AUSTRIA	Mean	1.33	1.5	2.5	2.5	1.5
	Std. Dev.	0.47	0.5	0.5	0.5	0.5
	Var. coeff.	0.36	0.33	0.2	0.2	0.33

* A- Staff specialization B- Communication ability C- Company's broader staff needs D- Staff compensation E- Synergies with foreign partners

Vocational Language Requirements

The above discussed results confirm that construction companies working in large variety of countries with different national languages would prefer to employ professionals with essential language skills. Figures 1 to 4 additionally show that English is the most required language in all partner countries, as would be expected. However, communication channels where English is mostly required vary between respondents. While Turkish professionals require using English mainly in writing and reading e-mail/fax, Austrians require it in talking on the phone and in writing/reading e-mail/fax and, Greeks require English in talking on the phone and making presentations.

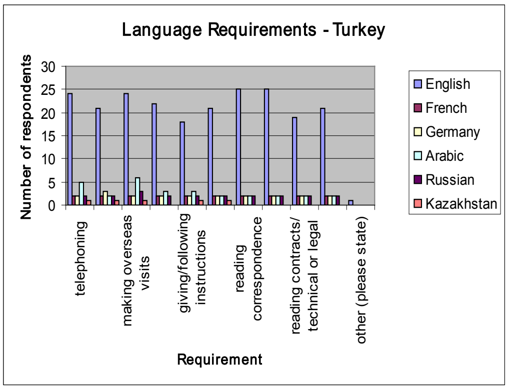

Figure 1: Language Requirements of Turkish Contractors

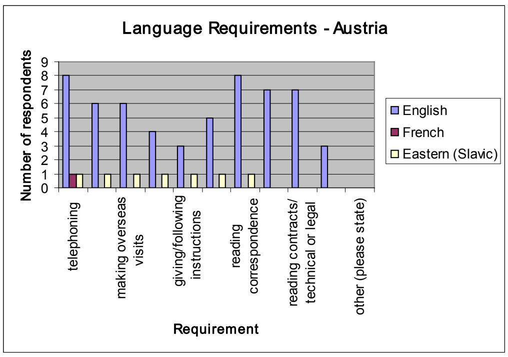

Figure 2: Language Requirements of Austrian Contractors

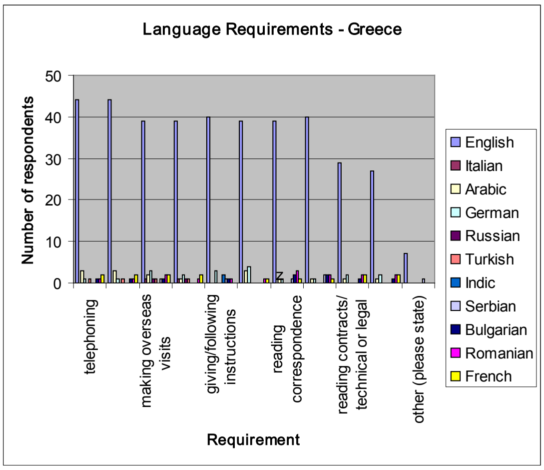

Figure 3: Language Requirements of Greek Contractors

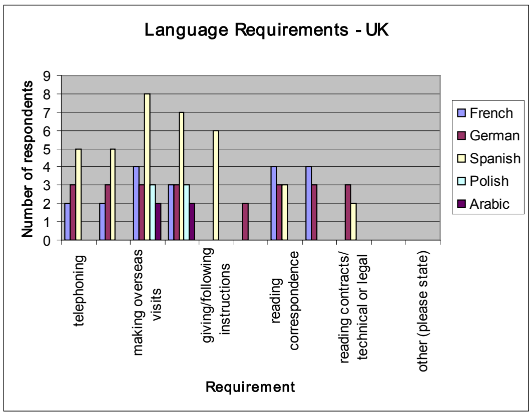

Figure 4: Language Requirements of British Contractors

Results in Figures 1 to 4 also demonstrate that while English, French and German are the most common languages used by the construction professionals, professionals require to use foreign languages which are usually the language of the neighbour countries and the countries which their international contractors generally undertake projects. Arabic is thus observed as one of the mostly required languages by European construction companies. This is mainly due to the continuous construction demand in Arabic countries and the large amount of foreign contractors undertaking important construction projects in these countries.

Means of Learning a Foreign Language and Expectations from an E-learning Material

Results in Table 3 explain that most of the respondents learnt a foreign language either starting from high school or during their undergraduate studies while none used e-learning materials. Meanwhile, Table 4 shows the results related with respondents' expectations from an on- line vocational language teaching material. It is observed that 'construction industry vocabulary' is the most common expectation of construction professionals from an on-line vocational foreign language material. Improving their 'speaking' and 'listening' abilities are the following activities that the respondents expect from an on-line language teaching material.

Table 3: Means of Learning a Foreign Language

% resp.	P1	P2	P3	P4
(a) starting from primary school	0	33	44	0
(b) in the high school	32	33	21	80
(c) during undergraduate studies	32	33	23	5
(d) during graduate studies	11	0	7	15
(e) e-learning	0	0	0	0
(f)other	25	0	5	0
TOTAL (%)	100	100	100	100

Table 4: Expectations from An On-Line Vocational Language Teaching Material

% resp.	P1	P2	P3	P4
(a) grammar	6	0	2	20
(b) listening comprehensi on	6	23	28	16
(c) reading comprehensi on	8	8	17	12
(d) speaking	22	31	18	20
(e) vocabulary	18	34	28	28
(f)) equally focus on all	40	4	7	4
TOTAL (%)	10 0	10 0	10 0	100

CONTENT OF EVLAC MATERIAL

The current stage of the project is where content of the material is being organised depending on the results of the questionnaires. The content of the on- line learning/teaching material will be grouped under 6 main headings. These are professional roles, contract/sub contract management, labour relations, quality assurance, education and training and, communications and information sharing. There will be a glossary, vocabulary exercises, listening and reading exercises under each main heading in 4 languages. Glossary will give the meaning of each construction related word/phrase in both the local language (Turkish, Greek, German) and English. Listening exercises will include authentic materials in the form of audio/video recordings of construction professionals talking on their daily practices related with the subject headings. Video recordings will have transcripts in national languages together with English subtitles. The developed materials will then be introduced to construction professionals/ students in order to evaluate its success in fulfilling the industry expectations.

CONCLUSIONS

The aim of EVLAC project has been to adopt the methodology and the results of LANCAM project to develop new learning materials that focus on the construction industry related work culture/ practice issues in Turkey, Greece, Austria and UK, while focusing on Turkish, Greek, German and English language learning and teaching. In order to achieve this, the first step was to undertake two questionnaire surveys to identify the communicative needs of construction professionals/companies and to gather useful information about working in construction project management in Europe. This article focused on the questionnaire survey findings related with the vocational foreign language requirements of construction professionals/companies. Findings show that vocational foreign language competence is an important criterion in hiring construction professionals for international projects. Findings additionally show that construction professionals require learning not only European languages like English, German and French but also other languages like Arabic, Russian due to increasing construction demand in the Arabic and Russian speaking countries.

The EVLAC project is currently at the development stage of e-learning materials based on questionnaire survey findings together with literature and LANCAM project findings. The e-learning material will then be implemented in vocational language and construction management classes and to different construction professionals like architects, project managers and engineers in selected construction companies in order to get feedback and take corrective action if required.

The progress of the project can be followed from the projects web site http://bmb.cu.edu.tr/evlac.

ACKNOWLEDGEMENT

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REFERENCES

Bertin , C. , Bertin, J.C. Mise en place d’une formation en anglias a l’Institut des Transport des Transport Internationaux et des Ports. *ASP: La Revue du GERAS*,2,139-162, 1993.

Dechesne, M.A. English Usage and needs in the workforce: Review of the literature and relevance to higher education curriculum development, *Information Analysis,* 1998.

The EVLAC Group, Enhancing vocational language skills and working culture awareness of European construction professionals, *PM World Today*, Vol. X, Issue VIII, 2008.

EVLAC web site , http://bmb.cu.edu.tr/evlac/

Furuya, C., Assessing the needs of Japanese engineers abroad. *TESOL Matters*, October/November, p.16, 1998.

Garcia-Mayo, M. Designing an ESP course for health science students. *ASP:La Revue du GERAS,* 7/10, 501-510, 1995.

Haissinski, Y. Maury, M. A study of English needs of scientific executives in business. *Les Languages Modernes,*1, 124-130, 1990.

Holden, W. Instructors as business people, business people as instructors: the needs analysis in a negotiated syllabus for corporate learners. *The Journal of Language for International Business,* 6(2), 55-66, 1995.

Moody, J. An assessment of language needs for technical communication in a multilingual speech community: Implications for teaching LSP in Papua New Guinea. *Annual meeting of the Southeast Asian Ministers of Education Organisation regional language seminar,* 1993.

Pennington, M.C. Research on language in Hong Kong: An overview. *Pasific Language Research Forum,* Sydney, Australia, 1993.

Rogerson- Revell P., Developing a cultural syllabus for business language e-learning materials, *ReCALL* 15(2): 155–168, Cambridge University Pres ,2003.

Sinhanetti, K., ESP courses at Tertiary level: A reflection of Thai business community. *Annual conference on Languages and Communication for world business and professions* ,Ypsilanti, MI, 1994.

Wongsothorn, A., Steps in EFL graduate program design by the Language Institute, Chulalongkun University. *Case studies in syllabus and course design, SEAMEO Regional Language Centre: Singapore,* 1992.

LEARNING OUTCOMES IN CONSTRUCTION MANAGEMENT FIELD AT CIVIL ENGINEERNIG STUDIES AT FACULTY OF CIVIL ENGINEERING IN RIJEKA

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The study reform based on the Bologna declaration gave the Faculty of Civil Engineering in Rijeka the opportunity to reconsider what has been done in the particular civil engineering field at the traditional studies and to define learning outcomes for new studies.

For the definition of learning outcomes in the field of construction management it is very important to take into consideration the type and complexity of tasks which the student will have to approach after having completed different levels of study programmes.

The history of teaching construction management at the Faculty of Civil Engineering in Rijeka is briefly described in this paper. The learning outcomes in the field of construction management at actual studies, the university undergraduate and graduate study programme, are presented and analyzed in more detail.

KEYWORDS: study reform, learning outcomes, construction management.

INTRODUCTION

The main goal of the Bologna declaration was to create a European space for higher education in order to enhance the employability and mobility of citizens and to increase the international competitiveness of European higher education. The deadline for the goal is the year 2010. (European Commission, 2009)

The Bologna declaration principles addressed the adoption of a common framework of readable and comparable degrees, the introduction of undergraduate and postgraduate levels in all countries, introduction of ECTS-compatible credit systems, development of European dimension in quality assurance and the elimination of remaining obstacles to the free mobility of students and teachers.

Croatia has signed the Bologna declaration in 2001. A considerable number of different activities (adjustment of laws and regulations, study reform, encouragement of students' and teachers' mobility etc.) have been conducted since then in order to achieve recognisable and accepted standards in European higher education.

The study reform of the year 2005, including the development of a quality assurance system, and start of delivering the reformed studies that ended in 2006 are recognised as the first two phases of the Bologna process. The third phase, implementation of the learning outcomes concept, is probably the most complex part of the reform because it necessarily addresses the traditional principles in Croatian higher education. Contemporary, student oriented, teaching departs from the traditional concept of ‘knowledge transfer’ from the teachers’ into the students’ „heads“ and is concerned with constructing students’ knowledge, understanding and skills which should enable them to develop competencies appropriate for easy and effective adjustment to the labour market. This makes a change from the more traditional approach whereby the academics tend to define courses in terms of what is taught, rather than what the student can do at the end of the module or a programme.

Civil Engineering university studies at all Croatian Civil Engineering faculties are now organised in the same way:

- undergraduate study in CE: duration 3 years, minimum 180 ECTS
- graduate study in CE, duration 2 years, minimum 120 ECTS
- postgraduate (specialist or doctoral) study in CE: duration 1-3 years, 60-180 ECTS

Due to the nature of the Civil Engineering studies, which are based on applied sciences and intended to prepare students for the precisely defined profession, their transformation in line with the concept of learning outcomes, is relatively simple.

The learning outcomes at a study level are defined by answering a few very simple questions:

- What will the students know, understand or be able to do upon completion of a certain level of study? Which competencies will the student develop? Which personal (usually called generic) competencies will the student develop?

Because of the already mentioned practical nature of the Civil Engineering studies, the above questions are familiar to the teachers and the definition of the learning outcomes is more like an „experience inventory process” with acceptance of the recent global trends (e.g. internet access to information) as well as the trends in Civil Engineering profession (e.g. a larger number of different employments during the future engineers’ working life-time work etc.)

The goal of this paper is to encourage discussion about the intended learning outcomes in the field of Construction Management by presenting an example of the defined learning outcomes in this field at the university programmes in Civil Engineering at the Faculty of Civil Engineering in Rijeka.

TEACHING CONSTRUCTION MANAGEMENT AT FACULTY OF CIVIL ENGINEERING IN RIJEKA

University Undergraduate Civil Engineering Studies

When teaching construction organization and technology at the university undergraduate studies at the Faculty of Civil Engineering in Rijeka up to 2004/05 is discussed, a number of problems which have not been resolved throughout years must be pointed out. It must be noted that there was no separate unit (department or sub-department) for construction organization and technology at the Faculty at the time. The teaching staff structurally belonged to Transportation Engineering Department which rendered impossible clear articulation of problems and development plans of the field in question for a number of years. It can be stated that such situation is a result of different circumstances of mostly subjective nature which reveal quite a negative attitude and ignorance towards this field of some decision-makers. However, not the very teaching staff of this field can be pardoned for this situation because, although scarce in number, did not actively participate in defining the development demands. The stated problems have also influenced the structure of teaching these subjects in which process the situation culminated by declaring Construction Organization and Technology an optional subject, this being a unique case compared to other faculties of civil engineering in Croatia. It stands to reason that the consequence of this decision was knowledge deficiency from this field shown by the graduate civil engineers who had not attended this course, which was exceptionally noted by those working in contractor companies.

University Undergraduate and Graduate Civil Engineering Studies (from 2005/06)

The study reform which was intensively being worked at during 2005 gave the opportunity to correct the insufficiencies of the previous study curriculum by defining the required knowledge and competences from construction management field at undergraduate graduate and graduate level of university and vocational studies.

The very year 2005 brought significant positive changes in organization and technology field development at the Faculty through founding the Sub-department of Construction Organization and Technology and Architecture, that is, through curriculum changes of those courses according to Bologna declaration principles.

In addition to giving the Construction Organization and Technology course the mandatory subject status at the university graduate studies, the implementation teaching programs have been modernized and adjusted to those being taught at other faculties of civil engineering in Croatia. Moreover, new courses have been introduced (Project Management, Construction Management, Investment Policy, Construction Maintenance, Fieldwork whose aim is to substitute the Professional Training through the first teaching cycle and is, therefore, not exactly a new course) (Table 1, Table 2 and Table 3). One of the main intentions of the mentioned courses is to considerably prepare the students for the professional civil engineering training, especially for the construction execution, for construction preparation, for direct structure construction, that is, for more complex tasks of construction management.

Table 1: Teaching Construction Organization and Technology at the Faculty of Civil Engineering in Rijeka – University Studies (2005/06)

	Course	**Active Teaching L+E+S**	**ECTS**	**Course Classes status**
University Undergraduate mandatory	Construction Organization and Technology	3+2+0	6	V-mandatory
	Construction Economics	2+1+0	4	VI- mandatory
	Construction Regulations	2+0+0	3	VI – optional
	Construction Management	3+0+0	3	VI – optional

	Fieldwork	0+2+0	3	VI - mandatory
	Total of mandatory	**5+5+0**	**13**	
	Total of optional	**5+0+0**	**6**	
	TOTAL	**7(8)+6+0**	**16**	
University Graduate mandatory	Project Management	2+1+1	5	I- mandatory
	Construction M achines and Facilities	2+2+0	4	III-optional
	Total of mandatory	**2+1+1**	**5**	
	Total of optional	**2+2+0**	**4**	

The table offers the review of courses related to the field in question, number of teaching classes and ECTS points for mandatory and optional courses of university graduate studies at all faculties of civil engineering in Croatia.

By comparing the courses at the Faculty in Rijeka and at other faculties the following can be concluded:

- By comparing the mandatory courses, the number of teaching classes (5) is the same at all faculties. The number of exercise classes in Rijeka (5) is right behind the Faculty in Zagreb (6).

- The ECTS points of mandatory courses (13) are the highest at Faculties in Rijeka and Zagreb.

- By comparing the optional courses by number of classes and number of ECTS points, the Zagreb and Osijek Faculties with 8 teaching classes and 12, respectively 14 ECTS points have the advantage. The Faculty in Rijeka is trailing behind everybody with 5 teaching classes and 6 ECTS points.

- Regarding the course structure, only the Faculty in Rijeka has a course named Construction Organization and Technology. Other faculties have a separate course named Construction Organization. The faculties in Zagreb and Osijek offer optional courses named Infrastructure Engineering Technology and Building Construction Technology.

- The Faculties in Rijeka and Osijek offer a separate course named Construction Economics, that is, Engineering Economics, which is included in the Construction Organization course at other two faculties.

Table 2: Graduate C ourses R elated to t he F ield in Question at F aculties of C ivil E ngineering i n Croatia

Studies	University undergraduate

Faculty	Course	Status	Teaching classes	ECTS
Faculty of Civil Engineering i n Zagreb	Construction Organization	Mandatory	3+3+0	7
	Construction Regulations	Mandatory	2+0+0	3
	Fieldwork	Mandatory	0+3+0	3
	Total	Mandatory	5+6+0	13
	Sociology of Profession and Professional Ethics	Optional	2+0+0	3
	Business Economy	Optional	2+0+0	3
	Introduction t o La w f or B uilding P rofessionals Construction	Optional	2+0+0	3
	Technology	Optional	2+0+0	3
	Total	Optional	8+0+0	12
Faculty of Civil Engineering and Architecture i n Split	Construction Organization	Mandatory	3+1+0	5
	Construction Industry Production	Mandatory	2+1+0	4
	Total	Mandatory	5+2+0	9
	Introduction to Business Economy	Optional	2+0+0	2
	Introduction to Law	Optional	2+0+0	2
	Sociology of Profession	Optional	2+0+0	2
	Total	Optional	6+0+0	6
Faculty of Civil Engineering i n Osijek	Engineering Economy	Mandatory	2+0+2	4
	Construction Organization I	Mandatory	3+2+0	6
	Total	Mandatory	5+2+2	10
	Construction Regulations	Optional	2+0+0	2
	Infrastructure Engineering Technology	Optional	3+1+0	6
	Building Construction Technology	Optional	3+1+0	6
	Total	Optional	8+2+0	14

It is not possible to make a comparison at a graduate studies level because the Faculties in Osijek and Zagreb implement the graduate studies within the field of construction organization and technology while that is not the case at faculties in Rijeka and Split.

However, what can generally be stated is that the Faculty in Rijeka does not offer the construction organization program at graduate studies where this specific field is represented only by the course Project Management as a mandatory one in the first semester (2+1+1 teaching classes and 5 ECTS points) and by the course Construction Machines and Facilities as an optional one in the third semester (2+2+0 teaching classes and 4 ECTS points).

The cause for this situation is deficiency of staff, a problem the management is aware of and trying to solve it by taking appropriate measures because it represents an objective obstacle in further development of the field.

It can be concluded with pleasure that, compared to the previous situation and regardless of staff deficiency, since 2005 a significant breakthrough in establishing and developing the field at the Faculty in Rijeka has been made by making great effort. This breakthrough is manifested not only by previously conducted detailed course structure analysis, but also by modernizing the curriculum and teaching methods (e.g., using adequate software, field trips, workshops, team work and other), by course growing presence in specialist vocational studies, by its growing presence in professional education programs and other.

LEARNING OUTCOMES AT CIVIL ENGINEERING STUDIES

Learning outcomes – general

Learning outcome can be defined as a specification of what a typical learner will have achieved at the end of the programme or part of the programme or course. Learning outcomes are the specific intentions of a programme or module, written in specific terms. They describe what a student should know, understand, or be able to do at the end of that programme or module. Programme outcomes are related to the qualification level and will relate to the sum of the experience of learners on a particular programme.

Learning outcomes on the course (or a module) level are intended to help students to understand what is expected from them and to help teachers to focus on the most important knowledge, understanding and skills that they want the students to acquire. Learning outcomes are also useful for the students to know in advance what is expected of them at a certain course or module.

The learning outcomes on the course level can be defined through the following four steps: (1) Definition of course goals; (2) Definition of the learning outcomes the basis of the defined goals; (3) Definition of the assessment methods and (4) Definition of the teaching methods appropriate for the learning outcomes intended.

It is very important to analyse the student success ratio and the students' evaluations (as well as other proofs of teaching effectiveness) as the basis for the enhancement of the course content, teaching methods and assessment criteria.

Learning outcomes at the Civil Engineering studies

There are a number of very advanced international associations that deal with improvement of engineering and/or civil engineering education: SEFI (European Society for Engineering Education); IGIP (International Society for Engineering Association) and finally, EUCEET (Thematic Network of Civil Engineering).

EUCEET has been dealing with different aspects of the Civil Engineering education very actively since the Bologna process started. During 2004 and 2005 EUCEET was focused on the Socrates-Erasmus Tunning II project.

This project aimed at harmonising state of the practice in desirable learning outcomes at different levels of the Civil Engineering studies. One of the activities performed was the research about specific and generic learning outcomes at engineering studies. The academics and employers were asked to estimate the relevance of the given learning outcomes for the different levels of the Civil Engineering studies. (EUCEET, 2009)

List of suggested and discussed subject-related competences in Tunning project:

- Ability to apply knowledge of mathematics and other basic subjects
- Ability to use knowledge of mechanics, applied mechanics and of other core subjects relevant to civil engineering
- Ability to design a system or a component to meet desired needs
- Ability to identify, formulate and solve common civil engineering problems
- Ability to identify, formulate and solve complex civil engineering problems
- Understanding of the interaction between technical and environmental issues and ability to design and construct environmentally friendly civil engineering works
- Ability to design and conduct experiments, as well as analyse and interpret data
- Ability to identify research needs and necessary resource
- Ability to use the techniques, skills and modern engineering tools, including IT, necessary for engineering practice
- Ability to apply knowledge in a specialized area related to civil engineering
- Understanding of the elements of project and construction management of common civil engineering works
- Understanding of the elements of project and construction management of complex civil engineering works
- Understanding of professional and ethical responsibility of civil engineers
- Understanding of the impact of solutions for civil engineering works in a global and societal context
- Ability to communicate effectively
- Understanding of the role of the leader and leadership principles and attitudes
- Recognition of the need for, and the ability to engage in, life-long learning
- Ability to function in multi-disciplinary teams

List of suggested and discussed generic competences in Tunning project:

- Ability to work in an interdisciplinary team
- Appreciation of diversity and multiculturality
- Basic knowledge of the field of study
- Basic knowledge of the profession
- Capacity for analysis and synthesis
- Capacity for applying knowledge in practice
- Capacity for generating new ideas (creativity)
- Capacity to adapt to new situations
- Capacity to learn
- Critical and self-critical abilities

- Decision-making
- Elementary computing skills (word processing, database, other utilities)
- Ethical commitment
- Interpersonal skills
- Knowledge of a second language
- Oral and written communication in your native language
- Research skills

Learning outcomes in the field of construction management at university studies of Faculty of Civil Engineering in Rijeka

Implementation of learning outcomes, at programme and course level, at the Faculty of Civil Engineering in Rijeka is part of the activities that follow the Strategy of the University of Rijeka (2007.-2013.) (University of Rijeka, 2007) concentrated in the goal "Curriculum reform based on the learning outcomes" Also, at the Faculty is going on project, financed by the National foundation for science, higher education and technological development of the Republic of Croatia, "Learning outcomes in higher education of civil engineers". The main goal of the Project is to define basic elements for the curricular reform of CE studies. The Faculty itself recognised the need for introduction of learning outcomes concept in existing programmes by adopting in January of 2009., the action plan for the implementation of learning outcomes at course and programme level.

Table 3: Competences and skills

Study Programme	Undergraduate	Graduate
Professional Competences	Required Competences 1. Understanding of organizational and technological aspects of building construction and infrastructure engineering structure construction 2. Ability to design organization and technology of construction work performance during construction preparation stage 3. Ability to identify and resolve organizational and technological problems during the construction process 4. Ability to organize the construction site and operate the construction of infrastructure engineering and building construction structures Ability of planning, organizing and managing the production and business processes of lesser or medium complexity within the business systems (civil engineering and public utility companies, local government offices) Suggested competences which are to be acquired through optional courses 1. Understanding of basic legal terms, commercial law terms. Knowledge of construction regulations in force and essential baselines of technical regulations. 2. Understanding of basic construction company management principles	Required Competences 1. Understanding and application of management methods during single stages of construction project life-cycle 2. By applying the acquired field competences from the undergraduate level to the specialization field within the construction industry the student develops: - understanding of organizational and technological aspects of complex structure construction - ability to design organization and technology of complex construction work performance during construction preparation stage - ability to identify and resolve organizational and technological problems during the complex construction process - ability to operate the complex structure construction Suggested competences which are to be acquired through optional courses 1. Planning, dimensioning and conducting of the production processes by using a more complex construction machinery 2. Understanding of financial calculation and construction company investment principles 3. Structure maintenance project design and management
Skills	1. Basic computer skills – writing and text editing, creation of databases and computer presentations, etc. 2. Ability to apply software for resolving construction organization and technology problems	1. Ability to apply software for project management problem resolving

Generic Competences	1. Basic professional knowledge 2. Develop in oral, written and graphic communication with both professionals and non-professionals 3. Inter-disciplinary teamwork 4. Capacity for analysis 5. Capacity for practical knowledge application	1. Basic professional knowledge of project management 2. Capacity for analysis and synthesis 3. Capacity for practical application of requirements 4. Creativity 5. Capacity to adapt to new situations 6. Decision-making capacity 7. Capacity for acquisition of new knowledge 8. Research skills

Teaching Methods

The applied teaching methods must be adapted to the required professional and generic competence acquisition requirements. A large number and diversity of competences indicates the need for applying different methods whose right choice will facilitate a specific competence acquirement. The contemporary IT tools facilitate the acquirement of professional and general competences and skills particularly in relation to resolving specific problems from the field (e.g., preparation of dynamic plans, price calculations, tenders, project management tools and other), as well as for the development of communication and presentation competences.

When teaching courses of this field of study, it is recommendable to encourage discussion about technical problems, team work for solving program tasks, writing and presentation of student's seminar papers and workshops along with the classical presentation methods. With regard to nature of the profession, organizing field visits or prolonged construction site stays as part of the Field Work and Professional Training course, as well as assigning of tasks related to a specific construction site problem which the students must resolve in writing by applying specific IT tools and orally discuss with the teacher is of outmost importance. By staying at the construction site the students get an insight into required documentation and have to keep a site diary themselves. Moreover, field visits, visits to construction material and construction product production facilities and specialized fairs are a recommendable addition to the teaching process because the students are given the opportunity to test the acquired knowledge and broaden it with new acquirements by seeing and recognizing the specific products, elements, machines, facilities and production processes. It is highly recommendable to organize a short presentation during such visits which are held either by the teacher or by professional staff because it gives students the opportunity to ask questions and have a discussion.

The evaluation methods all come down to evaluating the learning outcomes of courses. It must be taken into account that the defined learning outcomes are adjusted to the teaching methods and student achievement assessment methods and that the students are informed about them in the beginning of the course.

Assessment of active participation and discussion in class as well as test exercises for different teaching units which can be evaluated just for some, not for all the students are quite advisable. It is also advisable to limit the number of works which are assessed, to apply the random selection method but also to enable the students to submit the assignment if they want to, taking into consideration the number of works. The assessment is also made by regular and makeup preliminary exams, final exams and a program which is assessed as a written paper and as its oral presentation. Team work is assessed with grading the completed report and its oral presentation. What is assessed is the role and participation of each team member, team work as a whole, team leader role and the role of one or more presenters. The tasks relating to field work and professional training are assessed as both a written work – resolving of a specific task relating to the specific construction site, and as oral presentation. The final, that is, the graduation thesis should be the final examination of acquired competences and skills of primarily professional nature, but also of problem presentation and problem solution skills.

CONCLUSION

Learning outcomes, their definition, their characterisation and their measurement are recognised as very important factors of the success of the Bologna Process.

Definition of specific and generic competences for different study levels, fields and courses is currently in process at the Faculty of Civil Engineering in Rijeka. In defining learning outcomes for the construction management field specific subject competences for different study levels and necessity to prepare students for their future careers were taken into consideration.

It is important to provide proper information to all stakeholders about competences which the students acquire at civil engineering studies as well as to monitor the relevance of intended learning outcomes in permanent contact with employers and former students.

Partnership and cooperation with stakeholders is crucial in the ongoing process of curriculum innovation based on learning outcomes.

REFERENCES

Annual 2008., Faculty of Civil Engineering University of Zagreb, Zagreb, 2009. (*in Croatian*)

http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf (April 17, 2009)

http://www.gradst.hr/files/users/strogrlic/Program_Preddiplomskog_studija_gradjevinarstva.pdf (May 15, 2009)

http://www.gfos.hr/portal/images/stories/nastava/studiji/studijski-program-sveucilisni-preddiplomski-studij-hr.pdf (May 15, 2009)

http://www.eccenet.org/Activities/Edu-Train/02_EUCEET-Tuning-ECCE.ppt (April 23, 2009)

Programmes in Civil Engineering, Faculty of Civil Engineering University of Rijeka, Rijeka, 2005.

University of Rijeka, Strategy 2007.-2013., University of Rijeka, 2007. (*in Croatian*)

CSR TRAVELS ABROAD: NO BUSMAN'S HOLIDAY FOR UK CONSTRUCTION?

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In the past decade the UK's top construction contractors and consulting engineers have developed an extensive array of policies and procedures associated with Corporate Social Responsibility (CSR). This reflects the onus on companies and their personnel to behave in a transparent, accountable and ethical manner. This position paper explores how UK constructors CSR principles are enacted abroad. It explores some of the challenges that companies have when operating within different legislative and cultural climates. This is explored through two case vignettes which reveal that, despite extensive international legislation and guidelines associated with CSR, challenges remain in reflecting UK practice abroad. Nevertheless, there are examples of where UK firms have taken voluntary action to ensure that their ethical standards are not compromised, even when working in very different socio-economic contexts. It is suggested that enforced international minimum standards could provide a way of ensuring adherence to ethnical treatment of workers in the future. The role of key international agencies in enforcing such standards is discussed.

KEYWORDS: corporate social responsibility, international construction, ethics

INTRODUCTION

The last decade has seen the profile and importance of CSR in the construction sector grow significantly. Recently, the CIB W55/W65 symposium held in Dubai in 2008 was the catalyst for a debate which played out across the cnbr network. The debate surrounded allegations of the abuse of human rights of construction workers in the United Arab Emirates (UAE). This paper is intended to contribute to developing and positioning this debate by providing further avenues of enquiry concerning the behavior of organizations involved in international construction ventures. More specifically, it aims to suggest ways in which the industry might be better regulated across international boarders in order to ensure the adherence to high ethical standards, even when operating in different socio-economic contexts.

This paper has its genesis a textbook: *Corporate Social Responsibility (CSR) in the Construction Industry* which was edited by the authors (see Murray and Dainty 2009). This book gathered a range of perspectives on various aspects of CSR and its enactment by constructors. Drawing upon the insights provided within this book, in this paper we seek to examine the ways in which CSR policy is translated in international contexts and some of the challenges involved therein. The title of the paper and use of the idiom 'no busman's holiday' is intended to convey that UK constructors (consultants and contractors) face particular risks when undertaking work abroad. It is however recognized that the CSR practice of UK constructors at home has also received attention from various bodies including the Office of Fair Trading (OFT) (see Male 2009) for evidence of cartel formation within the industry).

Thus, whilst constructors operating abroad may suffer from 'travel sickness', for some the infection could be carried abroad and further propagated in new markets.

In the UK, a 'busmans holiday' refers to individuals who engage in their profession whilst away from their normal place of work, or more commonly whilst on holiday. British Expertise (2007) for example, cite several examples of construction professionals taking a busman's holiday including an engineer from consultant who undertook a sabbatical as an unpaid volunteer working on a hydro-electric project on the Zambezi river. However, personal commitment made by constructors to 'do good' and 'make a difference', terms commonly associated with moral and ethical behavior, are frequently overshadowed by unethical and illegal corporate business practice which can also take place when operating within developing countries. In this paper we highlight both good and bad practice in respect as a precursor to exploring how corporate behavior might be better regulated in the future.

INTERNATIONAL CONSTRUCTION AND CORPORATE ETHICS

Notwithstanding difficulties of definition, construction is one of the world's largest industrial sectors with a workforce of 110 million (CICA, 2009). Given the importance of this industry sector it could be envisaged that all aspects of its operations would have received attention from researchers. However, despite a serious of textbooks and research papers on the topic e.g. Seymour (1987); Langford and Rowland (1995); Crosthwaite (1998) Bon and Crosthwaite (2000); Mawhinney (2000); Oz, (2001); Bosch and Philips (2002) Howes and Tah (2003) and Whitla et al (2006), their exists surprisingly little research focusing on the 'darker side' of constructors' behavior abroad. Exceptions that have a direct focus on what would now be considered to fall under the CSR umbrella include scholarly papers and reports into the construction industry in developing countries (Ngowi, 2002); technology transfer to developing countries (Miles and Neale, 1991; Miles, 1998); a focus on the detrimental impact of international dam construction (McCully, 2001) and the sector's role in meeting the Millennium Development Goals (Ofori, 2007). In addition, working commission CIB W107 now provides a forum for debates around such issues. Ofori (2006) notes how the commission's agenda has evolved, and whilst poverty alleviation through construction and post-disaster reconstruction remain a core theme, recent research has examined the application of public and private partnerships (PPP), business ethics in construction, the utilisation of information and computer technology (ICT) and the importance of total quality management (TQM). Specialist journals such as the *Journal of Construction in Developing Countries* also provide a forum for debate around CSR issues such as corruption (e.g. Zou, 2006). It would seem, therefore, that there is a burgeoning interest in the behavior of international contractors within developing country contexts.

Although more detailed definitions of ethical behaviour in the built environment are provided elsewhere (see Fewings, 2009), for the purpose of this paper a simple definition has been adopted: "where individuals and corporations are intrinsically aware of when their decision making processes, actions and legacy are fair, just, transparent and morally acceptable to project stakeholders and society as a whole". Cordeiro (2003) emphasises that even where indigenous practices exhibit a lack of shared public ethics, multinational enterprises (MNE's) should not adopt local practices that are clearly unethical. He cites examples such as 'poor waste disposal' and the 'employment of children' and argues that MNE's 'should lead by example' as they have the power to shape an ethical environment. However, around a decade ago, Crosthwaite's (1998) research examining the behaviour of the UK's leading international contractor's uncovered similar behaviour. The contractors' primary objectives for operating overseas were to 'to tap into booming markets' (60% 'very important' & 30% 'important'). 'Helping poorer countries to develop' on the other hand was not considered 'very important' by any responding contractor and, with only 10% stating that this was 'important'. The contractors had a preference for working in developed countries, apparently due to their belief that 'less corruption' exists compared to developing / transitional economies.

A recent pole of Chartered Builders (CIOB, 2006) provides evidence of divergent perceptions of what constitutes 'unethical behaviour'. The report states that *"… while corruption is present to some degree in many areas of the construction industry, there is some disagreement of where networking and the development of harmonious working relationships stop, and corruption starts"*. In 2007 the *New Civil Engineer* (NCE) cited a senior industry figure (Armitt, 2007) who questioned the inappropriateness of 'commission payments' made to foreign officials as a means to win work overseas. During a lecture on 'Engineering Ethics' he had apparently argued that questioning local political culture was outside an engineer's remit. In a similar vein, Gunhan and Arditi's (2005) research into USA based international constructors found that respondents acknowledged the propensity for bribery in host countries, but that this was generally considered to go with the territory. Such evidence points towards companies working abroad adopting different ethical standards, although the ways in which this plays out demand further investigation though case examples.

CASE VIGNETTES

The two case vignettes below provide illustrative examples of where UK constructors have confronted ethical dilemmas when engaged in overseas construction. The Pergau hydroelectric project highlights the role of bribes in dam construction, a form of construction which appears to have a propensity for attracting controversy (Murray and Meghji 2009). The second example explores accusations of human rights abuses in the UAE, and attempts by UK constructors to begin to take positive action to address the problem.

Case 1: Corruption in the Pergau Dam project

The Pergau hydroelectric project is located in Malaysia, a former British colony. The Pergau controversy centred on what one politician described as an 'incorrect linkage' and a 'brief entanglement' between senior UK Government officials including the then Prime Minister (PM) Margaret Thatcher and the Malaysian PM, Dr Mahathir Mohamad. The political involvement included the use of special protocol employed by the then Defence Secretary offering aid, not for the purposes of reducing poverty, but as an enticement to secure arms sales for UK companies under the auspices of an 'Aid for Trade' arrangement. The protocol and other secret documents were subsequently uncovered during scrutiny by the National Audit Office (NAO, 1993) and the House of Commons Committee of Public Accounts (1994). It transpired that £234m of aid for trade linkage with Malaysia involved Britain winning a £1bn arms contract to supply radar, naval frigates and Hawk jet-aircraft trainers to Malaysia. The body responsible for allocating aid money, the Overseas Development Administration (ODA) had rejected the proposal, but was overruled by the Government. In 1994, The World Development Movement (WDM) secured a victory in the High Court which presented the UK Governments' involvement in Pergau as a violation of the 1966 Overseas Aid Act that expressly prohibits British aid money being used for the purchase of arms.

In 1988 a consortium of British companies was initiated through an application to the Department of Trade and Industry (DTI) for aid through the ATP for the Pergau dam. Contract Journal (1994a) noted that the House of Commons Committee of Public Accounts Committee report ‘strongly censured’ members of the consortium over their role, particularly the degree of optimism bias regarding the projected cost. Palast (2000) a journalist makes reference to the allegations of bribery associated with the project following his interview with Jeremy Carver, an adviser to anti-corruption campaign Transparency International.

> *'I went to a DTI reception,' Carver said. 'I was introduced to someone who identified himself as the chairman of a company and we were talking about corruption. He announced with enormous pride that he personally had handed over the cheque to the government minister for the Pergau Dam "bribe" in Malaysia.' The corporate honcho, the chairman of Balfour Beatty, was not confessing, but boasting about the payment which he may have considered not a bribe but just the cost of doing business Malaysian-style. Carver noted that the then Tory Trade Minister, learning of the pay-off, publicly congratulated Balfour Beatty on its patriotic competitiveness.*

Kershaw (1994) undertook a content analysis of series of issues from one Malaysian newspaper-*Harakah* that reported regularly on the issues surrounding Pergau and noted the offence taken by the Malaysian PM when accused by the British media of accepting bribes. Hack (1994) notes that the problem worsened for Mahathir when in February 1994, the UK Sunday Times newspaper reported that British construction company Wimpey had in 1985 being willing to pay bribes of up to $150,000 in an unsuccessful bid to win contracts. This was the final catalyst the lead to Malaysia issuing a ban on the awarding of government contracts to British firms. However, Contract Journal (1994b) reported that only one UK constructor had suffered due to the tendering list ban and other projects already undergoing construction continued.

Case 2: Workforce abuse in the UAE

Non Government Organisations (NGO’s) such as the International Labour Organisation (ILO); Corporate Watch and Human Rights Watch (HRW) provide a regular litany of cases that point to unethical behaviour within the international construction industry. Recently, Human Rights Watch (2008) provided evidence that construction workers in United Arab Emirates (*Building Towers Cheating Workers*) had suffered abuse of labour rights at the hands of unscrupulous employment agencies. The BBC news and current affairs program Panorama (BBC 2009) also featured a special report on the plight of workers in Dubai in which the poor conditions endured by such workers was explored. Molavi (2007) also highlighted the difficult conditions of immigrant workers in Dubai through a National Geographic article. These media interventions emphasise that the plight of such workers has found its way into mainstream news bulletins and newspapers.

A key welfare requirement for workers in middleeastern climates (the midday summer break) is explored by Shamseddine (2007). Since 2005, the Ministry of Labour in the UAE has enforced a directive that requires contractors to stop works between 12.30-15.00, enablingworkers who undertake opertaions in open areas, or are exposed to direct sunlight, some respite. However, depite the clear intent by the Ministry to eradicate transgressors Issa (2007) found that some contractors had made litle provison to accomodate the workforce during the rest period. The report by HRW (2006) was based on interviews with around 60 migrant workers which revealed that they had been exposed to '*wage exploitation, indebtedness to unscrupulous recruiters, and working conditions that are hazardous to the point of being deadly*.' It would therefore appear that there is some way to go in ensuring compliance with employee welfare legislation.

In response to the poor conditions faced by many workers, some UK contractors have begun to attempt to begin to address such conditions via a voluntary charter in which they commit to addressing unsafe working conditions. Price (2008) reports that UK constructors, including Balfour Beatty, Carillion and Laing O'Rourke, initiated the 'Build Safe Dubai' initiative, and that these companies have invested significant sums of money to improve the workers camps. She comments that a '*slew of headlines about the poor conditions workers endure in Dubai and their own corporate social responsibility policies led firms to take a close look at the facilities they were providing*'. This has included major multi-million pound investments in labour camps by creating more space, improved recreation facilities and subsidised catering. This example demonstrates how UK firms can improve the plight of workers by applying standards expected in the UK within the international context. Indeed, according to Price's article (*ibid*) several firms have said that they are able to turn down projects where the cheapest price is demanded by clients at the expense of welfare.

DISCUSSION: PROVIDING MINIMUM ETHIICAL STANDARDS FOR INTERNATIONAL CONSTRUCTION

The cases summarized above suggest that UK constructors travelling abroad need to consider what they pack in their suitcases. The policy, practices and behavior that our constructors adhere to perform an ambassadorial role for UK construction. However, despite many UK constructors having lengthy CSR documents, typically referring to their association with initiatives such as '*Business in the Community*' FTSE4 Index, *Considerate Constructors* and *Respect for People*, their enactment can mutate in the journey abroad.

The cases summarised above point to a need for UK constructors to be more transparent about their involvement in projects where they suspect unethical practices are being administered, and to take action where their ethical standards are being compromised. Whilst participation in corruption, by its very nature, will continue to be hidden from public view, such behaviour does contradict professional codes of ethics (such as those required by the ICE and CIOB) and those regulations and conventions developed by various industry and governmental bodies. In the case of the UAE, UK constructors have challenged the status quo of what is deemed acceptable practice. Arguably, what is now required is for minimum international standards to be adopted which enable similar ethical standards to be established and regulated.

In terms of a potential regulatory framework, compliance with a new international standard (ISO 26000) Guidance on Social Responsibility, to be published in 2010, will no doubt also raise an awareness of the issues discussed in this paper. The ISO (2009) state *"The need for organizations in both public and private sectors to behave in a socially responsible way is becoming a generalized requirement of society. It is shared by the stakeholder groups that are participating in the WG SR to develop ISO 26000: industry, government, labour, consumers, nongovernmental organizations and others, in addition to geographical and gender-based balance."* It is important to recognise that compliance with this framework will be voluntary. Hence, the support of other agencies in upholding ethical standards will remain important.

If constructors are to adhere to strict ethnical standards then support from the UK Government could be considered essential. However, organizations such as the Export Credits Guarantee Department (ECGD), the UK's official export credit agency, have not been immune from criticism. Moreover, looking for ethical leadership from the UK Government is perhaps misguided as a recent public debate over politicians' expense accounts in the UK has shown! A way forward might, therefore, be to base minimum standards on those set by other agencies with an interest in anti corruption initiatives, professional ethics and equality. Key amongst these are Transparency International, the International Federation of Consulting Engineers, the OECD Watch, and the International Labour Office.

Transparency International was founded in 1993 and now has around 90 national chapters. In 2005, Transparency International's *Global Corruption Report 2005, Special Focus, Corruption in Construction and Post Conflict Resolution* revealed that although a proliferation of developing countries had officials and agents acting as 'bribe takers', it was companies and agents employed in developed countries who tended to offer the bribes. The ramifications of corruption practice include the construction of unnecessary or ineffective projects that can also involve the enforced displacement of indigenous peoples. Furthermore, buildings constructed using substandard materials and / or workmanship (e.g. reduction of reinforcement bar diameter to increase profit margins) has also lead to the unnecessary death of civilians in countries such as Italy. It is by highlighting such practice that Transparency International has a vital role to play in raising awareness about corruption and helping to shape the international regulatory reforms necessary.

FIDIC has undertaken a sustained programme of anti-corruption in initiatives including the formation of a Business Integrity Management System (BIMS) developed by Engeli and Pieth (2000) who note the propensity for consulting engineers to become embroiled in what they refer to as 'the game' of corruption. The BIMS is intended to promote integrity during the procurement of projects. This offers an excellent framework for avoiding involvement in bribery, fraud, collusion or extortion and is designed to complement the ISO9001 quality management system.

OECD Watch is an international network promoting corporate accountability and responsibility. OECD Guidelines provide a mechanism for resolving problems arising from irresponsible corporate behaviour provide a framework for addressing the role and responsibility of the private sector in sustainable development and poverty eradication. Their work in holding the OECD's Investment Committee to account and in testing the effectiveness of Guidelines for multinational enterprises could provide another framework for overseeing the efficacy of ethnical codes. Similarly, the role of the International Labour Organization (ILO), which seeks to "*advance opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity*" (ILO 2009) is also important in ensuring the fair treatment of workers internationally. It promotes rights at work, encourages appropriate employment opportunities and strengthens the dialogue around work-related issues (*ibid*). The ILO clearly has an interest in preventing the abuse of migrant workers in the construction industry, and where applicable, the employment of children. Together, it would appear that these organisations and agencies provide a framework for holding the international practices of multinational organisations to account, and moreover, to enforcing adherence to moral codes.

CONCLUSION

This paper has outlined the challenges inherent in ensuring that UK constructors adhere to high ethnical standards when operating overseas. The case vignettes briefly reviewed within the paper reveal both the problems which can occur when ethnical standards are compromised, and the steps that UK constructors can go to in a bid to ensure that they operate in a way which is consistent with the application of ‘best practice’ CSR.. However, given the size, complexity and informality of the sector, and variable nature if regulation and enforcement in countries where UK contractors operate, it would seem that augmenting voluntary measures with greater scrutiny from agencies such as Transparency International, the International Federation of Consulting Engineers, the OECD Watch, and the International Labour Office will be key in ensuring that international standards are upheld in the future. Moreover, given that construction management researchers have largely ignored the darker side of constructors behavior, exploring ways in which CSR and wider ethical standards can be effectively translated and enacted within different socio-economic contexts would seem to provide a rich opportunity for future research exploring the globalization of construction.

REFERENCES

Armitt, J. (2007) Armitt Defends Overseas Commission payments, New Civil Engineer, 21 June.

BBC (2009) Panorama, Slumdogs and Millionaires, Broadcast on BBC 1 06/04/09, http://news.bbc.co.uk/panorama/hi/front_page/newsid_7986000/7986756.stm (accessed 06/04/09).

British Expertise (2007) International Awards 2007/08 Finalists, available at: www.britishexpertise.org

Bosch, G. and Philips, P. (2002) The Construction Industry: An International Comparison, Routledge Studies in Business Organisations and Networks, UK, Routledge.

Bon, R. and Crosthwaite, D. (2000) The Future of International Construction, London, Thomas Telford.

Chartered Institute of Building CIOB (2006) Corruption in the UK Construction Industry, Englemere, Chartered Institute of Building.

CICA (2009) Confederation of International Contractors’ Associations, available at: http://www.cica.net/

Committee of Public Accounts (1994) Overseas Development Administration: Pergau Hydro-Electric Project, Committee of Public Accounts - 17th Report 1993-94, HC number 155, 30th March, HMSO, London

Contract Journal (1994a) Pergau Dam Slam, available at: http://www.contractjournal.com/Articles/1994/10/06/32162/pergau-dam-slam.html

Contract Journal (1994b) Few Hurt by Malaysian ban, available at: http://www.contractjournal.com/Articles/1994/09/15/31486/few-hurt-by-malaysia-ban.html

Cordeiro, W.P. (2003) Should Business Ethics be Different in Transition Economies, Journal of Business Ethics, 47, 327-334

Crosthwaite, D. (1998) The internationalization of British construction companies 1990- 96: an empirical analysis, Construction Management and Economics, 16, 389- 395

Engeli, G. and Pieth, M. (2000) Developing an Integrity Programme for FIDIC: A Private Sector Initiative to Prevent Corruption in IFI-Funded Public Procurement, Background Paper, Commissioned by the World Bank and prepared for the Annual Meeting of FIDIC 2000 in Honolulu.

Fewings, P. (2009) Ethics for the Built Environment, London, Taylor & Francis.

Gunhan, S. and Arditi, D. (2005) Factors Affecting International Construction, ASCE Journal of Construction Engineering & Management,131 (3),273-282.

Hack, K. (1994) Decolonisation and the Pergau Dam Affair, History Today, 44 (11), 9-12

Howes, R. and Tah, J. (2003) Strategic Management Applied to International Construction, London. Thomas Telford.

Human Rights Watch (2006) Building Towers Cheating Workers; Exploitation of Migrant Construction Workers in the United Arab Emirates, available at: http://www.hrw.org/en/reports/2006/11/11/building-towers-cheating-workers

Human Rights Watch (2008) One year of my Blood, Exploitation of Migrant Construction Workers in Beijing, available at: http://www.hrw.org/en/reports/2008/03/11/one-year-my-blood-0

International Labour Organisation (2009) About the ILO, available at: http://www.ilo.org/global/About_the_ILO/lang--en/index.htm

Issa, W. (2007) No place to escape from searing sun, Gulf News, 02.07.2007, pp.4

ISO (2009) Social Responsibility. International Organization for Standardization, available at:http://isotc.iso.org/livelink/livelink/fetch/2000/2122/830949/3934883/3935096/home.html?nodeid=4451259&vernum=0

Kershaw, R. (2004) The Inconvenient Rationality of Islamism: Harakah During The Pergau Dam Episode, Indonesia And Malay World, 32 (94), November, 345-365.

Langford, D.A. and Rowland V. R. (1995) Managing Overseas Construction Contracting, UK, Thomas Telford.

Male, S (2009) Cartels in the construction supply chain, chapter 8, In, Murray, M and Dainty, A (edits) Corporate Social responsibility in the Construction Industry, London, Taylor & Francis.
Mawhinney, M. (2000) International Construction, Oxford, Blackwell Science.

Miles, D (1998) Evaluating International Development Projects, Evaluation, 4 (4), 469-482

Miles, D. and Neale, R. (1991) Building for Tomorrow; international experience in construction industry development, Geneva International labour Office

McCully, P. (2001) Silenced Rivers: The Ecology and Politics of Large Dams, Zed Books Ltd.

Molavi, A. (2007) Sudden City: A feverish dream of the future springs from the sands in Dubai, National Geographic, 211 (1), 94-113

Murray, M. and Dainty, A. (2009) Corporate Social responsibility in the Construction Industry, London, Taylor & Francis.

Murray, M. and Meghji, M.R. (2009) Corruption within international engineering-construction projects, Chapter 7, In, Murray, M and Dainty, A (edits) Corporate Social responsibility in the Construction Industry, London, Taylor & Francis.

National Audit Office (1993) Pergau Hydro-Electric Project**,** Report by the Comptroller and Auditor General, HC 908, London, HMSO.

Ngowi, A (2002) Editorial: Challenges facing construction industries in developing countries, Building Research and Information, 30 (3), 149-151

OECD Watch (2006) Government failing to stop UK company abuses overseas (accessed 10/01/09)

Ofori, G. (2006) Construction in Developing Countries: A Research Agenda, Journal of construction in developing countries, 11(1), available at http://www.hbp.usm.my/jcdc/input/JCDC%20Vol%20WEBPAGES/Vol%2011(1).htm.

Ofori, G. (2007) Millennium Development Goals and Construction: A Research Agenda, Proceedings of (CME 25) Construction Management Economics: Past, Present and Future, 16-18th July, University of Reading, pp 1 (abstract).

Oz, O. (2001) Sources of competitive advantage of Turkish construction companies in international markets. Construction Management and Economics, 19 (2), 135–44.

Palast, G. (2000) War on Corruption? Not quite, Minister, *The Observer*, 9 July, Business, p.5, Online, available at:
http://www.guardian.co.uk/Columnists/Column/0,5673,341271,00.html

Price, H (2008) Dubai Labourers: A Matter Of Life and Death, Building, available at: Http://Www.Building.Co.Uk/Story.Asp?Storycode=3123800

Seymour, H. (1987) The Multinational Construction Industry, London, Croom-Helm.

Shamseddine, M (2007) Midday breaks violators will be named and shamed-minister, Gulf News, 02.07.2007, pp.4

Transparency International (2005) Global Corruption Report 2005, Special Focus, Corruption in Construction and Post Conflict Resolution,

Whitla, P, Walters, P and Davies, H (2006) The use of global strategies by British construction firms, Construction Management and Economics, 24 (9), 945 -954

Zou, P.X.W. (2006) Strategies for Minimizing Corruption in the Construction Industry in China, Journal of Construction in Developing Countries, 11 (2), 15-30.

PRAGMATIC FAILURE CULTURE IN CONSTRUCTION PROCESSES

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Costs of failures in construction processes can be significant to project budgets. An ongoing empirical study, at a large Danish contractor, creates an in depth understanding of causes of failures. Underlying structures for AEC project management practices are studied from a sociological structuration perspective. Different failure cultures are studied as structures for the inter-organizational interactions in building processes. The project studied is successful in terms of time, costs and from the project's narrative although a fatal occupational injury is somewhat damaging this picture. The study shows a wide range of failures throughout the production phase. Most are minor problems leading only to limited reflection and narrow redressing actions. The ambiguity is that this "successful project" encompasses what could be seen as a failure culture. Conclusions are that project cultures entail an expectation of a certain level of failures throughout the project.

KEYWORDS: failures, project culture, project management, structuration.

INTRODUCTION

There is an absurdity attached to failure and success, since it is often failure or the unanticipated that leads to deeper reflections, change and improvement. The paper deals with an ambiguity that a building project that is regarded successful includes an expectation of a certain level of problems. The paper illuminates failures in construction processes from a different angle than rational understandings e.g. frameworks of causes and consequences of failures since it considers preconditions of actions rather than just the incidents. On basis of structuration theory and secondarily cultural theory the question is in connection to failures in operations; how actions and reflections on these occur in project based organisations? The empirical data stems from an ongoing Industrial-PhD-project hosted by NCC Construction Denmark, one of the largest Contractors in Denmark, in cooperation with University of Aarhus.

The starting point of the study is a frustration of what apparently seems to be an industry problem: a "failure culture". A review of existing knowledge on failures in the industry and within the company reveals a substantial amount of knowledge on the subject. Yet a range of problems are repeated across the portfolio of projects in the company and the industry. Internal company benchmarking data shows that quality issues, concerning both process and product, amount to large sums and strategies are imposed to reduce these. Earlier studies of stumbling stones in the building processes on a NCC project have estimated costs of the problems to 8 % of the total production value (Apelgren 2005) corresponding a summary from the Danish authorities (DEACA 2004) and Josephsons (1996) extensive studies in Sweden. Moreover the Danish building industry has been severely criticised on quality issues in the public debate, so it is a topic of current interest. The conception of failures in this paper is open-minded since it recognises the different dynamics of failure mechanisms (e.g. Jørgensen 2008; Apelgren 2005). Some can be latent, others emerging. The ambition is however not to reproduce arguments of large networks of causes and effects but to report the qualitative insights that the specific cases produces, based on the theory and acquaintance of the field. The position of the investigation at a large contractor delivers a unique possibility to gasp a glimpse of what is underneath the surface of project cultures and company structures.

The paper opens with remarks on the methods used. Mirroring the abductive method it proceeds with the theoretical frame focusing primarily on structuration theory and secondarily culture. Central points from the empirical case material are followed by an analysis of structuration and cultural elements. Finally discussion and conclusion deals with failure cultures as a part of a successful project leading to implications for the company.

METHOD

The scientific approach is abductive, where theory and empirical knowledge is developed concurrently (e.g. Alvesson & Skjöldberg 1994). According to Hanson abduction in simple terms means the ability to see patterns; to reveal deep structures (in Alvesson & Skjöldberg 2000; 17). The theory is a starting point and eye-opener and through an open empirical case-study a discussion of divergence between theory and empirical findings is applied through continuous iterations. The theoretical framework combines processual elements with elements of stability (structures) via Giddens theory of structuration (e.g. Giddens 1984) as *ontology-in-general* (Stones 2005:75) and theory on cultural elements (e.g. Alvesson 2002) as *ontology-in-situ*. A study of preconditions of actions demands for an in-depth study, rather than a wide approach. Consequently a single-case-study is selected which is double-edged in the sense that "when compared with quantitative research or multiple case studies, [it] is ordinarily judged to be lacking in rigor, comparability, and replicability" (Barzelay 1993). However, it is an extremely valuable method of social science research when used for purposes of analysing how people frame and solve problems (Ibid.). It delivers a possibility to get a deeper insight in nexuses and ambiguity and examine what is underneath the surface of project cultures and company structures. The fact that the analytical phase is emergent entails some theoretical limitation, e.g. a limited cultural scope.

Empirical material: Observations and interview

The 3 year PhD-project has an aim to create an in depth understanding of causes of failures and to facilitate change activities within the company. The empirical data was collected from 80 days of ethnographic observations of primarily on-site processes from September 2007 until autumn 2008. The starting point was site management activities, where work tasks of the contractors' project team were central. The primary focus was on the pre-cast concrete elements assembly phase as well as the installation phase. One-on-one observations (shadowing) were carried out on-site, in the site-office and at site-meetings. Participant observations and interviews also mapped interactions with designers, suppliers, subcontractors, craftsmen as well as functions at the headquarters. Numerous qualitative interviews were conducted with relevant actors as well as study visits at the suppliers' facilities. The "output" consists of a structured record of 130 problems observed on-site and a parallel diary describing day-to-day problem-solving. This mirrors an attempt to systematically analyse the failures without ending at a quantitative argument. A limitation is that not all failures were registered since it is not possible to follow all parallel activities. Moreover the collection method can lead to "death by data suffocation" as a result of the substantial quantity of data. Also the economic involvement and integration with the contractor might bias the investigation. This condition is included in the analytical reflection carried out and the Industrial-PhD program setup and the involvement of a research institution should also limit this bias.

(STRONG) STRUCTURATION THEORY

Stones (2005) concept of *strong structuration* is moulding the “dried out” abstract theory of Giddens into an applicable implement for empirical researchers. The concepts of structuration theory can be seen as an *ontology-in-general*, “concepts about the very nature of social entities over and beyond any particular empirical manifestation of them in specific social circumstances” (Ibid; 7), while on an *ontic level* a cultural analysis can deliver insight of the practical level of the building projects. To Giddens, society consists of social practices that are produced and reproduced across time and space (Kaspersen 2001). On basis of structures the social practice constitutes individuals as conscious, knowledgeable agents and through “*activities agents reproduce the conditions that makes these activities possible*” (Giddens 1984; 2), i.e. structures are reproduced, or perhaps reinforced or transformed. Agents and structures are hereby two sides of the same thing: The social practice (Kaspersen 2001). Structures are both medium and outcome of processes and because the actors are knowledgeable structures are a condition for actions embedded within the agent and not deterministic.

Characteristic for structuration theory is that it goes beyond just looking at agents or structures or giving *a priori* primacy to one or another (Stones 2005; 4). Giddens embed values/ norms as structural properties within the agent (Giddens 1984; 25). Structural properties consist of rules and resources. Rules can be understood broadly as “techniques and formulas that, anchored in our tacit practical consciousness, are employed in action or *simply;* “how to go on in social life” (Kaspersen 2000; 382). Rules relate on one hand to interpretation, *the constitution of meaning* (Giddens 1984; 18), and on the other hand to normative regulation (Ibid.). Sewell (1992; 9) put the notion of resources into “ordinary English” as *human* (authoritative) and *non-human* (allocative) resources. Both are media of power (Ibid). Structural properties are an unacknowledged condition of the activity but also unintended the structural properties are reproduced. Thus the structural properties are both constraining and enabling (Giddens 1984; 25) and the unintended consequences introduce the reproductive nature of actions which may as a result of the agents’ knowledgeability and reflexivity, or by incident, lead to change over time. As Bourdieu’s “habitus” that does nothing in itself, but is a disposition for agency, structure has no existence independent of the knowledge that agents have of their day-to-day activity (Ibid; 26). Quality-focus infrequently structures the building processes since other structures often becomes predominating. This way traditional cause/ consequence analysis’ often fail to deliver applicable knowledge to the actors and rational conceptions of failure mechanisms is in itself not sufficient. Thus the presumption is that elements in project cultures are essential in understanding dynamics in the problem solving which is why substantial catalogues of knowledge on failures often fail to structure the actions on projects.

Cultural scope

On an *ontic* level empirical implications on structures in the construction industry stress the importance of a cultural perspective. Kaspersen (2001; 233) criticise the structuration theory for the lack of a cultural scope: The theory can not grasp why actors act in different ways and why structural properties can be different to different people. Giddens notion of rules can be strengthened by including a cultural scope. There are a number of indications of differentiations in cultures in the construction industry. A study of organisational cultures focusing on the work processes (Koch 2002) as well as Thuesen (2006) describes a differentiation of cultures.

Organisational culture can be described as “patterns of meanings and ideas in the organisation” (Alvesson 2002; 96). The focus of study is symbols such as metaphors, myths and narratives (Ibid; 3) as well as meaning and interpretations regarding central aspects of project culture. Theory of culture in organisations based on symbolic interactionism discusses these meanings and interpretations as integrated, differentiated and/or ambiguous. Alvesson (2002) discuss organisational cultures as a multiple cultural configuration that consists of both shared orientations as well as differentiated and unclear elements. In line with Koch's (2002) definition of safety cultures, failure cultures are viewed as a focussed aspect of organizational cultures. *Failure cultures* are then the shared and learned meanings, experiences and interpretations of quality and failure in construction processes, expressed partially symbolically, which guide peoples actions towards problem-solving in the day-to-day work and prevention of flaws, mistakes, failures and defects. Failure cultures are therefore seen as a conflicting set of symbols, metaphors and meanings and moreover the approach is a further step away from classical explanations of structures. The failure cultures are furthermore shaped by people in the structures and social relations within and outside the organization. Within cultural theory there is an understanding, that the founders of social orders play an important role as a culture creator and/or bearer (Alvesson 2002) which is another point of interest in the cultural investigation.

CASE: THE PERIMETER BLOCKS PROJECT

The case material stems from an ongoing building project that was organized as two separate projects on the same lot and in the same site accommodation. The primary object of the study was the construction of the first two of four six storey buildings (238 apartments) called *the perimeter blocks project* and the other project was six, six storey buildings (144 apartments) called *the square blocks project*. The total budget of the projects was 68 million Euros. In both projects NCC Construction is the general contractor and the executive manager is in charge of both, also in the design phase. He is however primarily connected to the daily execution of the square blocks. The executive manager is responsible of the total project and keeping to the budget and time. All three persons in the project team of the perimeter blocks were replaced during the project. All four subcontract managers, two at each project, are young with either no experience or experience from only a few projects.

The projects are successful in terms of measures as time and costs. Furthermore the social construction of the projects as a success is heard from the projects history narrative. But by the death of a construction worker this image is to some extent broken. Vital to the success has been that the project was very carefully worked out and had wide boundaries (in form of time, costs and work space). Other factors that were pointed out as important to the success where competencies and collaboration across the value chain, a consistent and competent executive manager throughout the design and execution phase, a focus on simple solutions and buildability, and sufficient time to make competent decisions and execute these on-site. At the beginning of the construction phase the construction of the penthouse storey was identified as the only critical element in the process. However, the empirical data shows that a wide range of problems is present throughout the on-site production phase. The data collection focussed on the quality in the processes, rather than a quantitative registration. In the following some particular examples are presented.

Assembly of the precast concrete carcass

The carcass structure is based on precast concrete elements. On basis of the design done by the architect, the structural engineers modelled the structural project in 3D-CAD. The 3D-model provided an opportunity for collision control between elements and installations. The project is evaluated by the on-site team as having an unusually high standard. There are three precast concrete manufacturers responsible of different types of elements: light walls and horizontal divisions from one supplier, heavy brick façade walls from another and stairs from the third. Moreover bathroom cabins from a fourth supplier is delivered and mounted with the carcass. There are a number of failures in the process of erecting the panels. Failures occurs which are at some point initiated by all the different involved parties. Failures related to planning, the structural engineer project, the factories, on-site management, and execution is all present. Failures initiated by the manufactures are, however, the most represented. Production flaws in the form of misplaced recesses, joint locks, inserts etc. is a common problem, as well as slanting elements and problems of keeping within the tolerances, is often detected. The problems are reported to the manufacturer and it is decided who is responsible and who will redress the problem. As a result at some point there are three "finishing gangs" from the different manufacturers present at the site - in addition to the original concrete assembly gang. Yet the management group as well as NCC concrete department, which is a subcontractor on this project, refers to the project as very successful. This is in spite of a fatal injury:

A fatal occupational injury

In the ground floor gable two large brick sandwich elements was already mounted. The assembly gang started mounting the first façade elements adjacent to the gable. There was too much insulation so the element did not fit and the gang sent for the foreman to document the problem with a photo. At the same time a craftsman started casting under the gable elements for fixation. He was also on the photo that was taken. They decided to lift up the façade element to remove the excess insulation. Suddenly a sound was heard when the supporting steel structure broke. The foreman knew something was happening and shouted at the person at the end wall to get away. However, the closest gable element fell out taking the next gable element with it. The worker did not escape the 10 ton element… Soon the construction site and hut were crowded with police, ambulance men, people from the health and safety department of the contractor, as well as the working environment authority. The incident was thoroughly investigated by the health and safety department of the contractor as well as the police and the working environment authority. The investigation pointed at a number of different causes which were present at the same time and eventually caused the failure. Other than the excess insulation and the worker being in an unsafe area, the investigation pointed at incorrect handling of the element, that the bolts of the supporting steel structure can have been tightened with too much momentum, and that the inserts did not meet the dimensioned strength.

Immediately after the accident a number of emergency procedures were implemented in the company. Later it led to permanent changes in procedures e.g. restricted rules to cordon off areas close to the erection of large elements. On an industry level rules on the inserts' strength and procedures to tighten the bolts have been enhanced (DAPCP 2009). For a while there was a stressed atmosphere at the construction site but within a week everything was apparently back to normal. The executive manager addressed this directly by saying that they had to leave it behind and get going. After two more weeks the assembly gang was replaced; officially due to difficulties in cooperating with the foreman and not because of the accident. The accident was not mentioned for a long time at the site. However, it was mentioned by the NCC Concrete Department six months later as a part of the evaluation of the project.

ANALYSIS: STRUCTURATION AND CULTURE

When considering the enabling and constraining structural properties of the actions it is also required to look to previous actions of the value chain. A visible resource is the designers' project materialised through a traditional paper plot drawing. The 3D-model is only represented on-site by a large 3D-plot on the paper drawing. This can be seen as a strong resource enabling the assembly gang to place the panels in the right direction, though. The project material prescribes some normative rules too e.g. assembly technique and sequence. Industry and national institutions also delivers rules, standards and regulations as well as the contractor have central internal procedures. The different rules and resources is interwoven and materialised in different ways through the processes. While the structures can descend from both far away as well as close to the actions or from the agents' interpretation, the structures are always "in-situ" since they 'do something' to the action and therefore are present. The project has observable presence of knowledgeable actors that influence actions and reproduce and transform day-to-day activities. The structural properties span a space to manoeuvre that can be both enabling and limiting. The most noticeable structurating elements in the on-site processes are the *non-human*, *allocative*, *resources* that refer to the project management. Not surprisingly this is mainly time and costs but also work space, tools, materials, equipment, workforce, information, and weather impact are important. The schedule is a continuous indicator and influence on the process and time equals money in this context. The different actors in the hierarchy do not have the same point of origin in this respect: In a long period in the beginning of the project there are major discussions on the piece rate between the NCC Concrete management group and the craftsmen. This incongruence has the unintended effect that it structures following activities, affecting other areas of cooperation between the groups. Later on, when the assembly gang is replaced, the management group focuses on settling the piece rate right away and similar problems are avoided. This shows that different structures can clash between different groups. The individual actors also navigate in a variety of rules and resources that also can be seen as conflicting; e.g. focus on progress (and costs) sometimes contrast other structures e.g. internal quality assurance (QA) and safety at work.

The structures can be more or less visible in the actions. The invisible structures are also enabling and constraining. The project material is an example of a structure that interwove practises and can be more or less invisible through the process. This can be a token of a good project material, but if a problem emerges the structure suddenly becomes visible. However, the visibility and symbolic meaning of the project material is closely related to the specific project; the practises of the agents and their interpretation.

Interpretive actors

The empirical data shows a wide range of problems throughout the on-site production phase. Most failures are minor problems leading only to limited reflection and narrow actions to redress the problems. The day-to-day handling is routinised; The NCC production manager doing his round on-site, detecting a problem (perhaps told by the craftsmen), photo documentation, typed into a spreadsheet, reported to the relevant supplier: "If you don't redress the problem, we will do it at you expense", response from the supplier and eventually redressing of the problem. At the project completion the parties make a final financial agreement to cover the expenses. This procedure secures progress of the project which is considered vital. However, unintended, it reproduces a notion of a certain level of problems as accepted in the pre-cast concrete project. This is symbolised by the fact that there are possibly four finishing gangs present at the same time at the construction site.

The knowledgeable actors are almost present to the extreme on the project. Solving problems on basis of their own knowledge at the construction site without consulting competences outside the near surroundings is almost a rule in itself. The executive manager is very dominant and an autonomous leader. He is the first to demonstrate the competence of problem solving through his own practice, which is an influential element to the rest of the project team. There are numerous examples that the actors learn through reflection on their actions and thereby (unintended) structure the following actions. The structuration is mostly situated in the immediate environment of the project and tied to the individuals or perhaps the project group. The problem solving is often carried out in the closest project group. If this proves inadequate experiences are drawn across the projects in the site lot – especially from the square blocks project towards the perimeter blocks. On the former the actors are more experienced and the schedule is a bit ahead. The executive manager is very significant in this process and in relation to the subcontract manager it can be viewed as apprenticeship.

Reflections are triggered when something differs from the expected. Yet in the case of the routinised problem handling, symbolised by the pre-cast concrete panels, it is almost expected that the elements are flawed leading to only minor corrections of the problem. The reflections are often conveyed through the actions to report or redress the problem, interactions with the closest colleague and/or, in this case, a question from the observer. That reflection is triggered by something differing from the expected also introduces an element of coincidence since the actors are not omniscient and can not be expected to discover all problems.

Transformation or reproduction

Stones' (2005) analytical distinction between external and internal structures moreover shed a light on relations between projects and bureaucracies. The company delivers a setting (structural properties) to the actors that consist of both something intangible (interpretive rules/norms), some instructions or procedure (normative rules), and some resources which are utilised in the actions. These are a result of strategies or organizational reflectivity across projects. When failures have too large consequences, economic or in this case human, the incident can lead to a transformation of the system. The case shows that central procedures only to a small degree comes into effect, and often in a different guise than intended, since it is incorporated into an altered setting. Apparently this is accepted; As long as the fluctuations are not too big (e.g. time, costs and fatal incidents) the executive manager is left alone by headquarters. This way the whole system can be seen as accepting a certain level of failures on different levels. The presence of knowledgeable actors is again enabled and constrained by different interests that keep the house of cards from falling. An unintended consequence is a reproduction of a perhaps suboptimal system. However, the executive manager discursively presents his view upon his part as a role model. He is aware of his impact on the four young subcontract managers in particular and preaches the praxis of on-site problem solving with only little inclusion of central competencies. Time and time again central structures are dismissed and only when creating immense value central procedures are welcomed.

Only the one incident, the death injury, imposes actions that have an impact on future processes further than the project individuals. From the viewpoint of the system this incident leads to reflection that not only reproduces but also transforms structures. Interestingly, the focus was from the beginning put on the solution concerning the penthouse storey, which actually was problematic. But as seen other parts of the process was also flawed. In the process of erecting the carcass the reflection was mainly triggered when something differed, like new or special panels, or the consultants addressing an issue. But the process did cause problems although most of them were trivial and only one fatal! Yet the project is articulated and perceived as successful since the budget and the time frame is met. The perception is that when they choose to focus on the penthouse construction they become less vigilant about other parts of the processes.

Failure culture

The study elucidates how quality is handled and managed in the process. The different groupings show signs of integrative but also differentiated elements of “a failure culture”. The concrete management group reflects the overall management group in general with a pragmatic view of the relation between progress and quality issues, but stands a bit out symbolised through the foreman saying: “*If it goes – it goes*”. This contrasts the initial work gang that is eager to do things *right the first time* which often conflict an emphasis on progress. The subsequent gang’s view to a large degree resembles that of the concrete management group. Interestingly they are recognised by management for their speed and the general impression is that they matching or even surpass their predecessors’ work. A third party is represented through competencies and structures delivered by the headquarters of the contractor, which is a *culture of legitimisation* since structures are not only systems to secure quality in-house but also a recognition of a quality focus to customers and surroundings. The study shows that the latter actually becomes the most significant role of these central quality structures.

The emergent analysis indicate that the specific phenomenon of organisational cultures addressing handling of quality in the process, named failure culture, can be described as a multiple cultural configuration that consists of both shared orientations, as well as differentiated and unclear elements as suggested by Alvesson. Integration is much more distinct within the on-site groups; the management groups and the craftsmen, and this can overall be described as *pragmatic quality handling*. These characteristics are elements of project cultures that can be described as highly resistant to outside interference. The *culture of legitimisation* is representative of a viewpoint of the headquarters and a focus on quality structures. However there are also integrative elements across the two failure cultures.

DISCUSSION

There is a wide range of arguments on failures in the construction industry, founded in social practice and communicated through various different channels, which in reality says very little about the processes that produce the failures since they do not consider the dynamics and the preconditions of the actions. Indications are that a company like NCC Construction, with a large portfolio, has large, but unknown, costs of failures in operations. The failures disappear in the budgets as unrecognised rework. The successful project encompasses a failure culture with an expectation of a certain level of problems throughout the projects and the project cultures are highly resistant to outside interference. The interactions with functions at the headquarters illustrates that all levels of the company are included. An assertion is that this also encompasses many other actors in the Danish construction industry and therefore is a structure for the industry in general. The guiding principle of the accepted level will be relative to the competitive bidding and therefore how close the calculation hits the target.

Looking at how company structures are actually manifested through the actions, factors as time and costs becomes predominating. Among other structural properties also previous experiences can be structurating. These are highly dominated by individual or project network experiences and seldom based on organizational ditto. So structuration is primarily situated at projects, primarily directed at individuals or the project group, and knowledge is disconnected from the main organisation. Often the properties must create a direct sense of value to the individual or the project. This selection is also based on experiences of the actors or the project network and this social construction affects the selection and rejection of the options at hand. Additionally direct procedures, orders, or commands can become structures for action. In contrast or collaboration with incentive structures it creates a tense space to manoeuvre. The project represents an industry structure rather than a company structure since most distinctive elements of the headquarters are dismissed, meaning the project has no more similarities with other NCC projects than with projects from other contractors.

Vital to structuration theory is a dualism of structure and agency. The cases reveal that structures can be contradictory - and often turns “visible” by this clash. This is a departure from pure structuralism and brings back agency to the actors. In a NCC context, where central procedures, regulations and reporting are increasing, the necessity of the presence of a space for actors to exert their agency is highlighted, which point at co-presence of structure and agency as vital elements. Yet at the moment there seem to be a lack of both. Methodological structures that affect the actors are often invisible. By following planning and interactions prior to the execution, bits of the reasoning and the procedures that form the rationality are often revealed. Mostly as part of the discursive or perhaps practical consciousness (Giddens 1984; 7) that is made discursive through reflection. It is difficult to manage unconscious motives and cognition but through training, education and relevant procedures the company can stimulate the discursive and practical consciousness of the employees.

The emergent analysis points at a multiple cultural configuration at the production site. An integrating element is the pragmatic quality handling across the groups. Based on prior experiences and literature, an assumption is that the ability to walk this thin line can be important for the success of the projects. But at the same time it is a frustrating element that sustains a high degree of flaws in the construction process. On-site the culture of legitimisation is underexposed, which can be seen as an expression of not only a clash between strategic intensions of the company and on-site processes but also between structural properties of different social groups and different failure cultures. The pragmatic quality handling is an element in the success of the project, but the ambiguity is that this “successful project” also covers what could be described as a failure culture.

CONCLUSIONS AND IMPLICATIONS

Conclusions are that within the project culture there is an expectation of a certain level of failures and problems throughout the project. Through the actions of the project management this failure culture is unintentionally reproduced time and time again. Moreover, the study shows that understanding the causes of failures in the building process demands a wider scope and can seldom be narrowed down to simple causalities. Quality is a structure for the actions of the individuals on the projects but it is rarely the strongest argument. In the day-to-day activities the actors are reflective towards problems, mostly carried out in the close project surrounding. In a broader perspective they reproduce an unintended structure that can be seen as an expected and accepted level of failures and flaws in the processes. A transformation of the structures and actions are only seen when the consequences are comprehensive or fatal. Central structures are only present to a small degree in the specific project and local judgement can be seen as pivotal in the processes. The co-presence of structures and agency as vital elements in strategically addressing failures and quality is an important argument for the future processes of the contactor. The structures must to a wider degree take account of this autonomous local judgement that is indisputably present. And with respect to this, focus on the project experiences must be enhanced in order to facilitate organisational learning so that the experiences to a wider degree becomes structurating not only to the individuals and the project group but also to future projects. There is no point in reinventing the wheel in each project. As banal as this points may seem, it is however highly relevant.

The objective is not to demonstrate a theory. But mobilising the structuration theory has brought something to the empiric material – and vice versa. However, an ambition is to strengthen the cultural perspective and “rebuild” the theoretical foundation to enhance the focus on the cultural elements.

REFERENCES

Alvesson, M. and Sköldberg, K. (1994) Tolkning och reflektion. Vetenskapsfilosofi och kvalitativ metod. Lund: Studentlitteratur

Alvesson, M. and Sköldberg, K. (2000) Reflexive Methodology – New Vistas for Qualitative Research. London: Sage

Alvesson, M. (2002) Understanding Organizational Culture. London: Sage

Apelgren, S., Richter, A., and Koch, C, (2005) Snublesten i byggeriet (Stumbling Stones in Construction). Lyngby: DTU Civil Engineering, Technical University of Denmark

Barzelay, M. (1993) The Single Case Study as Intellectually Ambitious Inquiry. Journal of Public Administration Research and Theory, Vol. 3, No. 3, 305-318.

DAPCP (2009), available at: http://www.bef.dk/

DEACA (2004) Svigt i byggeriet – økonomiske konsekvenser og muligheder for en reduktion. Summary from the Danish Enterprise and Construction Authority

Giddens, A. (1984) The Constitution of Society. Cambridge: Polity Press

Josephson, P. E. and Hammarlund, Y. (1996) Kvalitetsfelkostnader på 90 talet – en studie av sju byggprojekt. Göteborg: Institutionen for Byggnadsekonomi, Chalmers

Jørgensen, K. (2008) Svigt i byggeprocessen (Failures in the construction process). Lyngby: DTU Management, Technical University of Denmark

Kaspersen, L. B. (2000) Anthony Giddens. In: Andersen, H. and Kaspersen, L. B. (eds): Classical and Modern Social Theory, 376-390. Oxford Blackwell

Kaspersen, L. B. (2001) Anthony Giddens: introduktion til en samfundsteoretiker. 2nd revised edition, 2006. Copenhagen: Hans Reitzel

Koch, C. (2002) Multiple Safety Cultures at the Construction Site. In: Construction Innovation and Global Competitiveness, Proceedings for 10th Int. Symposium, CIB, (2) 1105-1116.

Stones, R. (2005) Structuration Theory. N.Y.: Palgrave Macmillan

Sewell, W. H. (1992) A Theory of structure: Duality, agency and Transformation. The American Journal of Sociology, Vol. 98, No. 1, 1-29.

Thuesen, C. (2006) Anvendelse af den rette viden – et studie af byggeriets kulturelle organisering. Ph.d-thesis. Lyngby: DTU Civil Engineering, Technical University of Denmark

CHANGES IN QUALIFICATION STRUCTURE OF LABOUR IN CONSTRUCTION IN CROATIA (1978 – 2008)

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The construction sector employs a 9.4% of the total working force in Croatia. Construction workforce is divided into unskilled, semi-killed, skilled and highly skilled employee. The established methodology (Clarke) is used in comparative analysis of qualification structure of labour construction in Croatia, Germany and Britain. The results of the analysis are as follows: The employment sector in construction slightly decreased during 1978-88 period, than fell drastically during 1988-98 period and started to increase since 1998. Analysis in educational structure of workforce shows that the number of skilled workers increased from 52% to 64%, while the number of non-skilled workers decreased from 44% to 26%. There has also been an increase of employees with bachelor degree or higher education in civil engineering. Finally, it can be concluded that trends in educational structure in Croatia is more similar to Germany than Britain.

KEYWORDS: structure, qualification, labour, construction.

INTRODUCTION

Comparing to other trade sectors, construction industry has many specificities. One of its specificities is that construction sector represents a pool for employment of a large number of manual workers without a formal education. The construction sector in Croatia is not an exception. The number of employees in the construction trade in legal entities is 98,551. If the number of employees in crafts, trades and free lances is added, it amounts to 137,272, which represents a 9.4 % of the total labour force working in Croatia (Central Bureau of Statistics, 2008). In the last ten years there has been a constant increase of people employed in the construction sector, which is the result of the restoration after the war, as well as of large investments into infrastructure objects. A large portion of these investments refers to roads, which were declared a priority because of the strategic importance of tourism. Statistical data from 2001 and the following years indicate that there has been a constant increase, both in the number of employees, as well as of productivity and the value of jobs done. A constant increase of GDP can also be noticed, which increased from 4.1 % in 2001, to 5.9 % in 2006 (Croatian Chamber of Economy, 2007). According to the statistical data for 2007, the total number of construction companies in Croatia was 9,063, which represents a big growth comparing to the last ten years, when the number of companies was 819. Construction companies fall into small (less than 50 employees), middle – sized (50 – 250 employees), and big companies (with more than 250 employees). According to the data provided by the Croatian Financial Agency, the number of small and middle – sized companies since 1990 has constantly been increasing, while the number of big companies has decreased. Croatian companies also enter foreign markets. But, unlike in the past when the market was much larger and comprised Europe, Asia and Africa, nowadays it is mostly European market. Construction companies in foreign markets are generally engaged as subcontractors.

Structure of Croatian construction labour force

Construction workforce is divided into unskilled, who only have the basic school education, semi – skilled, and skilled workers. Semi – skilled, skilled, and highly skilled workers are educated and trained at courses, vocational construction schools, and technical construction schools. Similarly to Britain, skill shortage is not a new phenomenon within the industry (Dainty et al. 2005: 275). Research results have showed that construction companies have not been aware of the shortage of skilled workforce in the last ten years after the war (Horvatic & Karakas, 2008: 462). The problem has become actualized in the last few years, when the number of employees in construction sector could not satisfy the scope of business that construction companies got in the market.

As some of the jobs in construction appeared to be unattractive, as well as because of the shortage of workforce compared to the scope of work in construction, engaging foreign workers is absolutely necessary. Croatia has quotas of employment for foreign workers, which change every year. Last year the Construction Employers Association of Croatia demanded from the government to increase these quotas, due to the increased scope of work. Foreign workers mostly come from neighbouring Bosnia and Hezegovina. There is also a phenomenon of the workers without an appropriate formal education, who have become skilled through long practice at construction sites.

There is also a problem of black economy, which is not an exclusive characteristic of Croatia, though. According to the Construction Employers Association of Croatia, illegal work comes in two types. The first type is unregistered companies and crafts, which advertise and sell their services in the market. The second type is formed of registered companies and crafts that apart from the registered workers also engage illegal workers either on a temporary or constant basis.

Another problem is construction work and services done by individuals, unemployed workers registered at job centres, employed workers in their free time, and retired people, who are engaged by many households because of lower prices. Black economy is typical for construction sector, but the estimated 15 % of it in Croatia is a somewhat larger percentage comparing to other countries. It is also helped by a flawed tax system.

Changes in qualification structure of labour in construction: a comparative analysis of Croatia, Germany and Britain

This section tries to answer the following three questions:

1. What is the main tendency concerning the overall employment in construction in Croatia?
2. Has educational structure of workers in construction in Croatia changed during the last thirty years?
3. Are trends in educational structure of working force in construction in Croatia more similar to trends in Germany or to Britain?

The established methodology (Clarke, 2007) is used for comparative analysis of qualification structure of labour in construction in Croatia, Germany and Britain.

Employment in construction

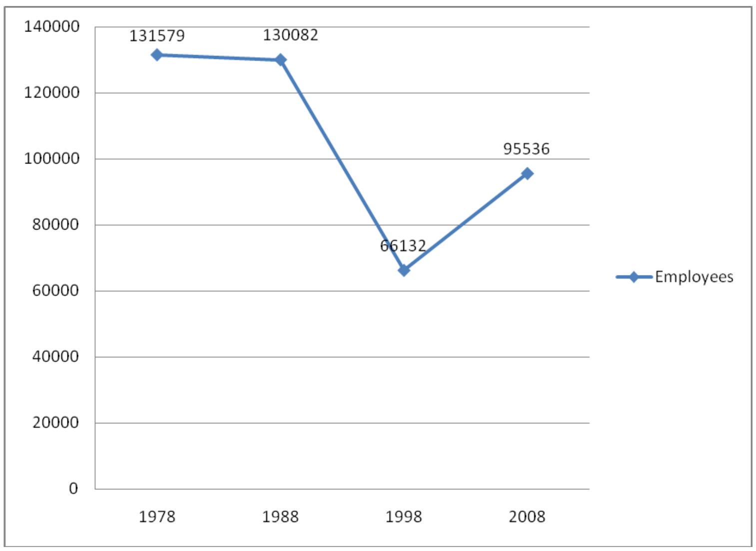

Figure 1. Employment in construction

As Figure 1 show, the over employment in construction slightly decreased during the 1978 - 88 period. However, the employment drastically fell during the 1988-98 period from 132,000 to 66,000. In other words, during the 1988 - 98 period approximately more than a half of the people who worked in construction lost their jobs. There are several factors that decreased employment. First, state owned enterprises dominated in the system during the period of communism. Consequently, employment was not only based on economic but also on social criteria. Firms kept even those workers that were superfluous. A radical change of economic and political system changed this paradigm. After privatization, new private owners were not willing any more to keep workers that were redundant. It should be noted that the transition was a very painful process throughout Eastern Europe and during this process a lot of workers lost their jobs. However, this process was even more painful in Croatia because of war (the second important factor). Almost all the branches of economy, including construction, decreased their activities during the war. Third, Croatian market is smaller than Yugoslav' market, and, therefore, smaller internal market contributed to contraction in construction activities. In addition, Croatian construction firms lost their external markets, especially in countries that have been members of Non-alignment movement. As a result, many workers lost their jobs in construction companies. Number of workers in construction started to increase since 1998. This phenomenon was connected with the following processes. First, after the war Croatian economy started to recover, and construction has had a very important role in this recovery. Second, reconstruction after the war gave opportunity for many construction companies. Third, big infrastructural projects have had a positive impact on employment in construction. As a result, construction started to be, during the last eleven years, a lucrative business once again and many workers have found their jobs in construction. A general conclusion can be inferred that employment in construction is strongly correlated with the state of economy as whole. Construction companies hire new workers during the period of economic growth and people lose their jobs in construction during the period of recession. However, as an analysis below shows, not all construction workers are equally affected by economic crises.

Educational structure of construction workers

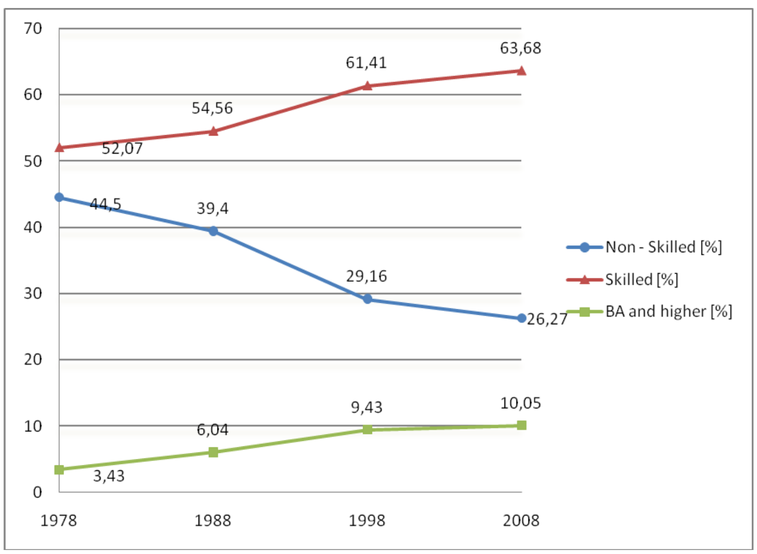

Figure 2. Non-skilled construction workers

It is evident, from Figure 2, that non-skilled construction workers were affected most by transition. In 1978, 44.5 percent of workers were non - skilled and today only 26 percent belongs in this category. Situation is even more evident when we compare absolute numbers. In 1978, almost 59,000 workers in construction were non - skilled but today only 25,000. At the same time percentage of skilled workers increased from 52 percent to 64 percent. People with high school increased their percentage from 10 percent to 39 percent of workers in construction. Furthermore, percentage of people who have BEng[1]

[1] BE or BEng, Bachelor of Engineering, refers to the first degree in engineering, after three to five years of studying

or higher education in civil engineering has increased from 3 percent to 10 percent. This increase was especially sharp during the 1978–98 period when their percentage tripled. In other words, labour in Croatia has become less manual during the last 30 years. Those who want to work in construction in Croatia need formal education, and this is a trend that gives reasons for optimism. Construction companies gradually hire more and more people who finished at least construction high schools and, even better, people who have BEng or higher education in civil engineering. There is a trend, in recent time, even to hire people with the highest level of education in civil engineering. For example, in 2003, there were eleven people in construction companies with Ph.D. in civil engineering. The same number was 32 in 2007. In other words, Croatia experienced triplication in number of doctors in construction companies in only four years. During the same period of time the total number of people with MA in civil engineering increased in construction companies from 45 to 65. Therefore, it can be concluded that people who work in construction have much higher education today than they used to have 30 years ago.

Comparison of educational structure of workers in construction in Croatia, Germany and Britain

Analysis above shows that structure of changes of labour in construction in Croatia is much more similar to changes in Germany than in Britain. Interestingly, even percentages are similar in Croatia and Germany. According to Clark and Herman (2007, 86), "the proportion of skilled workers employed in Western German construction rose from 48 per cent in 1950 to 61 per cent by 1990, only to fall subsequently to 56 per cent by 2003." Percentage of unskilled workers, during the same time, fell in Germany from 36 percent to 17 percent. Similarly, during the 1978-2008 period, percentage of skilled workers in Croatia increased by 12 percent and percentage of unskilled workers fell by 18 percentage. Obviously, the process started later in Croatia but trend has been the same.
Interestingly enough, changes in total number of labour were also similar in Germany and Croatia. According to Clark and Herrmann (2007, 88), "in West Germany the number [of workers in construction] fell by over half from 1.5 million in 1970 to less than 700,000 by the beginning of the new millennium." The same figure fell also by over a half (from 131,000 to 61,000) in Croatia during the same period of time. However, labour force in construction fell in Britain by only 10 percent (from 1.8 million to 1.6 million) during the 1970 - 2002 period. Furthermore, the qualification structure of working force in construction in Britain has also not changed a lot during the last 30 years.

CONCLUSION

Construction sector in Croatia has had two phases after independence. The first phase is the period from 1988 to 1998, when the number of employees and construction activities decreased. This decline can be explained through changes in political and economic system. Secession from Yugoslavia automatically caused reduction of foreign and domestic market in Croatia. During the war there were no significant investments, and then there was the period of privatisation of state-owned companies, which saw the downfall of social sensitivity and massive loss of jobs. The second phase lasted from 1998 to 2008, when construction sector experienced a continuous growth resulting in the

increase of GDB and the number of employees. The growth of workforce and investments is the consequence of building of large infrastructure objects, which are especially important for tourism, the most important branch of economy in Croatia.
Surveys clearly show the shortage of workforce. Consequently, in Croatian companies there is a large number of foreign workers, predominantly from the neighbouring country of Bosnia and Herzegovina. Like in other countries, “black” economy is also present. According to estimations, 15 % of total workforce relates to “black” economy, which is higher than in other countries.
Analysis of educational attainment indicates a change in education of workforce in the last 20 years. The number of skilled workers increased from 52 % to 64 %, while the number of non – skilled workers decreased from 44.5 % to 26 %. There has also been an increase in the number of employees with a bachelor degree or higher education in civil engineering. Construction companies gradually hire more and more people who finished at least high school.
If we compare Croatian workforce to that of Great Britain or Germany, we can see that changes in educational attainment show greater similarity to those in Germany than in Britain. If we compare the total number of employees in construction and its ups and downs by decades, it also shows greater similarity to Germany than to Great Britain. Even the percentages of workforce according to educational structure and their changes show a great similarity between Germany and Croatia.

REFERENCES

Clarke, L., Herrmann G., 2007**.** Divergent divisions of construction labour: Britain and Germany in Dainty, A., Green S. and Bagilhole B. (ed.), *People and Culture in Construction: A Reader*, London and New York: Taylor & Francis

Horvatic, S. and Karakas Z., 2008: Obrazovanje i osposobljavanje kadrova u graditeljstvu, *Sabor Hrvatskih graditelja*, Cavtat, Hrvatski savez građevinskih inzenjera

Republic of Croatia - Central Bureau of Statistics, 2008. Statistical Yearbook 2008. *Employment.* Available at: <http://www.dzs.hr/default_e.htm>

Croatian Chamber of Economy, 2007. Croatian Construction Industry Report. Available at: <http://www.hgk.hr/>

Dainty, A. R. J., Ison S. G. and Root D. S., 2004. Bridging the skills gap: a regionally driven strategy for resolving the construction labour market crisis, *Construction and Architectural Management, 275-283*

Ceric, Anita and Radujkovic Mladen, 2007. Human resource management - Croatia case. *Proceedings of CIB World Building Congress "Construction for Development"*. Haupt, Theo,Milford, Rodney, Cape Town, South Africa

ORGANISATIONAL INTEGRATION OF BRANCH OFFICES FOR CIVIL ENGINEERING BUSINESS DEVELOPMENT: THE CASE OF A MAJOR UK CONTRACTOR

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The recent acquisition and resultant change management process to integrate the civil engineering divisions of two construction businesses provides the context for this research. The teams are located in the main and branch offices and integration is occurring in parallel with the development of relationship marketing strategy for improving customer orientated behaviour. Geographical and local issues of organisational culture are constraints and affect organisational performance and behaviours. The findings examine relationship strength and closeness between key clients and employees from the main and branch offices. The analysis of the findings assesses post-acquisition change management for integration and relationship marketing, particularly cultural issues and implications for main office management. The recommendations concern management decision making for implementing the strategies, allocating customer responsibilities by sector and offices to strengthen customer relationships and organisational performance.

KEYWORDS: behaviours, business development, customers, main and branch offices.

INTRODUCTION

Globalisation and current economic forces as they have been shaped during the 21st century are forcing many construction industry enterprises to seek core competencies that will lead them to achieve competitive advantage. Moreover, other barriers to entry in the construction industry are being removed, making the national construction sectors open to competition from across the world (Ngowi and Pienaar, 2005). The “credit crunch” is intensifying this process. There is a real struggle for all companies to remain active and profitable. All actors within the construction industry need to be flexible enough to survive in rapidly changing markets and they “must nurture a few core competencies in the race to stay ahead of rivals” (Mintzberg et al, 2003, p.16).

Acquisitions and mergers have been utilized as viable means of organisational growth in order to gain competitive advantage in the 21st century, aiming to “amass customers before rivals enter the market and to strategically enter networks of firms” (Kisessling et al, 2008, p.287). The current economic climate encourages some companies to acquire others to build market share. Lying behind many recent mergers and acquisitions is the effect of physical distance between employees working at main and branch offices. Frequently overlooked in the past, this becomes crucial as it influences organisational performance levels in general (Clinebell and Shadwick, 2005) and potentially inhibits the spreading and embedding of core competencies in particular (Hamel and Prahalad, 1996).

The purpose of this paper is to provide empirical evidence of the impact of acquisition process on organisational performance, while examining through action research and observation the interdependence of spatial distance between main and branch offices, as means of influencing business development performance upon customers. The recent acquisition of Taylor Woodrow Construction by VINCI SA, and the merging of the two civil engineering businesses, namely Taylor Woodrow Construction and Norwest Holst, provides the detailed focus for this paper.

The research is laid out in the following fashion: First the literature on relationship management as a core competency will be discussed followed by the links of acquisition and organisational performance, in parallel by examining the role of physical distance of main and branch offices upon organisational commitment. Then through theoretical development and empirical evidence we will explore the links of spatial distance and acquisition on customer orientated behaviour and relationship marketing effectiveness. The paper aims to come up with useful recommendations on improving relationship management strategy, together with levels of organisational performance and integration.

BACKROUND AND LITERATURE REVIEW

Construction Industry is considered among the most traditional industries, by having actors that behave in an adversarial and pure transactional way. During the last fifteen years, following Latham's and Egan's report in 1994 and 1998 respectively, the industry began to change by realising that one significant way to achieve high levels of productivity and profitability is by working together and building relationships, and as a result increasing their efficiency (Akintoye et al, 2000). In parallel during the 1990s there was a general move away from the traditional transactional approach of marketing mix towards relationship marketing, since "relationships were becoming ever more important in increasingly complex and mature markets" (Christopher et al, 2000, p.xi), echoed to sometime-lagged degree in construction (Smyth, 2000; Smyth and Fitch, 2009).

The marketing mix (Borden, 1964), based upon mass-market consumer goods and developed around the so-called 4Ps of product, place, promotion and price (McCarthy, 1964), was producer-oriented and aggregates consumers into segments that vary the mix of the 4Ps. The consumer is viewed as passive, sales and profit being maximised through efficiency measures. Relationship marketing (Berry, 1983) was developed for business-to-business relationships, especially for intangible services (e.g., Grönroos, 2000). This is customer focused, using agile production and tailor-made services to configure services to "segments of one" (Gummesson, 2001). The objectives are to add value to provide client satisfaction, increase repeat business and secure increased unit profit. The consumer is viewed as active, the producer is proactive and the primary emphasis is upon effectiveness in the market.

The transactional yet relational contract measures of partnering and supply chain management for example provide a basis to transition to relationship marketing and management. Implementing effective relationship marketing leads many organisations towards a more comprehensive relationship management approach, whereby analysis of and investment in relationships, plus a clear view of the wider value that can be gained from relationships extends beyond the straightforward features of the product or service exchanged (Ford et al, 2003).

According to Pryke and Smyth (2006) a relationship approach proves to be more adequate especially when dealing with projects within the construction sector. Hence through a relationship approach value is added, through the social management and deep understanding of the interdependence and interrelationships between employees, employees and companies and between companies and ‘project actors’ (Pryke and Smyth, 2006). Thus, performance across projects is improved and clients seem to become more satisfied by the outcomes.

As cited in Akintoye et al (2000) contractors tend to look upstream rather downstream in their supply chain. Clients are providing contractors their workload and the arrangements and the relationships with the clients are contractual. According to Smyth (2000) the cost is five times higher for securing a new client, than keeping an existing one, while it is considered that investing in the development of long term relationships “will be offset by reduction in business development” (Smyth and Thompson, 2005, p.13). Moreover contractors have been criticised by clients and consultants because they have a tendency to draw their attention to tangible elements and tasks (80%) and the remainder on service experience, whereas clients desire the reverse (Pratt, 1999).

Client and the contractor are not conflicting entities, but one party needs the other and the need requires working together. Relationship management tends to improve promise fulfilment, develops trust, builds confidence and hence reliability rises. This proactively develops cooperative relationships (e.g. Pryke and Smyth, 2006). Relationship management requires pan-organisational working and this includes services that are delivered from branch offices.

Acquisitions and mergers are used to gain “first mover advantage”(Kiessling at al, 2008) especially in a highly competitive and risky environment, as it is a way of increasing innovation and capacity, which may include inimitable and valuable resources of worth to investors and market reputation amongst influencers. The acquired firm may lack the financial strength to fully mobilise any dynamic capabilities and competencies in the market. Despite such reasoning for mergers and acquisitions benefits for both parties depends upon successful integration of the businesses. Acquisition, mergers and change management processes causes human distress in an organisation: adapting and adopting procedures, new leadership styles and by building relationships with new colleagues and supervisors (Hope, 1976). These factors can reduce short-term performance.

The human distress factor among employees of target firm rises further where the top management team leaves the new company. Usually the senior level managers are feeling more threatened after an acquisition and tend to leave earlier, causing considerable disruption to organisational performance. Senior level managers have the intellectual and considerable social capital required for ongoing business operations. This intellectual capital can either be knowledge for employees’ capabilities and team strengths and weaknesses or market knowledge based on organisational relationships with networks contacts (Kiessling et al, 2008). The social capital is closely linked involving internal and external networks of business relationships and associated activities. Long term relationships either at a personal or organisational level affects reputation among suppliers and customers and are the resources most hard to imitate. Assets like relationships, their quality, and shared values both in internal and external networks are critical factors for continuous success and are mainly affected after acquisition or merger following organisational changes. The extent to which such intellectual and social capital is more widely embedded in (one part) of the organisation provides a test as to whether the competencies and capabilities are 'owned' by the firm, and, provides the basis for spreading and embedding these more widely across the new organisation.

Globalisation, acquisition, mergers and current market conditions are building the multi-office organisation at a increased scale of dispersion and geographical distance from the main offices (Rosenfeld et al, 2004). Moreover as Child (1987) and Martin (1992) comment it is the culture and the respective relationships, trust and integration levels in the company that will either lead to providing an integrated service or functioning in a 'differentiated, fragmented manner'. Clinebel and Shadwick (2005) hypothesized that employees in the branch banks will have lower levels of job satisfaction, organisational commitment, job involvement and partial inclusion and higher levels of role conflict and role ambiguity. It was proved that the physical distance is sometimes perceived by employees working at branch offices or on site as a psychological distance to high level management because of poor levels of communication and interaction both formal and informal. On the other hand, employees working in main offices are closer to leadership system and feel included to company's vision and operations.

Podsakoff et al (1993) have concluded that employees spatially distant from their managers have proved to have lower levels of organisational commitment. Moreover there was a negative correlation found between spatial distance, job satisfaction and performance. Last but not least, Kerr and Jermier (1978) claimed that the physical, geographical distance between high level managers and employees in branch offices is preventing effective leadership and could be characterized as neutralizer of leadership'.

These points concerning main and branch offices have yet to be examined in construction. The geographically dispersed organisation is not only facing spatial distance issues related to leadership or management, but is also affected by local cultures and issues arising by operating in different regions in the same country or even in different countries. As branch offices are created based on economic criteria, locality issues that effect the formation of subcultures tend to be overlooked (Auch, 2008). As Auch and Smyth (2009) state there should be a cultural fit of the organisational culture with the external cultural environment that is complimentary or aligned to the whole organisational culture. Local culture adds a further complication to integrating different organisations and developing a common or complimentary organisational culture.

METHOD

This study combined action research and observation methods through an in-depth case study. Qualitative research methods are used mainly based on data retrieved from the company and semi-structured interviews developed to explore the general climate and culture together with relationship management (RM) tools used in the organisation. The nature of the study and the interdependence and complexity of the raw material used was limited in time and size by business related issues, yet privileged research access was gained through the methods employed.

The case study context is provided by VINCI Construction UK Limited and more particularly the Civil Engineering Division. The action research was undertaken as part of the

Knowledge Transfer Partnership between University College London and the company. The KTP requires academic rigour in addressing issues of academic and industry importance and thus provides a valid source of qualitative data.

One practical issue concerns levels of organisational performance. These are quite hard to measure. Key company drivers are a frequent choice and have the benefit of accurately reflecting what is important to the company. As this research is a single case study, the issue comparative methodology is not raised. In this case, team integration and customer orientated behaviour as means for successful relationship management strategy is deemed important.

FINDINGS AND ANALYSIS

VINCI Construction UK Ltd was created in January 2009 by merging the construction businesses of Taylor Woodrow Construction, Norwest Holst and other smaller regional contractors. The Civil Engineering Division emerged from the civil engineering businesses of former Taylor Woodrow Construction and Norwest Holst and is operating in six sub sectors, namely rail, water and industrial, highways, energy, energy from waste and new nuclear. This organisational structure was established in the wake of the acquisition of Taylor Woodrow Construction business by VINCI PLC in September 2008. The integration process was started early February 2009 under the new brand name of VINCI Construction UK Limited.

The main reasoning behind the acquisition and the merger was to create a new Top-5 UK Contractor, generating £1.4bn with 4600 employees. The acquisition reinforces the VINCI brand in the UK and increases market share. Both construction businesses were providing clients with complimentary operations, being rarely found on the same tendering list.

Norwest Holst was acquired in 1991 by VINCI SA, which was then branded as Société Générale des Enteprises. After the merger and reorganisation, the two civil engineering businesses needed integrating. The first steps towards team integration were office integration. Both Norwest Holst and Taylor Woodrow had main offices in Watford. Co-location of the main offices was relatively easy, the Building Division being located in the former Taylor Woodrow main office and Civil Engineering in the former Norwest Holst main office. Co-location helps the development of an integrated culture, including customer orientated behaviour from the main office. Internal conflict and politics become evident, if not always overt, as people are appointed and position themselves for the available roles. Former Taylor Woodrow people were allocated many of the high management level posts of the division; even though Norwest Holst has been part of VINCI for longer and some have been employees for more than 18 years.

Moreover most of the procedures especially regarding the preparation of tenders, tendering processes and bidding adopted are based upon former Taylor Woodrow's Win Strategy process, because it is more closely aligned to relationship management competencies, evaluating future sector growth, targeting repeat business customers targeting certain project opportunities. As the Civils Marketing Plan suggests, the division is committed to using a relationship management approach across each of the six stakeholder markets: customers, suppliers, referrers and influencers, internal and recruitment markets (Christopher et al, 2002). RM can be summed as aiming at customer retention and repeat business, maintaining continuous customer contact at multiple levels, portfolios and programmes based upon long term relationship value (Smyth and Fitch, 2009), not just projects.

All employees should therefore be focusing on creating value for the customer by providing high value services, quality and by being committed to fulfilling customer expectations and where possible exceeding those expectations. Creation of value can be described as providing the customer with added value benefits most of which will promises beyond contractual requirements, exceeding customers' expectations. However, this strategy has yet to be consistently followed by all employees. The organisational backgrounds were different. Former Norwest Holst was focused mainly on the volume of bids and its approach could be described as rather transactional, because it was reactive to tenders and tried to bid as many projects as possible. It was unable to either commit the resources needed for each tender or to focus on customer programmes and portfolios. Taylor Woodrow since 2004 has been working towards a relationship approach based upon customer value rather than volume of project bids. Success rates for the last five years (Figure 1) were at an average of 14% (by bid value) for transactional approach and 45.63% (by value) for the relationship approach. In terms of volume, the figures are translated in 309 lost bids and 59 won bids for Norwest Holst and on the other hand, for Taylor Woodrow these figures are 22 won and 40 lost bids (Figure 1). The relationship approach this has been the result of focussing mainly on the rail and energy sector and also on specific customers from each sector. Indicatively rail sector has grown from £40m in 2004 to £160m in 2008.

Integration requires changes in thinking, routines, tolerance and sensitivity during the period of adjustment. It needs proactive sector selection; selecting long-term customers and only last focussing on specific opportunities with high winning probabilities. Organisational performance initially deteriorated slightly, some role conflict, lower morale and job satisfaction in evidence. Signs of improvement were in evidence 3 months into organisational integration. Some individuals have welcomed the changes and perceive the RM strategy to be more in line with their inclinations for working practice than the former methods.

Business Development Teams were amongst the first to experience the changes, particularly in the main office. Fears and doubts of inconsistent and sufficient support from main office senior managers were prevalent in the branch offices, one main branch office in Derby, one in Bristol and one in Birmingham with several other satellite offices mainly on construction sites. Regular interaction between the business development team members and the main office is now in place, although local senior management still needs to increase branch office support for its Business Development Managers. Understanding of the new strategy was weaker and resistance to change has been stronger in the branch offices. Business Development Managers 'sponsored' by managers who have left the new organisation or who have been working with high degrees of autonomy have found it more challenging to adapt to and adopt new guidance from the main office.

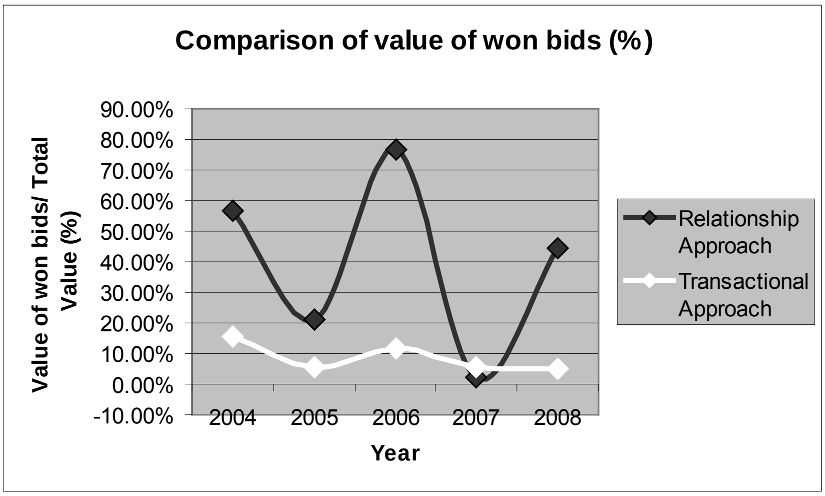

Figure 1: Comparison of relationship and transactional approach by bid value (Chambers et al. 2009)

The level of interaction in short term project specific offices is much lower, these employees particularly feeling psychologically distant. Some branch office employees seldom interact with senior Business Development Managers, seeing their work as task and project specific (Chambers et al, 2009). On the one hand, in the regional offices the level of client-contractor and consultant-contractor interaction is high. This factor provides the reason for the company being successful in winning bids. Yet many clients are not organised regionally, especially in the private sector; although, some civil engineering clients are organised on a geographical basis, hence efforts to spread those successful relationships in one region to build goodwill and relationships in other regions. There are attempts to spread and embed the Network Rail relationship beyond the greater London area, a process to be copied across other regions.

Spatial distance of main or branch offices, client bodies and/or specific projects is an obstacle that is hard to overcome. Business Development teams are responsible for each sub-sector and are targeting building client relationships and related opportunities. Building strong relationships demands specific targeting of clients key decision makers, including influencers, such as preferred consultants.

The Business Development Teams are at the front-end of the project business and therefore are required to adapt quickly. Other functions and operations are undergoing similar transformations albeit at different stages of transition. The process of integration is a work in progress. It is proceeding well and whilst there are constraints, the combined turnover, stronger resource backing and high brand profile are having positive impact in the market (cf. Chambers et al, 2009). Relationship management is being developed and embedded as a core competency, which will be strengthened as integration proceeds.

CONCLUSIONS AND RECOMMENDATIONS

Johnson et al (2005) claim, “competitive advantage can be gained through exploitation of resources and competences – particularly those core competences that competitors find hard to imitate” (Johnson et al, 2005, p.151). Acquisition gains competitive advantage and increases market share, employing acquired inimitable competencies or complementary services. This paper reviewed the theoretical links of acquisition, spatial distance between main and branch offices, and the impact on relationship and related business performance.

To conclude, customer-orientated behaviour is inconsistent amongst employees, across sectors and across offices in the Civil Engineering division due to recent acquisition. Spatial distance and local cultural issues, particularly transactional practices, contributed to lower organisational performance towards customer-orientated behaviours. Having a strong core competency of relationship management strategy provides a focus for integration, yet also provides tactical behaviours that inherently encourage integration. The comparative history of the former companies demonstrates the higher success rate of the relationship approach: securing business, profitable projects and repeat business. The new strategy is expected in the long-run to improve performance, even though short-term issues of integration pose some obstacles between organisational cultures and the main-branch office dimension.

This single case study research has implications for other organisations. It is expected similar issues are posed for many companies undergoing integration post-acquisition. Spatial distance and cultural differences are probably germane to many organisations in construction. The evidence has been particularly pertinent to customer relationship management and performance.

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REFERENCES

Akintoye, A., McIntosh, G., Fitzgerald, E. (2000), A survey of supply chain collaboration and management in the UK construction industry, European Journal of Purchasing & Supply Management, 6, 159-168

Auch, F. (2008), Understanding the impact on organisational culture by cultural variations relating to different geographical locations' within England, focussing on the contributions of individuals and teams within an organisation, Thesis, Bartlett School of Graduate Studies, University College London

Auch, F. and Smyth, H.J. (2009), Cultural divergence in project firms: the case of a leading main contractor operating from multiple offices. IPMA World Conference on Human side of projects in modern business at the, 15-17 June. Helsinki: 23rd IPMA World Congress 2009

Berry, L.L. (1983), Relationship marketing. Emerging perspectives on service marketing. L.L. Berry, G.L. Shostack, G.D. and Upah (eds). Chicago: American Marketing Association.

Borden, N. (1964), The concept of the marketing mix, Journal of Advertising Research, June, 2-7.

Boufonou, P.V. (1992), Evaluating bank branch location and performance: A Case Study, European Journal of Operational Research, 87, 389 – 402

Chambers, M., Fitch, T., Keki, I. and Smyth, H.J. (2009), Differences between customer experience and business development propositions: the case of a major contractor in the infrastructure market ARCOM 2009, 7-9 September. Nottingham

Child, J. (1987), Information, technology, organisation and the response to strategic challenges. California Management Review, 29, 33-50

Christopher, M., Payne, A. and Ballantyne, D. (2006), Relationship marketing: creating stakeholder value. Oxford: Butterworth- Heinemann

Clinebell, S., Shadwick, G. (2005), The importance of organisational context on employees' attitudes: an examination of working in main offices versus branch offices, Journal of Leadership and Organisational Studies, 11(2), 89-100

Ford, D., Gadde, L.E., Håkansson, H. and Sneholta, I. (2003), Managing business relationships, Chichester: Wiley

Gordon, I.H. (1998), Relationship marketing: new strategies, techniques and technologies to win the customers you want and keep them for ever. Chichester: Wiley

Greenberg, J. and Baron, R.A. (2003), Behavior in organisations: understanding and managing the human side of work. Harlow: Prentice Hall

Grönroos, C. (2000), Service management and marketing. London: John Wiley and Sons.

Gummesson, E. (2001), Total relationship marketing, Oxford: Butterworth-Heinemann.

Hamel, G. and Prahalad, C.K. (1996), Competing for the future, Boston: Harvard Business School Press

Hope, M. (1976), On being taken over by Slater Walker, Journal of Industrial Economics, 24(3), 163-179

Johnson, G., Scholes, K., Whittington, R., (2005), Exploring Corporate Strategy: Text and cases, 7th Edition, UK, Pearson Education Limited

Keki, I., Smyth, H., (2009), Investigation of Market Management in Construction: The importance of influence and referral markets in business development, RICS COBRA 2009, 10-11 September, Cape Town.

Kerr, S. and Jermier, J.M. (1978), Substitutes for leadership: their meaning and measurement, Organisational Behavior and Human Performance, 22, 375-403

Kiessling, T., Harvey, M. and Heames, J.T. (2008), Acquisition issues – operational changes to the acquired firm's top management team and subsequent organisational performance, Journal of Leadership and Organisational Studies, 14(14), 287- 302

McCarthy, E.J. (1964), Basic marketing: a managerial approach. Richard D Irwin Inc..

Mintzberg, H., Lampel, J., Quinn, J.B. and Ghoshal, S. (2003), The strategy process, concepts contexts cases. Global 4th Edition, London: Pearson Education Limited

Martin, J. (1992), Cultures in Organisations: Three perspectives. New York: Oxford University Press

Ngowi, A.B. and Pienaar, E. (2005), Trust factor in construction alliances, Building Research & Information, 33 (3), 267-278

Podsdakoff, P.M., MacKenzie, S.B., Paine, J.B. and Bachrach, P.G. (2000), Organisational citizenship behaviours: a critical review of the theoretical and empirical literature and suggestion for future research, Journal of Management, 26(13), 513-563

Pratt, J. (1999), Understanding clients. 4th National Construction Marketing Conference, July, Centre for Construction Marketing in association with CIMCIG. Oxford: Brookes University Oxford

Pryke, S., Smyth, H.J. (2006), The management of complex projects: a relationship approach. Oxford: Blackwell Publishing Ltd

Robbins, S.P. (2003), Organisational behaviour. Upper Saddle River, NJ: Prentice Hall

Rosenfeld, L.B., Richman, J.M. and May, S.K. (2004), Information adequacy, job satisfaction and organisational culture in a dispersed-network organisation, Journal of Applied Communication Research, 32(1), 28-54

Rousseau, D. (1978), Characteristics of departments, positions and individuals: context for attitudes and behaviour, Administrative Science Quarterly, 23(4), 521- 540

Smyth, H.J. (2000), Marketing and selling construction services. Oxford: Blackwell Science.

Smyth, H.J. and Thompson, N.J. (2005), Developing conditions of trust within a framework of trust, Journal of Construction Procurement, 11 (1), 4-18

Smyth, H.J. and Fitch, T. (2009), Application of relationship marketing and management: a large contractor case study. “Construction Management and Economics”, 27(3), 399-410

Staff Business Development Perception Survey (2009) Data from survey conducted 1st Quarter 2009, KTP between UCL and VINCI Construction UK. Watford: VINCI Construction UK plc

Sutton, R.I. and Rousseau, D.M. (1979), Structure, technology and dependence on a parent organisation: organisational and environmental correlates of individual responses, Journal of Applied Psychology, 64(6), 675- 687

VINCI Construction UK (2009a), VINCI Construction UK (Civils Division): Marketing Plan 2009. Watford: VINCI Construction UK plc

VINCI Construction UK (2009b), Report on Business Development in Civil Engineering & Air. Report produced as part of the UCL and VINCI Construction UK KTP. Watford: VINCI Construction UK plc

LEADERSHIP STYLES OF WOMEN MANAGERS IN THE UK CONSTRUCTION INDUSTRY: KNOWLEDGE CAPTURE

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This paper is part of an ongoing doctoral study about exploring the contribution of women managers towards the construction industry. UK construction is typically portrayed as a male dominated industry. Women are highly under-represented particularly at the managerial and technical sectors of the construction industry. This research intends to explore the contribution women managers could bring to the construction industry. Exploring the benefits women could bring to construction will help to recruit more women workforce to construction industry which in turn will help to address the skills shortages in the industry by bringing in a wide range of skills and talents. Women's presence in managerial workforce is growing and continues to motivate research on the leadership styles typically exhibited by women to determine if women have their own ways of leading. Further leadership is considered as an important quality for those who occupy managerial positions in organisations. In this context this paper takes the leadership styles exhibited by women managers in construction industry as the primary unit of analysis. Thus this research fall under three major knowledge domains namely gender, leadership and construction. In order to ensure the comprehensiveness and completeness of this study, an expert knowledge capturing exercise has been undertaken. This paper shares the captured expert opinions about the identified knowledge domains.

KEYWORDS: construction, gender, leadership, UK.

INTRODUCTION

The UK construction industry is slowing down especially at the housing market. The construction industry faces many challenges such as low performance, high dissatisfaction among clients, low productivity, poor image, high fragmentation, skills and labour shortages, recruitment difficulties etc.

The skills and labour shortages both at technical and managerial levels has been a problem in the UK construction industry for many years (Egan, 1998; Whittock, 2002; Construction Skills, 2007). The recruitment difficulties that the industry faces with traditional workforce are adding further impact on the level of skills shortages. Construction employers recruit and rely increasingly on workers from overseas, either inside or outside the European Economic Area (EEA), giving rise to immigration issues with an increasingly diverse force (Gurjao, 2006). However, a recent survey by CIOB (2008) revealed that migrant workers are not common as senior and middle managers in UK construction. Even if migrant workers hold managerial skills they are often not recruited due to their poor English language competence (CIOB, 2008). Further, the industry prefers people with construction background when they recruit specifically for senior/ middle level managerial jobs. Because taking people from different background and train them to relate it to construction may take longer time and may incur more cost. This issue contributes to an increment in the shortage of skills particularly at senior and middle management levels in the UK construction industry. The current economic condition makes this situation even worse.

A gendered perspective view on the construction industry indicates that the typical gender segregation pattern of the construction industry, which is the concentration of men and women into different kinds of jobs, is highly according to the societal expectations of the gender roles. Women constitute nearly 9% of the total construction workforce, of which more than 85% hold administrative and secretarial positions which are not contributing directly to the construction mainstream. Therefore the women who directly contribute to the construction mainstream is very low in number and they largely fall under either professional jobs (11%) or craft and trade level jobs (4%). This representation is very low as 1.5% in the total construction workforce.

In this context, increasing the number of women managers at senior and middle level management in construction may help the industry to reduce the recruitment difficulties and skills shortages. The recruitment base for the construction is limited largely to one gender. Recruiting from a wider pool of talents and skills will help to address these recruitment difficulties and in turn the skills shortages. It will also benefit the industry by maximising the utilisation of existing workforce. However, before persuading the industry to recruit more women managers it is imperative to find out what contribution women managers can bring to the construction industry.

In order to analyse the contribution of the women managers, their leadership styles are taken as the primary unit of analysis. Growing presence of women in managerial workforce created an interest among the researchers to study women's role as leaders. Organisations have paid more attention to the leadership styles of those who occupy managerial positions as they believe leadership is an important factor in solving organisational problems. Considering these points and the past researches done on possible differences in the leadership styles of men and women, this research endeavours to investigate the leadership styles typically exhibited by women mangers in construction and their contribution towards the construction industry.

The next section explains the overall methodology of this research including the expert interviews based on which this paper is produced. The preliminary findings from the expert interviews are presented thereafter.

RESEARCH METHODOLOGY

Research methodology refers to the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data (Collis and Hussey, 2003; Remenyi et al., 2003). The selection of an appropriate methodology is vital in order to achieve valid and reliable results. For this, it is important to understand the philosophical underpinning of this research.

Research Philosophy

The two contrasting views on how social science research should be conducted can be labeled as positivism and social constructionism / phenomenology (Esterby-Smith et al., 2003; Collis and Hussey, 2003; Remenyi et al., 2003). The key idea of positivism is that the social world exists externally, and that its properties should be measured through objective methods, rather than being inferred subjectively through sensation, reflection or intuition (Esterby-Smith et al., 2003). The phenomenological paradigm assumes that the reality is not objective or external but is socially constructed and given meaning by people (Esterby-Smith et al., 2003). This research intends to explore and investigate the ways leadership styles of women managers may contribute to the UK construction industry. Leadership characteristics and styles mean different things to different people (Pedler et al., 2004), thus a socially constructed idea should be obtained in order to identify the appropriate styles. In this context, it could be said that this research takes the overall phenomenological stance. The research philosophy that is adopted contains important assumptions about the way in which we view the world. These assumptions will underpin the research strategy and the methods one chooses as part of that strategy (Sauders et al., 2007). The three major ways of thinking about research philosophy are ontology, epistemology and axiology (Collis and Hussey, 2003; Sauders et al., 2007). These ontological, epistemological and axiological assumptions are concerned with the nature of reality, the acceptable knowledge in the field of study and the values respectively. These three assumptions help to position the research within the philosophical continuum.

Research Strategy

A research strategy may be thought of as providing the overall direction of the research including the process by which the research is conducted (Remenyi et al., 2003). The commonly used research strategies in business and management research are experiment, survey, case study, action research and ethnography (Sauders et al., 2007; Remenyi et al., 2003; Esterby-Smith et al., 2003). This research intends to find out the contribution of women managers towards UK construction industry by identifying the leadership styles exhibited by women managers in construction. Accordingly, an in-depth analysis of the construction industry with a gender perspective is therefore vital for this study. Also the researcher neither is part of nor has control over the actual environment. Thus “case study” has been chosen as the most appropriate research strategy. Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2003). This study takes the ‘individual’ as the ‘case’. In this scenario it is the woman manager in construction industry. It has a single unit of analysis which is the ‘leadership styles exhibited by women managers in construction’. This research, therefore, adopts an exploratory, multiple, holistic type of case study.

Research Techniques

Research techniques refer to the specific methods used to collect and analyse the data. Data collection and analysis are developed together in an iterative process in a case study (Hartley,2004). This research adopts Multiple Leadership Questionnaire (MLQ), Personal Attribute Questionnaire (PAQ), semi-structured interview and expert interview as the data collection techniques.

MLQ offers researchers the most validated and efficient measure of broad range of leadership behaviours (Bass and Avolio, 2006). In this regard MLQ will be used to measure the leadership styles of individuals (women managers in construction). The outcome of the analysis will help to investigate the contribution of leadership styles exhibited by women managers in the construction industry towards its development. The leadership styles that are exhibited by a person are influenced by the person's gender (Cubillo and Brown, 2003; Larson and Freeman, 1997). It is therefore appropriate to find out the gender qualities of the construction women managers. To fulfil this purpose Personal Attributes Questionnaire (PAQ) by Spence et al. (1975) will be used. The analysis of the PAQ will help to find out the personal characteristics of an individual in terms of masculine, feminine, or androgynous qualities. This research also uses semi-structured interviews as part of the data collection technique. Semi-structured interviews have the advantage of being a 'halfway house' between the rigid layout of a structured interview and the flexibility and responsiveness of an unstructured interview (Moore, 2000). The interview guidelines prepared cover the issues such as personal information, job history, role of woman manager in the organisation, context in which the manager works, skills and competencies, leadership styles, gender discrepancy issues, diversity issues, barriers in effective leadership, challenges they face in resolving problems. Expert interviews, based on which this paper is produced, are not part of case studies but are conducted prior to case studies in order to obtain further knowledge in the subject from experts who excelled in issues associated with construction industry, gender and leadership. This will ensure the comprehensiveness and completeness of this research. The experts were carefully identified in such a way so that a comprehensive knowledge capturing from all three knowledge domains was ensured.

PRELIMINARY FINDINGS

This section shares the expert opinions captured through expert interviews as part of the research. The expert interviews have been conducted among the people who excelled in areas related to construction, gender, leadership or combination of any of those. This section is presented under three major headings namely construction, leadership and gender. Under each heading the captured expert opinions are discussed.

UK construction industry

The UK construction industry is described as much more service industry compared the industry to the past years. There is a significant shift in the health and safety consideration. It is considered as a cleaner and safer industry. The considerations on environmental aspects have also been improved. There has been a very slight shift in the culture of collaboration. Procurement roots such as partnering encourage such collaborative environment. However, collaboration cannot be forced. Factors such as win-win situations, win-win solutions, future gains, rewards, and incentives are therefore needed to promote collaboration.

Despite the improvements in the construction industry, the industry still faces challenges and struggles to tackle many of those. The major problem that the industry has at the moment is its survival with the current economic crisis. The construction industry faces difficulties in delivering the project in time, within budget and at the required quality. The other problems that exist in the industry for a long time are identified as low productivity; high fragmentation; poor image; skills and labour shortages; and recruitment difficulties. UK construction industry is a global industry. To certain extent UK construction industry builds elsewhere and employs people from other part of the world to UK. The skills shortages may be due to either the fact that there are not enough skilled people at all or they are not in the place where the industry wants them to be. In addition, there are restrictions with employers as they may not recruit people from all over the world due to issues like government immigration regulations. The construction industry is still fragmented. One of the reasons for this fragmentation is due to the way people are trained and educated. Training and education for different disciplines are provided separately whereas the construction requires the people from different disciplines to work together as a team. Construction being the labour intensive industry, people management needs improvement. High dissatisfaction among clients is another challenge that the industry faces. Little has been realised about the user needs, particularly when the product has a long life span where users or their requirements might change over the time.

The efforts industry has made or could make in order to tackle the skills and labour shortages are discussed with experts. One solution is to train more people who are already in the industry or people who want to join the industry. Introduction of technology to reduce the need of some skills or skilled people could be another solution knowing the fact that it might create some rooms for other inviting jobs to handle the technology. However, there will not be any substantial reduction in the labour intensive nature of the industry due to the introduction of technology. One other solution suggested is to re-engineer the process to the extent it re-designs the entire supply chain operations. Making the industry more attractive by ensuring job stability would be another step that the industry could take to meet the skills shortages. Diverse entry could be encouraged. There are various types of diversity such as technical, cultural, professional, gender etc. Diversity can benefit the industry, but mere diversity will not result in the improvement. Diversity itself does not create collaboration unless it is linked with the team work. In reality it doesn’t happen in the industry. Because, little or no time is spent on team building, team working, and getting people from diverse disciplines to work together coherently. This is one of the things which are not good at the industry and need improvement. All in all, the industry needs people who actually understand what they know, what they do not know, and do not pretend to do things that they are not good at. Because it is a complex manufacturing process, is ever changing and requires people who really do understand the whole of the process, particularly if they are senior or middle managers.

Gender

All the experts interviewed agreed that there are two major perceptions of gender as a biologically determined element or as a socially constructed one. People are fundamentally socialised in working particular ways more than they are different by nature. However, gender has very close identity with being a male or female in biological term. When talking about the female gender, we think particularly of women in social roles rather than domestic roles. It has therefore issues and it helps to see gender is something that functions as an aspect of roles people have in society rather than thinking in terms of the physiological.

Women leaders showing masculine behaviour are evaluated more negatively than male leaders showing the same behaviour (Eagly, 1992). However democratic male leaders and democratic female leaders are not evaluated differently. This is further supported by a study by Wolfram et al. (2007), on the professional respect for female and male leaders, where they revealed that the gender differences are in line with general gender stereotypes suggesting that women are gentler, more expressive and more socially oriented than men. Individuals who show gender role discrepant behaviour run the risk of being less positively evaluated by others. This issue was discussed with the experts and their views are presented below.

There is lack of female role models in the construction industry and it leads women to follow male role models when taking on leadership roles. As a result there could be instances where women behave like a man or openly reveal masculine qualities. This could make others feel uncomfortable due to the gender stereotype and expectations. ‘Women in construction sector’ is a relatively new phenomenon. Therefore there is a learning process in both women managers and to her associates. It takes time for the associates to accept a gender discrepancy. It also takes time for women managers to find the right way of dealing with their subordinates. Being stereotypical, it might be said that the female stereotype leadership is much more connective, collaborative, and corporative. However, it is important to have leaders who are sure about their expertise, are knowledgeable and decisive. If women behave in a stereotypically female gendered way in a leadership role, then they are not respected. But if they behave overlay a male way they are not respected either. Therefore getting the right balance is the challenge for women in leadership roles.

The experts’ opinion say that it is the quality of the knowledge be in parted and the capability to understand the technology and processes that surrounded play a major role rather than being a male or a female. The type of leadership role also depends on the maturity and experience of the sub-ordinate or the target group. Therefore an appropriate leadership style relates much more to the context and situation rather than it does to the gender.

Leadership

Leadership is a complex process and it carries many definitions. According to the experts, leadership has been described as ‘understand what you are trying to do as a whole, working with the associates to understand their skills, and getting the best out of them’. It is a process of setting the right direction, deciding the right things to do, facilitating those who have skills to actually do it, and monitor and take corrective actions. In summary, leadership is about setting up a vision; walking the talk; understanding what needs to be achieved by different people; being hand-ready, not hands-on or hands-off; clarity; communicating; sticking out for people or work force; making people feel important; bringing about change. A leadership style one exhibits depends on the circumstances, context, the knowledge and skills of the subordinates, and the culture of the organisation.

Leadership could be an enabler of management. Leadership gives direction and guidance and it acts on top of the functions of management such as planning, organising, coordinating, and controlling. Management is much more to do with ensuring that the conditions are right for the people to do their jobs. Therefore it is rather more functional; more to do with day to day operations; less to do with strategies or vision. But there is a blurred line between leadership and management as they are not absolutely separate. A good leader will often have very good management skills as well. Good managers are not necessarily good leaders. In the construction industry there is much more management focused than leadership focused.

In terms of the work place like construction it is much more normal to refer to people as managers except perhaps those at the very top of the organisation who would probably see themselves as leaders. But lower down in a hierarchical organisation people are likely to say that they manage. But they are likely to be effective manager if they have good leadership qualities. It is important to spread or distribute the leadership down through the organisation as everyone thinks they are leaders in some way. A leader-manager model will therefore be more effective rather than a leader alone or manager alone model.

DISCUSSION

The captured expert knowledge about construction, gender and leadership has been discussed in the aforementioned chapter.

Leadership in construction industry depends on circumstances, the type of experience of the leader, the skills and knowledge of the subordinates, and the culture of the organisation. The industry is moving towards collaborative, mentoring, guidance, building relationship, and communicating. The labour force now is more literate and knowledgeable. Leadership in the industry is more of a guidance role as people sometimes expect the leader to guide them. In the process of guidance certain commands and control may have to be imposed. The trend is moving from 'looking after customer' to 'looking after employees' as it is believed that if employees are motivated then the customer satisfaction will automatically be achieved. Therefore leadership could be getting the best out of the workforce by making them enjoy the job.

Talking in stereotypes, men are more focused on the tasks and less focused on the people doing those tasks. Women would probably focus more on people and may see the tasks as less important. Therefore it could be said that men being more concerned about time; about deadline; about getting a job finished, whereas women might be more concerned about collaborative; the ways things are being done; and whether everyone is contributing. But based on the experience of the experts, there are lot of men who are very people focused and there are men who are not at all decisive. Similarly, there are women who are very focused on the tasks and can be quite brutal with regard to people. Therefore it could be a mistake to assume women are always going to be sensitive about people. Although the gender characteristics play a part, they are not the only factor in the leadership styles exhibited. The styles are influenced also by role models and what behaviour women leaders have seen. If a woman's role model is a very stereotypically male kind of leader, then she may exhibit some of those characteristics when she herself becomes a leader. Because that is what she has learnt. Coaching and training would help to overcome this, by enabling women to take what is the best of those characteristics. Not all the female qualities are very good for leadership. For example, it is not respected if the leader is overly tentative and overly indecisive. Therefore to some extent, even if it is going against the grain of women's personality and the way they typically behave, they may have to behave rather more definite way than they might normally. However, the gender stereotypical views and expectations act as a barrier for women to lead effectively and efficiently. For a woman to lead in a male dominated industry there should be a level of acceptance. People in the industry need to believe that women can lead successfully. Success can be in various terms, for example delivering a project on time, within the budget; managing a team and making everyone happy; dealing with and solving problems. Therefore if women can prove the success then it will give a key opportunity, despite the fact there could be barriers for women in doing so. The collaborative culture that the industry is trying to move towards could also leave more scope for women.

CONCLUSION AND WAY FORWARD

This paper is produced based on the expert interviews conducted as part of this research. The gender stereotype and leadership issues in construction are addressed in this paper. The knowledge and experience of the experts are shared and this will help to take this research forward in the right direction.

The construction industry in UK has changed over the last years and it is considered much more a cleaner, safer and service industry. The number of women managers who are in the industry is still very low. However there is a realisation that the industry needs to maximise the utilisation of the existing workforce in order to help to address the skills shortages and the recruitment difficulties especially at senior and middle management levels. It comprises of people from different culture, different disciplines, and with different levels of knowledge, experience and skills. This diverse nature of the industry leads to a culture of fragmentation. However, by linking the team working with the diverse workforce the fragmentation can be reduced. The culture in fact is moving, but slowly, towards collaboration leaving more scope for women to join the industry. In this regard, it is considered imperative to analyse and understand what benefits women managers could bring to the construction industry. Thus, the contribution of women managers towards the construction industry needs to be explored and investigated which is the next step of this research.

As part of primary data collection case studies will be conducted among the women managers in construction, both at senior and middle levels, in order to analyse their role in the construction industry and to find out what type of leadership styles that they typically exhibit. Also construction being a male dominated industry, the impact of such context on the way women lead will be analysed. Semi-structured interviews and questionnaires will be used as data collection tools for the case studies. The knowledge captured through expert interviews will be carefully considered in every stage of case study research in order to produce a comprehensive conclusion.

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REFERENCES

Bass, B. M. and Avolio, B. J. (2006), “MLQ for Researchers”, Available at: http://www.mindgarden.com/products/mlqr.htm

CIOB, (2008), Skills Shortages in the UK Construction Industry, UK: Chartered Institute of Buildings.

Collis,J. and Hussey,R. (2003), Business Research: A practical guide for undergraduate and postgraduate students, 2nd ed., New York: Palgrave Macmuillan.

Construction Skills, (2007), “Construction Skills Network: 2007 – 2011”, Available at: www.constructionskills.net/csn.

Cubillo, L. and Brown, M. (2003), Women into educational leadership and management: international differences?, Journal of Educational Administration, 41 (3), 278-29

Eagly, A.H., Makhijani, M.G. and Klonsky, B.G. (1992), “Gender and the evaluation of leaders: a meta-analysis”, Psychological Bulletin, 111, 3-22.

Easterby-Smith, M., Thorpe,R. and Lowe,A. (2003), Management Research: An Introduction, London: Sage Publications.

Egan, J., (1998), "Rethinking Construction", Available at: http://www.mosaicprojects.com.au/PDF/rethinking_construction.pdf.

Gurjao, S. I., (2006), INCLUSIVITY:The changing role of women in the construction workforce. In: Pietroforte,R., De Angelis, E. and Polverino, F.(eds.), Proceedings of the Construction in the XXI century: Local and Global Challenges - the Joint International Symposium of CIB Working Commissions, La Sapienza, School of Engineering, The University of Rome, Page 1–11.

Larson, A. and Freeman, R.E. (1997), "Introduction", In: Larson, A. and Freeman, R.E. (Eds), Women's Studies and Business Ethics: Toward a New Conversation, Oxford New York, NY: University Press, 3-10.

Moore, N. (2000) How to do Research: The Complete Guide to Designing and Managing Research Projects, London: Library Association Publishing.

Pedler, M., Burgoyne, J., and Boydell, T., (2004), A manager's guide to leadership, UK: McGraw-Hill Business.

Remenyi,D., Williams,B., Money,A. and Swartz,E. (2003), Doing Research in Business and Management: An introduction to process and method, London: Sage publications.

Saunders, M., Lewis,P. and Thornhill, A. (2007), Research Methods for Business, 4th ed., Harlow: Pearson Education Ltd.

Spence, J., Helmreich, R. and Stapp, J. (1975), 'Ratings of self and peers on sex role attributes and their relation to self-esteem and conceptions of masculinity and femininity', Journal of Personality and Social Psychology, 32(1), 29-39.

Whittock, M. (2002) Women's experiences of non traditional employment: is gender equality in this area a possibility?, Construction Management and Economics, 20, 449-456

Wolfram, H. Mohr, G. and Schyns, B. (2007), Professional respect for female and male leaders: influential gender-relevant factors, Women in Management Review, 22 (1), 19-32

Yin,R.K., (2003), Case study research: design and methods, 3rd ed., Sage Publications, London.

CAREER BUILDING IN THE CONSTRUCTION SECTOR

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This paper describes an educational development project for a branch of construction economists in the Netherlands. Main goal of the project is to set up a career ladder system with emphasis on a training structure for working people. The project is financially based on a grant system with Life Long Learning as a theme. Besides the improvement of quality of their services, the construction economists need more colleagues at every functional level of their profession. Main results are a set of professional profiles, curricula, courseware and input- and output procedures. Purpose of this paper is to show that small and medium sized companies – if well organised in a branch and supporter by certain state finance – can improve their Human Resources Management and thus help downsize the always huge percentage of failure costs in the construction sector. This should count for every country with well established branch organisations. Developing together with other disciplines will generate a plus value and efficiency effects.

KEYWORDS: education, training, project development, HRM.

INTRODUCTION

Career building in the construction sector is usually something of your own. Compared to other industrial and service sectors, construction companies don't pay much attention to it. Important sectors as finance, energy, communication and even governmental institutions present the young starter a broad imagination of his career possibilities. In the-also-important 10% GDP- construction sector only a small number of big construction companies afford themselves a well thought human resources management (HRM). This counts for every country in which the construction sector is determined by participation of a huge amount small- and medium sized companies.

Also the Netherlands respond to this very rough description. Notwithstanding this roughness, it is enough to explain the strategically vision of Dutch branch organization NVBK that led to a educational development project for career building. NVBK[1] unites Dutch construction economists. This discipline knows a 40 year independent development. Main feat of arms is organizing a 2 year Basic Training Construction Economists, since 1991. This course is meant for people that have a certain experience in dealing with building costs. These people have their jobs with architects, client organizations, engineering and management bureaus, developers and construction companies.

Under the influence of gradually developing follow up courses, NVBK felt the need for a strategically move of connecting a row of construction economists (CE) courses to a row

[1] NVBK – Nederlandse Vereniging van Bouw Kostendeskundigen; www.nvbk.nl

of professional profiles. General idea: giving a perspective for a so-called career ladder. Also it should facilitate the HRM of every discipline in the construction sector. Selecting CE's for jobs or for participation in projects are a source of failure costs when standards are lacking. Like in many other countries, title protection by law in the Netherlands is scary (only for architects), the branches have to organize their own system. See for example IPMA's certified project managers.

Working out this strategy led to the tactical aspect of obtaining to more efficient programmed CE-courses. Content of a course is only serving the content of a profile. This is the field of Quality Management. Making this strategy operational, an educational development project 'EKB' was initiated by NVBK. Being a relatively small branch NVBK could finance this project only by a governmental grant. This grant was obtained from a Ministry of Economical Affairs grant system, called Training for Life Long Learning[2], meant for all sorts of branches and their working members. Philosophy behind is quality improvement of economical sectors that work with 'old' knowledge and neglect investment in training related to projected professional profiles. A wide broadened business attitude of small and medium sized companies.

This paper describes the stages and results of the EKB project. It also concludes for broadening to other disciplines, and in other construction sectors.

Initiative

Redesigning its long term strategy on education for its members, NVBK concludes for the need of first: professional profiles, second: developing of new courses, and third adaptation of existing courses (quality improvement) to these profiles. All this without losing existing quality of courseware, course leaders, lecturers and facilitating organizations. NVBK also concludes that financing from own budget and/or earnings from existing courses couldn't be sufficient at all. Informed about the grant system Training for Life Long Learning NVBK initiates an educational research and development project 'EKB' in 2005.[3]

In 2006 the Ministry of Economical Affairs approves the Overall Project plan and through a tender EKB gets its grant. This grant covers 70 % of the total project costs. The 30% part is brought up by NVBK, mainly through participation by working groups of professional construction economist, merely being member of NVBK.

The Overall Project plan counts with about 6000 people practicing 'construction economy' in Dutch construction sector. The names of their jobs differ widely: construction economist, cost estimator, cost consultant, cost engineer, cost planner, cost controller and cost manager, with company related prefixes as aspirant-, junior-, medior- and senior-. Qualifying through the system of *sworn* construction economist (Chamber of Commerce, national law) lies – in this free, less regulations market -far behind us.

[2] LIT I - Ministerie van Economische Zaken/Senter Novem – Subsidieregeling Scholingsimpuls

[3] In 2006 BNB Dutch branch of building contract specialists joined the project. This article describes the NVBK-part of the project.

The project plan also indicates that employers permanently are lacking qualified construction economists. Apparently existing courses deliver not enough or not appropriate candidates. There are hardly candidates fresh from university (bachelor level), while construction economy has no seducing identity for young students.

The goals defined in the project plan can be summarized in one global goal:

To develop a career ladder system with connected courses (European Community educational levels 4 and 5) for workers in construction economy sector.

As stages of the EKB-project - after the initiative - are identified: 1 - Definition: specific project goals, CE professional profiles, the didactic vision, project procedures; - 2 - Design and development: course development tool, design of curricula, development of course input- and output procedures, e-learning environment; - 3 - Pre executing stage: marketing, planning of the courses, timetables, inviting lecturers, courseware, educational facilities; - 4 - Execution: execution of courses, monitoring; - 5 - Evaluation: evaluation of courses, improvement measures, evaluation of the whole project.

Next chapters follow this line up of stages of the project.

Definition stage

Goals of the project

In the Introduction we find the summarized (global) goal of the project (to develop a career ladder system….), in the project plan more specific goals of the project are defined:

1. To produce a set of professional profiles, to be introduced to HRM people of companies with construction economists,

2. Find solutions for analyzed problems through a didactical vision that describes a package of (newly formulated) courses,

3. To relate the result (output, diploma) of the courses to professional profiles,

4. For every course an input controlling system that also gives practical knowledge a value that can lead to entrance to the course or to exemption for certain parts of the course,

5. For every course an output recognizing system, everyone in the branch and construction knows the value of the diploma,

6. Regular education at universities make it possible for students to fill in their bachelor with elements of construction economy.

In the scheme of figure 1 these different goals are represented in an input- throughput – output model that is related to regular education and EC levels of education.

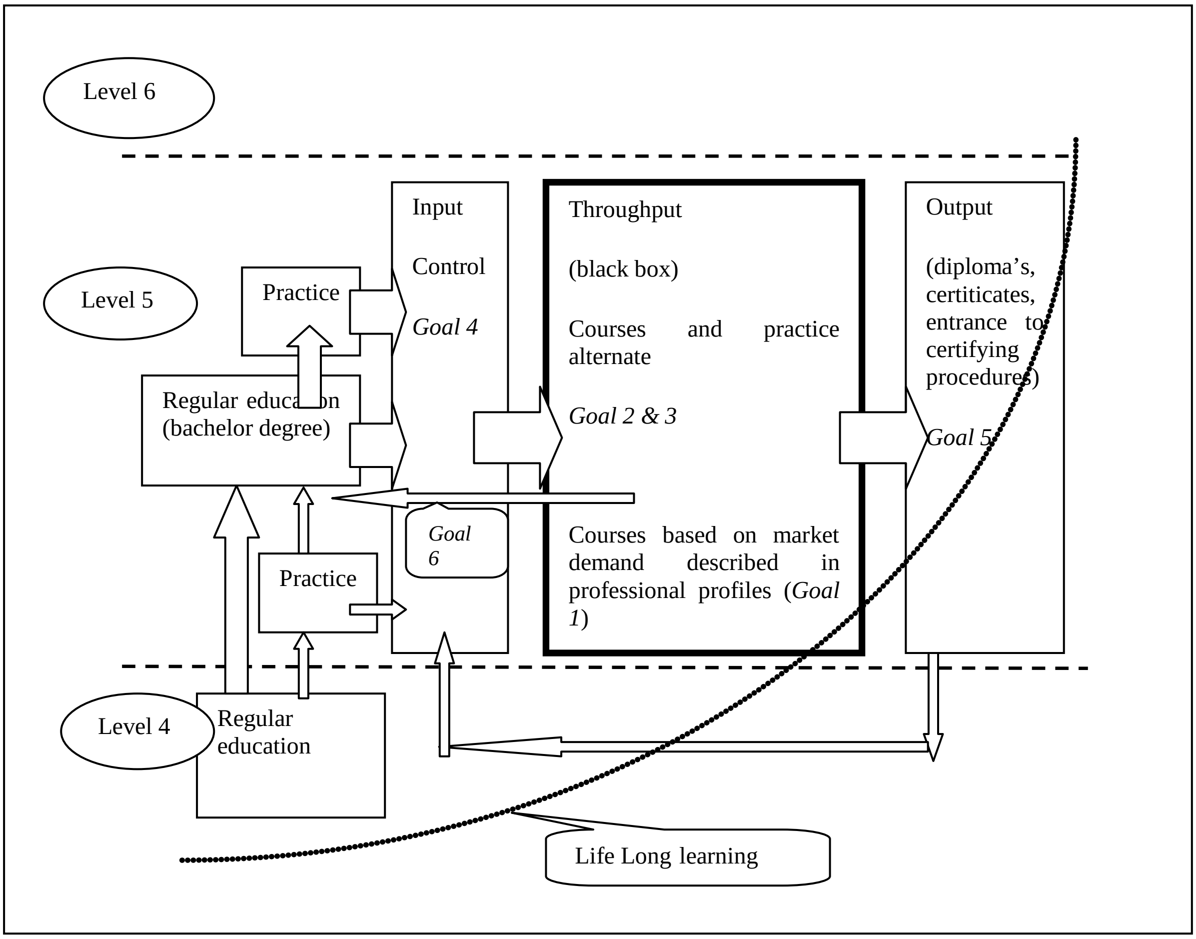

Figure 1: Model for system development

Key success factors

As key success factors of the project are identified:

- integration of companies practice in courses
- construction sector oriented educational institutes
- active branch organization
- embracing the Long Life Learning policy all project partners
- harmonizing existing courses with the system to be developed
- researchers, developers and project management from the educational field

Project organization and communication

The project organization is built up with a steering committee at the top. This committee gets its information from the project manager. This project manager is head of the project group and is supported by a planning and control unit. Members of the project group are coordinators of the different working groups. This is the well known linking pin structure.

In steering committee we find representatives from branch NVBK, partnering educational institutes and education development specialists. The working groups consist mainly of branch members, course leaders, researchers and developers.

For the communication of the project internally and externally serves a project information site. Articles and flyers are written and distributed to reach all sorts of construction economists.

Definition of training structure

A training structure is defined to give any construction economist – employee of independent consultant - a career perspective based on Life Long Learning. This structure consists of European Community educational levels, primarily identified CE-functions annex professions and existing structure of university and post university courses. See figure 2. The grey shaded professions belong to the projects' scope.

Professions/functions CE branch			
EC educ.level:	**Residential/Non residential**	**Infrastructure**	**Mechanical& Electrical**
6	Cost manager or Cost engineer		
5*	Cost consultant		Cost consultant
5+	Construction economist	Construction economist	Construction economist
5	Allround estimator	Allround estimator	Allround estimator
4	Estimator	Estimator	Estimator

Figure 2: Identified professions/functions related to EC educational level

In figure 2 we can see that a career as construction economist starts with being trained as cost estimator. After several years of practice one can continue with an course for all round estimator, and so on. A certain ladder of professions/functions can thus be recognized. This ladder, together with years of practice, is the back bone of the career ladder, based on Life Long Learning.

CE professional profiles

In order to design curricula for courses of which the output corresponds to the professional titles, functions or job names, a certain program of requirements (in construction projects: the client's Brief) is written. This program consists of (mainly) the professional profiles and a didactic vision.

Through several rounds of working group meetings the profiles for the professions of figure 2 are consolidated. Since the working groups were representative for the whole CE branch, these profiles can be considered as a good average and counting for the whole CE branch as a –free to use by companies – standard in the HRM-field.

A professional profile consists of:

1. Description of the profession in general

2. Description of core tasks on the basis of input data – production – output result, with indication of auxiliary equipment and connected people.

3. Matrix of relationship between core tasks and a standard of 25 competencies[4]

4. Typical elements as responsibility, general attitude, complexity, trends, stakeholders

These profiles can be long, depending mainly on the amount of core tasks, the higher the educational level, the higher the amount of core tasks a professional must fulfill.

Didactic vision

Most important element of the didactic vision is the firm constraint that courses are based on competence learning. Other important element is to get recent examples of working in practice in curriculum and courseware. From these cases the need for theoretical fundamentals can be derived. Thus practice is leading in the development of the curriculum, while traditional education has a tendency to stick with a not mutual connected set of theoretical subjects. This tradition has had his best years now we are in a fast going society

Another aspect of this fast going society is the digital exchange of information and knowledge. This didactic vision sees to implement e-learning environment which is very common in regular education, but not for working people that have hardly a day per week for their training activities.

The digital era gives also possibilities to reduce the lessons for training at the institute. Student can work at the office or at home. This demands a more university studying attitude than usual is in the minds of the students that are sent to training by their company.

By working at the office on cases for the training is it also possible to obtain new or more adequate cases from the students company. There is more inspiring contact between lecturers (course leaders) and responsible people from the students' company. Learning on the job is back, but with the course institute alongside. All this is directed to train the student for core tasks he should manage in the next stage of his career.

In general this means a double 1 to 1 (student/ professor and student/professor) effort than lecturing for large groups and testing the whole group. In general also a didactic vision does not take into account the financial consequences of this more personal approach.

Design

For designing curricula a generator is developed, which could only give the first values for the content-needed hours relationship. Being the professional profiles more idealistic

[4] So called Colo format for medior professional education (regular education)

then reduced to the necessary element on the basis of acceptable cost and time to reach the next step on the career ladder.

In figure 3 a rough idea of the generating process is given. Important for dimensions of a training is the relationship between hours for lectures and the total hours to spent for the training.

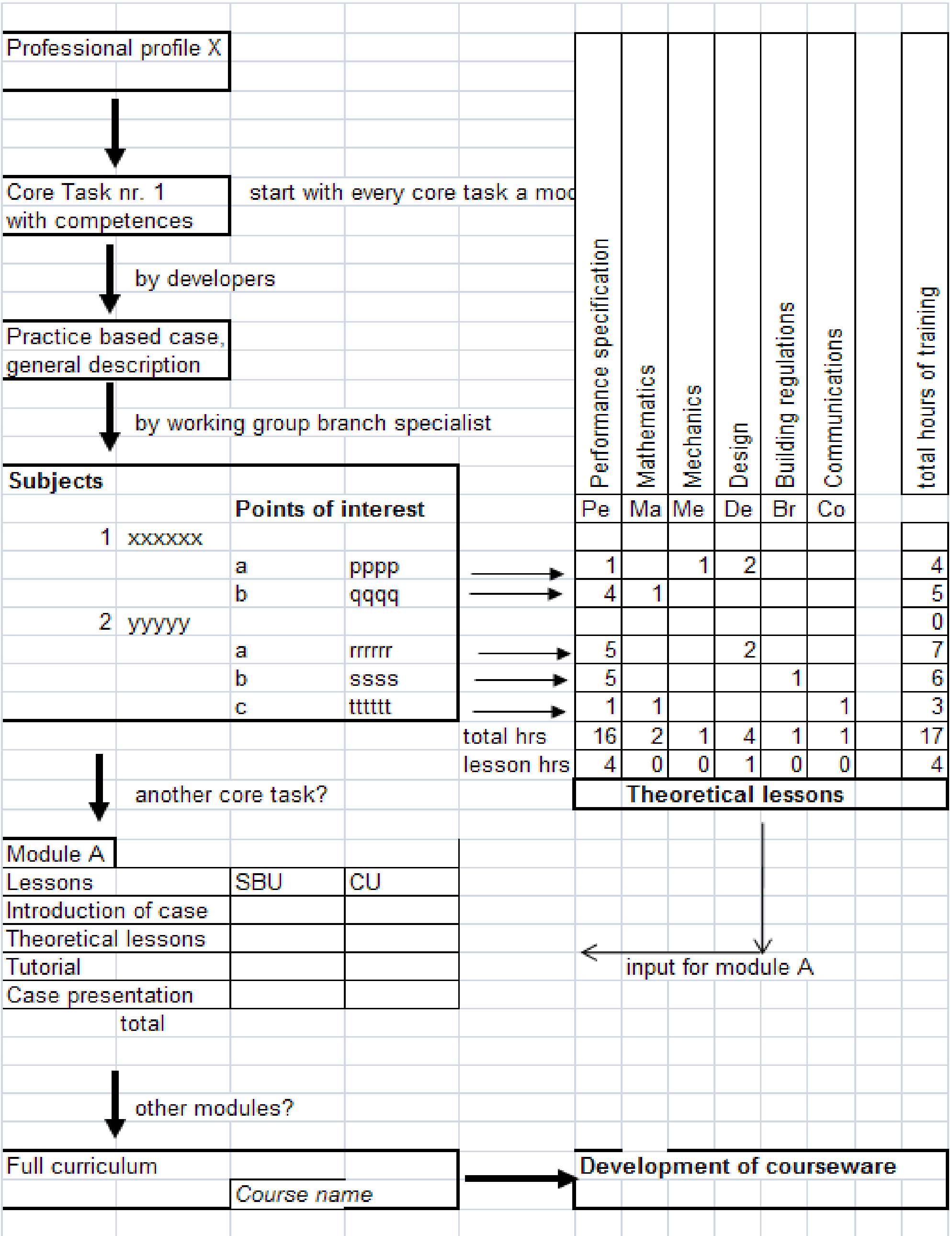

Figure 3: Curriculum generating approach.

For designing the sequence of the modules the pyramid model is developed. This model shows how to take foregoing training on the ladder as a starting point. Hook on for new students to what they were used to in their foregoing training and have probably improved in practice.

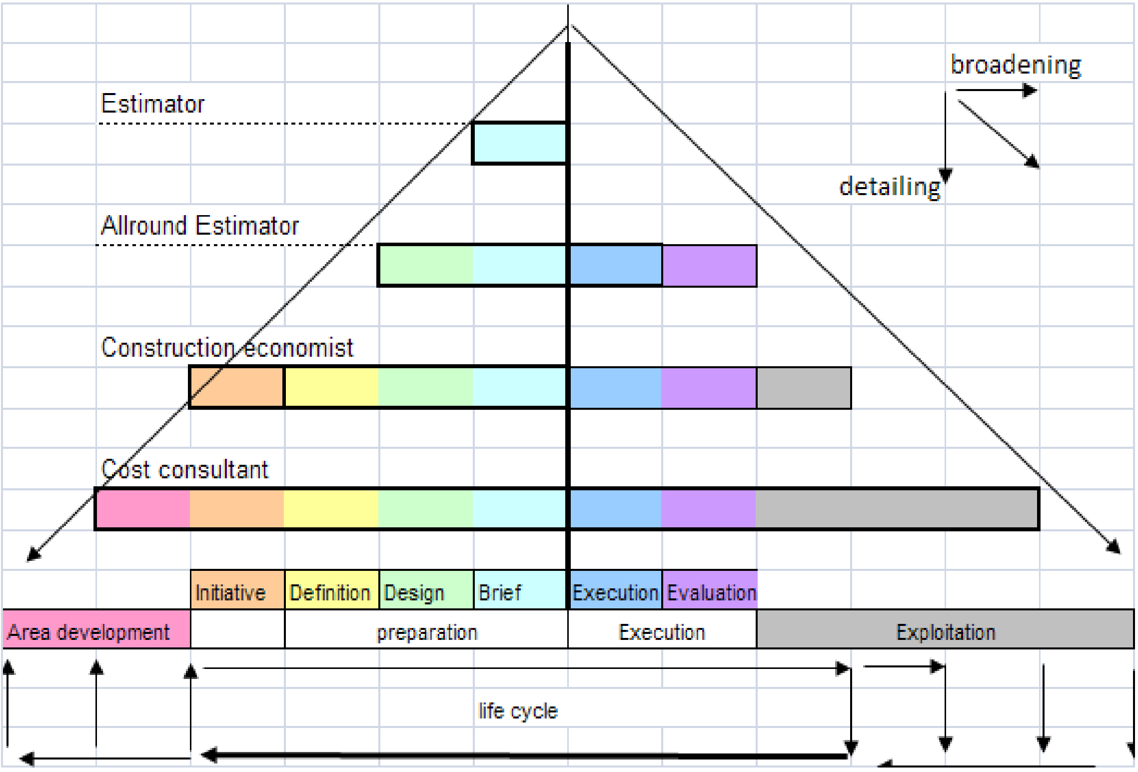

Figure 4: The pyramid model

For all profiles mentioned in figure 2 the so-called model-curricula are developed. Working on this, it becomes clear that market constraints interfere with the planned preparation of training for all profiles, in the field of marketing, attract lecturers and professors, making (new) courseware etc.

Preparation of execution stage

This stage the emphasis is on marketing communication by the educational institutes[5] that are facilitating the courses. This is an effort that should be easier through the system of certified courses. During the development years of the EKB project, branch NVBK was not yet successful in imposing his members to follow the next course on their career ladder. This quality system for improving the work and preventing failure costs is also slightly frustrated by the fact that the Dutch construction sector is lacking professional CE. Companies have a tendency to accept students without awareness of the specific elements of working as a CE, or accept estimators without hardly any practice.

A solution for the future can be described as follows. To maintain his certificate as (for example) CE Infrastructure an employee has to make a choice from course-to-follow, to

[5] HAN University of Applied Sciences, Expertise Centre; The Hague University of Applied Sciences, Master & Professional Courses

keep his work on a certain quality level. A certifying office[6] every year publish the value of relevant course, expressed in points. Having successfully follow a course with enough points, the certificate or diploma is registered. This can be a self feeding mechanism. See figure 5. Marketing can be easier. It is possible to avoid the acceptance of non qualified candidates by the institutes, which brings down the quality of the course ladder.

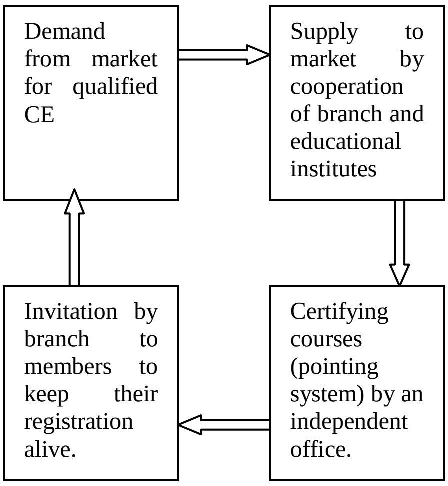

Figure 5: A possible self feeding mechanism for marketing of courses.

Execution

Year 2008 is dedicated to execute and monitor the developed courses, including input procedure and output registration. Due to market conditions not all developed curricula are monitored:

- basic training construction economist Residential & Non Residential buildings,
- training cost consultant,
- basic training construction economist Infrastructure,
- basic training Mechanical & Electrical cost planning.

Though not fully monitored, enough evaluation information was gathered to improve educational structure, courseware and communication structure.

Evaluation

At the end of this stage the following results of the EKB project are to use or to implement in the next 5 years, see table 1.

Table 1: Summary of project results

[6] In the Netherlands the foundation RKN, Register Kostenmanager Nederland, www.stichtingrkn.nl

Result	Rights to use
Professional Profiles	Free for every company or independent construction economist to adapt to own situation.
Didactic Vision	Suitable as permanent source of inspiration and free to renew in case of important changes in education and or construction sector.
Curriculum Generating Approach	Free to develop towards a generator.
Curricula	Authors right for branch, right to use for partnering institutes.
Courseware development	Authors right to the authors, right to use for branch and/or partnering institutes.
Entrance-to-course instruments	Authors right to branch, right to use for partnering institutes.
E- learning environment	Authors right for branch, right to use for branch and/or partnering institutes.
Certified output registration	Authors right to branch, right to use for partnering institutes.

CONCLUSIONS

Evaluation sessions of the project lead to the main conclusion of the project: a career ladder system for two disciplines can be build. Another conclusion is that full implementation will cost some more years, due to educational market constraints and strength of branch organizations. Main conclusion for a construction sector in general is that a self feeding mechanism should be constructed for one or more disciplines, in which education is fed by the need from practice and practice is fed with competent workers.

One recommendation is to expand this project with in fact two disciplines, to a group of 4- 5 disciplines. There will be more efficiency and governmental support will be less needed.

REFERENCES

(see notes below each page)

RISKS AND COSTS OF INJURY IN CONSTRUCTION COMPANY

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Although civil engineering working processes take a great deal of injury risk, various combination of negative impacts on the employees safety also increase that risk in routine. This article analyzes the largest sources of injury risk in realization of construction works. If the injuries at work occur, they make a number of direct and indirect costs, therefore the investment in protective measures along with human side certainly justifies. The article describes wanted organization of safety system that includes EU regulations. Planned protective measures must be flexible and have to be controlled. There is emphasised importance of cooperation and information exchange between occupational safety participant and the relationship of safety at work and the quality of business.

KEYWORDS: injury risk, costs, safety system.

INTRODUCTION

A great number of occupational injuries, often with severe consequences, represent an emphasised problem of companies performing constructional work, but also of wider social community (i.e. the state).

The Croatian construction industry has, for many years, been among businesses with the highest number of injuries, particularly injuries with most difficult consequences. Between 2,184 and 2,660 workers were injured in the construction per annum in the period from 1997 to 2003. Later, that number increased for several hundreds. The year 2006 showed 6% more injuries compared to 2005, but 4% less injuries compared to 2007. Until the year 2000 the construction work wasn't really that widespread. The number of lethal accidents at work was between 9 and 16 per annum, while in 2003 it increased to 20 to 27 per annum. That came as a consequence to the increase in number of employees – for over 50% in the past seven years. During 2007 there was 2,844 occupational injuries reported in construction industry that, at the time, had about 135,184 employees. Taking into account all of the above, the construction industry has the highest injury rate, considering the number of employees, and also has the highest number of severe injuries, 340 of them (26% of all severe injuries in Croatia). In 2007, 21 person died, which is 2 less compared to 2006 and 6 less compared to 2005, but is still over 50% more compared to all occupational deaths in Croatia (Pap, 2008). These data shows us that the number of hurt people increases with the intensification of the construction works (highway construction and mass apartment construction started in year 2000).

Similarly, the stagnation or decrease in injuries is present when the work force participating in the construction works is somewhat stabilized.

Occupational illnesses are not that often in construction business (in the period 2003 -2007 average 3 cases per annum, that is under 5% out of all registred in Croatia) and most of them are related to skin diseases. Then chronic periarthritic changes caused by cumulative trauma and diseases caused by vibrations (Pap, 2008).

Endangering the health while at work is more often and more severe in economically and democratically undeveloped countries. According to the EUROSTAT data, each year 5,700 workers die due to occupational injuries, and another 160,000 workers die as a consequence of work related illnesses. That number exceeds 2.2 million workers worldwide. Considering all activities, the multi-annual average number of occupational lethal injuries in Croatia is not much higher than the EU average (3.5 to 5 persons on 100,000 employees), but the number of killed in the Croatian construction industry is about 5 times higher than in EU. Hence, the situation in Croatia is similar to some countries that were later accepted in the EU. The number of lethal injuries and lethal accidents in the construction industry is the lowest in the Scandinavian countries. At the same time, the number of reported occupational injuries in EU, in all business activities, is around 50 while that number is 80 in construction industry (out of 1,000 employees) (Žmegač, 2007). In Croatia that number is officially about three times lower, in both cases. Therefore, it is justified to assume that the actual number of occupational injuries in Croatia is considerably higher from the official data, and that only one third of the accidents and injuries and processed.

Unlike Croatia, in some countries which are more advanced regarding health and safety protection at work, the number of injuries compared to the number of workers in the construction industry was considerably reduced with the usage of appropriately organized activities and investment in prevention. (Example: in Ontario, the best Canadian province when it comes to the protection at work results, the number of fatal injuries for 100,000 workers has been constantly reduced -in the period 1966 –1986 for 60.6%; in the period 1986 –2006 for 52.1%, and in the period 2006 –for further 35.8% (The Construction Safety Association of Ontario, 2006). Croatia has aligned its health and safety protection at work legislation with the EU, but without a deeper and more extensive analysis of the source of danger in certain business activities, particularly those that have most injuries, and without encompassing all specific problems, merely formal acceptance of those regulations will hardly improve the safety conditions in any relevant amount. The direction of necessary research and the purpose of the research result is indicated in the article. The system of the protection at work during construction has been proposed in accordance with current legislation that is aligned with EU; and has been amended based on the experience with security systems in countries that have protection results as we would like to have.

COST EFFECTIVENESS OF THE PROTECTION AT WORK

¨Research made in the United Kingdom has shown, that expenses of accidents and health disorders at work in the construction sector (including expenses of delays, truancies, health and insurance expenses) constituted 8.5% of the overall construction project expenses (Apanavičiene and Liaudanskiene 2008, p. 15).¨ Many costs can occur due to occupational injuries, and main cost groups are stated in the Table 1.

Direct costs are easy to express as a financial loss, while indirect costs are more difficult to calculate. Large indirect costs are deriving from the loss of working days caused by occupational injuries. Due to occupational injuries 1,216,613 working days were lost in Croatia in 2007 (Pap, 2008), and for the construction business alone the estimate is that over 100,000 days were lost. As the lost working hours we should calculate also the possible posttraumatic stress disorder in workers that experience accidents, but who are not necessarily injured themselves in those accidents. Symptoms are visible immediately or as a delayed reaction to the stress, and can represent serious problem if are not recognized and treated profesionally.

Table 1: Types of expenses in the company and due to the worker's occupational injuries

Direct cost	Indirect cost
-First aid and medical assistance costs	-Lost working hours of injured employee
-Hospital (and rehabilitation) treatments cost	-Lost working hours of other employees
-Earnings recompensation to the injured employee	-Lost working hours of the business manager
-Damages, one-time money aid, and other expenditures based on assumed liabilities	-Production losses (productivity reduction and slowed dynamics of project realization)
-Legal proceedings cost	-Cost of hiring a new employee
	-Increase the costs of health insuarence

The cost shares according to the types of occupational injuries are, as a rule, very close to the shares according to the lost working hours. If we could determine which types of injuries cause the biggest loss of working hours in Croatia (traumatic injures, musculosceletal disorders etc.) we could then, according to those findings, steer the preventive actions much more effectively. We know what causes certain injuries and diseases, and we can target those areas with appropriate organization of the work (breaks during work shift) and with the appropriate organization of the work space (ergonomic), adding more protective equipment, increased control on the work place and regular medical exams. We should try to replace the human labor with mechanization as mush as possible at jobs and activities that have the worst consequences for the health of those performing them.

In addition to the costs regarding the occupational injuries of employees, due to accidents that happen as a consequence of a poorly performed protection measurements, additional injuries on machinery and equipment can occur, as well as the intermissions in planned dynamics of performing works, that consequently leads to other losses.

A part of all mentioned expenses is always a liability of the company (the employer), and it is possible to refund another part from the insurance company. But the insurance company shall, before paying any expenses, check in detail whether in the working process, during which the injury occured, all formal and compulsory measurements of protection were in place. If it is established that this was not the case, the insurance company shall not consider itself responsible to undertake any expenditure relating to the accident.

The quality system according to the ISO 9000 implies that the quality tracks and measures costs, and these types of costs are considered as costs of non-quality. Furthermore, we cannot neglect negative image that occupational injuries have on the company where they occur. Investment in occupational safety is a good investment because one serious injury could cost much more than the price of preventive investment. Greater investment in safety system and its better organization can have relatively rapid savings but the effect of happiness makes them difficult and unreliable to quantify. Figure 1 trends show approximate the expected relationship between accidents and profits in relation to the investments in the safety at work (Joseph, 1999).

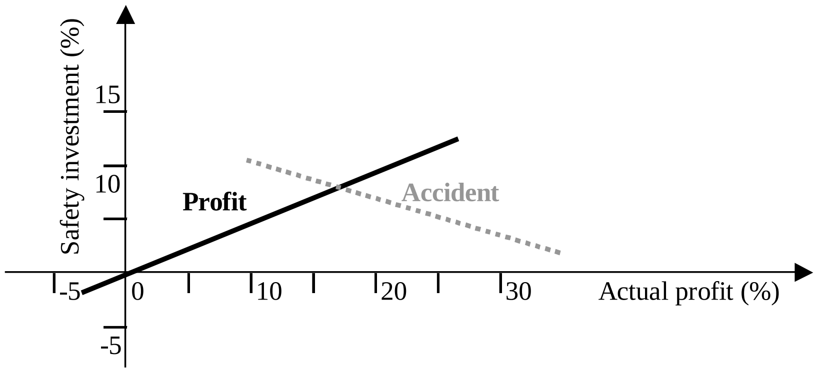

Figure 1: Expected relations between investments in to the safety at work and profits

International Labour Organization (ILO) has, on the recently held world congress on protection and health at work, pointed out that the appropriate health protection at work improves working conditions and has a positive effect on the productivity, and on economic and social growth.

By avoiding injuries and occupational illnesses the savings are evident, and not only for the company in question, but also for the wider comunity. All costs caused by occupational injuries and occupational illnesses (some illnesses are often visible after many years), that are taken by the entire society, amount to, according to the ILO, as high as 4% of GDP. In Croatia 2008 also 4% of GDP, whith is about billion Eu per annum (National Council, 2009). The state has great reasons to be interested in avoiding injuries and professional injuries, and thus it should act as effectively as possible in the area of protection. Croatia obviously lacks more preventive action. There are not enough research on the sources of danger and their efficient removal, and we should also mention the unsufficient number of controllers of protection at work. The new concept of the health insurance at work in Croatia is focused on stimulating those that successfully practice safety at work, and on sanctioning those that work the opposite way. This concept introduces differentiated rates of the contributions of the protection at work, that are dependable to the expenses payable by the employer in the past year. If a certain company had, in the past year, costs for occupational injuires and professional diseases that were higher than the average in the construction sector (each sector has its prescribed different rate that depends on the risks and expenses), then such a company should increase the rate of the contribution it pays for its employees for as much as 50%. In cases where the above mentioned expenses were 50% lower than the average of the sector, the contribution rate should be lowered for 25%. Such a way of calculating contributions should become effective this year, thus we still do not know its results in practice.

CAUSES AND RISKS OF THE OCCUPATIONAL INJURIES

Accidents are the consequence of different disorders between a man and the working environment in which that man works. Hauever, all disorders do not end with an accident. One of the analysis shows that out of 330 disorders, nothing damaging happened in cca 300 cases, in 29 cases an injury or material damages had almost happened, and in only one case an accident had actually occured (Holroyd, 1999). Once we consider the number of recorded injuries, we can assume how many potentialy harmful situations there were, that could have ended up much worse than they did. That shows us how big is the area on which we should actually act. If we consider only the number of reported injuries (2,844 x 330/ 250 work days per year), we can conclude that during 2007, in the construction business in Croatia, each working day there were about 3,750 disorders that could have an occupational injury as a consequence. We should take seriously all accidents, even those that do not result in injuries (which is mostly luck). We should analyze them considering the level of danger that was present as well as the oversights that occured. The Croatian *Law on protection at work* prescribes that in such a case a revision of the estimated danger in the company should be made. The evaluation of danger is the duty in the construction business. Analysis of data on current condistions determine the levels of risk for health. Evaluation also contains the plan of measurements for decreasing the level of danger.

There are numerous negative influences that are interlinked and that impact the safety of construction work on construction sites (Figure 2). On every element out of that group we can and we should act in an appropriate way.

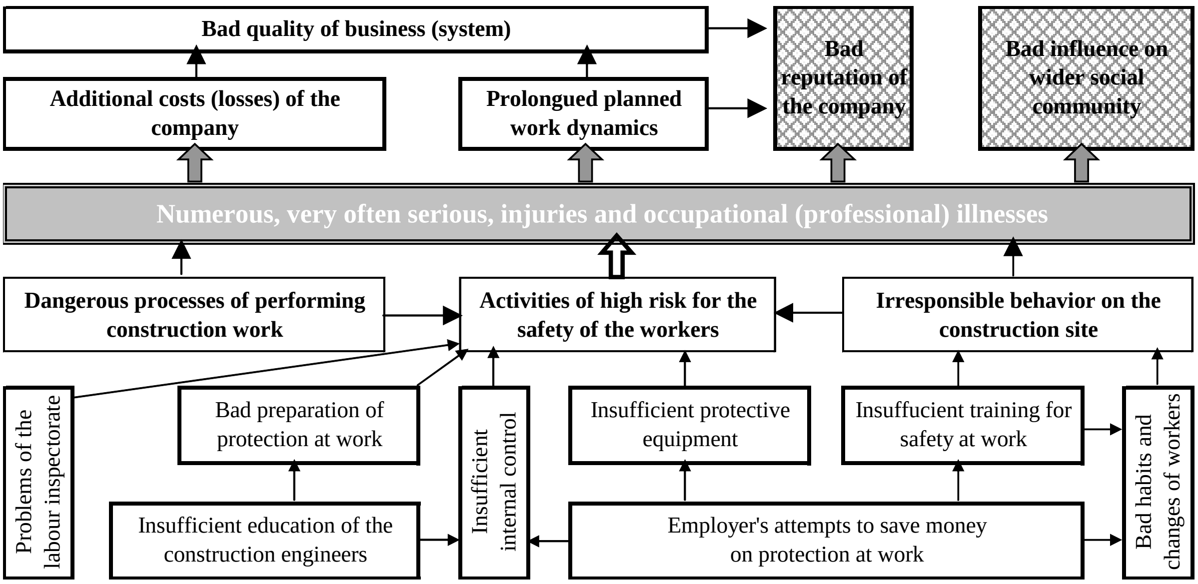

Figure 2: Interlinked causes of the low safety in the Croatian construction sector, and negative consequences arising from those causes

Very high risks of injuries derive from specifics of realization of the construction projects. Work processes that take place on construction sites are, due to their particulat contents, potentionally dangerous for the health of workers. Therefore, many of them represent activities with special working conditions and require the implementation of the special rules of the protection at work.

It appears the the most common causes of injuries are certain improvisations that workers are prone to due to imprudence, lack of knowledge, lack of discipline and and efforts to finish work faster. The work force on the construction site is frequently changing, and itis known that usually the newly hired workers get hurt on the construction site. A big number of those injured are younger people that do not respect the rules of the safety at work, they underestimate the danger and the overestimate their capabilities, they are not aware of the importance of the protective measurements and they are prone to simplifying processes, they do not handle tools and equipment according to the assigned regulations. The employees are usually educated too formaly, only because it is legaly required, and not because they are trying to protect themselves.

Many employers are still trying to save money by eliding the measures of protection. Hiring part time workers, sometimes without reporting them, increases the risk, and those workers do not undergo the compulsory training for safety at work before starting and they seldom pass any medical examinations with the specialist of the occupational medicine. The danger increases as the deadlines approach, when the pace of the works should be accelerated. Shifts are longer then, the necessary rest is missing and the concentration is dropping. The number of workers performing the same type of work at the construction site increases, and the control is more difficult. The safety conditions of workers are much lower in small companies, where they constantly lack experts on safety at work, hence they do not pay enough attention to it.

Accidents do not happen accidentaly – in most cases they are caused by the entire sequence of circumstances that can be prevented. These circumstances are mostly predictable, but they require appropriate analysis of the problem.It is necessary to have statistical data about accidents and injuries that have happened, as they indicate where we should focus our attention (the most common causes of accidents and those with most severe consequences), and where should we act with protective measures in order to minimalize the risk. Perennial trackings showed that occupational injuries are mainly caused by inadequate protection at work, and particularly by activities contrastive to the regulations of the protection at work (these make, in the past years in Croatia, 50 –70% of causes of all injuries in all activities). A force majeure was to blame for the accident with only a couple of promilles out of all injury cases (Pap and Karatović, 2007), which proves that the highest number of injuries could have been avoided.

Considering the non reporting of all accidents and the lack of inquiries on causes of accidents in the construction industry in Croatia, it is interesting to compare the existing data regarding severe injuries in all business sectors (and most of them are in the construction) with better tracked data (for only construction) in some other countries. (Germany as the country with advanced economy and one of the oldest member of EU, Lithuania as one of the newest members of the EU, and similar to Croatia in number of workers, and aforementioned Ontario, that is excelling in successful protection at work.) Out of such orientational data we can usefuly deduce regarding sources of the danger and the size of the risk on our construction sites. From data of the official reports in the Table 2 and Table 3 it is visible that, even though in operational construction activities in Croatia equipment, machinery and protective devices are generally on a lower level, and the regulations are not as strict as in the EU, or are not as strictly implemented, types of injuries and the way they occur, as well as their presence are very similar.

Table 2: Data of the inspectors control about causes of occupational injuries in Croatia (Pap, 2008)

Causes of occupational injuries in all business in Croatia (year 2007)	Percent
Performing of operations in a way that is contradictory to the rules of protection at work	56%
Weak organization of the work, lack of technology development and work instructions	9%
Problems with the surface on which the work is performed	8%
Errors in the work equipment	8%
Problems with protection against fall	6%
Lack of or errors in protective equipment	4%

Table 3: Comparative overview of the occurence of severe injuries in Croatia (all sectors) (Pap and Karatović, 200 7) and i n c onstruction s ector of Lithuania (Apanavičiene and Liaudanskiene, 2008), Germany (Clemens, 2009) and Ontario (The Construction Safety Association of Ontario, 2006 -2008)

Ways of occurences of lethal and other severe injuries	Croatia 2006 (all severe	Lithuania 2007 injuries)	Germany 2008 (only lethal	Ontario, Canada 2006-2008 injuries)
Falls of the workers	40%	38%	36%	41%
Pinches – tools and machinery	18%	19%	14%	12%
Clashes and impacts	17%	14%	12%	16%
Falling objects and materials	15%	10%	28%	15%
Electricity	2%	8%	3%	11%
Harmful substances	2%	4%	3%	2%

SAFETY SYSTEM IN CONSTRUCTION COMPANY AND PROJECTS

Dealing with safety on the construction site falls into the scope of work of the organization itself and its functioning must be built in the system of the construction company. Protection at work is implicated in many determinants of the ISO 9000. Maximum protection at work is possible to achieve only if problems of the safety and integral protection are viewed through clearly defined processes inside of the system of the company, as a part of quality management.

System should be oriented to prevention activities, avoinding distresses in the safety of the working processes, and ensuring that if they do occur, their consequences are as easier as possible. Each system of protection should comprise of planning, co-ordination, implementation of all measurements of protection at work during the construction works, and their constant control (internal and external), gathering data (the database) and information exchange (as wide as possible).

As it is shown on the Figure 3, the external influences on the safety are represented by the international programs and the governmental safety work system, connected to those external factors. The element of the system are legislature (legislation), jurisprudence, labour inspectorate, health care system, educational and reasearch of the condition and the safety problems focused on programs of improving the safety and promoting the culture of the safe working. Manufacturers of the machinery, tools, equipment and protective devices for workers make the external influences to.

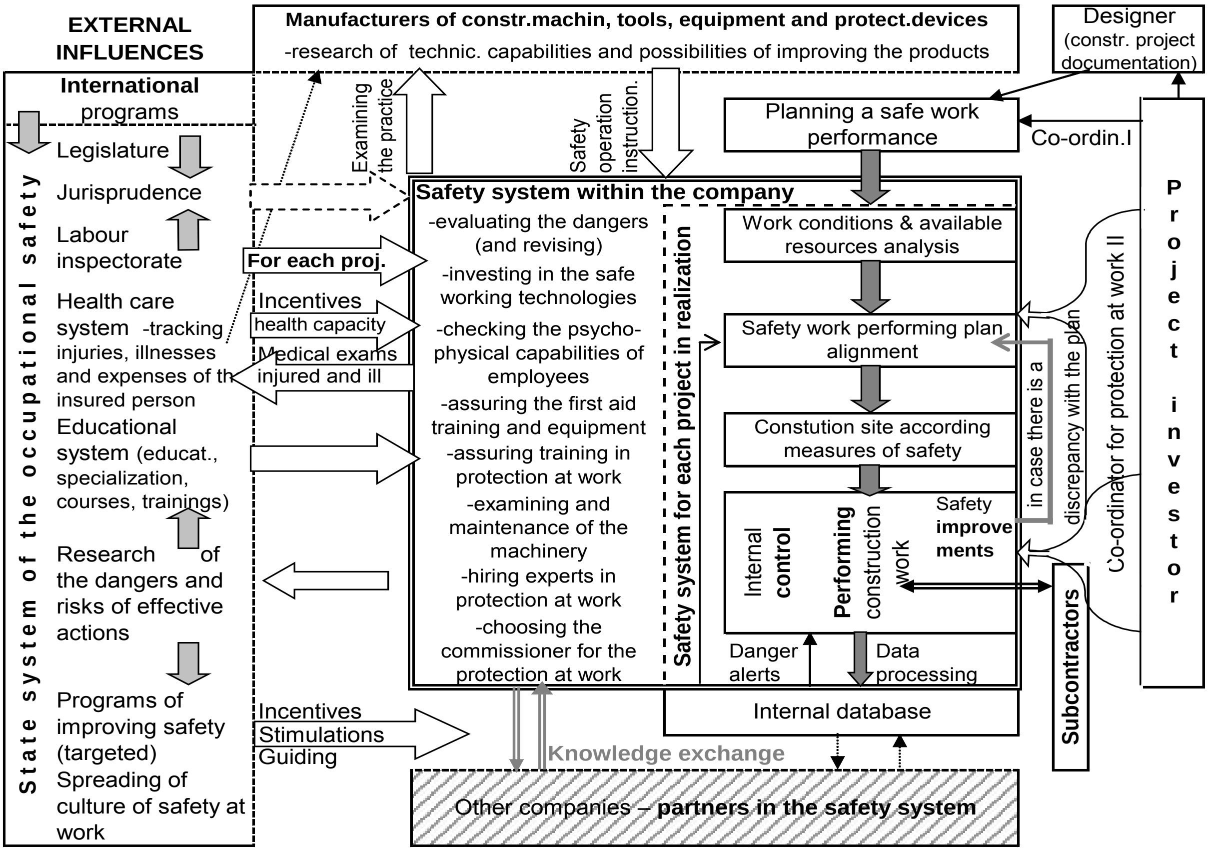

Figure 3: Elements and connections of the safety systems during realization construction

The contruction project investor acts on the construction safety outside of the system of the company, but within each building project. *Book of regulations regarding protection at work for temporary or moveable construction sites* from 2008 fulfilled *the Directive 92/57/EEC*. According to that regulations, a part of the responsibility for protection at work during construction work is transferred to the investor. The investor is obliged to name co-ordinators for the phase of the project execution (Co-ordinator I) and for the phase of the work completion (Co-ordinator II). Through the first co-ordinator it must ensure making of the plans for construction works (which makes the integral part of the project documentation) in accordance with the principles of the protection at work and the specifics of the future construction site. The co-ordinator II has a task to coordinate the implementation of the principles of the protection at work and related to that he must also co-ordinate all workers on the construction site, make sure that the work is performed in a safe way and ensure the harmonization of the plan of safe work performance with the changes which arised during the execution. Protection planning in the project phase, while neither the construction company nor the duration of execution are known inevitably demands later alignment of that plan with the real conditions of execution. That should be done in a team, at the same time as the technical preparations of the company, experts of protection at work, site engineer and protection at work co-ordinator II. That plans must be flexible, because the planned dynamics of work is often changing.

The safety system of a construction company can be divided to the joint part, caring for the safety of the entire company, and to the (sub)systems of each of the projects in realization. As each project is unique and unrepeatable, the organization is essential for the (sub)system of the protection at work, for each project (construction site). They contain elements of the project of organization of the construction (choosing safer work technology, terminating construction activities which is convenient considering the safety of the workers, planning of the adequate measures of protection at work), organizing the construction site in accordance with safety demands, ensuring the necessary equipment and personnel for first aid on the workplace, ensuring the fast connection with the medical service, ensuring the protective equipment for the workers, ensuring the maintenance services of equipment, tools and machinery, co-operation with subcontractors and with internal control (the expert of protection at work and the commissioner of workers for the protection at work), frequent warning the workers about dangers, heving all dokumentacion of occupational safety, tracking the safety conditions and comparing them with the plan, that should be adjusted according to the real situation in the case of major discrepances. From experience from each project data is collected for the database for safe work performance within the company.

We should strive towards everyday's percieving of problems, enforcing all written instructions, accepting suggestions coming from motivated workers and solving problems in one's own working environment. Therefore, we should improve the communication with workers, educate them and include them in all safety measures in the working place. Positive experiences from the practice show that workers need concrete and short information before the work starts (warning regarding dangerous situations that might occur on that day).

The activation of interrelation of paralel systems is also suggested, where these systems represent companies from similar lines of work. Their co-operation regarding the protection and safety at work is beneficient for both sides, and the synergy effect can be expected. Wider sources of information are at their disposal, learning on someone else's mistakes, better perception of the centers of danger is possible, constant remindings of danger, and maybe there will be a desire for competition in quality.

CONCLUSIONS

In EU as well the construction business is first in the number of occupational injuries with the most severe consequences, compared to the number of employees, but in Croatia that difference is much higher. Therefore construction business should be the area of the special interest for examining the dangers and according to them the entire development of the targeted protection at work programs. Up to now, a rather spare reasearch of the area of protection at work in construction sites in Croatia imply to the condition that is not good enough (low marks of elements of protection at work –from 2.0 to 3.8) (Palačić, 2006) and with that, a large space for improvement.

Problems of the protection during construction works should first be located and defined, and then detect what causes them and sort those causes. It is necessary to exam the possible ways of targeted risk minimization, primarily those that are the biggest and the most dangerous ones, considering negative consequences. It is also desirable to investigate examples of activities in practice that have obtained good results with regards to the safety of the workers.

With necessary knowledge and skills, the protection should include conscience (moral) regarding responsibility towards ourselves and other people, which we can achieve by spreading the culture of the safe working. Working in the safe way should become a habit. Hence, it is important that the company's manager (boss) takes the protection at work seriously. If he is consistant with that, the work force will follow. To become a competent expert it is necessary to have a life long education, as work technologies in the construction business change all the time, as well as the possibilities of protection at work and regulations.

Effective protection at work is possible to achieve only if there is harmonized activity of all participants through organization planned on the process level. The co-relation of system's quality and the level of safety at work is emphasized. The prevention from occupational injuries must be built in basics of the business. We should think about implementation of protection at work measures as of activities that shall improve the quality of work and life, and shall, as a consequence, have the public gain due to the increased effectiveness of workers, better arranged organization of work and smaller additional cost. Active co-operation adds to that – the exchange of the information between participants of the protection at work should be expanded to the co-operation between companies as well.

REFERENCES

Apanavičiene, R., Liaudanskiene, R. (2008) Health Protection and Safety Management in Lithuanian Construction Sector. *Quality, Environment, Health Protection and Safety Management Development Trends*, Brno: Tribun EU

Clemens, R. (2009), "Todlich verungluckte Bauarbeiter 2008", Arbeitsgemeinschaft Netzwerk Ges, available at: http://www.gesunde-bauarbeit.de/

Holroyd, T. M. (1999) Site management for engineers. London: Thomas Telford

Joseph, A. J. (1999) Implementation of Health and Safety on Construction Sites. Rotterdam: Singh, Hinze and Coble

National Council for the Protection of Work (2009), "State of protection of health and safety at work in Croatia in 2008 year", available at: http://www.sssh.hr/downloads/zastita2009.pdf

Palačić, I. (2006) An occupational safety management study. Sigurnost, 48(4), 341-356.

Pap, Đ., Karatović, I. (2007) Stanje zaštite na radu u 2006. godini. Sigurnost br. 49(2), 187-209.

Pap, Đ. (2008): Stanje zaštite na radu u 2007. godini. Sigurnost br. 50(2), 183-199.

The Construction Safety Association of Ontario (2006 -2008), "Annual Report", available at: http://www.csao.org/t.tools/t6.news/archives.cfm?featureSectorid=5

Žmegač, B. (2007), "Usporedba broja ozljeda u RH i EU", available at: http://www.zastita.com.hr/

MUNICIPAL WATER CHALLENGES IN BIH

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In addition to providing water services, municipalities in Bosnia and Herzegovina (BiH) are responsible for maintaining and operating municipal infrastructure. The municipally owned companies are in a perpetual financial crisis due to several reasons – the major being the traditional 'clientilist' model of water service provision.

The post-socialist and –war heritage in BiH is one where prices do not cover operating costs, maintenance and investments are limited, quality standards are low, and water facilities are not protected from potential hazards. In the case of the Sarajevo water supply, the exponential trend equation states that water losses grow by 1.9 percent per year. Probably all municipal water companies would fail the test of 'going concern.'

The purpose of this paper is to highlight the current challenges of the BiH water supply system and to propose a strategy of achieving its better results based on benchmarking performances.

KEYWORDS: BiH, water supply, benchmarking.

INTRODUCTION

Since the late 1970s neoliberal views have been that private sector participation (PSP) in the water sector could address deficiencies in providing water services. That had a far-reaching influence on a number of actors within the water provision making privatisation a central issue of development policy during the 1990s.

England and Wales have been the first countries to undertake radical reform by privatising their respective water industry in 1989. That opened the way for private sector participation in water utilities in other parts of the world including developing countries, primarily Chile and Venezuela.

BiH signed on 16 June 2008 in Luxembourg the Stabilization and Association Agreement with the European Union. The agreement obliges BiH to reform the country in line with EU requirements in return for EU support. The water sector reform represents one of very important elements of that process as it asks for the huge investments into the sector to meet the EU standards from the perspective of consumers and the environment. Consequently, the water sector is increasingly coming under scrutiny of researchers and policymakers.

Estimated infrastructure investment needs of new EU member Countries of Central and Eastern Europe for the period 1995-2010 amount to EUR 505 billion. The largest share of the total goes to the water/sewage sector in the amount of EUR 180 billion, equivalent of 1.5 % of GDP. In BiH, water/sewage sector will be even the higher priority target due to the backwardness of the sector and the urgent need for financing (Brenck et al, 2005).

This paper attempts to point out that deep reforms in the water sector in BiH should be triggered without any delay. They ought to be aimed at establishing the proper institutional and regulatory framework for water provision and distribution, cost-effective operating water companies and undertaking necessary investments with resulting efficiency gains yielding to consumers.

The emphasis is on setting out the relative position of the BiH water industry by making international comparisons in a number of key supply quality performance areas, from leakage rates to infrastructure leakage index. The aim is to derive the desirable properties of the appropriate practices for BiH drawing on theory and evidence from around the world.

The paper is organised as follow. In the first section, the municipal water system in BiH is discussed, stressing in particular the issue of deteriorating water services and the necessity to their improvement. The second section is dealing with water sector benchmarking as a tool for improving water distribution efficiency and finally, in the third section, a reform model of water provision is proposed.

COLLAPSING WATER SECTOR

In BiH, responsibility for water service provision is decentralised and rests with municipalities. That includes securing and regulating services, establishing companies and other organisations providing the services, adopting rules of operational procedures, setting fees and other charges, making decisions on the companies' management etc. (World Bank, 2009).

In BiH, there are some 130 municipal water companies serving the needs of 3.8 million of inhabitants, in comparison to around 3,000 water companies in Austria serving 8 million inhabitants (Kölbl et al., 2007) or 116 public water companies in Croatia serving 4.3 million of inhabitants.

The municipally owned water companies operate as formally autonomous organisations, separated administratively and financially from the municipal government. However, devolution of responsibility to company level is substantially very weak. In fact, companies are a part of the municipal political apparatus who predominantly influence water companies by appointing water company managing staff and securing budget subsidies for covering operational losses and investment financing.

They are not empowered and enabled to function as efficient service providers. By being obliged on overemployment, artificially depressed tariffs, following political rather than economic criteria in signing up contracts and undertaking investments etc. they spiral costs, accrue losses and weaken quality of service (Foster, 2005.)

Water system is in dismal condition, facing challenges such are increasing demand, low access to water services, excessively high consumption of water per capita, enormous amount of unaccounted for water, weak legal and regulatory framework, and lack of regulatory and self-regulatory bodies. Associated primarily with management incapacity and deteriorating infrastructure, these challenges have determined the “water crisis” meaning poor access in rural areas and insufficient pressure even water supply interruptions, especially for the high buildings, in urban areas.

Due to severe lack of investment funding, municipal water companies are relying on municipalities for providing capital investment funds. However, since significant levels of investment funding are needed to rehabilitate and particularly to expand water networks municipalities, they altogether rarely manage to meet enormous water sector investment needs. The municipal borrowing is restricted by law and so funds are limited. Municipalities themselves depend on grants and subsidies from higher levels of government i.e. from cantons and/or entities.

Even for municipalities with high per capita revenues it is impossible to cover the level of investment required for complete rehabilitation of the system by them alone not to mention municipalities with low per capita revenues. To illustrate, the Government of Sarajevo Canton plan to ensure significant investment financing for the Sarajevo water supply company during the upcoming period. It is estimated that the investment could be equal to the computed depreciation (approximately 14 million euro per year). This practically means that investments are expected in the amount of approximately 55 million euro during upcoming four years (VIK, 2008).

The biggest challenge for municipalities, cantons and entities is to address these financial challenges and to undertake investment at least for preventive maintenance, if not for largely neglected rehabilitation of the water system especially in rural areas. Due to insufficient finance devoted to the sector, authorities are turning to international financial institutions, including the World Bank, European Investment Bank (EIB) and European Bank for Reconstruction and Development (EBRD) for water infrastructure investment.

Due to lack of financial resources for investment and maintenance and inefficient water management in most of water companies, water coverage and service quality are unsatisfactory. As a consequence, service quality has been dropping sharply. The water service quality has been deteriorating markedly for at least the last twenty years. More than 13 years after the Dayton Peace Agreement, access to water services has been unacceptably low or unreliable.

About 36.8 % of the total population in BiH or rather 65 % of households do not have running water delivered by public pipe to inside the household. While in the pre-war period up to 90% of the urban population had continuous supply, its proportion has fallen to about 45%. Only 45% of the total population has continuous 24-hour service and water rationing is common, especially in the summer. Service delivery and reliability is extremely uneven across municipalities.

Water has poor quality ratings even among consumers who are connected to the system due to low pressure, frequent interruptions or water supply shortages. As a result, consumers are reluctant to pay the water bills. In turn, the lack of tariff revenue has resulted in a rapidly accelerating deterioration in the operating conditions of the water companies. That prevents maintenance causing service to deteriorate further. So difficult has vicious circle created that the water supply system is made unsustainable (World Bank, 2009).

Municipal water companies have very limited influence on tariffs. Municipal councils set user fees and charges. Water prices are set well below production cost being too low to even cover current operation and maintenance costs. They hesitate to pass unpopular fee increases to avoid losing local political support.

Nevertheless, it is necessary to adjust the pricing schemes in accordance with supplying water on a user-pay, cost-recovery basis. Current practices steadily deteriorate conditions of the water network and accelerates asset decline. For instance, the capital value of the Sarajevo water company has decreased for around 150 million euro over the last 10 years (VIK, 2008)

In particular, the method of charging for water supply, based on number of persons benefiting or area of the properties served, should be changed because it prevents the economic cost-benefit analysis to be employed. Such a billing method makes impossible for consumers signal their incremental satisfaction with the incremental amounts of improved service (World Bank, 2009)

For many years, water tariffs have at maximum secured revenue covering expenditure on energy, wages and supplies for emergency maintenance. Therefore, charging for services does not ensure resources needed for replacement of deteriorated parts of pipelines and other equipment. Water company operations are actually financially unsustainable

To make things worse, there are problems with collection of water charges. Low collection rates and low willingness to pay among customers, particularly within large public sector consumers (ministries, military facilities, hospitals, student dormitories and schools in addition to ruling political parties' offices) create high bills arrears. Water companies include in their annual plans improving collection of water charges at a minimum of 3% per year (in the town of Mostar even 10 %). While taking 2-3 months to collect bills is generally reasonable, anecdotal evidence shows that a vast number of Mostar's citizens do not pay their bills at all. The Mostar water company resort to measures, such as disconnection policies against delinquent consumers, information campaigns, collection reminders, penalty systems for late payments, and taking legal actions against non-payers mostly in vain.

POOR PERFORMANCE INDICATORS

A comprehensive survey of the available literature consisted of in 43 analytical studies, is resulted with water losses and population density as the most important drivers in water supply (Hirschhausen et al, 2008). In the five column model, the issue of water losses belongs to the category of supply quality as shown in the figure 1.

Performance indicators that deal with water losses are water loss ratio (%), real losses per connection and day (l/(connection*d)), real losses per mains length (l/(km*h)), infrastructure leakage index (ILI) and non-revenue water (%).

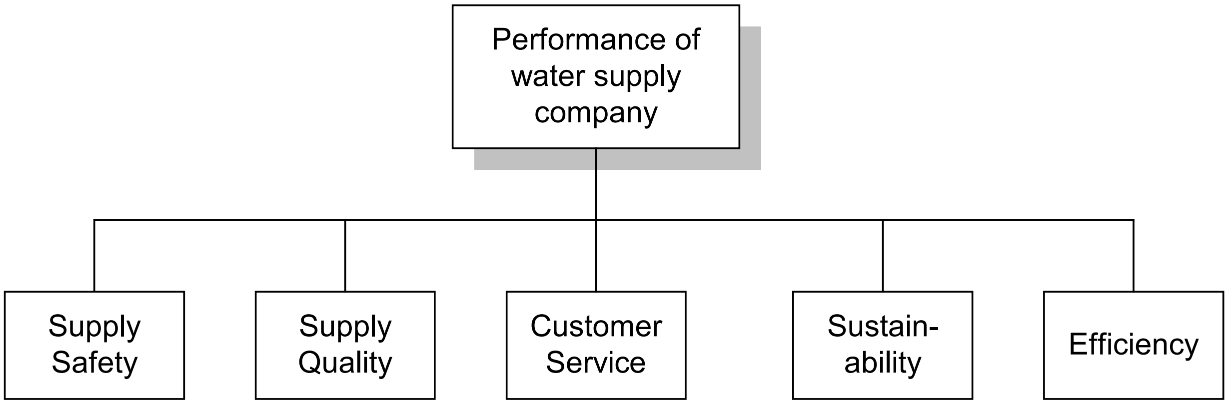

Figure 1: Target categories of benchmark system (adapted from Kölbl et al 2007)

The single most used parameter indicating performance is non-revenue water (NRW). However, it is important that the NRW is obtained through the accurate number of connections but in BiH with less than 25% the metering of measurement of production and consumption is more than difficult (World Bank, 2009).

Data for identifying gaps between standard requirements and actual supply quality is generally not obtainable, preventing the diffusion of efficiency analysis in BiH. This limitation means we cannot easily put the BiH water companies' performances into an international perspective. Comparable water quality information is difficult to find for many water companies. Consequently, we decide to consider only supply quality for the Sarajevo water company (shorter VIK).

Table 1: IWA water balance for the VIK Sarajevo, 2007 (VIK, 2008)

<table>
<tr><td rowspan="9">System Input Volume

85385 x 10^3 m^3</td><td rowspan="4">Authorised Consumption

29402 x 10^3 m^3</td><td rowspan="2">Billed Authorised Consumption

28335 x 10^3 m^3</td><td>Billed Metered Consumption

28335 x 10^3 m^3</td><td rowspan="2">Revenue Water (or billed volumes)

28335 x 10^3 m^3</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water

57050 x 10^3 m^3</td></tr>
<tr><td>Unbilled Unmetered Consumption
1067 x 10^3 m^3</td></tr>
<tr><td rowspan="5">Water Losses

55983 x 10^3 m^3</td><td rowspan="2">Apparent Losses

792 x 10^3 m^3</td><td>Unauthorised Consumption
213 x 10^3 m^3</td></tr>
<tr><td>Customer Metering Inaccuracies
578 x 10^3 m^3</td></tr>
<tr><td rowspan="3">Real Losses (CARL)

55191 x 10^3 m^3</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Point of Customer Metering</td></tr>
</table>

In 2007, 66.8 % of system input volume was 'lost' not reaching the customer. The result falls broadly outside of acceptable limit for the NRW, which ranges up to 20 per cent for developed countries, but it is in line with results for some Middle East and Asian cities where the NRW values reach even 80 per cent. At the level of some countries in the West Balkan Region, e.g. Croatia, it is traditional to consider NRW losses of less than 25 per cent as being a good performance (Kovač, 2006).

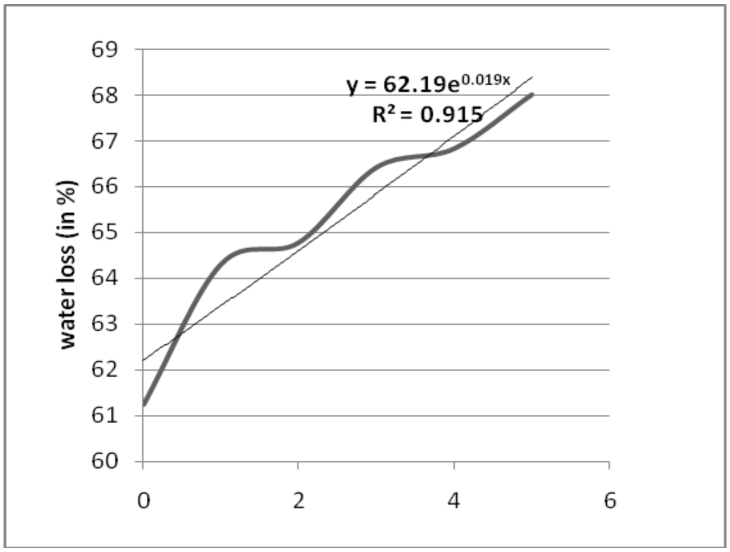

Figure 2: Water Loss, VIK Sarajevo, 2003-08.

The losses of the VIK Sarajevo i.e. the Sarajevo water supply network are about the 2/3 of system input volume that has been particularly evidenced over last six years (see figure 2). Estimating apparent losses is quite difficult e.g. due to not registered water quantities used through illegal pipelines and connections. In area covered by the Sarajevo network, there are many illegally settlements built.

As a large part of water losses, real losses tend to increase as systems grow older. According to the VIK Sarajevo (2009), due to poor pipeline and asset management (selection, installation, maintenance, renewal, replacement), the water supply network has become "useless in more than 60% of its total length".

The average age of the network may be identified as the factor exerting the biggest influence on water losses. The 1000 km Sarajevo water network requires to be rehabilitated due to the pipe deterioration (according to the yearly 2 % replacement rate, over 63% of transmission and distribution pipelines is written off i.e. at least 500 km of network), small pipe sizes (around 150 km of network is to be replaced to satisfy increasing number of inhabitants and fire protection requirements), inadequate materials pipelines are made from (approximately 169 km of asbestos -cement pipelines should be replaced) and the increased defects (repairing some pipelines cause new defects on other parts of the network due to increased pressures) (VIK, 2009).

The conditions of other water supply networks in BiH are similar. Between 50% to 80% of the pipelines require replacement in all water supply networks. These problems are directly related to lack of investment funding. In particular, they are a direct consequence of a long term (over 30 years) treatment of the depreciation costs, computed according to the national rules. As a result, leakage, up to 60% in some systems, is a problem for all cities.

Water companies in BiH are still operating only with water losses presented as a 'percentage' of the volume of water supplied to consumers. The water loss ratio alone is an issuficient indicator for interpreting the volume of water losses for a single utility. However, much convincing has to take place to persuade water companies even in developed countries e.g. in Austria (Kölbl et al, 2007) to use more appropriate performance indicators such as the Infrastructure Leakage Index (ILI).

The problem is that only utilities with GIS-systems are able to deliver exact data on the average length of service connections needed for the ILI calculation (Kolbl, 2007). The Sarajevo water company uses the GIS-system and it has recently reported on water losses in a format recommended by the International Association for Water (IWA). For the year of 2007, the IWA water balance for the KJKP VI Sarajevo is as follows: (VIK, 2009):

$$ILI = CARL / UARL = 2405/70.4 = 34.2$$

CARL = Current Annual Real Losses [litre/(connection * day)] = 2405
UARL = Unavoidable Annual Real Losses [litre/(connection * day)]= 70.4

According to the World Bank Institute Banding system, the Sarajevo water company performance of 34.2 can be allocated to the lowest ‘D band’ with the ILI value of “16 or more”. This requires leakage reduction programmes as an imperative and high priority, and a five-year plan to achieve next lowest band (Fantozzi et al 2006).

INTRODUCING PSP SOLUTIONS

Most BiH water companies still have plenty of room for more efficient operation but efficiency gains alone will be insufficient to mobilize the resources missing in the sector. However, it is necessary to wait for in-depth research into the possibility of introducing competition into the various phases of water production and distribution (González-Gómez and García-Rubio, 2008). Nevertheless, if difficult to adopt some measures encouraging competitive environment to due to the nature of the sector, secondary solutions encouraging more efficient performance among companies in the sector should be applied.

Bearing in mind that the BiH water sector has been suffering from inefficiency due to excessive political interference and rent-seeking behaviour by vested interests, it is legitimate to raise a question whether the private-sector involvement would be economically successful. The full divestiture model meaning the government transfer of 100 % of the equity in the municipally owned water company to the private company is not generally a proper solution. In the sector, where the business model is mass-retail and provision is decentralised, the public sector will continue to have a larger presence.

Only France and England (not the rest of the UK) have predominantly private water systems. Further, Spain has about one-third of the system run by private companies. Elsewhere in West Europe, water is still predominantly run by the public sector. In East Europe, privatisation of water has been restricted largely to the Central European countries, with recent trends indicating that the rate of privatization has been even slowing since the late 1990s. The overall impact has been lower than expected (Brenck et al. 2005).

No modality, not even a fully public sector utility, is likely to be successful where all local conditions are considered weak. However, there are a number of modalities that are more likely to succeed even when there are multiple weak local conditions. It should be pointed out that since over a decade ago no research study has proven the superiority of the public sector bodies (González-Gómez and Garcia-Rubio, 2008).

Two models of private sector involvement in water supply seem feasible in BiH. They are briefly described below, ordered in terms of the extent of private sector responsibility, as summarized in Table 2.

Table 2: Potential models of private sector involvement in the BiH water sector

	Management contract	Lease/affermage contract
Definition and responsibility of the operator	A private contractor takes responsibility for management services in return for a fee	A private contractor operate and maintain utility, employ staff, retains revenues from customer tariffs, and pays lease fee
Profit function for operator	Fixed fee+ bonus-managers' salaries and related expenses	Revenue from customers – operating and maintenance costs – lease fee
Asset ownership and capital investment	Public	Public
Commercial risk	Public/private	Public/Private
Repair /renewal of system	No	Yes
Operations/maintenance	Private	Private
Contract duration	3-5 years	8-15 years

Source: Adapted from Budds and McGranahan (2003)

Under a management contract, the municipal authority makes a private contractor responsible for running the distribution system but retains responsibility for investment and expansion and employing the workforce. It transfers certain operation and maintenance responsibilities to a private company for a period of between three and five years. Remuneration for managing the water service is either fixed in the form of a flat rate or performance-related.

When the fiscal space is very weak or limited, as it is in BiH as a whole, affermage/lease contracts may provide the feasible model. They are similar to management contracts, but with a rather important difference: the private sector operator takes responsibility for all operation and maintenance, including billing and revenue collecting. Under an affermage/lease contract, a private company is responsible for delivery of water service, and for necessary investment in reparing and renewing the existing assets, but the public authority remains responsible for new investment and for the investment in extensions. Affermage/lease contracts involve private investment in renewing the network, but not in extending the system making fiscal space less of a limitation.

In 1990–2004, about 340 contracts involving public-private partnerships in water supply were closed in low income countries. About a fifth of them were management and lease/affermage contracts, 52 percent of which were in Eastern Europe and Central Asia. There is the proliferation of these contracts in the Region in addition to the reliance on public investment for capital expenditure. Countries as diverse as Armenia, the Czech Republic, and Russia have closed management or lease contracts confirming the trend. It remains to be seen whether this is a short term or long term trend (Vagliasindi and Izaguirre, 2007).

CONCLUSION

In the early 1990s, many European countries launched water sector reforms aimed at improving water service. It is thus not surprisingly that BiH by being a latecomer continues to be significantly outperformed by them. Therefore, the BiH water sector needs urgent measures to become more efficient. The BiH authorities must first of all embrace deeper reforms since there is the dissatisfaction with the traditional 'clientilist' model of water service provision, which places the country among the poorest performers worldwide.

The reform process should be aimed at breaking this model by addressing the underlying institutional causes. A key feature of the reform should be the separation of the functions of policymaker and service provider, with introducing independent regulators. Politicians should be confined to supplying strategic guidance to the sector. It is necessary to put in place a range of institutional, operational, and governance reforms to improve service performance.

Independent regulatory authorities should be established to secure that utility companies are insulated from political interference and require that their business is conducted in line with sound operational and financial principles. Within a consistent transparent tariff policy, mechanism for tariff adjustment must be defined. The regulator should set tariffs at a level that allows the company to recover the efficient costs of operation, as well as a reasonable rate of return, while at the same time monitoring the achievement of quality and coverage targets. The regulatory authorities should gradually raise tariffs to cost-recovery levels, bringing fees and charges closer to the levels seen in the EU.

The BiH small and fragmented i.e. municipally owned and regulated water sector suffers from weak financial strength and lack of qualified and trained staff. A high level of investment in the water system should be undertaken in years to come to improve the network and to meet more demanding water quality standards. However, municipalities find it difficult to deal with the financial and technical issues posed by water. It seems that the acceptable approach for the BiH would be to employ the two-step approach: firstly, a short-term management contract then a longer-term lease contract with a private operator.

In particular, we suggest carrying out a pilot project on benchmarking in the water supply sector. The system of performance indicators should preferably be based on developing a mid-term strategy leaning upon the IWA system of performance indicators.

REFERENCES

Budds J. and McGranahan G. (2003) Are the Debates on Water Privatization Missing the Point? Experiences from Africa, Asia and Latin America. Environment & Urbanization 15(2), 87-113.

Brenck A. et al (2005) Public-Private Partnership in New EU member Countries of Central and Eastern Europe: An Economic Analysis with Case Studies from the Highway Sector. EIB Papers 10(2): 82-111.

Fantozzi M. et al (2006) Some International Experiences in Promoting the Recent Advances in Practical Leakage Management. Water Practice & Technology 1(2).

Foster V. (2005) Ten Years of Water Service Reform in Latin America: Toward an Anglo-French Model. Water Supply and Sanitation Sector Board Discussion Paper Series Paper No. 3. Washington, D.C.: World Bank.

González-Gómez F. and García-Rubio M. Á. (2008) Efficiency in the Management of Urban Water Services. What Have we Learned after four Decades of Research? Hacienda Pública Española / Revista de Economía Pública, 2(185-2/2008): 39-67.

von Hirschhausen Ch. et al (2008) Quo Vadis Efficiency Analysis of Water Distribution? A Comparative Literature Review. Efficiency Analysis Working Papers WP-EA-18. Berlin: DIW.

Vodovod i kanalizacija (VIK) (2008) Development Projects in Areas of Water Supply, Sewage and Waste Water Treatment in Sarajevo Canton. Sarajevo: VIK.

Vodovod i kanalizacija (VIK) (2009) Analiza stanja u VIK d.o.o. Sarajevo**.** Sarajevo: VIK.

Kölbl J. et al (2007) Experiences with Water Loss PIs in the Austria Benchmarking Project. Proceedings Water Loss 2007 Volume I, Bucharest.

Kovač J (2006) Case Study A.15: Case Studies in Applying the IWA WLTF Approach in the West Balkan Region: Pressure Management. In Thornton J., Sturm R. and Kunkel G. (2008) Water Loss Control, second edition. New York: McGraw-Hill.

Vagliasindi M. and Izaguirre A. K. (2007) Private Participation in Infrastructure in Europe and Central Asia - A Look at Recent Trends. World Bank’s Gridlines Note 26: 1-4.

World Bank (2009) From Stability to Performance: Local Governance and Service Delivery in Bosnia and Herzegovina. Washington, D.C.: World Bank - Sustainable Development Department Europe and Central Asia Region (ECSSD).

UTILISING INTRANET TECHNOLOGIES IN CONSTRUCTION SECTOR SMES: BUILDING UP KNOWLEDGE BASES FOR EXTREME WEATHER EVENT RISK MANAGEMENT

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Intranet technologies accessible through a web based platform are used to share and build knowledge bases in many industries. Previous research suggests that intranets are capable of providing a useful means to share, collaborate and transact information within an organization. To compete and survive successfully, business organisations are required to effectively manage various risks affecting their businesses. In the construction industry too this is increasingly becoming an important element in business planning. The ability of businesses, especially of SMEs which represent a significant portion in most economies, to manage various risks is often hindered by fragmented knowledge across a large number of businesses. As a solution, this paper argues that Intranet technologies can be used as an effective means of building and sharing knowledge and building up effective knowledge bases for risk management in SMEs, by specifically considering the risks of extreme weather events. The paper discusses and evaluates relevant literature in this regard and identifies the potential for further research to explore this concept.

KEYWORDS: EWEs, Intranets, knowledge management, SMEs.

INTRODUCTION

The world in recent years has seen a number of Extreme Weather Events (EWEs) causing large losses of life as well as significant economic losses (Easterling et al., 2000a). As a result, cumulative economic and social costs of extreme weather related events has been increasing around the globe (McBean, 2004, Tompkins, 2002). Apart from individual households, business sector also suffers economic losses due to the effects of weather extremes. Small and Medium-sized Enterprises (SMEs), which represent the majority of business establishments in any economy, suffer at a higher magnitude than their larger counterparts. This is due to their increased vulnerability to these effects (Bannock, 2005). SMEs make up more than 90% of firms in the construction industry too. Therefore improving effectiveness in SME operations by an approach that is sympathetic to their needs of managing risks is likely to benefit the construction industry to a significant extent.

It is recognised that one of the inherent weaknesses of SMEs is that they face resource limitations. Whilst this hinders the adoption of EWE risk management practices, it is also well known that the ability to manage risks due to EWEs is inconsistent and varied across the SME community at large. For instance, in terms of buildings and contents insurance, this

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inconsistency is displayed to a greater extent with a significant number of SMEs being under insured, thereby exposing their assets and becoming more vulnerable to weather extremes (AXA Insurance UK, 2008). The inconsistent SME ability to manage EWE risks was also displayed during the 2008 flooding of the Morpeth area in Northumberland, specifically with respect to flood defences. Therefore it is proposed in this paper that collaboration among SMEs within their respective communities and networks is the best way to achieve EWE resilience. Given the fact that many SMEs within their ordinary course of business tend to operate as close collaborating networks and supply chains rather than individuals, it is argued that an Intranet system will facilitate and develop their collaborative behaviour and reduce the fragmentation of knowledge. Employing an IT system will allow to bring together the valuable knowledge, with regard to EWE risk management, which is otherwise widely dispersed. At the same time as the system will be commonly accessible to the network, individual members will benefit from a better knowledge base requiring a lesser resource commitment.

The paper is organised as follows. First, it presents the background and the research problem. It then argues how Intranets are formed to facilitate more intensive collaboration. The paper, then provides the case for a collaborative Intranet approach in the context of SMEs and how EWE risk management knowledge sharing can be facilitated via an IT based system. The paper concludes by establishing the case for further research in this area.

BACKGROUND AND RESEARCH PROBLEM

EWEs such as floods, heat waves and storms are expected to increase in number and severity in future, due to the impacts of climate change (Munich Re, 2007, Stern, 2007, Environment Agency, 2005). These EWEs are capable of creating severe impacts on the society and the environment (Easterling et al., 2000b, Nicholls and Alexander, 2007). The costs of damage caused by EWEs have increased gradually over the years and are expected to further increase in the future. Based on a variety of sources Dlugolecki (2008) estimates the global annual cost of weather damage on average is to be in the range of $200–330 billion. In the United States alone, costs of disasters associated with weather is estimated to be about $23 billion per year on average (Preston, 2005). In UK, insurers have paid over £3 billion to recover from 2007 summer floods alone, whilst the full economic and social cost is likely to be many times higher (Association of British Insurers, 2007).

A major portion of economic losses associated with EWEs are created upon the business sector. However, it is difficult to present statistical evidence for this as most studies that have attempted to assess the economic consequences of weather disasters have tended to concentrate primarily on aggregate-level effects, such as community wide and regional economic losses, rather than on firm level impacts (Webb et al., 2000). Out of the consequences exerted upon the business sector, a significant portion is suffered by SMEs, which represent the majority of businesses in any economy. In fact they are said to be the most vulnerable portion of an economy to the impacts of extreme weather (Crichton, 2006). According to Bannock (2005), their vulnerability arises virtually by definition from the small scale of their human and financial resources. On the other hand, as a majority of SMEs are local in their operations and rooted in local communities (Bannock, 2005), their owners are often hit twice by EWEs; as local citizens and business owners (Runyan, 2006), making it more difficult for them to survive. Whilst the cost of EWE on an individual SME may not cause a significant impact on the local economy in terms of the earnings it generates or the number of people it employs, the collective losses on a number of small businesses may devastate a local economy (Yoshida and Deyle, 2005). These factors warrant the uptake of necessary risk management measures by SMEs, to effectively manage EWE risk. Yet, previous research suggests that many small businesses are ill prepared for recovery after a disaster (Yoshida and Deyle, 2005). Further, the EWE risk management strategies for SMEs have become important issues requiring widespread attention. Despite the presence of these issues, disaster management literature has not dealt in depth with small business response to disasters (Runyan, 2006, Alesch et al., 2001, Tierney, 1994), not to mention EWEs. There is thus an obvious case for focusing on SMEs with regard to EWE risk and its management.

Analysis of background information with regard to EWE risk management in SMEs presents an interesting research issue that could stimulate a lot of interest within the construction industry. It raises the challenge of identifying ways and means of achieving effective EWE risk management in construction sector SMEs. Given the fact that over 90% of the total number of construction companies in UK fall under the category of SMEs (Sexton and Barrett, 2003), effective risk management in SME sector is likely to improve the effectiveness of the construction sector as a whole. Improving the efficiency of SMEs is essential to establishing an industry which delivers best value and satisfaction to its customers. Yet, construction management literature has not dealt with EWE risk management in depth, especially with regard to SMEs.

The aim of this paper is to propose a collaborative approach for EWE risk management in SMEs, utilising Intranets within SME networks and supply chains. Such collaborative EWE risk management will bring together the fragmented knowledge, which could be leveraged for effective and efficient EWE risk management. In this paper we propose more in depth research in to EWE risk management through a collaborative Intranet system that brings SMEs and their supply chain partners together. Providing long term solutions for SMEs to manage the risk, in collaboration with their principal supply chain partners or relevant Business Link organisations, is an area that has not yet received adequate attention both at a micro level as well as at a policy making macro level.

INTRANET TECHNOLOGIES

Intranet technologies have been developed in many industries to share and build knowledge bases that can be accessed via a web based platform. This technology has the potential to be exploited within SME networks so that the SMEs can build up EWE risk management capability within their companies.

An intranet is an inter-connected network that uses web technologies for the sharing of information internally within an organisation. By utilising Collaborative Intranet Technologies (CITs), SMEs could share information, collaborate and transact across various technical platforms and information systems, and across functional, structural and geographical boundaries within the organization, in a user-friendly manner (Bernard, 1996; Damsgaard, and Scheepers, 2000). Since Intranets use the web as the common platform for information and knowledge sharing, it provides a simple solution to transact and exchange across SME networks and supply chains.

Intranets may be implemented centrally in organisations as corporate intranets. They can also be implemented as units (such as divisions, departments or functional groups) depending on their size (Ingirige and Sexton, 2007). Functionalities of Intranets vary between the passive publicising of up to date company information among its employees to dynamic exploitation of some of its capabilities to integrate with social networks. Through its role of locating, transferring and more efficiently using information and expertise (Offsey, 1997), Intranets are positioned as effective and efficient tools in organisational knowledge sharing and learning.

Intranets are utilised to download and upload information from / to the central databases enabling organisation wide sharing of information and knowledge (Guenther and Braun, 2001). Curry and Stancich (2000) for example describe further functions of Intranets as encouraging information sharing, information publishing and facilitating document management. Wang and Xie (2002) indicate that Intranets have the capability to perform many functions in all directions of an organisation hence capturing the supply chains. This shows how the capability and performance of Intranets could leverage better performance of SME networks, enhance links between local chambers of commerce and business links that advice SME participation and improve collaboration across SMEs and other supply chain partners for EWE risk management in the construction industry.

CASE FOR SME COLLABORATION VIA INTRANETS

Studies have shown that higher levels of cooperation and trust exist between SMEs and their principal supply chain / network partners. For instance, Gray (2006) reveals that SMEs overwhelmingly prefer their trading partners (customers, suppliers, partners in joint projects and so on) for more business-related advice and information. On the other hand, the same author further reports that most SMEs, even those that are active in several networks, still fall short of requisite knowledge or resources in complying with various commercial regulations on an individual basis. This is indicative of the genuine cause for implementing the practice of collaboration within SME networks, as this enables the transfer of advice and information among network members to share risks of business failure. Collaborations also minimise resource requirements due to the effect of synergy. Many SME networks are driven by large scale organisations that have power and compliance to direct the SMEs in the network. For instance, in the construction industry, architectural and engineering consultancy organisations are capable of applying (and to a certain extent enforce) good practice among the members of the construction supply chain. The core Intranet specification can be designed to suit these contexts, where trust and long lasting relationships have already been established.

Earlier it was pointed out that EWE risks also have a major influence on SME business failure. Resource constraints of SMEs might not allow autonomous implementation of these tasks. Under the collaborative approach, resources required for these tasks will be shared between the SMEs in the particular network, so that they can benefit from a common database or a common collaborative approach. This will require the development of a knowledge base common to the network, which will allow effective knowledge sharing for SMEs. Knowledge sharing is essential for the functioning of business networks as it influences the co-operation and outcomes that firms are able to achieve (Valkokari and Helander, 2007). Thus, utilisation of such SME networks for risk management will offer other advantages such as improved communication and co-operation. Another factor that improves collaboration via Intranets is the issue of internet security. For instance, according to Hall (2001), well secured Intranets make users aware of its existence and encourage them to use them more frequently

From a SME perspective there may be barriers that will constrain the spirit of communication and co-operation. For instance, the move to more collaborative inter-organisational relations will cause difficulties unless the appropriate competences already exist, or are developed within a culture that embraces change (Macpherson and Wilson, 2003). Thus, it is important to examine to what extent IT systems are used in SME networks, enabling them to participate in collaborative IT networks. Results of an investigation into the adoption and use of ICT in SMEs (Rae, 2006) in the West London and Thames Valley area suggests that some SMEs are already using intranets in their businesses effectively. Such practices are not common within SMEs in the construction industry. But Hassan and McCaffer (2002) studied the use of intranets in large scale construction firms and stated that their usage is becoming more frequent and that within a 10 year period it doubled. Thus, it seems that the potential of using intranets for risk management purposes exists in construction, but less likely within SMEs and networks. Therefore, it is important that one of the key tasks at policy maker level will be to engage SME network leaders / principal supply chain partners of SMEs to use Intranets, who will in turn defuse this technology within SMEs that they regularly interact with.

In addition to the competencies, the attitudes may pose an effective barrier to the efficient operation of such collaborative networks (briscoe et al., 2001). For instance, it is important to establish a higher level of trust within the SME networks if such a collaborative approach for sharing information and knowledge to be successfully implemented. This can be particularly challenging in an industry like construction, which is traditionally seen as adversarial. Davey et al (2001) have found that interacting with other groups within a non-adversarial environment and benefiting from the process allows construction SME to collaborate with each other more successfully. They further reveal that the trust and confidence generated from working together successfully also leads construction SMEs to share good practice with others from the industry, including local competitors. It thus can be seen that even though some attitudes such as trust may pose barriers to the efficient operation of collaborative networks, such barriers are also possible to be eliminated from SME networks.

THE EFFECTS OF EWE ON SMES

EWEs are capable of creating significant negative impacts on SMEs. The main risks to any business posed by EWEs are increased costs and loss of revenue (Ingirige et al., 2008, Burnham, 2006, Heliview Research, 2008). Norrington and Underwood (2008) reveal that damage to property/ stock and reduced customer visits / sales as the mostly experienced negative EWE impacts by SMEs operating in South East region of UK in the past two years. According to AXA insurance (2008) the risks of blackouts and damage to property and inventory from EWEs are increasing around the globe. Damage to business premises or contents can affect the ability of a business to survive, due to lost sales or lost production hours, and increased costs such as alternative premises, overtime etc (Association of British Insurers, 2007). Business interruptions caused by EWEs may create severe problems for SMEs since many small businesses fund their operations from weekly cash flow (Runyan, 2006).

Sussman and Freed (2008) mention that businesses face the possibility of interruption due to delays in services like electricity, water, utilities, and transport infrastructure due to extreme weather. Businesses may have to suffer due to such supply chain disruptions arising out of EWEs prevailing elsewhere, even if the business concerned is not directly affected. Businesses in some sectors like tourism, apparel and food and beverages may experience decreased demand for certain goods and services overtime due to EWEs driven by climate change such as extreme temperatures, extreme rainfall, etc. EWEs may create implications for investment, insurance and stakeholder reputation giving rise to difficulty in securing finance and obtaining insurance cover at reasonable cost (Metcalf and Jenkinson, 2005), and higher insurance premiums (Dlugolecki, 2004). SMEs may also experience other forms of crises such as loss of market share, loss of key personnel, loss of production efficiency, withdrawal of supplies, withdrawal of licences, and loss of quality/standard accreditation (Aba-Bulgu and Islam, 2007). Alone or combined with some other, these effects may critically affect the survival of a small business. In fact, Wenk (2004) reveals that 43% of businesses experiencing a disaster never reopen, and that 29% of the remaining close within two years, indicating the severity of the consequences.

Interestingly, although the effects of EWEs are negative in many obvious ways, they sometimes seem to present businesses with some opportunities as well. Such opportunities, for instance, may arise due to changing markets, customer needs and investor expectations (Firth and Colley, 2006). The collaborative Intranet approach is leveraged to investigate the fragmented knowledge in this area. For an example, high temperatures as in European heatwave in 2003 may create more demand for warm-weather food and drink products. The construction industry will also benefit from extreme weather, due to the increased need for reconstruction and more robust structures (Dlugolecki, 2004). It is agreed that disasters allow community improvements to be made rapidly, rather than gradually (Webb et al., 2000). Thus post disaster reconstruction works may create windows of economic opportunities for SMEs. In addition to these, businesses may well be able to gain competitive advantage and exploit market opportunities if they have a good risk management system in place. Burnham (2006) mention that businesses who survive a EWE may successfully experience increased customer loyalty, new customers, cost savings and additional sources of revenue. In fact, businesses can turn many of the negative consequences mentioned above in to positive ones, if they are well prepared. Hence the need for having appropriate risk management measures in place arises, not only because of the significant threats associated with EWEs, but also because of the opportunities available.

THE MOTIVATION FOR 'EWE RISK MANAGEMENT' KNOWLEDGE SHARING

SMEs usually do not consider risk management activities as a priority area within their businesses due to the perceived misalignment between the opportunity costs associated with risk management measures and potential future probability of their businesses. Further, according to Jones and Ingirige (2008) they are more likely to adopt ad-hoc responses to a certain stimuli rather than responding to the wider debate about the climate conditions and are likely to take reactive measures rather than proactive ones. A study conducted by UKCIP on SMEs suffered by 2007 flooding reveals that they have adopted various ad-hoc measures to cope up with the effects of flooding. Sharing resources with neighbours, using sand bags as a flood barrier, and relocation are some of the steps undertaken during the time of flooding, whereas obtaining insurance cover, premises improvements and internal stock relocation are some of the measures taken after experiencing the floods. However, research shows that SMEs are reluctant to utilise risk management measures even after experiencing negative impacts. A recent study by Heliview Research (2008) reveals that only two out of five companies that have experienced extreme weather or natural disaster during the last year have taken steps to protect their business from this type of risks. Thus, there seem to be many barriers which prevent the uptake of risk management measures by SMEs.

As against the many barriers preventing SMEs from uptake of measures improving EWE resilience, it will be interesting to discover what factors act as drivers for such uptake.

Perquisites for insurance seem to act as a strong driver for risk management practices in SMEs. As an example, a study carried out by UKCIP has identified that businesses previously affected by flooding are now storing their stocks two feet above the floor level, to satisfy the insurance requirements. Further, higher cost of insurance premiums and even inability to obtain insurance cover if adequate risk management measures are not in place will promote such uptake. Regulatory compliance and market forces such as customer perceptions and expectations will also act as drivers especially due to the fact that SMEs normally serve a smaller market share. If customers start to place a strong value over risk management issues, SMEs might be compelled to apply them. Especially larger businesses who have SMEs in their supply chains are capable of initiating such practices, given the fact that non-resilience of SMEs being capable of disrupting the successful operation of the larger organisation as well.

Relevant knowledge to assess and manage EWE risks is fragmented across different SMEs. Absence of a complete knowledge base limits the ability of SMEs to respond to EWEs in an optimal way. Collaboration seems to provide a solution to this and many of the barriers that SMEs face with regard to EWE risk management. Collaboration will make it possible to achieve risk management with a lesser amount of resources, since resources will be shared. Webb et al (2000) reveal that activities that are less complicated and less expensive and measures that provide protection against a range of different types of emergencies are preferred by businesses over technically difficult and more expensive and time consuming efforts. Collaboration is a possible means of making even complex and costly measures into simple and inexpensive ones. Business collaboration is a cooperation between multiple enterprises working together to achieve certain business goals (Orriens and Yang, 2005). Rosenfeld (1996) identifies collaboration as an emerging approach to industrial competitiveness among SMEs. Potential to enter in to collaborations has been rapidly improved due to the advancements in information technology in the recent past. Nowadays, IT systems are widely used in achieving organisational collaboration in business networks. Intranet technologies can be identified as a widely used IT system in business networks. They are used in many industries to share and build knowledge bases that can be accessed and shared through a web based platform.

CONCLUSION

SMEs are increasingly affected by EWEs leading to both significant negative and positive organisational consequences. This necessitates the uptake of necessary risk management measures by SMEs targeted not only at minimising the negative impacts, but also at capturing the positive ones. Yet, the adoption of risk management practices by SMEs in order to cope up with these issues seems to be in its infancy still. Scant literature available addressing these issues portrays the lack of academic attention and the need for more focused studies. As many construction sector SMEs are involved in various networks and supply chains, the paper identifies the possibility of utilising these existing networks to effectively implement the EWE risk management practices. Collaboration in SME networks with a view to performing EWE risk management seems to offer interesting research prospects. Developments in IT systems and their usage in SMEs seem to facilitate the process of collaboration in SME networks. The paper identifies the potential of using a mature technology like intranets to achieve EWE risk management practices in SME networks. Successful Intranets need an effective Intranet specification and an efficient user interface, compliant with SME user needs.

The proposed solution gives rise to many research issues which have not been addressed previously. The applicability of the proposed solution has to be investigated in a practical context with the involvement of SMEs and other stakeholders. Implementation of collaborative EWE risk management practices will require formation of a knowledge base accessible to the members of the SME communities. Specifications of the knowledge base and the intranet system will have to be established in context of the SME networks. Structure, accessibility, knowledge accumulation and sharing in the network etc give rise to innovative research opportunities. The paper lays the foundation and sets the way forward for more comprehensive studies with regard to the use of intranets in achieving collaborative EWE risk management in SME networks. As these issues have not been explored previously, there seems to be a number of research issues which need more focused attention particularly from construction industry participants.

REFERENCES

Aba-bulgu, M. & Islam, S. M. N. (2007) *Corporate crisis and risk management: Modelling, strategies and SME application,* Oxford, Elsevier Ltd.

Alesch, D. J., Holly, J. N., Mittler, e. and Nagy, R. (2001) Organizations at Risk: What happens when small businesses and not-for-profits encounter natural disasters. *Small Organizations Natural Hazards Project, First Year Technical Report, University of Wisconsin-Green Bay.* Fairfax, Public Entity Risk Institute.

Association of British Insurers (2007) *Summer floods 2007: Learning the lessons,* London, Association of British Insurers.

Axa Insurance UK (2008) *Preparing for Climate Change: A Practical Guide for Small Businesses*, London, AXA Insurance UK.

Bannock, G. (2005) The Economics and Management of Small Business: An International Perspective. *London.* Taylor & Francis Routledge.

Bernard R. (1996). *The Corporate Intranet*, John Wiley & Sons, New York.

Briscoe, G., Dainty, A. R. J. & Millett, S. (2001) Construction supply chain partnerships: skills, knowledge and attitudinal requirements. *European Journal of Purchasing & Supply Management,* 7**,** 243-255.

Burnham, C. (2006) *A Guide to Climate Change for Small- to Medium-sized Enterprises,* Ontario, The Canadian Chamber of Commerce and Pollution Probe.

Crichton, D. (2006) *Climate Change and its effects on Small Businesses in the UK*, London, AXA Insurance UK.

Curry A. and Stancich L. (2000). The intranet – an intrinsic component of strategic information management, *International journal of information management*, Vol. 20, No.4, 249 – 268

Damsgaard, J. & Scheepers, R. (2000) Managing the crises in intranet implementation: a stage model. *Information Systems Journal,* 10(2), 131-149

Davey, C. L., Lowe, D. J. & Duff, A. R. (2001) Generating opportunities for SMEs to develop partnerships and improve performance. *Building Research & Information,* 29**,** 1-11.

Dlugolecki, A. (2004) A Changing Climate for Insurance: A Summary Report for Chief Executives and Policymakers. London, Association of British Insurers.

Dlugolecki, A. (2008) Climate Change and the Insurance Sector. *The Geneva Papers,* 33**,** 71-90.

Easterling, D. R., Evans, J. L., Groisman, P. Y., Karl, T. R., Kunkel, K. E. & Ambenje, P. (2000a) Observed Variability and Trends in Extreme Climate Events: A Brief Review. *Bulletin of the American Meteorological Society,* 81**,** 417-423.

Easterling, D. R., Meehl, G. A., Parmesan, C., Changnon, S. A., Karl, T. R. & Mearns, L. O. (2000b) Climate Extremes: Observations, Modeling, and Impacts. *Science,* 289**,** 2068-2074.

Environment Agency (2005) *The climate is changing: Time to get ready,* Bristol, Environment Agency.

Firth, J. & Colley, M. (2006) *The Adaptation Tipping Point: Are UK Businesses Climate Proof?,* Oxford, Acclimatise and UKCIP.

Gray, C. (2006) e-Governance Issues in SME Networks. *IKD working paper.*

Guenther K. and Braun E. (2001). Knowledge management: benefits of intranets, *Online,* Vol. 25, No. 3, 17-22, http://www.online.com.

Hall, H. (2001), Input-friendliness: motivating knowledge sharing across intranets, Journal of Information Science, Vol. 27, No. 3, 139-146.

Hassan, T. M. & Mccaffer, R. (2002) Vision of the large scale engineering construction industry in Europe. *Automation in Construction,* 11**,** 421-437.

Heliview Research (2008) *Climate change effects,* Breda, Heliview Research.

Hvolby, H.-H. & Trienekens, J. (2002) Supply chain planning opportunities for small and medium sized companies. *Computers in Industry,* 49**,** 3-8.

Ingirige, B., Jones, K. & Proverbs, D. (2008) Investigating SME resilience and their adaptive capacities to extreme weather events: A literature review and synthesis *Proceedings of the Conference on Building Education and Research (BEAR 2008).* Kandalama, Sri Lanka.

Ingirige, B. and Sexton, M. (2007), Intranets in large construction organisations: Exploring advancements, capabilities and barriers, *ITCON Journal*, Vol. 12, pp 409 – 427

Jones, K. & Ingirige, B. (2008) Extreme Weather Events and Business Continuity Planning. *CIB W70 International Conference in Facilities Management.* Heriot Watt University, Edinburgh

Macpherson, A. & Wilson, A. (2003) Enhancing SMEs' capability: opportunities in supply chain relationships? *Journal of Small Business and Enterprise Development,* 10**,** 167-179.

Mcbean, G. (2004) Climate Change and Extreme Weather: A Basis for Action *Natural Hazards,* 31**,** 177-190.

Metcalf, G. & Jenkinson, K. (2005) *A changing climate for business,* Oxford, UK Climate Impacts Programme.

Munich Re (2007) Press release - 22 October 2007. München, Munich Re.

Narula, R. (2004) R&D collaboration by SMEs: new opportunities and limitations in the face of globalisation. *Technovation,* 24**,** 153-161.

Nicholls, N. & Alexander, L. (2007) Has the climate become more variable or extreme? Progress 1992-2006. *Progress in Physical Geography,* 31**,** 77-87.

Norrington, H. & Underwood, K. (2008) *Climate change and small businesses: How directors are responding to the challenges of climate change - Research Findings 2008,* Guildford, Climate South East.

Offsey S. (1997). Knowledge management: linking people to knowledge for bottom line results, *Journal of Knowledge Management,* Vol. 1, No. 2, 113-122.

Orriens, B. & Yang, J. (2005) Bridging the Gap between Business and IT in Service Oriented Business Collaboration. *Infolab Technical Report Series, no. 20.*

Preston, B. (2005) Global warming and extreme weather events. *Catastrophe Risk Management.*

Rae, A. (2006) Abandoned Heroes: ICT adoption and use in SMEs. WestFocus Project Team.

Rosenfeld, S. A. (1996) Does cooperation enhance competitiveness? Assessing the impacts of inter-firm collaboration. *Research Policy,* 25**,** 247-263.

Runyan, R. C. (2006) Small Business in the Face of Crisis: Identifying Barriers to Recovery from a Natural Disaster. *Journal of Contingencies and Crisis Management,* 14**,** 12-26.

Sexton, M. & Barrett, P. (2003) A literature synthesis of innovation in small construction firms: insights, ambiguities and questions. *Construction Management and Economics,* 21**,** 613-622.

Stern, N. (2007) *The Economics of Climate Change: The Stern Review,* Cambridge, Cambridge University Press.

Sussman, F. G. & Freed, J. R. (2008) Adapting to climate change: A business approach. *Markets and business strategy.* Arlington, Pew Center on Global Climate Change.

Thibault, K. M. & Brown, J. H. (2008) Impact of an extreme climatic event on community assembly. *Proceedings of the National Academy of Sciences,* 105**,** 3410-3415.

Tierney, K. J. & Dahlhamer, J. M. (1996) Business Disruption, Preparedness And Recovery: Lessons From The Northridge Earthquake. *DRC Preliminary Papers, Disaster Research Center, University of Delaware.*

Tierney, K. J. (1994) Impacts of recent disasters on businesses: The 1993 midwest floods and the 1994 northridge earthquake. *Disaster Research Center, University of Delaware.*

Tompkins, H. (2002) Climate Change and Extreme Weather Events–Is there a Connection. *Cicerone,* 3.

Valkokari, K. & Helander, N. (2007) Knowledge management in different types of strategic SME networks. *Management Research News,* 30**,** 597.

Wang, S and Xei, J. (2002), Integrating Building Management System and facilities management on the Internet, *Automation in construction*, 11(6), pp 707-715

Webb, G. R., Tierney, K. J. & Dahlhamer, J. M. (2000) Business and Disasters: Empirical Patterns and Unanswered Questions. *Natural Hazards Review,,* 1**,** 83-90.

Wenk, D. (2004) Is 'Good Enough' Storage Good Enough for Compliance? *Disaster Recovery Journal,* 17**,** 1-3.

Windrum, P. & Berranger, P. D. (2003) Factors affecting the adoption of intranets and extranets by SMEs: a UK study. *Manchester Metropolitan University Business School Working Paper Series.*

Yoshida, K. & Deyle, R. E. (2005) Determinants of Small Business Hazard Mitigation. *Natural Hazards Review,* 6**,** 1-12.

MARKETING FOR SMALL REAL ESTATE PROMOTERS IN PORTUGAL

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Presently, marketing plays an essential role in any economic organization. Marketing strategy is a key factor for economic sustainability of any company and, in fact, deserves paramount importance in their general management. Remarkably however, most marketing international literature hardly addresses the construction industry as such and a small number of references may be found for real-estate marketing as well. This status does not happen incidentally, of course. Marketing viewed at the strategic level is a difficult issue in the construction and real estate sectors for a number of reasons, most effort being devoted to advertising only. Actually, strategy as a whole raises a set of questions in the above sectors, chiefly because of their links to the global economy and because of the specific nature of their markets in most countries. Small companies are by far the largest number in those sectors and a myriad of small markets may be in fact identified from a set of viewpoints. These may be geographic, field, product, etc. This paper reports a research project undertaken in Portugal where a set of selected small real estate promoters were inquired on their marketing approach. The objective was to develop the contents of a marketing plan for companies of that type, therefore contributing for enhancing their role in the submarkets they aim.

KEYWORDS: marketing, real estate promoters, construction companies, company strategy

AIMS

Real estate has experienced sustainable growth in the last few decades in Portugal (and in many other European countries, as well). However, after 2003, market forces have been changing and the number of unsold houses has significantly risen[1], the construction of new houses has dramatically decreased and property selling prices have fallen [1]. Consequently, real estate promoters have recorded lower selling and smaller profits. This led to decreasing employment in the building industry and in real estate related activities.

The evolution of the above indicators shows both the effects of demand decrease (mainly for exogenous reasons) and the effects of market saturation (that may either affect all market segments or only some traditional housing segments for which most building effort has been directed in the last few years in this country). Accordingly, keeping a satisfactory level of return (or bare survival) will imply new marketing strategies for real estate promoters that

[1] The number of licensed buildings by local authorities and concluded buildings in Portugal had a negative annual variation of 8,1% and 10,2% respectively [1].

may help them to cope with the saturated, highly competitive, extremely demanding and ever changing housing market of tomorrow.

While operating in a saturated market, strategies based on intensive production may reveal inefficient; adopting sound marketing dictated strategies may be a valuable option under these circumstances. Actually, the added value of marketing based strategies in other economic activities has been helping companies to realise the importance of leaving production oriented options and adopting market oriented strategies, or, in other words, to stop performing under pull logic and adhere to a push based operating policy [2]. There are a few well known simple rules (and obvious, at a certain point) that are usually reputed efficient for achieving success in the real estate activity: by increasing building quality, by enhancing the service, by decreasing the selling price, by assuring relevance in the market (and leadership), by adopting customization policies, by introducing innovation, by exceeding the client expectations, and so forth. However, these rules have both strong and weak points and may not conduct to consistent success: The right strategy must chiefly take into consideration the market needs. The use of marketing models in other sectors going through similar problems has revealed successful; therefore there are reasons to believe that they may also help understand the real estate market and gauge the most adequate strategy. The research project reported in this paper emerged from the above assumption. The research question was put as follows:

"May a sound marketing approach add value for real estate promoter in the present market scene?"

Answering the above question, involved going through the following more detailed issues:

> How well Portuguese real estate promoters are aware of marketing? Do they have a formal marketing structure in their organizations? What tools and methods are used and who caters for their implementation?
>
> What methodology (marketing plan) should a real estate promoter follow in order to detect and benefit from the best market opportunities?

This paper reports the methodology followed in the project for answering the above questions

METHODOLOGY

In order to answer the research questions raised above, a descriptive and qualitative approach has been adopted. According to Bodgan & Biklen (1994), this may be considered an exploratory study using an intentional and non probabilistic sample. It is based on an inquiry administered to a set of selected real estate promoters, aiming at evaluating their knowledge and the level of use of marketing tools.

TARGET POPULATION AND SAMPLE

The target population of this study are the real estate promoting companies of medium and small size (turnover from five to fifteen million euros per year) mainly operating in the housing segment in the north of Portugal. Out of this population, a sample of two companies from each district of Braga, Viana do Castelo and Porto has been selected. All selected companies display similar selling profile, operate in the same business area, and are willing to stay competitively and profitably in the market - they all had positive results in the last three fiscal years and they all have good reputation in their operating area. Many other factors are quite different, for example: their operating range (regional, northern area or country wide), their administrative and commercial structure, standing alone or within a larger real estate group and so on. This makes the sample more heterogeneous and potentially capable of detecting successful strategies for diverse company types[2].

DATA COLLECTION AND ANALYSIS

Data collection has been done through personal interviews to each company's general manager or chief executive officer and was based on a specific questionnaire. This option was preferred to collecting previously written answers to the questionnaire because there was the risk of not getting the views of the right persons and obtaining narrower replies. The questionnaire was built up according to the guidelines suggested by Kotler [3] for marketing auditing. The inquiry addressed the following areas: Environmental diagnosis; Market analysis; Clients; Marketing approach; Marketing mix policies.

Data analysis has been performed for each company surveyed covering the following issues:

- Market analysis: the company's view about the present and the future market situation; consistent practices of segmentation, positioning and brand.

- Clients: project development according to client needs; systematic policies for better knowing and influencing purchasing decision makers; policies for managing the company's image.

- Competition: regular monitoring of the main market competitors.

- Environmental assessment: procedures for environmental analysis; recognition of critical success factors.

- Existing marketing structure: formal marketing department within the company's organization; main functions of this department; marketing plan; business plan and links to the marketing plan; policies for setting up and controlling objectives.

- Marketing mix policies - product: procedures for analysing opportunities; follow up procedures for the company's plot portfolio; procedures for implementing the requirements of target clients in ongoing or future projects; quality assurance systems; consistent innovation policy; multidisciplinary teams for project definition, including the role of the target client.

- Marketing mix policies - price: criteria for establishing selling prices taking into account the affordability of the client segment

- Marketing mix policies - distribution: selling channels used and their efficacy; efficiency of vendors to pass on the product key attributes to the target clients

[2] See Annex 1: Characteristics of participating companies

- Marketing mix policies - communication: procedures used in each project and emphasis on the key attributes for the target client; communication actions used and selecting criteria.

Additional relevant information collected during the interviews was also recorded. This may be about good practices that increased the performance of the company surveyed or may relate to opportunities or threads faced by the company. In both cases, it revealed useful.

From the above information, interesting conclusions could be made about the companies' marketing knowledge, namely: the use of specific tools, the clarification of their strengths and the detection of opportunities for increasing their marketing performance.

RESULTS FROM THE INQUIRY: ANSWERS AND ANALYSIS

Answers to the questionnaire

Table 1 shows the strengths and the weaknesses detected in the inquiry. These are further classified according to their scope: general, if they are generally applicable to all companies surveyed or specific to the company where they were found (in this case they only reflect good or bad practices of that company and are not relevant to the study). The table presents results according to the assessment of the authors on the adequacy of concepts strategies and tolls scrutinized in the course of the interviews.

Table 1 - Strengths and Weaknesses

		Strengths			Weaknesses			Indicators		
Marketing areas		Gen	Spec	Tot	Gen	Spec	Tot	Gen	Spec	Tot
Market analysis		3	0	3	5	1	6	8	1	9
Clients		1	2	3	2	1	3	3	2	5
Competition		0	0	0	1	0	1	1	0	1
Environment		1	0	1	2	0	2	3	0	3
Marketing structure		0	3	3	4	0	4	4	3	7
Marketing mix	Product	2	1	3	8	0	8	10	1	11
	Price	2	0	2	0	0	0	2	0	2
	Communication	1	1	2	1	1	1	2	2	4
	Distribution	0	1	1	3	0	3	3	1	4
Sub-Total		10	8	18	26	3	29	36	11	47

Data collected revealed 62% (29/47) of weak indicators when compared to the total indicators surveyed or 72% (26/36) of general weaknesses when compared to the total general indicators considered.

Analysis of results

1. Market analysis: Looking deeper into this area, it may be concluded that promoters surveyed do not use opportunity detection practices, mainly focusing on threats. Additionally, some promoters do not conduct their marketing policies in the scope of a market

segmentation approach; others may perform marketing segmentation but do not identify target clients / market-segment which makes it inefficient. Finally, they barely promote their brand. In terms of market positioning, the promoters surveyed rely on the recognition of their good work from local clients.

2. Clients: No practices were found for detecting the requirements of target-clients; those of former clients are frequently adopted. Methods for influencing buying decisions were found in one promoter only. Managing the brand's image is not a major concern.

3. Competition: Lack of analysis of competitors was reported therefore preventing the identification of opportunities and threads.

4. When analysing the environment, promoters evidenced unawareness and lack of practice, especially in the long run. All companies surveyed agreed on the importance of key success factors but they could hardly associate them to the market segment they aim.

5. For the promoters surveyed where a marketing structure exists, it is incipient and mostly oriented to small communication actions (booklets, outdoors), and seldom in the scope of a sound communication policy. Marketing activities scarcely involve the organization structure, they are not adequately planned or budgeted and objectives are neither specified nor controlled (only one promoter does it). No marketing departments could be found; although marketing activities may be distributed through the organization with similar efficiency, this could not be found in promoters surveyed, either.

6. As for marketing mix strategies at the product level it could be concluded that promoters surveyed do not evidence sound practices for detecting investment opportunities. All of them considered the relevance of having a stock of plots for future developments. Plots were mostly selected considering the preferences of past clients and the economic conditions at the time they were purchased, because the preferences of forthcoming clients had not been surveyed and future economic conditions had not been anticipated. Promoters surveyed do not use a number of tools currently reported in the literature for project development (such as value analysis and quality certification systems), and project innovation is mostly focused in new materials coming out in the market, therefore they cannot be proclaimed distinctive of any specific promoter. Projects are developed prior to listening to the client's voice - that should define project requirements for the target market segments. There is risk that the project fails to meet clients' expectations (the product may unfit demand or unfit the best possible demand). At the price level, it may be concluded that all promoters surveyed currently use sound approaches for setting up the selling prices of their products. At the distribution level, all promoters surveyed prefer to use their own selling channels. However the selling staff tend to deal with other issues beyond sales (like administrative processes and paper work) and place smaller effort than they possibly should in important marketing areas (like detecting new clients, surveying new market segments and new business areas, exploring client needs, and so on). Finally, at the communication level, it was noticed that communication actions would greatly benefit from a global marketing strategy; otherwise they may be inappropriate and slightly efficient.

CONCLUSIONS

Following the results obtained from the inquiry, it may be concluded that promoters surveyed:

Scarcely use marketing strategies or tools in their current activity; they use communication tools but promptly and inefficiently and not regulated by a sound communication policy.

Do not have formal marketing structures in their organizations; marketing activities are not widespread through them.

Follow a production based strategy not a market based strategy - build and hope to sale.

Evidence lack of knowledge of marketing concepts in view of their vague answers to the inquiry; this may justify the poor diffusion of marketing tolls in their current activities.

REFERENCES

[1] INE – Construção: Obras Licenciadas e Concluídas 2º Trimestre de 2007.

[2] Kotler, P. (1994). Marketing Management: Analysis, Planning, Implementation, and Control. Prentice – Hall, Inc.

[3] Kotler, Philip. and Keller, Kevin. (2006). Marketing Management (13th edition), Pearson Education International, pp. 698 - 701

ANNEXES

Annex 1: Main Characteristics of Promoting Companies Surveyed

Companies	Scope of Action	Sales 2007 (€)	Organization Structure
		Pilot Study	
P1	Regional	5 000 0000	Administrative, Commercial
		Main Study	
B1	North of the Country	6 000 000	Within international group
B2	Regional	10 000 000	Vertical (construction and real estate)
V1	Regional and International	7 500 000	Within national group

Annex 2: Inquiry: Real Estate Marketing

1. Markets:

1.1. What views on the recent evolution of the real estate market and forecast for the next 3/5 years?

1.2. What segmentation policies used and what mechanisms adopted?

1.3. Positioning in the target market segment?

1.4. Brand policy adopted?

2. Clients

2.1. Are new projects conducted according to the requirements and needs of the target clients? How are they detected - having in mind that conditions through the project life-cycle must be analysed (2 to 4 years)?

2.2. Are buying decision makers known and their likely decisions anticipated? What does the company do for influencing them?

2.3. What perception and image do clients have of the company? How is image managed?

3. Competition

3.1. Does the company systematically follow the evolution of its competitors? What mechanisms or rules does it use and what relevant information can be extracted from that process?

4. Environment analysis

4.1. What are the relevant demographical, economical, technological, political and environmental issues that may affect the activities of the company? Is it possible to assess opportunities and threats from the analysis of the above issues?

4.2. What are the critical success factors in the real market sector' Why? Have they changed in the last few years?

5. Marketing Structure

5.1. Are marketing activities concentrated in a formal company department or are they informally distributed throughout the organization? What are the expectations raised by the marketing activities?

5.2. Does the company perform an annual marketing plan? What are the main activities and who is responsible for designing, implementing and controlling it?

5.3. Does the company make an annual budget and a long run budget for marketing? Do they come out of the marketing plans?

5.4. Are annual operational objectives (sales objectives) currently established?

5.5. Does the company implement controlling procedures (each month or trimester) for assuring the achievement of its objectives?

6. Marketing Mix

6.1 Product

6.1.1. How are detected the investment opportunities in a given market segment or location? How does it work, taking in consideration that Sales will only take place in 2 or 3 years time?

6.1.2. What is the policy and what are the criteria for constituting a spot stock? Is it relevant for success?

6.1.3. What are the procedures or tools enabling the transposition of target segment requirements to each specific project?

6.1.4. Is it used any national or international system for quality assessment of projects promoted by the company? Which system? If not, would it be interesting to have one? Would it enable better communication with clients?

6.1.5. Does the company follow any innovation policy? How? Is innovation risky in the real estate business (introducing new materials, building techniques, site plant or design style)? Is there any procedure for controlling such risks?

6.1.6. Are projects designed by a single entity or by a multidisciplinary team? Who participates in the team and what are the functions of each participant?

6.2. Price

6.2.1. What are the criteria followed for setting up prices? Are prices defined at the design phase?

6.3. Communication

6.3.1. Does each project possess a communication policy? Does it highlight the attributes required by the market segment targeted by the project – for example, innovation, status, location, eco-efficiency, price accessibility, safety, public transportation, proximity of schools, hospitals?

6.3.2. What are the typical communication and promotion actions used by the company? What are the selection criteria for them?

6.3. Distribution

6.3.1. What are the most important selling channels for each market segment targeted by the company? What functions are assigned to each of them?

6.3.2. Do sales people (either internal staff or outsourced companies) efficiently convey the appropriate selling messages of each project (key project attributes for the target client) according to the market segment concerned: quality, associated services, innovation, pricing policy?

6.3.3 Is there any training policy established for vendors (that takes into consideration different key attributes for different market segments and different projects)?

SMALL AND LOCAL UNTIL IT HURTS?

ARCHITECTS AND ENGINEERS DEVELOPMENT IN A PROFESSIONAL KNOWLEDGE INDUSTRY

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Micro, Small and Mediumsize enterprises are important in European Economy, both in terms of employment and innovation. Equally these firms are assigned an important role in the Architectural, Engineering and Construction industry (AEC). This article reports research made amongst small professional knowledge service AEC-companies in the region of Central Denmark. The aim of the paper is to analyse how SMEs is managed, is innovating, using ICT and their response to the financial crisis.

Drawing on management studies, professional knowledge service is viewed as something precariously constructed through interacting with customers. An extensive desk study and two interviews are used to investigate the local AEC-companies, focusing on two micro firms. There is considerable growth among knowledge service companies in the region. The analysis shows that microfirms are indeed distinct, innovation for example occurs in a complex interplay with limited internal efforts and external networking. And still as a relatively local phenomenon. Even if the financial crisis has considerably impact of the AEC-sector in 2008-9, the microfirms investigated still haven't been impacted and the pain of local embeddedness is still to come.

KEYWORDS: professional service, SME, AEC, financial crisis.

INTRODUCTION

Architectural and Engineering consulting services are frequently claimed to be part of the drivers of future economy as they belong the growing segment of knowledge intensive professional services (OECD 2006). Similarly micro, small and mediumsize enterprises are important in European and global economy, both in terms of employment and innovation (EU 2006). And these firms are assigned an important role in the Architectural, Engineering and Construction industry (AEC, Lu et al 2008). This paper reports the preliminary results of an ongoing research made amongst small professional knowledge service AEC-companies in a peripheral region of Central Denmark. These enterprises size varies between micro, small and medium size according to the EU-definition (EU 2006). The aim of the paper is to analyse how these SMEs are managed, how they innovate and how they respond to the financial crisis.

CONSULTING ENGINEERING AND ARCHITECTS– A SPECIAL SUBSET OF PROFESSIONAL SERVICES

Consulting engineering and architects companies operate as service providers for customers, predominantly owners of the coming building. Sometimes the cooperation with clients is direct, sometimes indirect through partners or consortia. Consulting engineering and architects is, therefore, a part of a broader business service sector (Løwendahl, 2005; Larsen, 2001), which can be regarded as knowledge intensive (Alvesson, 1995, Sturdy, 1997; Clark and Fincham, 2002). The term 'professional service firm' is usually used to encompass organisations such as accounting firms, lawyers, architects, engineering management consulting firms, advertising agencies and investment banks (Löwendahl 2005). According to Clifford Change Centre (2008) this definition, means that "a professional service firm is any organisation that uses the specialist technical knowledge of its personnel to deliver customised expert services to client organizations". The Clifford Change Centre definitions reveal that delivering services based on technical expertise is not confined to the engineering consultancies alone as one might think. It leads to a further conceptualization of the technical as systematic concepts for means-ends relations and into an insisting of the sociotechnical character of both service processes and deliveries. The engineering consultancies does focus on engineering, that is an abstract representation of the technical, delivered in drawing and documents. However the practice portfolio, to use Anand et al. (2007)-s concept, is quite a lot broader and encompasses process consultancy, project management, clients consulting apart from technical calculation etc. And the architectural services also encompass an element of expertise, technical if you like, but at least knowledgeable, within design. Consulting Engineering and Architects are thus as the rest of the professional service sector characterized by a mutual interdependency between clients and service providers in the very process of realizing the knowledge-intensive products. This feature paves the way for project organization as a tool for aligning internal and external processes (Suchman, 2003). The existence of strong and ongoing relations to customers implies that competition incomplete and restricted by network relations and a lack of comparable products (e.g. newly and uniquely specified features of the product).

As with the rest of the professional service sector, consulting engineering and architects companies core competencies can be described as multidisciplinary (Løwendahl 2005). Consulting Engineering comprise engineering, project management, construction management, structural engineering, HVAC, electrical, mechanical, environment and energy engineering (STD, 2004). Whereas architects can be said to encompass overall design and detailed design, sketching, 3D-conceptualisation, project management, clients consulting, and general management (KK 2009) These competencies are 'carried' by local cultures of professions developed in interaction with national, institutionalized professions. In a construction sector perspective one would usually underline the differences between architects and consulting engineers, whereas the professional knowledge service perspective adopted here underlines the similarities between the two and also their similarities with other professional knowledge service companies such as It-consultancy and auditing firms. As organizations, many professional service providers are characterized by a strong project orientation. Roughly speaking, a project is typically viewed as an temporary organization of resources and tasks relating to a more or less 'one-of-a-kind' product (Dunford, 2000, Hobday, 2000). Project teams in AEC are typically multidisciplinary, and interorganisational. The orchestration and integration of the different engineering and architectural competencies is required to produce the demanded services. Cross-disciplinary cooperation is not a straightforward endeavour and it is putting pressure on the organization's productivity

(Newell et al., 2002).

Management in professional services (SME)

Smets et al (2008) argue that most professional service firms (PSFs) cannot build competitive advantage on their expertise alone, but need a set of four interrelated resources; expertise, service,
reputation and relationship. Smets et al (2008:6) propose to think of expertise as consisting of technical knowledge, knowhow and experience. Technical knowledge is related to content management concepts, legal norms, or physical laws. ”Know how” is procedural knowledge, including communication and negotiation skills. Experience is according to Smets et al, related to relational and symbolic interaction with the customer, who wish to engage with a competent person, who understand the client situation. *Service* is understood as a strongly relational value. The interaction between the professional consultant and the client is very important when expertise is to be transformed into value for the customer. According to Smets et al. *reputation* is a signal of competence for the professional service firm. Their client would appreciate previous clients' quality assessments as they appear in the firm's reputation, reflecting word of mouth, a successful track-record and other appearances in the marketplace (Smets et al 2008).Although *relationship* often have to be built in single project contacts, repeat custom with longstanding clients enables trustful relationships; in turn, the experience and deep client knowledge gained from relationships provides opportunities for refreshing or developing expertise (i.e innovation).

Innovation in professional services (SME)

In their extensive study of innovation in professional services Anand et al (2007) views innovation as creation of new practices with a knowledge content (drawing on a community of practice perspective) Anand et al point at four types of innovation triggers: Socialised agency, differentiated expertise, defensible turf, and organisational support. Anand et al argue, from their management consultant context of professional services that individual employees in professional service providers typically undergo strong professional socialization as their careers progress, and this process internalizes how they express initiative within a firm, such as entrepreneurial behaviour (Anand et al 2007:411). Thus in their analysis socialised agency leads to innovation. Numerous authors have described how in the course of management fashions, management consultants need to differentiate themselves from their competitors. Anand et al. finds this differentiation related to the extension of existing frameworks through ongoing knowledge development in consulting firms as well as employment of new knowledge. As consultants encounter novel or divergent client demands, they improvise by extending existing tools and frameworks. Anand et al (2007:412)-s informants talked about how they modified “principles,” methodologies,” “processes,” and “frameworks” in the course of their work. Anand et al –s third trigger “defensible turf” indicates the utility in the client marketplace of a new practice. This involves the need to remove obstacles to the acceptance of a new practice area, the use of “client power”, which mitigates concerns that other members of the organisation might have about the new practice area lacking financial viability (Anand et al 2007:414). The fourth trigger organizational support concerns resources, personnel, training and political sponsorship. Sponsorship also involves well-connected partners who can provide introductions or referrals to regular clients (Anand et al 2007:415).

It derives that focusing on innovation in professional services overlap with the above discussed elements of excellency in performance (Smets et al). This goes especially for socialized agency and differentiated expertise, which lies close to Smets et al. discussion of expertise and service. Also Smets include innovation in their understanding of a well performing professional service company.

METHOD

This paper investigates micro, small and medium enterprises, providing two cases of micro firms. The paper uses mainly an interpretive frame but use nevertheless a mixed methods approach (Bryman and Bell, 2007). The ongoing study focuses on understanding how these companies are organizing and planning their activities in a time of crisis. At the present time, most of the empirical material comes from a desk study, supplemented with open interviews made with two companies.

The desk study draws on a number of sources in the analyses of architects and consulting engineering, notably material from trade associations, such as Danske Ark (association of Danish architect employers), DI Videnrådgivere and Foreningen for rådgivende ingeniørers (association of Danish Consulting Engineers. Dansk Byggeri, the association of Contractors and recent competence analyses carried out by architects education units (Danske Ark 2007, 2009, DI Videnrådgiverne 2009, KK 2009, AAA 2006). Such material is limited by its interest in members and its relation to institutional politics, yet it represents new and practically oriented knowledge. Moreover demographic information is drawn from various sources. In addition, articles published in AEC related journals as well as daily press were also consulted. In order to give a more general impression of the development of the industry, their representation in the studied area as well as the consequences of the financial crisis, the paper thus encompasses statistic data which complements the qualitative analysis. These data come from public documents such as publications from the mentioned trade associations and Denmark statistics. These statistic addresses generally the region and do not differentiate between big city and smaller town or countryside. This is a limitation when trying to identify specificities link to spatial dispersion. The two case companies were picked stochastically from a sample of 8 micro enterprises listed by professional associations, communes' web pages and phone directory. 2 interviews were carried during the spring 2009 with directors and managers of 2 architectural companies , both micro companies with less than 10 employees (EU 2006).The first is a 8 man company the second a single man company (denoted the "first case enterprise" and the "second case enterprise" below). 6 other micro (one man) companies in the area was also contacted. The interview were planned to be exploratory using a very broad set of five topics; market, management, innovation, IT, network and crisis response. The interviews lasted about half an hour and were documented through hand written notes. More interviews are planned. It is a limitation of the present paper, which the research project aims at covering both architects and consulting engineers companies. However the case studies concerning consulting engineers have not been finalized yet. The case study section presents therefore the desk research result and two case architects companies. Moreover the method adopted here prohibits us to investigate the symbolic and interactional aspect of delivering architectural services, and this will be included in later research.The unit of demographic analysis the central Denmark region, and the town/municipality of Herning was picked dues to closeness to the university enabling the combination of quantitative and qualitative field studies as well as using grey material. The latter were needed to evaluate the crisis "response" developed in the spring of 2009. As the field study developed it became clear that certain large companies, especially the engineering consultancy companies were not too eager to announce the employment impact of the crisis. Here local newspaper coverage, other sources, and direct informal contacts enable the analysis.

ARCHITECTS AND CONSULTING ENGINEERS IN CENTRAL DENMARK REGION

The central Denmark Region is one out of 8 units in the country and encompasses 22% of the population and, it covers geographically the mid Jutland and west Denmark. The region encompasses 19 municipalities with a total population of 1, 2 million inhabitants The largest city in the region is Aarhus with a total of 300 000 inhabitants, Herning occupies the fourth place with 46.000 inhabitants in the town and 85.000 in the municipality. Århus, the largest city in the region is roughly 80 kilometers away from Herning, whereas Silkeborg is 40 km away.A cluster/industrial district of architectural companies and consulting engineering in the city of Århus also supported by the presence of an architect's school and an engineering polytechnics with building curricula. Large architect's companies of this cluster encompass Arkitema, C.F. Møller, Schmidt Hammer & Lassen and 3XN, the four largest Danish architect companies (STD 2008). Those have their headquarters in Århus and also are recognised actors on the international market (STD 2008). These companies are also present in Copenhagen some 300 km away from Herning. The largest local (in Herning) architect company is Aarstiderne with some 130 employees. Similarly the six largest Consulting Enginers are present in Århus, but also in Herning. In Århus there are large departments of COWI, Rambøll, Niras, Alectia, Grontmij Carl Bro, Orbicon (STD 2008). The headquarters of these consulting engineering companies are located outside Århus and the region. The largest local consulting engineering company (in Herning) is Midtconsult with some 150 employees.

Professional knowledge services in the region

A recent investigation of professional services in the region was carried out by a consultancy company(Damvad 2008). Damvad defines knowledge services as encompassing three subsectors; IT-consultancy, consulting and creative businesses (including engineers and architects) and financial services. According to Damvad (2008) there is about 7.700 enterprises within professional knowledge service employing 33.000 in the Region of Central Denmark. The area has experienced a growth in employment of 18%, a growth in turnover per employee at 34,5 % and 27% in the number of enterprises between 2000 and 2006. The area still represents 7% of total employment of the region however. The mentioned growth can be compared to the shrinking sectors of manufacturing and primary sector industries. Despite the remarkable growth in professional knowledge services in the region, only 49 % of the employees are benefiting from a longer term educations and the companies still do little export (Damvad 2008). These features distinguish the professional knowledge services from those in the capital area of Copenhagen (Damvad 2008).

Management of SME/AEC

The management competences are well studied among the architects(KK 2009, Danske Ark 2007, AAA 2006) These studies all claim that architect companies are "undermanaged" since a host of competences are lacking. Danske Ark (2007) is a study about competences among architects companies investigating a gap between the actual competences of these companies and the competences they wish to have. The study indicates that there is a recognized lack of competences for managers and collaborators within area such a strategic development, personal management, business know how, resource management, project management, legislation, environmental friendly projects and digitalization/ 3D and sketching. When mentioning digitalization, one should remember that the studied population covers all active generations. The study also estimates that managers and employees have to be better at speaking English, build networks and cooperate across cultures and disciplines. Architect companies, following Danske Ark, face in the future challenges regarding globalization, technology development, milieu and professionalization of business development (Danske Ark: 2007). More specifically focusing on the expected competences among new trained architects, a study led by AAA interrogating employers, points at the following weaknesses among youngster: innovation and business know how, planning and management of projects, written communication and cross discipline collaboration. On a more personal level, the employers expect that their employees are willing to take responsibility, are able to work autonomously and have a good portfolio (AAA: 2007). The pattern is assumed to be the same by the consulting engineers, an issue to be further studied however. In the *first case enterprise*, with eight employees, the three partners have shared the market areas between them and they each stay in their own area by large tasks. They don't do marketing, but networking and "the tasks are out there". This atelier has three types of customers, building societies, municipalities and the private sector. The two first customer groups are 75-80% of all jobs. They use a lot to participate in tenders. This takes resources. Main market area is Ikast, secondly Herning. In the *second case enterprise*, with a single owner and manager, the personal discipline was mentioned as the main challenge. This company designs villas and bungalows, including smaller refurbishments and enlargements.

Innovation in SME/AEC

According to Damvad (2008) 55% of the consultants in the region develops process or product innovation. The enterprises cooperate with clients and suppliers, but also internally. Institutional actors, applied science units or universities are however remote from the innovation activities. *The first case enterprise* follow the development within sustainability, new building regulations, their customers trust them in knowing about the new rules. The company has tried to develop new building logistics, using prefabrication, site management. There is a need to develop new solutions as their clients are providing to narrow budgets for the various contracting areas. The company haven't tried partnering or lean construction as those "authorized" innovations was interpreted to be unfit to their particular market. *The second case enterprise* gets its inspiration from following other designs of villas, including former colleagues. When designing full villas, the owner operates with a broad set of design concepts, such as cubic main form, use of bended zink roof. These ideas are developed in prolongation of clients talks, but is not a response to explicit clients demands. In this sense the innovation is developed as a mixture of networking, client interaction and internal work.

Networks

Smestrup (2008) shows in her study that SME of the AEC sector in Denmark benefits from their collaborative links with other companies in the sector. The relations are according to Smestrup long term and strongly personalized. *The first case enterprise* uses their contacts with the large companies in Århus. As they are operating in a market with public tenders they need to be able to generate bids on a competitive basis, which requires strong networking. The links to the two main customers are moreover of long term character and creates a turf which is defensible. *The second case enterprise:* network from previous employments, word of mouth (through demonstration effect of realized houses in the area. Uses local contractors, often selected by the client.

Technology in SME/AEC

The ICT use in the construction sector has been rigourously promoted by a large government program (Koch & Haugen). For small enterprises the relationship with other firms are important, making ICT a relationship management tool (Ritchie & Blindley 2005). There are many tools developed trough information and internet possibilities, here are reviewed: the development of the company own website, the use of project web, the use of 3D models. Also common IT applications tools such as e-mail or CAD are used. Technology in SMEs is seen as a central tool for marketing, being visible and connect to customers (Weill and Vitale 2001) Contradictory to the researchers' expectations, the use of internet facilities is not seen as central for the respondents. The desk study reveals that 6 out of the 8 companies do not have a website; this occurs not only for micro enterprises but also for small ones. For example, for the manager of the first case enterprise, "internet as a marketing tool is not needed as the company does not market itself but networks since the tasks are out there". They participate in tenders and use their own relations to find new projects. Actually doing marketing as such is not part of their future development strategy. The *first case company* characterize its use of IT as "mainstream" .They consider IT is a tool. The company is in spring 2009 for the first time involved in a project using project web, and they haven't yet tried to exchange 3D-models. Also the company have an extensive website in contrast to 6-8 other small architect companies in the area. In *the second case enterprise* the owner does the design in the classical way, but uses the PC to store and handle various other documents. The company has a webpage under construction (in contrast to 6-8 other one man companies in the area). The webpage have however not given the company any customers

SME/AEC and the crisis

The architect companies in Denmark experienced a setback in employment at 11 % from may 2008 to December 2008 (Danske Ark 2009). The forecast for the spring was a further 8% down a total setback of 18% from may 2008 to april 2009. This set back are more serious in West Denmark (including the region studied), and more serious for companies with a turnover above 10 million Dkr. (1.43 mill. Euro). Among the micro companies 35,6 % expect unchanged employment, whereas 52,1% expect to have redundancies. Among the larger companies (more than 2 mill. In turnover) 85% expect redundancies. Similarly the 40% of the consulting engineers experience a decline in orders, whereas 45 % experience a unchanged orderportfolio (Videnrådgiverne 2009). It is especially the private market, which is shrinking. The consulting engineers forecast further shrinking of the market for around 40% of their members (Videnrådgiverne 2009). Nationally as well as in the region there has been redundancies among the large companies, although the consulting engineering companies do not publicly announce them. In the region a number of the big architect companies have announced redundancies. This goes for 3XN, C.F. Møller, Schmidt Hammer & Lassen, Arkitema and Aarstiderne (Børsen 2008, TV2 Finans 2009). The latter which also operate in Herning announced a 20 person redundancy by December 2008 (Børsen 2008). One architectural company is the area went bankrupt in January 2009 "Arkitektpartner Skjern og Ikast" (8 employees).There is presently a number of large scale building projects under construction. This includes Queens Corner (4500 squaremeters office building), A building for Onkology at the regional hospital unit (5500 sq.m.). A new art museum, "HEART", a multipurpose highrise including a hotel, swimmingpools (9200 sq.m), apartments, business facilities, underground parking, called DGI-parken (a total of 30.000 sq.m.) and a new Multiarena (12.000 spectators). Further smaller projects includes an extension of a shopping center, a new high school, a new public school (7.500 sq.m.) and a major renovation of a elderly home (12.000 sq.m including ca. 6100 m² new buildings and ca. 6000 m² renovation of existing buildings). Such project attracts companies from outside Herning and outside the region such as Henning Larsen Architects, Grontmij Carl Bro, Rambøll, KHR architects. As many of these projects are under construction this impressive activity is less informative when it comes to evaluating future possibilities for the smaller players. The present activities can thus be seen as the last remaining effects of the high turn of the economy. Additionally it can be mentioned that a large local property development and infrastructure project, Futopia, which first phase was evaluated to be between 1,2-1,5 billion DKr, was put on hold in may 2009 as the private developer went bankrupt (Aktivgruppen/Olicom 2009).

For *the first case enterprise* it appears that the crisis has taken the top of market, halting the "fabulous golden projects" and affecting predominantly the larger AEC companies, such as those in the Århus area. Whereas on the company's market, "Most jobs have to be made anyway" (interview partner/owner). The main market areas are the local public sector and the building societies and the company also work with renovation tasks. The company did loos some private jobs however. The company thus does not feel the consequences of the crisis yet. But they experience new recruitment possibilities. Previously the known companies in Aarhus, harvested all the freshly educated architects, making it difficult for the local companies to recruit. Since the beginning of this year though, they have started to receive spontaneous proposals. The current government subsidies, supporting renovation of family villas is without impact on their business. As their situation is not critical, the company does not feel a sense of urgency in creating new strategies. They have thus not considered starting doing marketing. In the *second case enterprise* the owner evaluates that the crisis has not been impacting on business. 2008 gave three "full" house design projects and some smaller projects which is a sufficient portfolio. It should be noted that a sufficient turnover for this one man company lies at a sum below the average yearly wage on an architect (according to Arkitektforbundet 2006 60.000 Euro). Although the architect is cooperating with local crafts-contractors, the current government subsidy is without impact on the business. As the situation is not critical, the company does not feel a sense of urgency in creating new strategies.

DISCUSSION

Using the proposed important dimensions by Smets et al (2008) and Anand et al (2007) the following discussion focuses on differentiated expertise and innovative services, defensible turf and also include a discussion on management and use of ICT. Finally these dimensions are brought into the context of the present crisis.

When evaluating the differentiation of expertise, it can be noted that as the companies operate in a location of a relatively small town and also argue that "nothing is too small and nothing is too big" as order, one might expect huge overlaps in competences and market areas. It appears however that the architect enterprises have specialized even within the area of Herning. The one enterprise focuses on building societies and public tasks, whereas the other focuses on villas for families. Compared to the large players in the area; Arkitec and Aarstiderne, one can note that Arkitec have one focus on business buildings and the first case enterprise, Arkitec and Aarstiderne would all participate in the public tenders for buildings for the municipality. The microfirms have thus successfully focuses and bounded an area of expertise. In direct prolongation of this the creation of innovation derives from these focused areas of expertise. Finally they constitute a defensible turf on the small local market. The marker is however not bounded in the sense that the one company are dependent of public tenders, where the larger players in time of crisis attempt to penetrate the local market. *Management* is in these companies very close to the execution of everyday tasks and rather strongly integrated with them, Rather than viewing this as undermanagement, it can be seen as an appropriation to conditions of a small project portfolio and welldefined focus in expertise. The concept of organisational support proposes by Anand et al, is less relevant in SMEs where there is not much support to gain internally because of limited personnel resource. Therefore “political” and professional support has to be gained in a network outside the company and this is also done by both companies. Both companies underline the importance of acting in the network.

The enterprise use *ICT* in a modest fashion. As the first case enterprise does not yet use 3D-models, can be viewed as a reflection of the present status in the sector, where 3D-models still is predominantly used by a few large players among architects and engineers. The first case uses project web in 2009 for the first time. The second case enterprise collaborate with families and small craftsmen, where classical sketches and paper drawings prevails as a strong communication and relationship building instrument. When actually adopting ICT it would be at a minimum level to be sure not to overinvest, as the limited local use of websites demonstrates.ICT use in small enterprises seems in particular to be guided by ICTs ability to support networking and interorganizational links (Ritchie & Blindley 2005), both when nurturing contacts but also to practically solve tasks with other firms.As described above the present crisis is outspoken for architectural companies. It appears less important in the development of the two micro firms however. They experience a good stability in new projects and the decay is limited and related to peripheral areas of expertise. Nevertheless we would argue that the first case enterprise have and will experience stronger competition than before in their core business areas. As this is more of an prediction however it is difficult to say what impact it will have.

CONCLUSION

The SME- companies exhibit a clearly distinct set of management, IT, networking and crisis solutions. When compared to large companies in AEC, the SME in AEC are more dependent of networking, have little use of management as a separate activity and the IT use is limited. The analysis thus transcends traditional stereotypes on small companies as prone for growth, in need for “large firm systems”, (one dimensional) professionalisation and/or being understood as extremely organic and creative. *Innovation* occurs in close connection with the focused areas of expertise of the companies. The companies do not fall victim for fashions in the sector in terms of management and IT solutions. It is more difficult do evaluate how fashions impact on the proposed architectural solution in the use of forms, aesthetics and balancing form and function. Compared to high profile small architectural firms these companies innovations are more discrete and use less of public media and the like. Even if large players and investigations of architectural firms claim a problem of undermanagement, *management* in the micro firms can and should thus be kept at a minimum as separate activity as it works well when integrated to the other activities of the small company.

ICT use in small enterprises seems in particular to be guided by ICTs ability to support networking and interorganizational links, it acts a relationship management tool. The common sector effort is thus very needed in enabling the adoption of common tools such as project web, 3D-models, classification, interface standards (IFC) etc. As the first case enterprise does not yet use 3D-models, can be viewed as a reflection of the present state of this development, whereas the second case enterprise demonstrate that micro enterprise only would use ICT if it really means a difference for them, which it still doesn't. The *crisis* has clearly struck the AEC sector, but it appears to have been especially in the top of the market, where the large companies act. Counter to our assumption however the micro companies studied did not experience strong signs of crisis. Actually around half of the architects and engineering companies evaluate their situation in the spring 2009 as unchanged compared to a year earlier. The local market represents a defensible turf, and only larger public tenders are subject to a more fierce competition for the micro companies than before. We can thus conclude that at present the strategy of being small and local does not hurt yet and this priviliges a continued non growth stability and local presence.

REFERENCES

Danske Ark (2009) Beskæftigelsesanalyse. Danske Ark. København.

Anand, N, Gardner, H and Morris, T. (2007) Knowledge Based Innovation: Emergence and Embedding of New Practice Areas in Management Consulting Firms, Ac. of Manag. J.50 (2), 406-28.

Bendixen M. (2007) Rådgivende Ingeniørers udfordring. Ph.D- thesis. DTU. Lyngby.

Bendixen M. & Koch C. (2006) Negotiating Visualities in Briefing and Design. Building Research and Information. 35(1), 42-53.

Brown, S.L. and Eisenhardt, K.M. (1997) The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations. Admin. Science Quarterly, 42, 1–34.

Bryman A, &Bell (2007) Business Research Methods. Oxford University Press. Oxford.

Clifford Chance Centre (2008) Website for Clifford Chance Centre for the Management of Professional Service Firms. Said Business School.

Damvad (2008) Videnservice i et klyngeperspektiv I Region Midtjylland.

Danske Ark (2009) Beskæftigelsesanalyse. Danske Ark. København.

Dent, M. and Whitehead, S. (eds) (2002) Managing Professional Identities: Knowledge, Performativeness and the 'New' Professional, Routledge, London.

Dubois A. and Gadde L. (2002) The construction industry as a loosely coupled system: implications for productivity and innovation. Construction Manag. and Economics 20, 621-631.

Dunford, R. (2000) Key challenges in the search for the effective management of knowledge in management consulting firms. Journal of Knowledge Management, 4(4), 295–302.

EU (2006) The new SME definition. Bruxelles: European Commission, Publication Office.

Gardner H., T. Morris, Narasimhan Anand (2006): New Practice Development: Recipes for Success. Clifford Chance Centre for the Management of Professional Service Firms. Said Business School. work paper No. 9, January 2006.

KK (2009) Jeg kan. Kunstakademiet København

Koch C (2003) Knowledge Management in Civil Engineering – Joining IT and organisation to support the production of Knowledge. Engin. Construction and Architec. Man. 10 (6), 391-401.

Koch C & Bendixen B. (2005) Multiple Perspectives on Organizing: projects between tyranny and perforation. Building Research and Information. 33 (6), 536-546.

Lu. S.L., M. Sexton & C. Abbott (2008) Key characteristics of small construction firms. An United Kingdom perspective. In Carter K., S.Ogunlana &A. Kaka: Transformation Through construction. Proceedings from Joint CIB WO65/WO55 symposition. Dubai. Heriot Watt University.

Løwendahl, B. (2005) Strategic Management of Professional Service Firms, CBS press, Copenhagen.

Newell, S., Robertson, M., Scarbrough, H. and Swan, J. (2002): Managing Knowledge Work, PalgraveMacmillan,Basingstoke.

Nicolini, D. Gherardi, S. and Yanow, D. (eds) (2004) Knowing in Organizations: A Practice-Based Approach, M.E. Sharpe, Armonk, NY.

Ritchie B and Brindley C (2005) ICT adoption by SMEs: implications for relationships and management, New Technology, Work and Employment 20:3, 205-217

Smets M., Morris T., Carroll S. (2008): Orchestrating for a winning performance: Rethinking Strategy in Professional Service Firms. Working paper no 13. Saïd Business School . Oxford

Steenstrup B. (2008) Impact of Networks on SME's performance, In Carter K., S.Ogunlana &A. Kaka: Transformation Through construction. Proceedings Joint CIB WO65/WO55 symposition. Dubai. Heriot Watt University.

Videnrådgiverne (2009): Konjunkturanalyse. DI-Videnrådgiverne. København.

CONSTRUCTION COMPANY OVERHEAD COSTS OPTIMIZATION STRATEGIES

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The dynamically growing competitiveness in the market forces construction companies to pay more attention towards the implementation of optimization strategies for reducing unreasonably high management system expenses. A relevant and innovative methodology for the evaluation of the construction company's competitiveness in terms of its overhead costs is presented. When selecting optimization strategy the relationship between the values of overhead costs and elements of business infrastructure and management system is determined by applying statistical methods. In order to optimize the expenses of construction company administration and facilities management the following strategies are analyzed: the company‘s real estate reorganization, shake-up of its administrative structure and the alteration of the company‘s management system.

KEYWORDS: overhead costs, optimization strategies.

INTRODUCTION

Recent analytical studies in business development and marketing revealed that all businesses are clearly feeling a great deal of economic pressure during the last period. The construction business in particular has been negatively impacted by the current tightening economy, so it is no surprise construction companies are interested in working with significant cost savings during these troubling times. Besides, the dynamically growing competitiveness in the market forces construction companies to pay more attention towards the implementation of optimization strategies for reducing unreasonably high expenses.

The competitiveness of a construction company can be evaluated in terms of price level and quality of supplied services, supplementary services and other factors. However, the essential factor of a construction company's competitiveness still remains to be bidding price, since it is the main criterion for the clients in selecting contractors (Zavadskas et al., 2008). The only efficient way to increase the company's competitiveness under highly intense competition in construction market with declining building contractors' profits and shrinking market shares is to control the costs of production and business.

When the company managers consider cost reduction, they frequently ask where they should start first and which costs they should target. Overhead costs are a good point to start. These costs are the fastest growing and most wasteful in many organizations. Eliminating the causes of overhead costs not only reduces costs, but also can improve quality, service, and flexibility of a company. On the other hand, cutting costs is counterproductive when it undermines the company's ability to grow and compete, or prohibits the employees of the company. Thus, a proper evaluation of overhead costs should be made adequately according to the peculiarities of a construction company.

CONSTRUCTION COMPANY OVERHEAD COSTS

Overhead costs definition

A few commonly accepted definitions of overhead costs appear in scientific sources worldwide. One of them, more suitable for construction industry, is presented by Cilensek (1991): “Overhead costs are defined as those costs that are not a component of the actual construction work but are incurred by the contractor to support the work”. Generally, the building contractor’s overhead costs are classified in two categories: project overhead costs and company’s overhead costs (Peurifoy and Oberlander, 2002). Project overhead costs include expenses that cannot be charged directly to a particular branch of work, but are required to construct the project. Company, or so-called “general”, overhead costs are items that represent the cost of doing business and often are considered as fixed expenses that must be paid by the contractor (Dagostino and Feigenbaum, 2003).

Consequently, construction company’s overhead costs are items that represent the cost of doing business and usually are considered as fixed expenses of the company. Overhead costs represent General and Administrative (GA) functions, such as Human Resources, Finance and Accounting, Information Technology, Legal Services, Purchasing and Procurement, Facilities Management and Strategic Planning. Overhead costs of construction company directly reflect its’ management system, organization of business activities and use of available assets as well as facilities. The structure of overhead costs, adopted in Lithuania, is presented in Figure 1. The overhead costs are classified into four main categories: head office expenses (such as expenses of building facilities, clerical, utilities and proceeding taxes and fees), common use transport expenses (costs for amortization, rental and fuel, as well as taxes), salaries of head office employees and proceeded taxes.

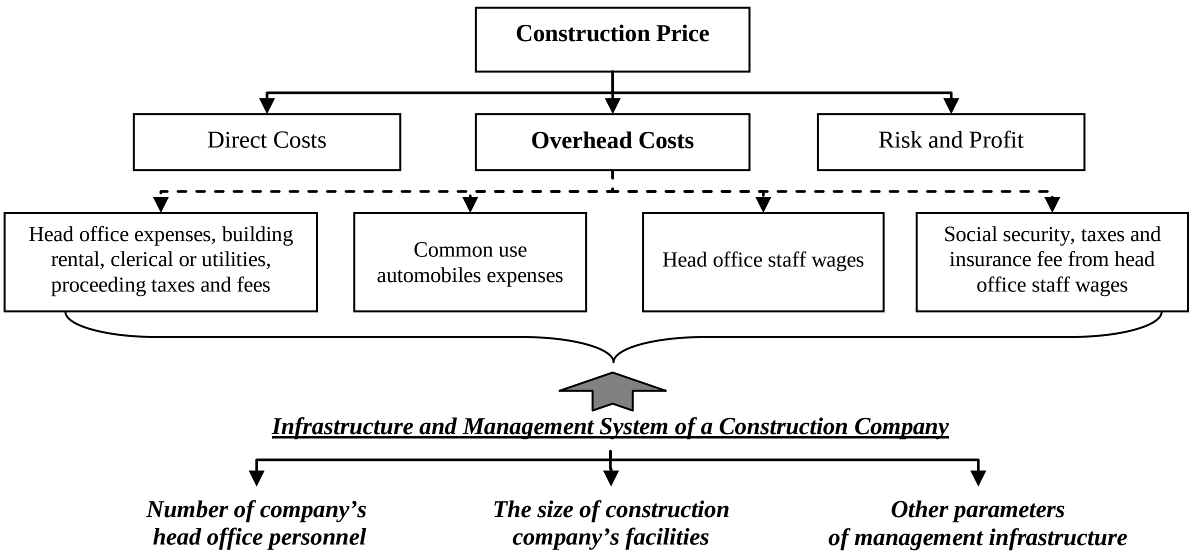

Figure 1: The structure of a construction company’s overhead costs

Since overhead costs comprise a significant part in the construction estimate, the evaluation of overhead costs is a key task for building contractors. However, the unstable construction market makes it difficult for contractors to decide on the optimum level of overhead costs that enable contractors to win public tenders and to manage large projects without financial losses (Assaf et al., 2001). Besides, if a contractor does not know his actual overhead costs, his unsuccessful effort to cover them may result in financial collapse of a construction company.

The structure of construction company overhead costs adopted in Lithuania is quite strictly defined by financial rules and construction standards; therefore, it is possible to select adequate criteria and parameters which allow analysing the construction company's competitiveness in the market in terms of its overhead costs as well as evaluating the efficiency of the company's management system. Thus three main groups of costs and these costs' centres can be distinguished:

- Administration costs, which depend on the number of head office employees;
- Expenses for the maintenance of buildings and premises, which depend on the size of buildings facilities;
- Other overhead costs, which depend on numerous factors.

Contractors need better understanding which of their processes and costs add value, and are essential for a viable business. Besides, there are opportunities to use GA functions more efficiently by trimming the operating costs around it. When the size of actual overhead costs exceeds the forecasted value, contractor can apply overhead costs optimization strategies and reduce the actual volume of costs by the influencing the costs' centres.

Overhead costs research review

Overhead costs of a company are an important research object for construction economics scientists and analysts. Relevant researches on overhead costs have been carried out for several decades; they investigate a lot of different problems related to the evaluation of the company's and project overhead costs, their allocation to different projects, specific jobs or other cost centres, actual overhead costs coverage and numerous other factors.

All research works on overhead costs evaluation can be divided into four main research trends:

- Construction contractor surveys, analysis of situation and statistical research on the understanding of the overhead costs concept as well as categorization of indirect costs, the implementation of evaluation, planning and control in practice (Holland and Hobson, 1999; Chan and Lee, 2003; Assaf et al., 2001);
- Analysis of construction delays vs. overhead costs volume (Taam and Singh, 2003);
- Analysis of the construction company's overhead costs distribution and allocation (Kim and Ballard, 2002);
- Analysis of fixed expenses recovering (Sehlhoff, 2003; Meinen, 2005).

Research papers in the first group reflect the overhead costs evaluation and management experience of construction contractors from various countries. Research in the second group involves the impact of construction project delays on the company's overhead costs refund and its operational efficiency. These scientific works are not so relevant to our research, as the next groups.

Researches in the third group involve the analysis and evaluation of company's overhead costs distribution methods and allocation techniques, which are particularly essential for large construction project management companies. Traditionally, company's overhead costs are distributed to different projects according to resource-based costing and volume-based allocation (Kim and Ballard, 2002). Several new tools (Activity-based Cost Auditing, Cause and Effect Diagrams, Pareto Analysis and Value Analysis), which may be useful to internal auditors in cost containment efforts, are explored. A further research is the development of new overhead costs allocation methods or the improvement of those already available.

The fourth group of research in the field of overhead costs involves the analysis of fixed costs evaluation and recovering. German scientific publications discuss the need for applying a market-based estimation system (Sehlhoff, 2003). The need of market-oriented practices of the enterprises is also emphasized by Lithuanian researches (Ginevičius, 2007). Current price determination methods are cost-oriented and based on the evaluation of indirect costs according to the productivity of the company. Construction companies are advised to use the so-called contribution margin accounting (break-even analysis), which provides the categorization of contractor's costs into variable and fixed, and is a very efficient tool for cost planning (Meinen, 2005).

Different researches on overhead costs investigate a lot of diverse problems related to the evaluation and allocation of overhead costs to different projects and cost drivers. But there are no systematic approach to evaluation of competitive value of company's overhead costs and implementation of different optimization strategies in regard to the position of the company in the existing market.

CONSTRUCTION COMPANY OVERHEAD COSTS OPTIMIZATION STRATEGIES

Overhead costs optimization

Construction company's overhead costs optimization strategies can be implemented to reduce the unreasonably high management system expenses and increase the competitiveness of a company. Over the past decade most global companies have implemented several restructuring methods to cut overhead costs, including business process reengineering, shared services and strategic outsourcing. Generally, the overhead costs optimization methods are as follows: the company's real estate reorganization, shake-up of its administrative structure or even the alteration of the company's management system (see Figure 2).

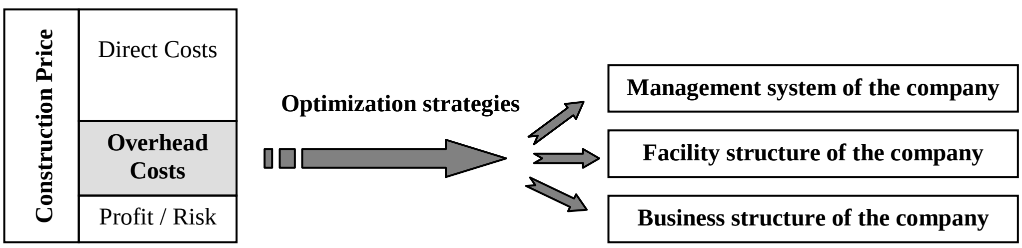

Figure 2: Strategies for optimization of construction company overhead costs

The optimization methods can be defined for each company individually, in accordance with their operational conditions and other important factors. The management system of a company, its structure as well as administrative costs can be reduced through company reorganization or restructurization strategies. Selection of the proper strategy and its implementation in the company is a hard task, which resolution in most cases involves the engagement of strategic management professionals. Usually, a new management system is created, which is transparent and comprehensible to all employees of the company. After the audit of administration operations is carried out new structural possibilities of operation are assessed (Couto et al., 2007), such as:

- Redistribution of employee workload flow;
- Exact job assignment;
- Strong subordination and accountability;
- Disestablishment of some particular job positions, replacing them with outsourcing;
- Attraction of high qualification professionals; other strategic solutions.

When minimizing the overhead costs, first of all companies should consider the possibility to cut advertising and research costs before anything else as they can be reduced almost immediately. Outsourcing of services and sharing services are two frequently applied models for cutting overhead costs due to redesigning of business processes of a company. A shared service model is seen as another way to reduce overhead costs. Some of the greatest long-term gains in operational efficiency are achieved when construction companies reengineer business processes to fundamentally change work process. Redesigning of business processes eliminates unnecessary works and usually allows a company to reduce the number of employees significantly. The largest expenses of a company used to be related to the company’s employees. Companies can save a lot on overhead costs by reducing the number of people employed, cutting back on staff hours and putting restrictions on overtime. Although company managers should be aware that such measures in some cases can negatively influence productivity and morale of employees.

In order to reduce the building facilities’ costs the reduction of owned real property is essential. For the task to be implemented, several strategies can be applied:

- Acquisition of new, smaller accommodation or rent of the accommodation owned to outsiders;
- Discarding separate technical departments and outsourcing;
- Sharing the infrastructure with other companies;
- Reduction of energy expenses;
- Audit and discarding of equipment and vehicles not used on a regular basis, due to reducing the auxiliary premises and other measures.

Reevaluating facilities is the first step in reducing the overhead costs caused by the real property owned. The construction companies should not get a space that is more than they need, or they will have unnecessary spending on unused space. Another way to reduce costs is to share them through some type of office sharing arrangement. As far as utilities go, construction companies can cut overhead costs by converting to high efficient lighting, heating and cooling equipment. By renting instead of buying equipment, especially computers or specialty machinery, company can also greatly cut down on overhead costs.

In order to increase the efficiency and competitiveness of a company in construction market, various construction company overhead costs optimization strategies can be applied separately or in complex. The nature of the considered strategies implies that their selection can be solved, for example, by the implementation of multiple criteria evaluation methods or other tools. At the same time it can be complicated to determine which overhead costs and in which extent should be reduced.

Evaluation of the competitiveness of construction company overhead costs

Usually the managers of construction companies start analysing the existing costs of the company and their drivers when they find it difficult to get new contracts or compete with other construction companies in the market. Conclusions about the exceeding size of overhead costs as well as their optimum level can be arrived by analysing the competitiveness of the company.

The analysis of the construction company's overhead costs competitive properties involves the following procedures: the analysis and evaluation of the overhead costs competitiveness limits in the market of existing construction companies; evaluation of a certain construction company overhead costs competitiveness in this market, analysis of construction company's management system and infrastructure items and selection of strategies for overhead costs optimization (see Figure 3).

The primary and most important task in determining a competitive value of a construction company's overhead costs is the analysis of overhead costs of rival companies and determination of their overhead costs limits in the market. To gather the required information a questionnaire has been prepared and a survey of construction contractors was carried out. A three-year data from 30 construction companies performing general construction work packages in the central region of Lithuania was gathered. The discussed set of companies belongs to the mid-sized company group. They employ from 20 to 250 employees, their annual volume of construction operations ranges from 0.9 to 21.8 million Lt. The management staff in the examined companies ranges from 3 to 24 employees, the size of buildings facilities is from 168 to 2000 m^2, and the annual overhead costs range from 1.0 to 1.36 million Lt. The size, structure and operational volume of these companies are analogous; therefore, the set of the companies responding to survey is considered to be homogenous.

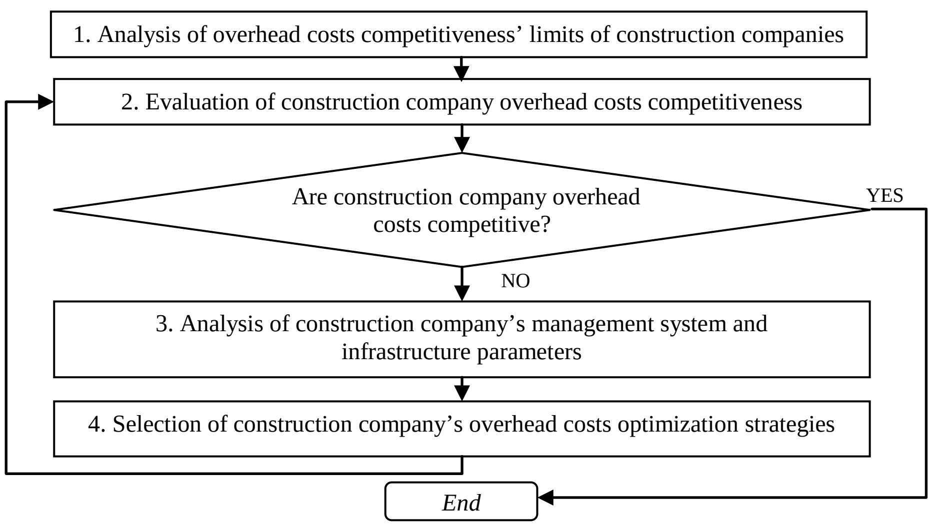

Figure 3: Evaluation of the competitiveness of construction company overhead costs

Since the value of a construction company's overhead costs reflects its management system and infrastructure, the questionnaire contained additional questions about the volume of the construction operations executed, the number of head-office employees and structure as well as size of company's realty. Therefore, in further analysis and processing of statistical data the relative values of overhead costs and their components - administration and facility management costs, were used. These relative values are obtained as portions of overhead costs or their components per unit of the executed construction volume.

To perform the analysis of the results of construction contractors' survey mathematical statistics were applied. The main statistical characteristics of relative values of overhead costs as well as their probability distributions, which are used to compare company's overhead costs with ones existing in construction market, were determined. The testing of the compatibility hypothesis about the normality of examined distributions allowed the employment of the consistent patterns of normal distribution for the evaluation of competitiveness of a construction company's overhead costs.

Thus, the competitiveness of a construction company's overhead costs is evaluated according to the distribution, gained from data analysis and given in Figure 4. When the relative value of overhead costs of examined company falls within the interval between the lowest and the average overhead costs relative values of the market, the overhead costs of that company are considered to be competitive. That means the company operates efficiently and has a rational structure of business and building facilities, as well as a proper management system. When the value falls within the interval between the average and the highest overhead costs relative values of the market, the company seems to be not competitive in terms of overhead costs. It might have an inefficient business infrastructure or inappropriate management system. In this case a reform of the company's management system and/or infrastructure by implementing specific reorganization, shake-up or other development strategies is imperative.

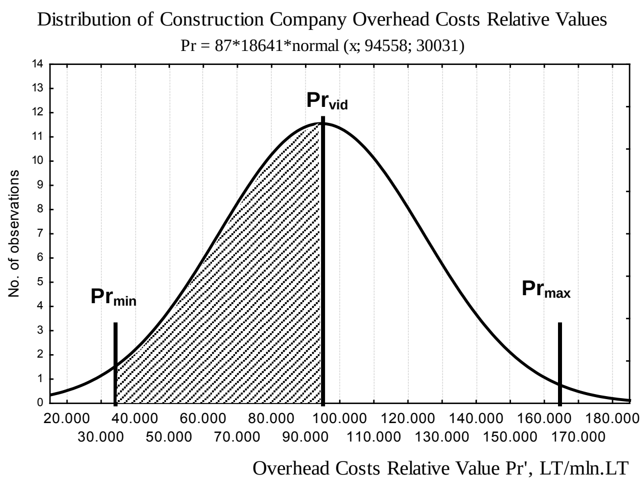

Figure 4: Distribution of construction company overhead costs relative values

The value of overhead costs is influenced by specific parameters, such as the number of head office employees or the size of facilities. The results of the construction contractor survey reveal that the amount of the other components of overhead costs is rather small compared to the administration and building facilities' costs and can be interpreted as a free member in regression equations.

After the applying of multifactor correlation-regression analysis the following equation was obtained:

$$Pr = 36107 + 14958 \cdot Sk + 197 \cdot Pl \qquad (1);$$

where:

Pr - the relative value of overhead costs;
Sk - the relative value of number of head-office employees;
Pl - the relative value of building facilities' area.

The multifactor regression model of overhead costs can be applied in practice to forecast the value of construction company overhead costs. It is a convenient tool for applying different overhead costs optimization strategies as well as defining the appropriate infrastructure parameters of the company.

However, research of overhead costs competitiveness alone is often not sufficient for evaluation of a company's management efficiency; thus, a thorough and sectional analysis of overhead costs components is necessary. The statistical analysis of overhead costs' elements - administration and building facilities' costs is required.

The relative value of administrative costs is a key parameter, describing the efficiency of the business structure and management system of a construction company. The group of administration costs includes head office staff wages, social insurance taxes and administrative expenses (mail, communications, office, business trips, transport and other expenses). The competitive advantages and disadvantages of a construction company's administration costs are evaluated with the help of the same methodology as one applied for the general overhead costs of a company (see Figure 5). Relation between the number of the construction company's management staff and administration costs is determined upon the accomplishing correlation-regression analysis:

$$Adm = 30543 + 7832 \cdot Sk + 1582 \cdot DSk \qquad (2);$$

where:

Adm - the relative value of administration costs;
Sk - the relative value of the number of head office employees;
DSk - the relative value of the general number of company's employees.

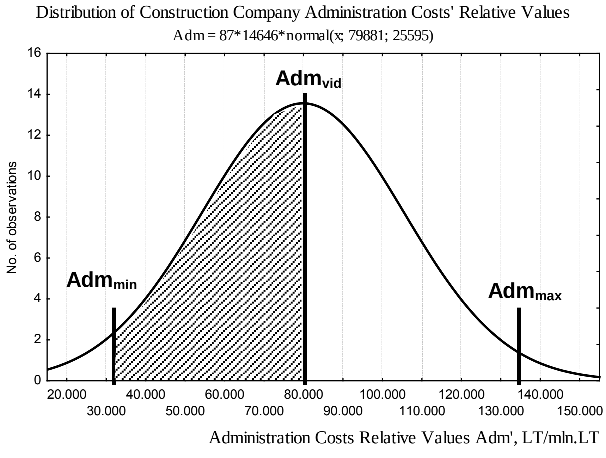

Figure 5: Distribution of construction company administration costs relative values

Another important parameter for analysing the operational efficiency of a construction company is the size of the realty owned. The buildings facilities costs consist of the following: costs for buildings amortization; exploitation and repair expenses; rent; insurance; lighting; heating; plumbing; sewage disposal; accommodation cleaning and other expenses. The relative value of buildings facilities costs is analysed in the same way as the relative values of the general overhead costs (see Figure 6). By applying the single - factor correlation-regression analysis the following dependence between the company building facilities' expenses and the area of the real estate and premises was obtained:

$$Pas = 667.69 + 17.62 \cdot Pl \qquad (3);$$

where:
Pas - the relative value of buildings facilities costs.
Pl - the relative value of buildings and premises area**.**

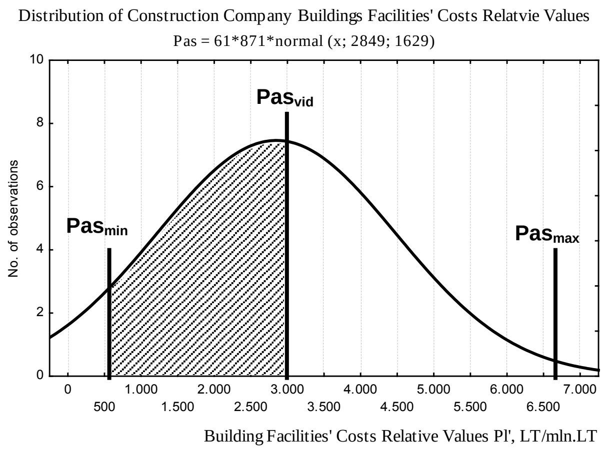

Fig. 6: Distribution of construction company building facilities' costs relative values

The evaluation of a construction company's overhead costs or their components (administration and buildings facilities costs in terms of the competitiveness in the market) poses few questions concerning the implementation of measures for increasing the competitiveness. Depending on which of the overhead costs components requires minimization, a favourable value of management system parameter is determined and adequate company development strategies are selected. Methods for the minimization of overhead costs are chosen individually for every construction company, in relevance to its actual operational conditions.

CONCLUSIONS

The article presents a relevant and innovative methodology for evaluating the competitiveness of construction company overhead costs and preliminary selection of overhead costs optimization strategies.

By applying the correlation-regression analysis the dependences between the relative values of construction company overhead costs and their components - administration and building facilities' costs, and company's infrastructure parameters - number of administration employees and buildings' area were defined. These models can be applied in practice in order to forecast overhead expenses in accordance with different parameters of a construction company's management system and evaluate possible overhead costs optimization strategies.

The obtained regression expressions can be implemented to select an appropriate construction company overhead costs structure and to form the overhead costs optimization strategies: altering and improving company management system, building facilities and business structure.

REFERENCES

Assaf, S.A.; Bubshait, A.A.; Atiyah, S.; Al-Shahri, M. (2001) The management of construction company overhead costs. International Journal of Project Management, 19, 295-303.

Chan, S.Y. and Lee, D. (2003) An empirical investigation of symptoms of obsolete costing systems and overhead cost structure. Managerial Auditing Journal, 18(2), 81-89.

Cilensek, R. (1991) Understanding constructor overhead. Cost Engineering (AACE), 33(12), 21-30.

Couto, V., Galioto, F., Mader, D., and Schädle, J. (2007) Optimizing Overhead — From Cost Center to Competitive Advantage, McLean, Virginia: Booz Allen Hamilton Inc.

Dagostino, F.R. and Feigenbaum, L. (2003) Estimating in Building Construction (6th ed.), Upper Saddle River, NJ: Pearson education.

Ginevičius, A. (2007) Quantitative evaluation of enterprise marketing effectiveness. Technological and Economic Development of Economy, 13(1), 19-23.

Holland, N.L. and Hobson, D. Jr. (1999) Indirect Cost Categorization and Allocation by Construction Contractors. Journal of Architectural Engineering, 5(2), 49-56.

Kim, Y. and Ballard, G. (2002) Profit Point Analysis – New Project Overhead Control. Proceeding of the 10th Annual Conference of the International Group for Lean Construction, August, 2002, Gramado, Brazil.

Meinen, H. (2005) Deckungsbeitragsrisiken im Baubetrieb und Risikoabsicherung, Baumarkt, 5, 36 – 39.

Peurifoy, R.L. and Oberlander, G.D. (2002) Estimating Construction Costs. New York: McGraw-Hill.

Sehlhoff, G. (2003) Marktorientierte Preise? Baumarkt, 12, 12 – 13.

Taam, T. and Singh, A (2003) Unabsorbed Overhead and the Eichleay Formula. Journal of Professional Issues in Engineering Education and Practice, 129(4), 234-245.

Zavadskas, E.K., Turskis, Z., and Tamošaitienė, J. (2008) Contractor selection of construction in a competitive environment. Journal of Business Economics and Management, 9(3), 181-187.

A SURVEY OF SMALL CONTRACTORS' INTERACTIONS IN SOUTH AFRICA

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Civil engineering contractors frequently engage in contractual arrangement involving other parties. Joint Ventures, subcontracting or the use of plant hire services are common features in the South African construction industry. For emerging Small Micro and Medium Enterprises (SMMEs) these interactions provide the opportunity to learn from others enterprises. Results from a survey conducted amongst SMMEs are presented describe these patterns of interactions in the marketplace, and the experiences of SMMEs when contracting with others. These interactions provide the contexts where learning events can occur, helping SMMEs to become sustainable competitive entities. However, the quality of these contexts are crucial for positive learning outcomes.

KEYWORDS: learning, SMMEs, survey.

INTRODUCTION

Due to the legacy of Apartheid South Africa exhibits a skewed distribution of infrastructure amongst its population. The legacy of years of colonial rule and race based social engineering has left the new democratic South Africa with a disparity between the historically privileged white minority and the historically discriminated black majority population. Through governmental initiatives and regulations such as the Preferential Procurement Framework Act (South Africa 2000a) and the Broad-based Black Economic Empowerment (BBBEE) Act (South Africa 2003a) steps are being undertaken to deal with the relative underdevelopment of the majority of its citizens whilst at the same time, utilising this investment as an opportunity to involve those who were previously marginalised in the economic life of the country. As it seeks to meet these challenges, the South African construction industry is undergoing transformation in structure, ownership and working practices; aiming to narrow the historical divide along established and emerging contractors. Whereas the former are typically considered to be white-owned and managed companies, the latter are viewed as being owned and managed by Historically Disadvantaged Individuals (HDIs), the term used in legislation to those who had been historically marginalised from participation in the formal economy. The respective market shares of these two groups of enterprises remain skewed towards the few established companies; public companies with its stocks traded at the stock exchange remain generating 60% of the market revenue, whilst emerging Small Micro and Medium Enterprises (SMMEs) struggle to become sustainable entities in a highly competitive environment characterized by low barriers to entry. SMMEs are frequently reported to be unable to remain in the market and failing to complete projects (e.g. Van Wyk 2003, Sebake and Sithole 2005) and government initiatives to support these companies have yet to show positive results (Kganyago 2004). Due to the legacy of the past many HDI-owned enterprises lack physical, financial and knowledge-based resources.

Reports often cite external (market) and internal factors as the reasons for the failures of emerging SMMEs; external factors typically relating to the market environment such as companies struggling to access finance, facing abuse by main contractors, and unprofitable tender processes. Internal factor relate to the contracting entity itself and include poor management (Van Wyk 2003) and the lack of technical skills (Sebake and Sithole 2005). However the root of the problems, perceived as hindering factors, is a general lack of knowledge and it is knowledge that according to Drucker (1993) is the key to any companies' success and economic power.

Whilst knowledge can be taught, and government initiatives, through short courses and workshops, are geared towards emerging contractors, the promulgation of the preferential procurement and BBBEE legislation has also created learning opportunities for emerging SMMEs. Leveraging these opportunities sees SMMEs interacting in the market environment with established companies – as established companies seek HDI partners on their projects in order to secure access to contracts. On projects where knowledgeable established companies are interacting with emerging contractors opportunities to learn from one another arise. However these relationships are marked by some characteristics that not only contribute to a project's success, but also form the locus of potential learning experiences for the emerging company.

Given this framework and recognizing the constraints in knowledge held by emerging companies a research project is currently conducted at the Cape Peninsula University of Technology and University of Cape Town addressing this issue. The focus of this research is the investigation of emerging SMMEs in South Africa, their interactions in the market place, as well as the contexts and opportunities for these companies to gain knowledge while working alongside established companies. The data and findings presented here are drawn from a survey conducted to describe the patterns of interactions experienced by SMMEs and qualities surrounding these interactions.

LEARNING FROM OTHERS AND THE CONTEXT OF LEARNING

SMMEs whether 'emerging' or not are typically owner-centred organizations. Various definitions of these companies in a South African context exist. The National Small Business Amendment Act (South Africa 2003b) and the Construction Industry Development Board Regulations 2004 (South Africa 2004) reflect some of these definitions but are not conclusive. For the purpose of the research project emerging SMMEs are defined as companies owned by HDIs, recently established, and small both in terms of turnover and number of employees. Such organizations would show low levels of maturity as defined by Churchill and Lewis (1983) yet they would show all properties to be described as companies by Katz and Gartner (1988). It is these organizations that require knowledge to become sustainable. Organizational learning theories thus informed the research project, and provide the theoretical base for the empirical work undertaken.

The SECI model of Nonaka (1991) was used as the main pillar of the theoretical framework. The SECI model essentially combines learning with tacit and explicit knowledge through four stages of conversions (Socialization, Externalization, Combination, and Internalization) – a spiral model of organizational learning. Using this spiral conversion of knowledge to describe the learning process, Nonaka and Konno (1998) extended the model to introduce the concepts of the *Ba* and *Basho*. Each conversion stage has its own *Ba*. The *Bas* are the needed platforms for the conversions. The *Basho* (meaning greater *Ba*) can be equalled to the wider marketplace in which organizations act and interact with others. It is in the *Basho* where organizations receive stimulus to develop their own knowledge. For construction companies this can mean the wider market place, but may also refer to projects, within which organizations interact and in doing so create opportunities to learn.

Knowledge and learning are context dependent (Nonaka 1991, Dodgson 1993, Nooteboom 2001). For learning to happen the contexts need to be appropriate. The context of learning, when seen from a social-constructivist point of view, is the combination of two: The interactions in which knowledge is created, shared, or transferred are one context. The setting of this very interaction is the other context. The context of learning is of particular interest to many researchers in organizational learning engaging the social constructivist perspective. Elkjaer (2003) points out that any theory derived from the social-constructivist perspective sees the learning process '*as participation in social processes…*' and postulates that this perspective looks rather at the context than at the individuals within the context – the *Basho*.

The social capital available to learners is of importance too. The concept of social capital implies two spheres. The first relates to the sphere internal to an organization or social unit, the second sphere relates to the wider network of resources accessible to the first but outside an organization or unit (Nahapiet and Ghoshal 1998). In a sense this differentiation reflects Nonaka's *Ba* and *Basho* again. Nonaka and Konno (1995) use the term ontological dimension to describe the level of individual, group, organization or inter-organizational involvement in knowledge creation. Social capital is linked with these ontological levels. Through the interaction within or between levels, as well as within or between social units knowledge is traded, created and learnt. The social construction of knowledge and social capital are intertwined. Social constructivists see learning only possible as a socially embedded activity (Elkjaer 2003); and from the process-orientated perspectives the social capital (network) is of importance if organizations are to be successful (Partanen *et al.* 2008). The social capital from which an organization can draw will thus determine the potential for organizational learning. Alliances, partnering agreements, joint ventures as inter-organizational set-ups can all open access to social capital which can be drawn into creating knowledge. However, with no social capital, there is no learning.

Thus, the quality of the social capital, the *Basho* with its interactions ought to be of importance. Adversarial relationships are not expected to be beneficial for either mutual or unilateral learning. Thus in order to frame possible learning experiences as encountered by emerging SMMEs in South Africa a survey looking into interactions in the *Basho* and the quality thereof were undertaken.

METHODLOGY

A national computer-assisted telephonic survey amongst Civil Engineering contractors, registered with the Construction Industry Development Board (CIDB) was undertaken. The CIDB is a governmental body which was found to '*…implement an integrated strategy for reconstruction, growth and development of the construction industry…*' (South Africa 2000b). It maintains a national register of contractors, which are distinguished in accordance with the nature of their work (civil engineering, general building, electrical,…) and the capability of the company graded 1 to 9, with grade 1 contractors being the smallest and grade 9 contractors the largest companies. A sample size of 20% of all grade 1 to 4 Civil Engineering contractors was selected, translating at the time of the survey into a pool of 528 contractors.

A questionnaire was designed and pre-tested firstly using academic colleagues and subsequently a small sample of contractors. At the same time the computer-based application was tested for its accuracy in capturing the data. The final questionnaire had four main sections. An introduction and consent to participate section, a demographics section gathering data on the interviewee (age, race, education,…), a section pertaining data on the contracting entity (size, turnover,…), as well as the main section pertaining interactions with other companies. Four main forms of interaction were defined: Joint ventures, being the subcontractor, using subcontractors, and using plant hire services. For each of these interactions data was gathered on frequencies of interactions, status of partners (established vs. emerging), typical clients, as well as experiences with the particular forms of interactions. Data gathered was mostly quantitative in nature, either in terms of numbers or using Likert-type scales, but was also supplemented with qualitative entries. The data gathered pertaining the experiences were largely qualitative and form the base for the discussions presented here.

RESULTS

The achieved response rate after adjustments eliminating non-HDI owned companies was 50%. Thus a total of 264 emerging SMMEs were accessed, interviews were conducted, and respective data was gathered.

Respondents and Companies

In order to frame the later presented results on experiences with interactions in the *Basho*, some key figures are shared here. Out of the respondents approximately 70% were male, with the remainder (30%) being female – a high number of female contractors are registered in South Africa, possibly due to the Preferential Procurement Policies, in which female contractors are eligible for extra points in tendering adjudication processes. The average years of experience in construction for all respondents was 7.0 years – rather low if one considers that most basic trade-skills programmes would take 3 years to complete. In fact 55% of the respondents had no form of construction related training at all. The contracting entities can best be described as micro to very small according to the National Small Business Amendment Act (South Africa 2003b), seeing in 95% of all cases companies employing less than 20 persons. The typical contract size in which the entities are engaged in were largely (85%) less than ZAR 2mil (approx. Euro 90k). And 80% of the surveyed companies were found less than 5 years ago.

Interactions

Respondents were asked about their previous interactions with other companies. In Table 1 the responses are listed. For the interactions for which respondents replied in the affirmative, experiences pertaining these interactions were then explored.

Joint ventures

The 73 contractors having been engaged in joint ventures before were interrogated about these interactions. Contractors appear to regularly change their joint venture partners. Asked if they had worked with their most recent joint venture partners before, only 31% replied in the affirmative. The remaining 69% had no previous joint venture experience with the particular partner before. Of the 31% replying in the affirmative the average number of previous engagements was three previous joint ventures with the same company, with the mostly mentioning that they had worked together twice before (mode = 2). Asked on who initiated the most recent joint ventures, 58% of the contractors stated that it had been their own initiative. In the other cases the surveyed contractors were approached by their respective partners. In 88% of all cases personal contacts with the respective partners were cited to be the reason for engagement.

Aiming to determine the quality of interaction and experiences with joint ventures, respondents were asked to rate the occurrence of problems within such partnerships. The relationships were rated on a scale of 1 (bad) to 5 (good). The average scored was 2.84. Where rating of their relation was on the lower two marks (31 cases), respondents were asked to elaborate on their problems encountered with their respective partners; this qualitative data retrieved can be binned in four categories: Approximately 20% of complaints were related to communication and managerial issues, 29% were related to financial issues, and 35% were related to the lack of experience of the partners. The remainder of complaints were typically combinations of complaints relating to financial quarrels and experience.

If the interactions with the joint venture partners were rated on the two higher marks (20 cases), respondents were asked to comment on positive aspects of working with joint venture partners. Here in particular issues relating to good communication were pronounced by the respondents (50%), this was followed by matters of mutual understanding (25%), the high level of experience by the partner (15%), and the helpfulness of partners (10%). It must be noted that when inspecting the data hardly any correspondence of typical complaints or praises towards the particular status of partner was found. Only in the case of complaints about the experience levels of the partners a higher level of complaints were noticed in cases where the partners was another emerging company (8 of the 11 cases). This can however not be measured statistically and is based on simple inspection of the qualitative data.

Being the subcontractor

A total of 120 respondents stated that their company worked as subcontractors before. However only 116 respondents were disclosing information and were thus analyzed. A total of 42 contractors (36%) stated that they had worked with the main contractor before. The remainder stated they had not worked for the particular main contractor before. In the 42 cases in which prior relations existed, the average number of previous engagements was 3, while the most often cited number of previous engagement (mode) being 2. The number of personal contacts leading to subcontracting contracts is lower than in the case of joint venture relations. Out of the analysed 116 cases a total of 65 (56%) attributed their engagement as subcontractors to personal contacts they had with the main contractor. Comparing this to joint ventures (88%) the economical and managerial dependency of subcontractors is highlighted though this result. It is the main contractor who decides and chooses the subcontractor, and combining this observation with the number of previous engagements, this choice does not appear to be related to personal contacts either. Using qualitative data in seeking information on how subcontracts were secured, six main categories could be identified. Typical ways in which the surveyed contractors got engaged in projects as subcontractors included: by tender (26%), by referral through third parties (20%), and active marketing by the surveyed contractor to main contractors (20%). Other means of getting subcontracts were previous employer-employee relations with the main contractor (18%), appointments through clients (12%), and the remainder of approx. 6% saw main contractors approaching the SMMEs.

The quality of interactions and experiences with their respective main contractors were assessed. Overall the results on the 5-point Likert-type scale were very neutral in respect of problems encountered with the main contractor. The average of all 116 responses used was 2.96, with a mode of 3. Relations with main contractors were thus in general seen neither particularly problematic, nor particularly good. The respondents showed no tendencies in perceiving the quality of their relationships with the main contractors as either dependent on the type of client or dependent on the status of the main contractor.

Asking the respondents about the most common problems encountered as subcontractors, some insights could be gained in form of qualitative data. Following a screening of the data, deriving an overview of the statements made, the data was binned into four problem areas: Finance, management, experience, and combinations of above. The majority of problems cited were related to financial quarrels (61%). Most often here were complaints about late-payments, and low rates for particular works. General dissatisfaction with the management of the projects by the main contractor was cited in 29% of all cases. The management style with regards to communication within the project appeared to be one major cause of concern here.

Turning to the good things contractor experienced, contractors were asked to comment on what worked well in their relationship. The data collected was qualitative and was thus categorized. The categorization followed a screening of the data entries, which resulted in four categories. Positive feedback received was mostly related to two categories, namely the management style of the main contractor (42%) as well as the willingness of the main contractor to assist and mentor (39%). This was followed by positive comments about the general benefits of good communication in projects (13%) and the remainder of the data (6%) were combinations of the above. An analysis of the data in terms of dependencies of the status of the main contractor was due to the low numbers of positive responses (31) not practical. However the high number of good experiences due to the willingness of the main contractor to assist the emerging subcontractor suggests that in particular cases in which established contractors, able to assist and mentor, hold a good potential to give emerging subcontractors a valuable experience.

Using subcontractors

A total of 107 respondents stated that their respective companies had engaged subcontractors in projects before. Assessing the frequency of engaging subcontractors in projects showed that the occurrence of the surveyed emerging contractors in actual fact engaging subcontractors is rather low. The bulk of the respondents who had used subcontractors before stated that they either had rarely or sometimes used subcontractors (61% compounded), with only 39% seemingly engaging more regularly subcontractors (always or often). The tie of emerging contractors to subcontractors engaged with was assessed by means of asking if there are ‘regular’ or ‘particular’ subcontractors they make use of. This revealed that 45% of the surveyed contractors who have used subcontractors in the past use the services of particular subcontractors again and again. The other 55% appear to change their alliances in the supply chain. Establishing how the surveyed contractors using subcontractors are getting access to the subcontractors, qualitative data, i.e. short description of the means of introduction to the subcontractors, were gathered. These were then later screened and five re-occurring categories were identified. The most common way of getting into touch with their respective subcontractors was through personal contacts (64%). Referrals by third parties, excluding clients, were cited the second most common way of getting into touch with their subcontractors (13%), with client referrals as a distinct way of referrals counting for 7% of the cases. Advertising in the form of adverts or through databases by the subcontractors drew the attention of the surveyed contractors in further 8% of the cases. The remainder were other means of contact which were either unclear or ambiguous in their explanations.

Aiming to determine the quality of interactions with the respective subcontractors, respondents were asked to rate their working relationship with the subcontractors on a Likert-type scale from 1 (many problems) to 5 (excellent). The results reflect normal distributed responses. The measured mean and mode were both 3.0, with a standard deviation of 0.92. Expressed in percentages the following picture can be drawn: Half (50%) of the respondents were neutral in their response, with 26% of the respondents viewing their relation as problematic (4% many problems, 22% some problems), and the other 24% viewing their relations as well (17% good, 7% excellent).

Also in the scenario of using subcontractors, the respondents were asked to comment not just on their negative experiences but also on their positive experiences. Of the 27 respondents with problematic relationships, 25 elaborated on these problems. The majority (92%) cited that different ways of working played ‘often’ or ‘not so often’ a role in their unsatisfactory working relations. Assessing qualitative data retrieved on causes of disputes and problems two major themes occurred. In more than three-quarter of these responses the experience of the subcontractor resulting in a poor product (technical inability) were cited as reasons for problematic relationships. Financial issues were singled out by one-fifth of the respondents, with the remaining responses relating to both, technical ability and finances, in combination as causes for problems. Turning to the respondents who viewed their relationships as good or excellent, comments on the working relations were collected too. Within these responses four themes occurred. The reliability and the technical abilities of used subcontractors, as well the ways of communicating with the subcontractors, and furthermore combinations of these were commented upon on positively with equal votes.

Using plant-hire companies

Out of the full sample 146 respondents (55%) stated that their company used the services of plant hire companies before. Determining the frequency of how often the emerging contractors sought the services of plant hire companies, the respondents were asked to rate their frequencies of interaction. The results show that 60% of the 146 contractors hire these services on every contract. This equals to approximately a third of all respondents of the entire survey. The strength of the tie between the emerging contractor and the respective plant hire companies was tested by asking if the contractors had a regular / particular plant hire company they used. Here a strong commitment can be observed with 64% of contractors (93 of the 146) relying on particular plant hire companies as opposed to seeking the services of various companies offering the same service. This is a remarkable contrast to the using of subcontractors patterns, where only 45% showed strong ties to particular subcontractors. Seeking to find out how the contractors got into touch with plant hire companies, they were asked to explain their mode of contact. The data collected was qualitative, but could be categorised in five broad bins. Personal contacts were by far the most common way of getting into contact with the plant hire companies (45%). This was followed by finding plant hire companies through adverts or the phone book (32%) – a mode with no prior contact. Referrals from third parties accounted for 15% of all cases. Other cases included combinations of the above (8%) or the plant hire companies seeking business with the contractor (2%).

The quality of the relationship with the plant hire companies were assessed asking contractors to rate this on a 5-point Likert-type scale. Only 20% of the respondents felt that they had problems. The majority (51%) of the respondents were neutral in their responses and the remaining 29% described their relationship with the plant hire companies as good or excellent. As for the interaction of working as a subcontractor, the cases in which the relationship was felt to be problematic, cultural differences, using the way work is conducted as a rough proxy, were cited as the most common reason (79%) for the problematic relationship with the plant hire company. Here it must be mentioned that plant hire companies, by their nature as a capital intensive business, can be considered as established companies. However the result from this particular question must be read with caution, as once a relationship was described as problematic, the way of working differently almost necessarily has to be a reason for the dissatisfaction expressed. Turning towards the types of complaints made relating to plant hire companies, the bulk of dissatisfaction (45%) appeared to be based around financial quarrels, with general management, time to complete task, related grievances mentioned in second place (28%). The remainder of grievances were mixtures of racial, cultural problems combined with one or both of the above grievances. Also in the cases of plant hires not only the problematic relationships, but also good relationships were further scrutinized. If respondents felt that their relationship with the plant hire companies were good or excellent they were asked to comment on what made the relationship good. Four categories were singled out: The majority of respondents (56%) felt that the plant hire companies were helpful and available, and 26% of the respondents attributed the good communication with the plant hire as being a positive factor in their relationship. The technical quality of the services rendered by the plant hire companies only appeared to be of importance to 12% of the respondents. The remainder of the responses were either combination of the above or unspecific comments.

Overview of interactions

Table 1: Key characteristics of interactions - overview

	Joint ventures	Being subcontractor	Using subcontractor	Using plant hire
Not engaged before	191 (72.3%)	144 (54.5%)	157 (59.5%)	118 (44.7%)
Engaged before	73 (27.7%)	120 (45.5%) / 116	107 (40.5%)	146 (55.3%)
Personal contact	88%	56%	64%	45%
Strength of tie	31%	36%	45%	64%
Frequency of interaction	Twice (mode)	Twice (mode)	Not par t of qu es-tionnaire	64% always
Problematic relation	31 (42%)	43 (37%)	28 (26%)	29 (20%)
Most cited problems	Experience Finances	Finances Management style	Technical ability Finances	Finances Management
Neutral relation	22 (31%)	40 (34%)	53 (50%)	75 (51%)
Good relation	20 (27%)	33 (29%)	26 (24%)	42 (29%)
Most cited praise	Communication Mutual understanding	Management style Mentoring	Reliability Technical ability	Helpfulness Communication

Drawing from the data above, the four forms of interactions surveyed can be summarized for the purpose of creating an overview. Due to the design of the questionnaire the data presented in Table 1 is not necessarily comparable; however presenting the data in this form enables a better indication of how the four forms of interactions are typically carried out, and where communalities exist. The data presented in Table 1 is not covering all aspects of the survey, only some key characteristics, as also discussed in the previous sections, are shown.

CONCLUSION

South African emerging contractors are characterized by low levels of experience and formal construction-related training held by their key personnel (primarily the owner). Their operations are small with few contracts coming their way, and they consequently struggle to be sustainable enterprises. However even in these contracts the contractors are exposed to other construction companies in the forms of joint ventures, subcontracting, or plant hire arrangements. Describing the social capital available to these contractors based on a survey reveals interesting patterns of interactions and experiences. Using plant hire companies is particularly prominent amongst the surveyed SMMEs and especially here a high level of re-occurring interactions and a low level of dissatisfaction with these relationships is noted. Plant hire companies are typically established white-owned businesses, and the positive engagement of these companies is promising in a country riddled by racial tensions. Further working as subcontractors is another main way of interaction in the marketplace. However dissatisfaction with the relationships to the main contractors are rated high, with financial quarrels often occurring. The most dissatisfying interactions however seem to occur in joint venture projects; the choice of the joint venture partner seems to carry little considerations as complaints about the experience held by the partners are high.

Using these interactions as vehicles for emerging SMMEs to learn form the collaborative partners are possible. A strong social capital with re-occurring partnerships forms the basis for a suitable *Basho*. Within the existing *Basho* interactions with others are in majority considered to be unproblematic or good. This allows for the creation of learning contexts in which the sharing and improving of knowledge is the order of the day. However, also unsatisfying interactions exist. These primarily stem from financial quarrels amongst partners, cited most often as problems; this issue thus needs to be managed creating a suitable learning context. The quality of the social capital of SMMEs needs to be lifted. The positive interaction with plant hire companies might suggest a way forward. Coupling emerging contractors with specific partners in recurring relationships may help to overcome problems such as trust and poor communication. However developing suitable learning contexts will require more in-depth analysis of current learning experiences, possibly focusing at plant hire interactions as one mode of interaction from which researchers can learn from.

REFERENCES

Churchill, N C and Lewis, V L (1983) The five stages of small business growth. Harvard Business Review, 61(3), 30-50.

Dodgson, M (1993) Organizational learning: A review of some literatures. Organization Studies, 14(3), 375-94.

Elkjaer, B (2003) Social learning theory: Learning as participation in social processes. In: Easterby-Smith, M and Lyles, M A (Eds.), The Blackwell handbook of organizational learning and knowledge management, pp. 38-53. Malden, MA: Blackwell.

Katz, J and Gartner, W B (1988) Properties of emerging organizations. The Academy of Management Review, 13(3), 429-41.

Kganyago, N (2004) Speech at national black contractors and allied traders forum conference. In, Midrand: South African Government Information.

Nahapiet, J and Ghoshal, S (1998) Social capital, intellectual capital, and the organizational advantage. Academy of Management Review, 23(2), 242-66.

Nonaka, I (1991) The knowledge-creating company. Harvard Business Review, 69(6), 96-104.

Nonaka, I and Takeuchi, H (1995) The knowledge-creating company: How Japanese companies create the dynamics of innovation. New York: Oxford University Press.

Nonaka, I and Konno, N (1998) The concept of "Ba": Building a foundation for knowledge creation. California Management Review, 40(3), 40-54.

Nooteboom, B (2001) Problems and solutions in knowledge transfer, Rotterdam: Erasmus Research Institute of Management.

Partanen, J, Möller, K, Westerlund, M, Rajala, R and Rajala, A (2008) Social capital in the growth of science-and-technology-based SMEs. Industrial Marketing Management, 37(5), 513-22.

Sebake, N and Sithole, B (2005) An investigation of performance of emerging contractors in the Thuba Makote pilot programme affecting the timeous completion of works. In: Talukhaba, a A, Akindele, O A and Appiah-Baiden, J (Eds.), 3rd Postgraduate Conference Construction Industry Development, Johannesburg. Construction Industry Development Board79-90.

South Africa (2000a) Preferential Procurement Policy Framework Act, No 5 of 2000. In: Government Gazette.

South Africa (2000b) Construction Industry Development Board Act, no 38 of 2000. In: Government Gazette.

South Africa (2003a) Broad-Based Black Economic Empowerment Act, No 53 of 2003. In: Government Gazette.

South Africa (2003b) National Small Business Amendment Act, No 26 of 2003. In: Government Gazette.

South Africa (2004) Regulations in terms of the Construction Industry Development Board Act, 2000. In: Government Gazette.

van Wyk, L (2003) A review of the South African construction industry - part 1: Economic, regulatory and public sector capacity influences on the construction industry, Pretoria: CSIR (Boutek).

CLUSTERING AS MEANS OF INCREASING INNOVATIVENESS AND BUSINESS PERFORMANCE OF CONSTRUCTION SMEs

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Innovativeness and technology have a major influence upon firm performance as well as the performance of a particular sector. It has been observed that creation and implementation of innovations can be significantly facilitated by enhancing idea and resources exchange among enterprises and R&D providers. This can occur in clusters that are typically geographically and/or sector limited.

The paper presents fundamental concepts of inventions and innovations, and innovation management. The importance of clusters and their influence upon knowledge transfer and innovativeness level is discussed. Drivers and barriers for innovation implementation in construction sector are presented. Slovenian Construction cluster is presented as an example of successful cooperation between construction industry, knowledge providers and funding institutions that has the potential to increase the sector business performance. Case study analysis shows that clusters can be a valuable tool for increasing the innovativeness level in regional construction sectors.

KEYWORDS: innovation management, construction industry, clusters, SME.

INTRODUCTION

In today’s world, where the competition is strong and pace of globalization is fast, only companies offering new or improved products and services can survive. Innovations that are the basis for new products are therefore vital, and innovation creation and its successful management have a major influence upon firm business performance (Thornhill 2006; Banyte and Salickaite 2008).

Innovativeness level varies among various countries, as well as from one industrial sector to another. For a particular society as a whole, this level can be directly linked to the society's GDP. The European Innovation Scoreboard reports (2004; 2008). show that European Union is still lagging behind Japan and United States in this field. This gap, however, has been continuously decreasing over the recent years. This data and accompanying interpretation should be taken with some case, as a) the report has been designed with a strong focus on innovation in high-tech sectors, which represent a small part of national economy, and b) the interpretation might have been politically motivated. The report, however, is one of the few publicly accessible longitudinal comparative studies in the field of innovations.

The sectors where small and medium enterprises (SMEs) are predominant deserve special attention also in terms of their innovation performance, especially when bearing in mind the fact that these sectors are important users of the new technology (European Innovation Scoreboard 2003). The approach that aims at improving the innovation performance of such industrial sectors should be tailored to their particular features.

This is particularly true for construction sector. This sector contributes to the national economies up to 15% of their revenues. It is highly fragmented and consists of business entities of various sizes and trades, with a large portion of construction companies that can be classified as small or medium size enterprises (Šelih 2007). Some researchers (e.g. Blayse and Manley, 2004) state that there is a direct influence of the innovation level in local construction industries and the likelihood of its contribution to the national growth. The influence of the current economic state, extent of existing built environment and other factors, however, should be taken into the account as well when this relationship is assessed. Unfortunately, construction sector is often perceived as being low- to medium- tech sector, with low innovativeness level. This perception has to be accounted for with care, as the context of innovation in construction sector is far away from being narrow.

Traditionally, construction industry has relied on technological changes, often underpinned by R&D programs of manufacturers (Arditi et al 1997). However, increasingly, non-technical organisational changes in business or marketing methods by consultants and contractors fuel business growth and improved project performance (Manley 2005). Such organisational innovation is often associated with the steady refinement of established methods, involving the roles of people, the organisation of work and response to market opportunities (Manley 2006). When these innovations are adopted, the companies have to be aware that there should be enough time to fully implement the innovations to achieve the full benefit.

Scope of the paper

After discussing the main barriers and drivers to innovation in construction, the paper discusses the role of construction clusters in enhancing the innovation emergence and implementation. The hypothesis that clusters are stimulating the innovations is tested on a case study.

CONSTRUCTION INNOVATIONS

Slaughter (1998) defines innovation as »the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change«. Within the construction industry context, a comprehensive definition of innovation proposed by Ling (2003) states that innovation is »a new idea that is implemented in a construction project with the intention od deriving additional benefits although there might have been associated risks and uncertainities. The new idea may refer to new design, technology, material component or construction method deployed in a project«. Construction innovations can therefore be implemented on construction projects, or within construction businesses (Manley 2006).

As generally agreed by the innovation management scholars, the innovations can be divided with respect to:

- their size: into incremental and radical, and

- their nature into technical and organisational innovations.

Technical innovations bring a novelty or significant improvement into production/product, while organisational (non-technical) innovations bring organisational changes in supply, marketing management or supply chain management. Examples of recent technical innovations are self-cleaning façade paints (product innovation), and production of a RC element made of self-compacting concrete (both process and product innovation). An example of an organisational innovation is an alternative procurement model, which is significantly different from the conventional procurement systems.

The distinction between incremental and radical innovations is based on the size of the innovation step. Improvement of an existing product/service/system is considered to be an incremental innovation, while a major R&D or organisational step is required to achieve a radical innovation.

Project orientation, uniqueness, machinery and labour intensiveness, unpredictable external conditions, safety and health hazards for workers and long duration of projects are all factors that significantly affect the ways construction innovations emerge, how they are defined and can be further diffused and adopted into construction process. Further, various participants are encountered in a construction project: the client as the key stakeholder initiating the project, the designer, contracting and subcontracting companies, and various suppliers and consultants. Depending on the innovation type, successful innovation may have to be able to cross the boundaries of a single business entity.

It is clear that R&D is not the only method of innovating; other methods include technology adoption, incremental changes, imitation, and combining existing knowledge in new ways (European Innovation Scoreboard, 2008). Appropriate innovation management techniques have to be used in order to exploit the innovations' potential within individual companies as well as sectors. Environment that enables and stimulates the creation of new ideas, and facilitates transfer of inventions into production and operation has to be created and nurtured.

Drivers and barriers for construction innovation implementation

There are various drivers and barriers to construction innovation and its implementation into practice. According to Manley (2006), who conducted an empirical study, the single most important driver of innovation is the client, especially repeat public-sector client. When these clients have high levels of technical competence, extensive experience and challenging needs, they are more likely to play a leading role in providing ideas for innovation, and achieve a high rate of adoption of advanced practices and technologies.

Most barriers hindering innovation implementation stem from the construction project special features. Budget and deadlines are defined in every construction contract, along with penalties if they are exceeded. As a consequence, contractor may not willing to take the risk associated with the innovation implementation, as the associated uncertainty may lead to extra execution time and cost. The client setting the deadline and budget can therefore be considered also as an obstacle.

Legal contracts signed by the involved parties, usually used in a construction project, lead to clearly defined duties and obligations among project participants. This clear assignment of duties and responsibilities may hinder the innovativeness within the project in general. Further, a conventional competitive bidding procurement scheme usually faces the participants with a unique setting in every new project. Under these circumstances, trust that is required to develop and implement an innovation in construction, however, can not be built within a single project.

During design and construction, standards and legal requirements regarding structural and health safety must be fulfilled. When new materials and structural systems appear as final results of technical innovations, the standardization must be changed in order to reflect the behaviour and properties of the new materials/systems. Pre-normative research that needs to be carried out prior to adoption of a new standard can be time consuming, and consequently the implementation of the innovation is delayed.

CLUSTERS

General

Clustering has been attracting scientific and public attention since 1990, when Michael Porter has published the book The Competitive Advantage of Nations. The book argues that the successful companies reach and maintain their market share and growth rate due to unique links with various business entities. The business networks, or clusters, enable knowledge, product and services exchange among their members, and facilitate the innovation transfer. In general, cluster members include manufacturing companies, special service providers (e.g. marketing, consulting companies), knowledge providers (R&D institutes, universities) and support institutions (e.g. Chambers of commerce, sector associations, development agencies)

Clusters can be identified as

- geographical, or region-specific (e.g. Silicon valley)
- sectoral (clusters of businesses operating together from within the same commercial sector),
- horizontal (interconnections between businesses at a sharing of resources level) and
- vertical (supply chain cluster).

Although Porter's theory has been criticized for not being founded on comprehensive empirical evidence, the governments have quickly grasped the idea and started to initiate various types of clusters by using the top-down approach. On European level, over the past years, the EC has allocated special funding for cluster support in various industrial sectors, including construction.

This may be contradictionary to the clusters as initially observed by Porter, where bottom-up approach was registered (i.e. industry has created networks on its own and not because of an external initiative).The end result (i.e. a functioning cluster), however, should be the same in both cases.

Clustering in construction sector

Due to the complexity of the construction sector, it is clear that general construction sectors can be classified simultaneously as sectoral, horizontal (as they include companies of one particular type, e.g. general contractors), and vertical (as they include various stakeholders of a construction supply chain, e.g. clients, designers, contractors, specialized subcontractors and material suppliers).

Typically, SMEs lack human resources and do not have R&D capabilities nor the financial resources to engage exterior knowledge providers, i.e. R&D institutions. Large proportion of SMEs in construction sector, as well as the project nature of work that does not enable permanent business relations and supply chains, stimulates the construction companies into seeking the new knowledge in clusters.

The main purpose of innovation clusters is therefore to enhance the innovation processes by simultaneous cooperation and competition among their members, which brings the following advantages:

- facilitated information exchange among stakeholders regarding the buyers, suppliers, technologies, business plans, human resources etc. Better access to information and knowledge transfer is enabled on the basis of the positive cluster capital (predominantly trust). A joint information exchange platform has to be built to facilitate the exchange process;

- use of synergy effects (joint R&D ventures, promotions, etc);

- enabling new business opportunities (e.g. cluster outreach to global markets);

Further, by joining a cluster, the organisation can decrease their transaction costs, create positive externalities (by which common needs can be met), decrease their production costs because of more efficient learning processes (since the cluster members belong to the same geographical, economical and cultural environment), use the advantage of the first market supplier (that can keep the market share due to the economy of scale), use the advantage of better product quality and in general increase the added value in the company.

The hypothesis that clusters in construction enhance the innovativeness level in their members will be examined for a selected case study.

CASE STUDY: SLOVENIAN CONSTRUCTION CLUSTER (SCC)

Slovenian Construction Cluster was established by a governmental incentive in 2004 by joining 21 founding members, who were predominantly contracting companies, a few construction product suppliers and IT companies (providing software for construction companies) and the main Slovenian R&D providers (several public and private institutes and both Slovenian universities that carry out Civil Engineering studies).

Various joint R&D projects in the area of construction technologies, organisation, quality, IT, human resources, education and national economic policy were proposed to be the first goals of the cluster. These projects were initiated by the industrial members. Nevertheless, they were willing to provide only partial contribution for these R&D projects, which hindered the full execution of the projects.

During the first two years of operation, the cluster operation costs were subsidized by the Slovenian Ministry of Economy. Currently, however, no public funding exists for the cluster.

The main challenges placed in front of the industrial cluster members are lack of R&D departments, personnel with limited motivation to take part in R&D projects, and low level of trust among its members, who often compete for the same projects on the market.

The SCC, as a separate business entity, has therefore shifted its focus to international, predominantly European framework projects where it assumes the role of a project partner but also encourages the members to joint the projects. To facilitate the involvement of the industrial partners, the cluster is offering limited technical and administrative support to the industrial partners taking part in the projects.

The following projects are currently running within SCC:

- Establishment of Slovenian Construction Technology Platform that mirrors the European Construction Technology Platform.

- e-NVISION (6^{th} FW project), “A New Vision for the participation of European SMEs in the future e-Business Scenario” with partners from Spain, Lithuania, France and Poland.

- Tech Transfer (6^{th} FW project), where an analysis of the state of the art in the field of civil engineering education is to be carried out, with partners from Poland, Spain and Greece.

- National construction classification project that wants to develop unified classification in construction field and could serve as the basis of future e-business and program solutions in construction.

Considering the size of Slovenia, this list shows that the cluster has been able to attract reasonable EU funds, stimulate the local industry to join the projects and to cooperate with other countries. This shows that it is successfully carrying out the role of the linking partner.

The list of current projects shows that additional knowledge will be created and used by the collaborating cluster members, so that their innovativeness will be improved. For the case study under consideration, the above stated hypothesis can therefore be confirmed.

CONCLUSIONS

Predominant conservative attitude and a large percentage of small and medium enterprises in construction sector hinder the implementation of innovations in practice. SMEs lack human and financial resources, as well as appropriate knowledge. National and regional sectoral clusters seem to be an appropriate response to these barriers. Slovenian government has recognized this fact and has allocated funds to support various sectoral clusters.

Slovenian construction sector is one of them. A survey of its performance shows that the cluster is now well developed, and is engaged in several national and EU projects. Additional opportunities are also opened for its members, and it is clear that innovation activities in Slovenian construction industry are stimulated also by the cluster. Nevertheless, a thorough examination regarding the satisfaction of its members should be carried out in the future, and the results should be used as the basis for future work to increase the willingness to collaborate in cluster activities.-.

REFERENCES

Arditi, D., Kale, S., Tangkar, M. (1997), Innovation in Construction Equipment and its flow into the construction industry, J. of Construction Engineering and Management, 123(4), 371-378.

Banyte, J., Salickaite, R. (2008), Successful diffusion and adoption of innovation as a means to increase competitiveness of enterprises, Engineering Economics, 1(56), 48-56.

Blayse, A., Manley, K. (2004), Key Influences on Construction Innovation, Construction Innovation, 4(3), 143-154.

European Innovation Scoreboard (2004), Comparative Analysis of Innovation Performance, available at http://www.proinno-europe.eu/extranet/admin/uploaded_documents/eis_2004.pdf (April 5, 2009)

European Innovation Scoreboard (2008), Comparative Analysis of Innovation Performance, available at .proinno-europe.eu/metrics (April 5, 2009)

Gann, D.M., Salter, A.J. (2000), Innovation in project based, service-enhanced firms: the construction of complex products and services, Research Policy, 29, 955-972.

Ling F. Y. Y. (2003), Managing the implementation of construction innovation, Construction Management and Economics, 21, 635-649.

Manley, K. (2006) Identifying the determinants of construction innovation, Joint Int. Conf. on Construction Culture, Innovation and Management, Dubai.

Porter, M. (1990), The Competitive Advantage of Nations, Free Press, New York.

Slaughter E.S. (1998), Models of construction innovation, ASCE J. of constr. engineering and management, 124(3), 226-231.

Šelih, J. (2007), Environmental management systems and construction SMEs: a case study for Slovenia, J. of Civil Engineering and Management, 13(3), 217-226.

Thornhill S. (2006), Knowledge, innovation and firm performance in high and low-technology regimes, J. of business venturing, 21(5), 687-703.

DEVELOPMENT OF INTERNATIONAL PROJECT MANAGEMENT IN CONSTRUCTION ENGINEERING:

AT THE TECHNICAL UNIVERSITY OF VIENNA

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The management of construction projects comprises all of the modern management methodologies and principles including project management and applies them across different phases of the construction projects to achieve successful project outcomes in terms of time, cost, quality, safety, processes, people and sustainability.
On the other hand construction projects are becoming more and more complex which is due to a number of reasons: technological advancement and applications of new construction methods; emphasis on sustainability in terms of time, cost, social and political measures.
This leads to significantly increasing request for highly competent project personnel.
The Technical University of Vienna, a leading educational organization in Europe, has developed new project management courses to cover the gaps in this education area.
This paper presents the first results of the conceptual phases and analyses the possible alternatives to introduce this innovative programme in Austria.

KEYWORDS: project management, education, construction engineering.

INTRODUCTION

Companies and even societies are becoming more and more project-oriented nowadays facing a new trend in order to apply professional project management as a strategic option to perform complex and extensive processes. Project-orientation, which can not only be measured in a maturity model therefore embraces not only the dimension project management but also the seven other following dimensions: programme management, the assurance of management quality in projects and programmes, assignment of a project or programme, project portfolio coordination and networking between the projects, organisational design of the project-oriented company, personnel management and process management in the project-oriented company.

The challenges for the project personnel and the respective project-oriented company are therefore becoming obvious. In the future the human capital of such a company must not only have the knowledge but also the regarding experience to perform professional up-to-date project management and all related fields of project management.

The request for highly competent project personnel has risen significantly in the past few years. The human resource departments of such project-oriented companies must therefore strive to recruit, train, provide a career planning or even a project management career path, organise certification programs, monitor the quality, provide project management coaching and provide other various services for such exquisite project personnel. Managers of pm pools and pm offices gain more and more importance in this project management personnel management process, especially in the coordination of the different activities. Nevertheless companies cannot provide all these services in house any longer, but need professional qualified courses at universities in addition in order to secure the quality of the trainings and therewith the project management competence of its employees. (Tsichritzis, 1999)

A short overview about project management within Austrian Universities has shown the following results: most universities of applied sciences offer project management in the traditional way, still focusing on cost, quality and time and no. Gantt charts and network diagrams are almost always a fixed part of the project management courses. Most lecturers have learned project management through their individual experience; therefore most of them present their students e.g. a mixture of certain elements, different standards (International Competence Baseline versus PM Body of Knowledge) and personnel experiences. Generic project management standards and a certain quality of project management courses are therefore still missing at Austrians universities of applied sciences. The situation at universities in Austria can be viewed as being similarly.

Therefore in line with market demand and this rising need for competent (knowledge and experience) project personnel and the lack of courses among generic project management standards the Technical University of Vienna has started to develop a new master programme for project management in construction.

In the next parts, we provide a brief introduction to project management, training models, research methodology, the case study and conclusions.

PROJECT MANAGEMENT

Although project management is a rather young management discipline (started in the 1940s in the US) there are already mixed definitions in the project management literature, either following the more traditional ways or including context elements and social competences.

Traditional definitions are provided e.g. by Baccarini (1999, 29), McCoy (1986) and others who define the project management process as controlling project costs, time, and measures of profitability to gain market share through efficiency. Other authors following similar definitions and concepts are e.g. Hartman and Ashrafi (2002); Jiang and Klein (2001), (Riggle, 2001) etc.

The authors of this paper will follow the more dynamic and integrative views of project management process (cf. Jaafari, 2003; Gareis, 1989; Ward, 1999; and Royer, 2000). These authors consider culture, organisation, and other ‘soft’ factors as additional dimensions which influence project success. They view project members and teams more from an action-oriented, interactive perspective in which process is part of and linked to product outcomes.

As those concepts are widely known in the project management community the authors will move on describing training models etc.

TRAINING MODELS

In this part we provide an overview on training models to provide a better understanding for the design of pilot project management courses at the Technical University of Vienna.

The existence of a learning loop feedback into the strategic intent was therefore of high importance for the development team, enabling improvement and long term sustainability (Connel, 1996; Taylor, 1994).In this particular framework, quality of decisions is assessed in regards of their influence on organizational effectiveness. Organizational results are broad and strategic level programs must combine a range of interventions taking into account, not only predetermined rationalized responses, but a range of responsive interactions (Nevis, 1997; Neal, 1995; Thomas et. Al, 2000). Inline with this approach the Technical University started new pilot courses to share and analyse the gained experience in the planed master programme.

According to (Tsichritzis, 1999) the workflow of developing and teaching an undergraduate course consists of the following four stages (Figure 1):

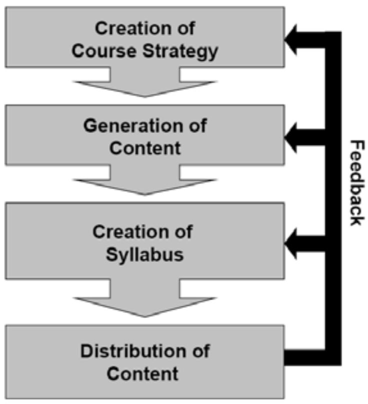

Figure 1: Teaching process

First of all the course strategy and learning objectives shall be developed in line with other course strategies of the Technical University and relationships to other provided courses shall be analysed. Next the course content and afterwards the syllabus have to be developed, being a guideline for the distribution process of the content, evaluation of the course and student. During the distribution of the newly developed content the course instructor receives feedback; which might lead to a re-design of course strategy, content and syllabus.

RESEARCH METHODOLOGY

This section introduces the underlying research methodology. Literature review and an analysis of provided courses were conducted in the first phase of research. In the second phase qualitative expert interviews served as a guideline for the identification of key success factors for project management courses at the Technical University of Vienna, Austria.

Qualitative research is appropriate when the examined phenomenon requires an explorative investigation (Degenhardt 1986), which provides the flexibility for identifying new variables and new relationships among them. Qualitative research is complex, involving fieldwork for prolonged periods of time, collecting word and pictures, analyzing the information inductively while focusing on participants' views and writing about the process (Creswell 1998). A set of open ended questions served as interview guideline to secure that all relevant topics are dealt with in the interviews (Rubin 1995). The open ended questions encouraged the interviewees to talk freely about the topic. In the case of unclear responses the interviewer asked into more detail and increased the quality of the information by active listening. The most important founding was that students are often missing basic project management skills and that the quality of these project management skills differs widely.

In the third phase a pilot course for project management was developed and introduced at the Technical University. The trainer for this pilot course first participated in a Train the PM Trainer programme. The course was provided as an interactive workshop. The students had to implement the course inputs directly into selected training projects. Adding an additional quality perspective the course was developed based on the standards of the International Project Management Association, Level D. After the course the students therefore were able to pass the certification to become a Junior Project Manager provided by Project Management Austria, the certification body of IPMA in Austria. The project is now in the last phase planning the roll-out of the new pm courses to more students, providing a common body of knowledge in PM and to use these experiences for the development of the master programme. The following graph illustrates the development design:

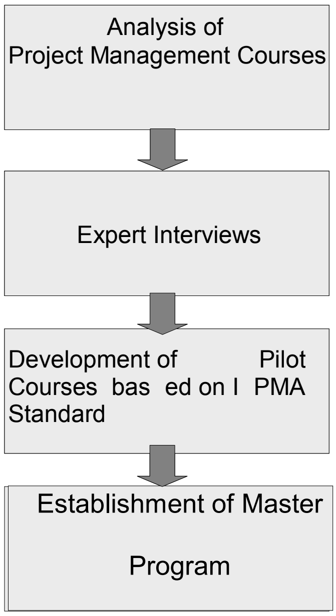

Figure 2: Research Design

THE CASE: THE TECHNICAL UNIVERSITY OF VIENNA

At the Technical University of Vienna eight faculties are covering the classic engineering and natural sciences. In 64 institutes more than 2000 scientific employees in education and research are working in the fields of construction engineering, mathematicians, electricians, chemists, physicians, architects, city and regional planners etc.

Although the Technical University of Vienna is Austria's largest and most important institution for technical education in Austria project management is still not a mandatory course in the bachelor and master programmes. Due to this gap there was an emerging need to introduce a pilot project management course for students in order to test whether the target group would recognize the need for professional project management and would accept the course design, based on a generic approach. In this part a specific aspect of teaching in Austria should be stressed, which is an important barrier in teaching at many Austrian universities. Due to the freedom of teaching (”Freiheit der Lehre”), the quality of the skills of Austrian universities' graduates are not transparent. According to Gellert professors, protected by this Humboltian principle, mostly teach whatever they like, and hardly engage in personal tutoring of students (Gellert, 1999). This might be a barrier in many universities to meet market demands.

ANALYSIS AND CONCLUSIONS

In this part we summarize and analyse the process and then the work content, stressing the main barriers and challenges of the research project:

One of the challenges of introduction of project management education is the maturity of organizations in project management. The Technical University of Vienna, with rather little experience in project management courses itself and professional project management on an organisational level might face therefore more barriers in introduction of pm courses.

The introduction of new courses is coupled with uncertainty, continuous change and resistance in the political structure of a university. We therefore advise to hire experienced senior project managers.

The core and reflective learning subject combined provides a unique learning experience. Application and link to case studies (bring your own projects) is inter-related to other aspects of project management theory. Our progressive approach to development has, in our opinion, so far proven successful. We believe that adopting an iterative approach was crucial to this success. However, we believe that other influences would have jeopardised development. Finally, we would like to highlight the fact, that the team adopted a student-centred approach to delivering the curriculum. In line with our previous experiences this has proven successful in capturing the interest of our students and also in encouraging them to develop their high-order cognitive skills.

REFERENCES

Baccarini, D. (1999), “The Logical Framework Method for Defining Project Success”, Project Management Journal, Vol. 30, No 4, 25-32

Gellert, C. (1999), “Innovation and Adaptation in Higher Education, The Changing Conditions of Advanced Teaching and Learning in Europe”, London, Philadelphia: Jessica Kingsley Publishers

Hartman, F. and Ashrafi, R.A. (2002) “Project Management in the Information Systems and Information Technologies Industries”, Project Management Journal, Vol. 33, No.3, p5-15.

Höllinger, S. and Musner, L, (1988) “Humboldts Erbe als Mythos und Herausforderung in der heutigen Hochschulpolitik“, in Wilhelm v. Humboldts Universitätsidee - ihre Bedeutung für die Hochschulausbildung heute, Berlin: Zentralstelle für Lehr- und Organisationsmittel des Ministeriums für Hoch- und Fachschulwesen, pp. 7-18.

Jaafari A. (2003) Project Management in the Age of Complexity and Change. Project Management Journal. Vol.34, No 4, pp 47-57.

Jiang, J. J. and G. Klein (2001), “Software Project Risks and Development Focus”, Project Management Journal 32(1), 4-9.

Kaplan, B. and Maxwell, J.A. (1996): "Qualitative Research Methods for Evaluating Computer Information Systems," in Evaluating Health Care Information Systems: Maxwell JA. Qualitative research design: an interpretive approach. Thousand Oaks, CA: Sage Publications.

McCoy, F. (1986) “Measuring success: Establishing and maintaining a baseline”. PMI Annual Seminar & Symposium, Montreal

Nevis,E., Di Bella, A., Gould, J. (1997) “Understanding Organizations as Learning Systems”, The Society for Organizational Learning Website; 1997.

Neal ,R. (1995) “Project definition: the soft systems approach”. International Journal of Project Management, 13(1):5-9.

Riggle, M. (2001) “Breaking the Cycle of Failure”, Intelligent Enterprise; No. 12; Vol. 4; Pg. 40-44

Thomas, J., Delisle, C., Jugdev, K., Buckle, P. (2000) “Selling project management to senior executives: what’s the hook?” Project Management Institute 1st Research Conference Proceedings, PMI Communications, Drexel Hill, PA.

Tsichritzis, D. (1999) “Reengineering the University“, Communications of the ACM, vol. 42, pp. 93- 100

Ward, Stephen (1999) “Requirements for an Elective Project Risk Management Process”, Project Management Journal, Vol. 30, No. 3, 37-43. Project Management (Reading, MA: Perseus Books).

DEVELOPING TECHNOLOGIES FOR STRUCTURE MONITORING

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Civil engineering objects are exposed to different loading cases, which can have an important influence on structure functionality, safety and durability as well as on the safety of their users. To assure the full functionality of structures through their entire life cycle including the construction phases it is of great importance that there are enough possibilities to follow their behaviour and response to different types of loadings. The first step to make this possible is to develop a stable and reliable monitoring technology which is based on robust and cost effective sensors applied at all important places of the structure especially where the access is difficult or even impossible after finishing of construction works. Very important is that the positioning of sensors at the chosen measuring points does not disturb the construction process and the measurement results can be continuously obtained from the early construction stages to the end of the structure life cycle.

KEYWORDS: monitoring, measurements, technology, structure performance.

INTRODUCTION

The idea of developing the efficient monitoring system arose in 1998 when more than fifty bridges, overpasses and viaducts in Slovenia were investigated. Some of them needed additional strengthening, some of them had to be totally reconstructed. The reason for this was that the Nuclear power plant in Krško needed new steam generators. They were transported by a ship from Spain to Koper. However, the transport of two compositions from Koper to Krško, that weighted more than 800 tons, used the road infrastructure system. In some cases, the weight of this transport several times exceeded the project loading and sometimes also the additional loading effects were caused due to inconvenient load distribution on bridging structures. The design engineers responsible for the strengthening and reconstruction of bridges had to establish their present bearing capacity to find the optimal way for making them capable to carry the heavy transport. In most cases the existing project documentation was the basis for strengthening and retrofitting projects and there was always the question if this was enough since no one could determine the degree of degradation of structures older than 30 years with certainty. Therefore, all accessible vital parts of structures were carefully examined and sometimes also the loading tests were performed. A big amount of examined important structure parts could be reached only by special made scaffolds or with the help of special trained stuff that used alpine climbing equipment. Therefore, it would be very convenient to have a monitoring system consisting of sensors already installed on such difficult reachable points which could provide data about the behaviour of structure and the condition of its vital parts.

Nowadays many types of sensors are developed so that they can be built into structure body (temperature and moisture sensors, sensors for measuring the corrosion level, etc.). In the present paper the main attention is focused to the development and usage of strain sensors that proved themselves very reliable and applicable.

THE DEVELOPEMENT OF SENSORS

The strains of concrete structure elements are usually measured on its surface. For the surface strain measurement on concrete elements at least 100 mm long strain gages have to be applied directly to the concrete surface. This could be a quite difficult task since in most cases the concrete surface is not smooth and is full of smaller or bigger holes or local damages and cracks. The concrete surface should be grinded as much as possible in order to be suitable for strain gage application. The smoothing of the surface therefore produces a lot of dust. That could influence a quality of adhesion. Another problem is that the whole process of strain gages application and wiring takes a lot of time and disturbs a normal working process on a construction site. Despite careful protection the measurement points and connection wires are usually exposed to rough conditions in the sense of temperature changes, precipitations and several possibilities of damage. This may cause disturbances in measurement signal especially when the period of measurement is very long. Last but not least, sometimes very important events that should be followed by strain measurements appear when the concrete is still in formwork and the places where the strain gages should be applied cannot be reached or the surface of observed concrete element may be too wet.

To avoid the majority of such problems the other concepts for preparation of measuring points can be used. For example, the strain gages can be applied directly on reinforcement bars before concreting the structure element. Advantages of this approach are that the strain gages with 6 mm long measurement grid can be used and with the application directly to reinforcement bars the influences of nonhomogenities of concrete are avoided. This measurement technology was used to follow the deformation changes on the contact surface of foundations and piers during the critical construction stages and during the loading test of the Viaduct Črni Kal (the largest viaduct in Slovenia – length: 1065 m, height: 100 m). The main disadvantage of this method is that the preparation of surfaces an application of strain gages together with wiring and placing of all layers of protection coatings takes a lot of time. The dust and eventual moisture that cannot be avoided on an open construction site are also disturbing factors.

The next step in development was then the idea to prepare the chain of measurement points outside the structure and to place it into the final position after finishing the process of reinforcement. The first opportunity for testing this idea was the estimation of a testing pile shaft resistance. The basis of this estimation was the measurement of the normal strains of the pile in its axial direction in measuring points distributed on equal distances along the pile axis. These strains are proportional to axial forces in the pile. When the course of the axial force along the pile axis is known, the resistance of the pile shaft can be estimated. The measurement points were distributed on equal distances of 1.0 m starting 0.5 m above the pile toe. As the strain gages, electrical contacts and communication cables are very sensitive, the moisture and mechanical burdening could be very harmful. So the measuring points were protected with special care. To insure the mechanical protection of the chain of strain gages together with the communication cables the whole measuring system was built inside the steel canal made of two standard C-profiles. The interior surface of the steel canal served also as the grounding surface for the strain gages to be glued on. From transportation reasons the canal was made from three segments that could be easily put together. The mutual connection of the segments was ensured by a special system of joints. The outside canal surface was degreased and made rough to ensure the adhesion with the concrete. Each strain gage inside the canal was protected against the moisture. When the measuring canal was finished it was connected with the pile reinforcement and put into the pit prepared for the pile concreting. The measurement system fulfilled the expectations and the measured results were accurate and stable. The only disadvantage of this measurement system was its non-flexibility. It could only be used to build the measurement chains where the measurement points are placed along one line and oriented in the same direction.

The final solution for strain sensors was to build a complete strain sensor for a single measurement point with all layers of protection coatings and wiring. Such sensors can be placed to desired positions in a very short time. They are insensible for moisture and dust and their vital parts are very well protected against mechanical damage. The basis for such sensors is a standard reinforcement bar of length about 150 cm and diameter 16 mm. In the middle of the reinforcement bar its surface is grinded on one or both opposite sides depending on the number of strain gages that should be applied. Strain gages can be connected in full, half, double quarter or quarter Wheatstone bridge. The connecting cable is protected by a PE tube and fixed to the reinforcement bar as seen in Figure 1.

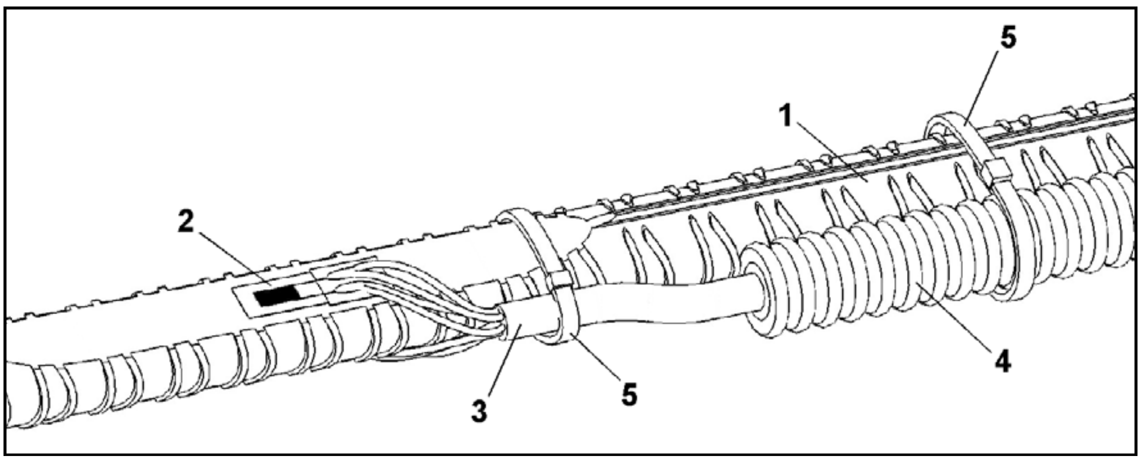

Figure 1: The measurement area of the strain sensor before application of protection coatings: 1 - reinforcement bar; 2 - strain gage with solder points; 3 - connection cable; 4 - PE tube for cable protection; 5 - PE binding element used to fix the cable to the reinforcement bar

The protection coatings consist of two layers of PU warmish, a layer of special silicone putty and a layer of permanently plastic sealant putty coated by aluminium foil. This combination of protection was tested and remained waterproof even at 30 m under the water surface. The final layer represents the physical protection and can be made of PE tube (Figure 2) when the dimensions of the measured concrete elements are not too small to be significally weakened by the built in sensor. Otherwise the physical protection of measurement area can be made of cement mortar with addition of acrylic emulsion as shown in Figure 3. This type of strain sensors proved themselves very reliable, easy to build and cost effective.

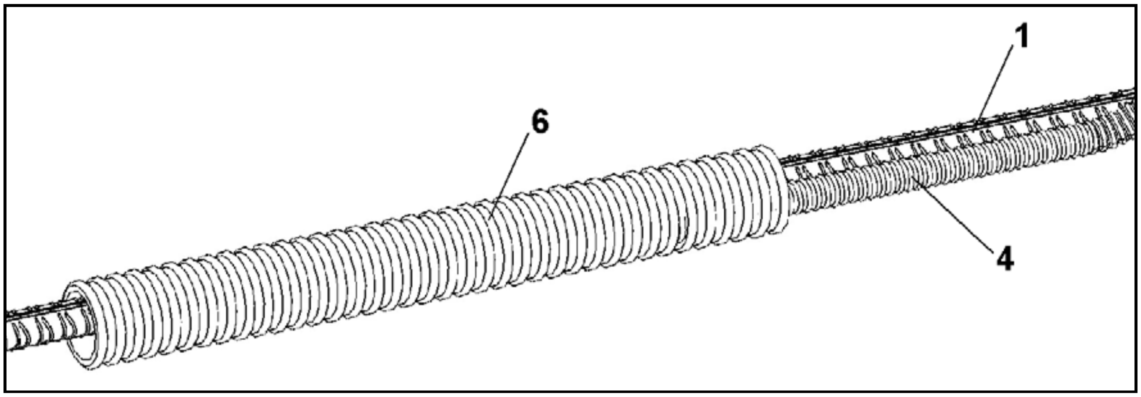

Figure 2: The final look of the strain sensor after application of protection coatings and physical protection of measurement area made of PE tube: 1 - reinforcement bar; 4 - PE tube for cable protection; 6 - PE protection tube of inner diameter 40mm for protection of measurement area

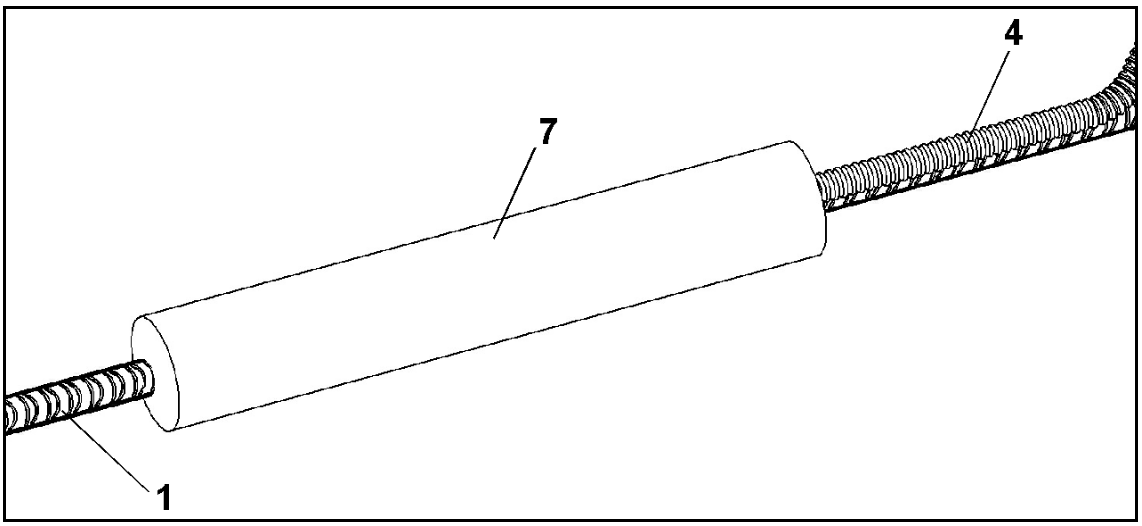

Figure 3: The final look of the strain sensor after application of protection coatings and physical protection of measurement area made of cement mortar: 1 - reinforcement bar; 4 - PE tube for cable protection; 7 – cylindrical shaped protection of measurement area made of cement mortar with the addition of acrylic emulsion (diameter 50mm)

EXAMPLES AND RESULTS OF STRUCTURE MONITORING

Investigations of deep foundations

Foundations of bridging structures are frequently laid on soils of unfavourable geological composition which leads to decision to lay foundations on pilots or wells. In spite of an extremely sophisticated and expensive realization of these foundation structures, in most cases no activities are run during the construction and exploitation phase that would provide a designer with a feedback about the outcome of the foundation design or how the selected foundation laying method affects the behaviour of the whole structure as a result of soil-structure interaction. To verify the numerical simulations of pile behaviour the described sensor systems were used to investigate the bearing capacity and shaft resistance of pile structures. These were embedded into some pilots and tested for their performance and sensitivity to mechanical damage as well as different embedment techniques (Štrukelj et al. 2005). The analysis of the obtained results showed that our endeavours are sensible since these systems would allow not only to monitor the pilot foundations but also to determine the extent of deformations transmitted to the soil with friction via the pilot coating and the extent of deformations transmitted to the pilot footing. This means that the whole mechanical soil–structure interaction could be monitored. It would be possible to analyze the pilot behaviour at vertical and horizontal loading. These systems would be especially effective if loading tests were used to determine the load-bearing capacity of pilots. Considering a great number of measuring results along the total pilot axis at different regimes and intensity of static and dynamic loads, designers could obtain a complete image of the testing pilot behaviour and its interaction with the soil. The results obtained in this way would also allow improving mathematical models and the realization of quality computer software for simulating not only the behaviour of foundations but also that of the structure as a whole. In the Figure 4, the time history of normal strains measured along the test pile axis during the statical loading test of a pile is presented. Because of graphical limitations only four curves are shown. On the basis of measured results the average pile shaft resistance has been estimated (Figure 5). The same situation was simulated by 3D computer analysis. After improving the soil model based on measured results the measured and calculated results showed very good agreement.

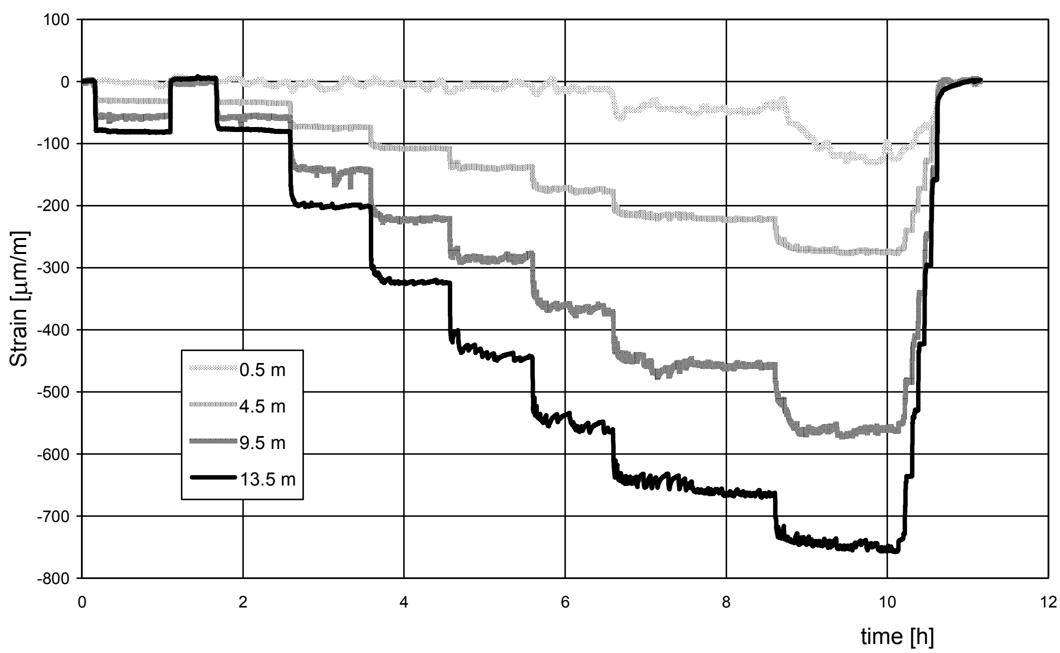

Figure 4: Time history of the measured normal strains along the test pile axis through all loading stages

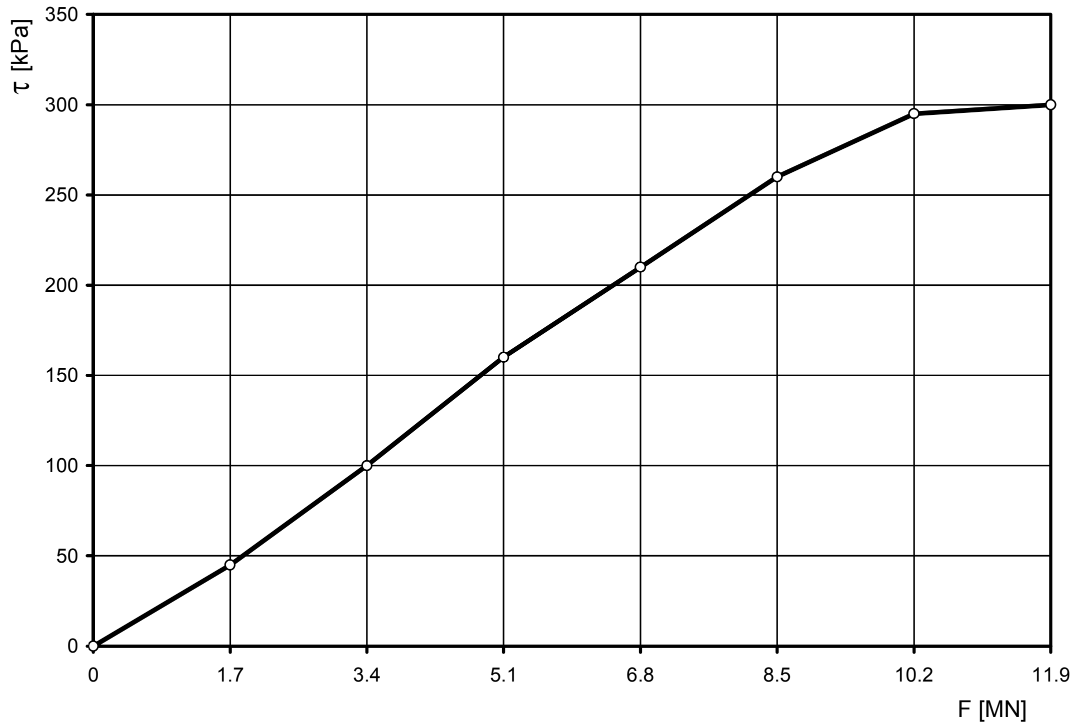

Figure 5: The estimated average pile shaft resistance as a function of a vertical loading obtained on the basis of axial strain measurements

Monitoring of bridging structures during construction

A new viaduct "Peračica" was built in 2007 on the highway Ljubljana – Jesenice. It overbridges a deep valley near Bled. The heights of three piers are 27.00 m, 50.00 m and 56.00 m. The spans situated on both ends of the viaduct are 73.50 m and the both middle spans are 110.00 m. The balanced cantilever technology was chosen for the construction. The building of the bridge deck started from each pier where the base segment had length of 7.50 m, the length of first segment on both sides of each pier was 4.00 m and all other segments except the last (middle) one were 5.00 m long. The disposition of the viaduct is shown in Figure 6. This was the first large viaduct where the efficiency of new developed monitoring system was tested. During the construction, 72 strain sensors were put in all important parts of the structure including foundations, piers and important places in bridge deck. Strains were measured in all measurement points and they were compared to the results of computer simulations. In this paper, only measurement results from the measuring points placed in the corners of the section between the first and the second segment of the deck structure seen from the highest pier in western direction will be presented because of graphical limitations. The section where the results are presented is also signed with A-A in the Figure 6.

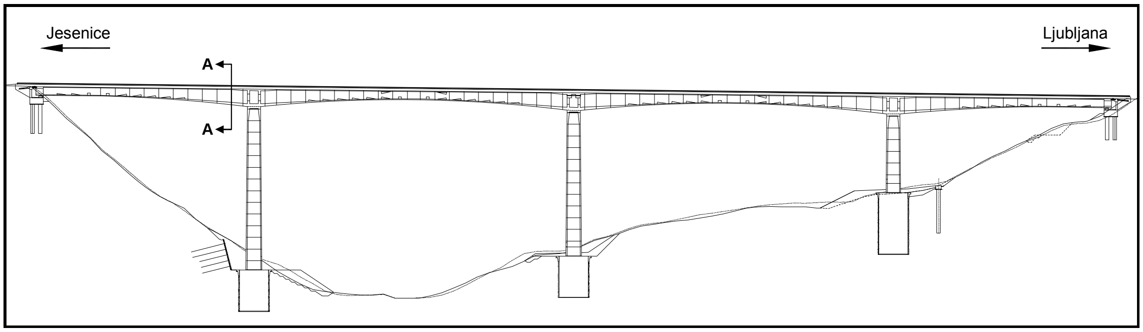

Figure 6: The longitudinal section of the Viaduct “Peračica”

In Figures 7, 8 and 9 the strains caused by three characteristical events during the building of one segment of viaduct are presented: In Figure 7 the strains during concreting of the third segment are shown, in Figure 8 the strains during prestressing of the same segment can be seen and in Figure 9 the strains caused by moving of the erection gantry from the second to the third segment are displayed.

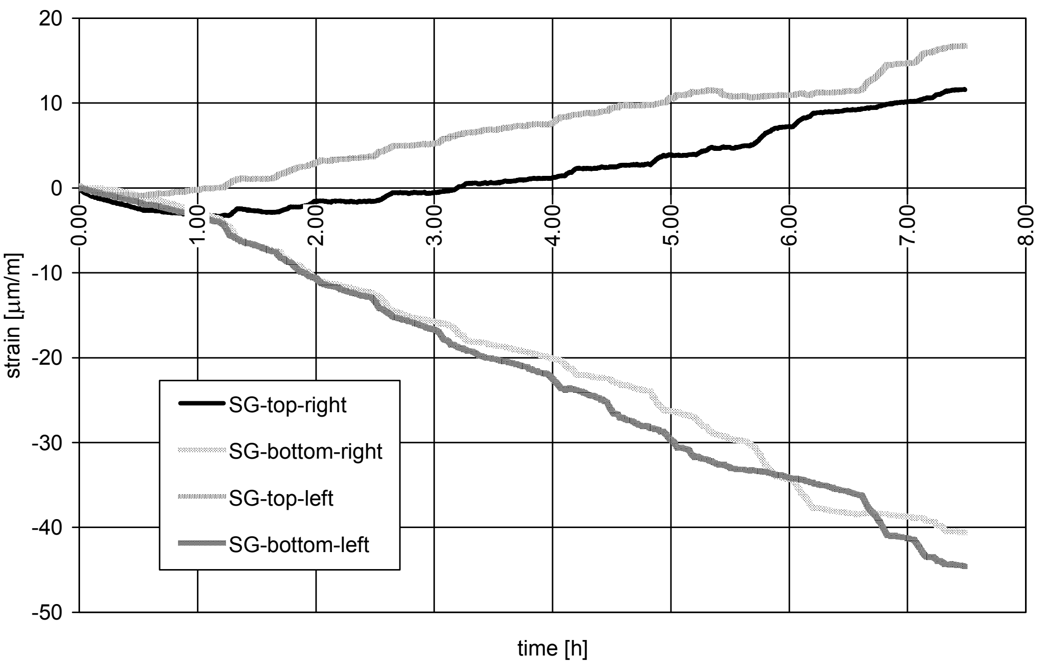

Figure 7: Strains in the corners of section A-A during the concreting of the third segment

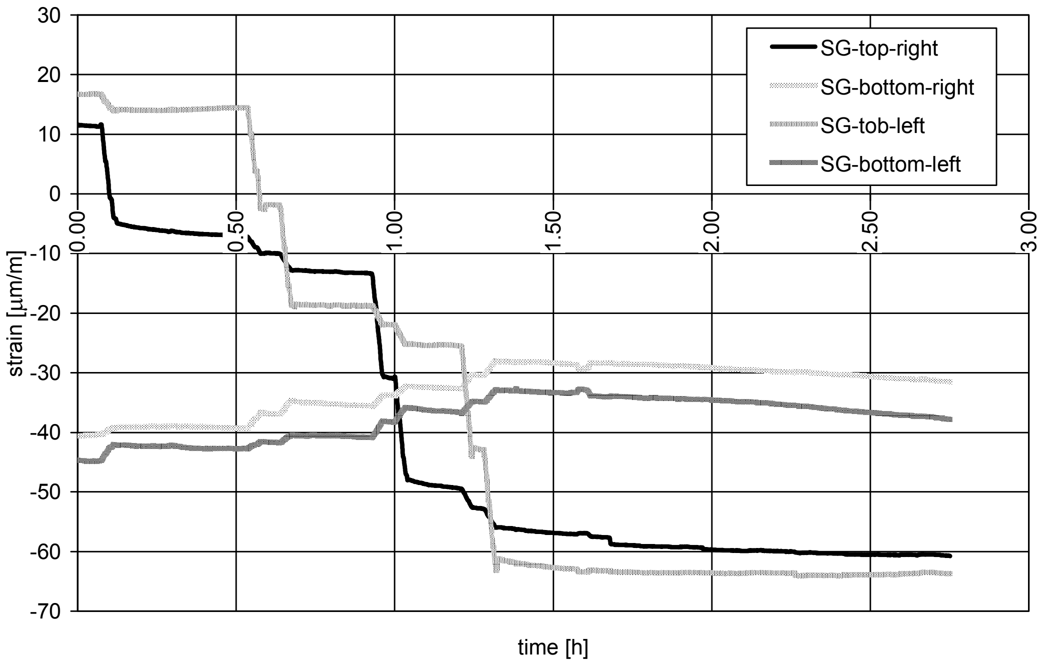

Figure 8: Strains in the corners of the section A-A during prestressing of the third segment

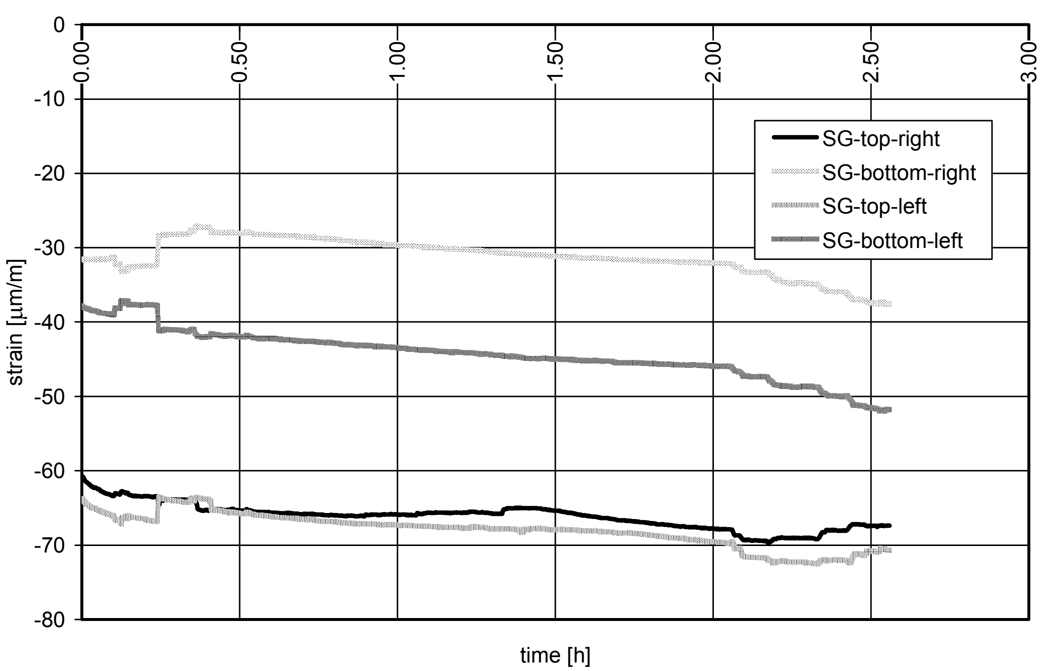

Figure 9: Strains during the moving of the erection gantry from the second to third segment

The described sensors were carefully tested before usage in the structure of viaduct “Peračica”. They were first built into the body of deck structure of a small highway overpass near Maribor in October 2004. Until now all twenty sensors are in operation and all of them are working properly and stable. Since the cost of material needed to prepare a sensor does not exceed 110.00€ (depending on the length and quality of connection cable and the number of strain gages used for preparation the sensor) the price – performance ratio is very convenient. The price of monitoring depends on type of investigation needed to be performed. The simplest kind of monitoring is the measurements of structural response on expected events in a short period of time. The operator has only to plug the connection cables from sensors to the measuring equipment and perform the planned measurement. On the other hand, permanent monitoring can be the most complex and it demands the measuring device which is connected all the time. It needs the permanent reliable energy source as well as the computer with software controlling the measurement and saving the measured results. If the computer has internet connection or remote access of any other possible ways, the presence of measuring stuff at the testing or in a construction site is no longer needed. The measurements can be manually (through the remote connection) or automatically triggered. Such complex type of measurement system can be used at the same time as a warning device which can set up an alarm when one or more measured values reach or exceed the programmed limits.

CONCLUSIONS

To sum up, during the construction works some very useful information about loading history, which are not available after finishing the structure, could be obtained with simultaneously performed monitoring of structure behaviour. Therefore, obtained data together with information gathered during the exploitation of the structure are very important, especially in case of strengthening, reconstruction or even maintenance of structure. A monitoring performed continuously during all important construction stages is of essential importance also in the case of using the construction technologies where the loading intensity on some structure parts during the construction is much higher than during the exploitation period (for example the technology of balanced cantilever construction of bridging structures). This contributes essentially to higher level of safety during the construction. With the use of measured data regularly obtained and analyzed during the exploitation period it would be also possible to create the criteria that could assure the optimal strategy of structure maintenance in order to keep the full functionality of structure through its entire lifecycle. Moreover, the analysis of the last stage in the structure life (eventual demolition) could be preformed with such monitoring system. In that case the important information about the influence of local overloading and collapse on global stability and safety of structures, that are similar to observed one, could be obtained. On the basis of such results the warning systems in case of some catastrophic events could be improved to assure safe evacuation of structure or prevent an access to dangerous areas. Besides, the safety for structure users can also be improved.

REFERENCES

Bijen, J. (2003) Durability engineering structures. Cambridge: Woodhead Publishing Limited

Crowter, C. L. (1988), Load Testing of Deep Foundations: The Planning, Design and Conduct of Pile Load Tests.

Hoffman K. (1989), An Introduction to Measurements using Strain Gages. Darmstadt: Hottinger Baldwin Messtechnik GmbH

Hoffman K. (1996), Hinweise zum Applizieren von Dehnungsmeßstreifen (DMS), 4. erweiterte Fassung. Darmstadt: Hottinger Baldwin Messtechnik GmbH

Page C. L. And Page M. M. (2007) Durability of concrete and cement composites. Cambridge: Woodhead Publishing Limited

Ryall M. J., Parke G. A. R. and Harding J. E. (2000) Manual of bridge engineering. Bodmin: Thomas Telford Limited

Štrukelj A., Škrabl S., Štern K. and Logar J. (2005) The assessment of pile shaft resistance based on axial strain measurements during the loading test. Acta Geotechnica Slovenica, 2005/2, 13-23.

Štrukelj A. (2008) The sensor for strain measurements in civil engineering structures. Patent declaration No. P-200800063. Ljubljana: The Slovenian Intellectual Property Office

PRIORITIZATION OF PRACTICAL IMPACTS OF ACADEMIC RESEARCH ON CONSTRUCTION MANAGEMENT

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In general, the contributions of academic research do have only minor, true impacts on practices in the private and public sectors. Academia is primarily engaged in its own scientific sphere of thinking and using theoretical vocabulary. University entities schould assume the dual roles of a scientific article producer and a practical problem solver. The aims of the paper are; To make a synthesis of the long-term, collaborative RDI work in the field of construction management, and to outline a high-impact research management philosophy with strong implementation aims. We have gained a series of high-impact contributions by cultivating the calculative-empirical approach, action research, case studies, and piloting. Our way of research management include the visionary hypotheses of both problems with their root causes and solutions as well as the implementation plan to make required changes in current practices within focal firms and organizations.

KEYWORDS: **collaboration, action research, construction management, research philosophy, industry impacts, implementation.**

INTRODUCTION

It is well known that the practical use of academic research results is far from expansive. The academic tradition, articles in scientific journals, all go ignored by the construction industry. The misunderstanding is mutual; scholars do not warm up to wide-ranging practical problems in business and processes. Even the term cooperation is understood differently: for the scientists it usually means that businesses will provide them with material and information for study, and for the businesses it means that the results can be utilised in making decisions and carrying out changes and transformations. A general assumption among the researchers is that a decent written report will be enough to bring about changes in operation, even though it was attested by Ackoff as early as in the 1970s that “knowledge does not alter behaviour, behaviour alters knowledge” (Ackoff R. 1970). Research results must therefore be consciously implemented into practice within the corporate world. Implementation requires the problem being researched to be distinctly real, the research methods to have the capacity to deliver the desired results, the application of the results to have been pre-planned, and contacts with the clients to have been established.

The purpose of this paper is to present the results of long-term (1978 – 2008) development work in which we aimed to produce practicable results, methods, or data files. The subject of this study is research projects itself and their practical results, with particular attention to the research methods and the implementation process. We began publishing international papers only at the end of the 1990s and were instantly faced with a difficult decision as to which we should do; development work, like an engineer should, or academic papers, like a natural scientist should. We chose both. Our “paper-mill” produced approximately 160 peer-reviewed international conference papers and journal articles between 2003 and 2008, all of them useless from a practical standpoint. Academic value is measured by an journals impact factor. However, only the most prestigious and indexed journals in natural sciences and management and economics yield high impact factors. Such journals rarely feature articles dealing with problems in construction, and are never read by construction professionals anyway. The Department of Structural Engineering and Building Technology at Helsinki University of Technology (TKK) is exceptional even on a global scale; structural design, construction technology, and construction mangemnt are taught in the same unit. Through competent project management in the Unit of Construction Management and Economics the development work has been adjusted to suit various project and corporate management systems.

From the beginning of 2010, Helsinki University of Technology will merge with Helsinki School of Economics and Helsinki University of Art and Design to form Aalto University. Concurrently, the university board will be composed entirely of people outside the university, mainly from the corporate world. Scholars are aiming for high academic status and corporations are expecting innovations. Hence, this is the time to evaluate the objectives for research at TKK; who is it that we are conducting research for? The researchers themselves, the scientific community, the University, or society or the economy in general?

TEKES (the Finnish Funding Agency for Technology and Innovation), a major financier of research and development in Finland, requires research projects also to receive funding from businesses. Thus the research subjects have to be chosen so as to garner sufficient interest from the businesses. This has had a clear effect on problem settings and the practicality of the results. Finnish scholars have now had to adapt to splitting their time between producing articles, solving problems for corporations, and implementing their research results. Finland is not different from other coutries in that the construction industry invests very little in development, and shows equally little interest in academic research services, even when TEKES funds 100% of all university-level research done for firms. With modest investment comes modest payback. Companies are not willing to apply even the positive results into their business operations. Scholars, seen as outsiders to the industry, find no consolation in the fact that research and development gets no more appreciation inside the construction industry, compared to “real construction work”.

RESEARCH METHODS IN CONSTRUCTION MANAGEMENT

The traditional research methods in economics and the social sciences, such as interviews and surveys, do not provide new answers to practical problems in construction projects. The respondents describe problems caused by other parties and suggest that the others should change their ways of doing. Statistical methods offer no more help in solving business and process problems. Company- or project-specific data selected from large statistics are too rough and narrow by default, and often unreliable. Even mathematical statistics fails to provide methods that could allow one to distinguish single factors from a practical mess. Full-scale experiments can be organised only seldom on a project-wide level. However, two of the leading scientific journals in the field that we have systematically studied have made extensive use of surveys in particular.

The CME Unit at TKK uses a computational-empirical approach, action research, and case studies, checking the results through real-life testing and implementation through pilot testing. The directors of the research must have hypotheses and a vision both of the problem and of its solution, and implementation needs to be a central goal of the research from the very beginning. It is our understanding that it is necessary that the management philosophy for the problem, the methods and tools needed for its solution, and the requisite data related to the methods be developed concurrently. Chace of the paradigma is often needed.

The computational-empirical method means that the contributing factors, effects, and differences are identified through computational methods, but the result is statistically tested against the empirical data and calibrated to match an empirical level. Which is contrary to what the research textbooks say; the differentiating factors schould be determined from the empirical mess through, for example, regression analysis. The computational-empirical method was applied in the development and constant updating of the Finnish Target Price System, among others (Kiiras 2006a). At the same time we established the principles for creating the data files or banks for construction management (Kiiras 2006b).

In action research we intervene in real practical action and are able to draw conclusions immediately. Interventions necessitate a clear vision of what types of measures are to be taken, and what tools are to be used. Action research was a salient method in the development of Advanced LoB. Our propositions are always subjected to testing, at the very least through pilot tests in real-life circumstances, as was done in our development of contract models and in the research development design of the so-called FinSUKE. At TKK we conduct the major part of our research through Master theses, which places particularly high demands on the direction of those theses and the whole reseach project. An interesting discovery that we have made through this process is that well-directed Master's theses produce a good deal of results, but the academic quibbling in doctoral dissertations detracts from any added benefits.

EXAMPLES OF PRACTICAL RESEARCH AND DEVELOPMENT

Five examples of collaborative reseach and development work is presented:

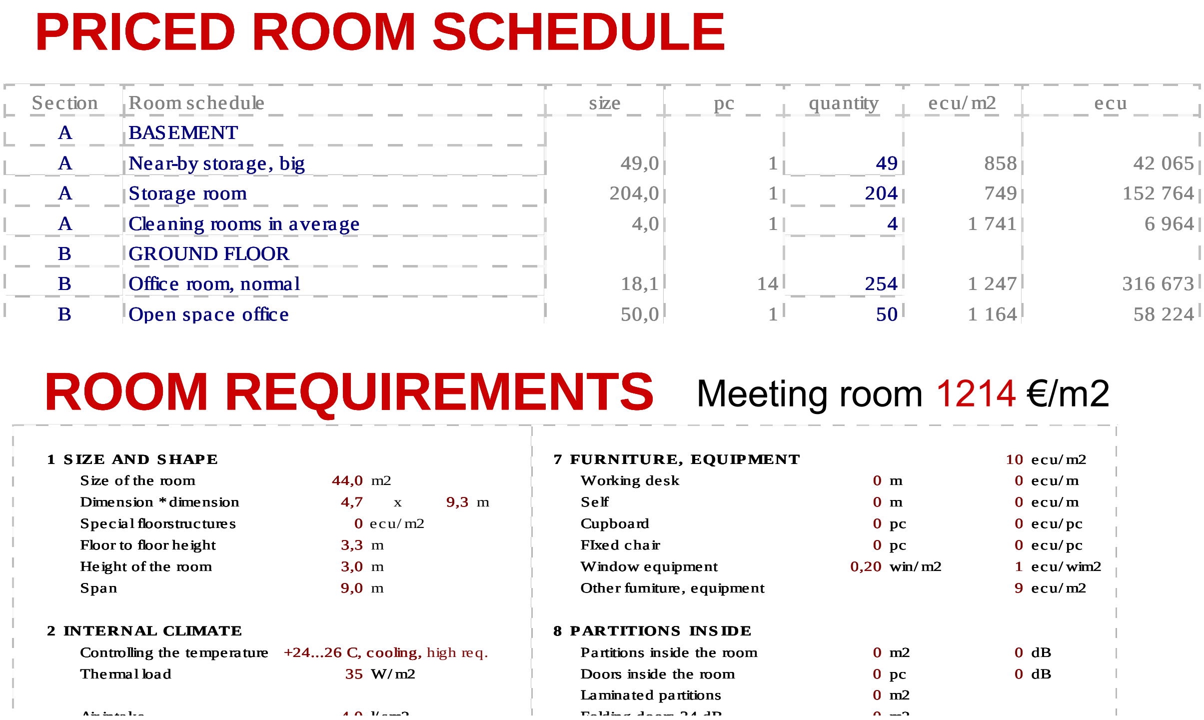
- Finnish Target Price System (FinTPS) 1980 →
- Advanced LoB or Time-Place diagram (AloB) 1985 →
- Finnish Construction Management (FinCPM) models 1995 →
- Design Management for CM projects (FinSUKE) 2000 →
- Risk Management for CM projects (CM-Risk) 2005 →

Finnish Target Price System (FinTPS)

The TPS was developed together with Professor Yrjänä Haahtela in 1980. This method changed the basic idea of project cost control; the traditional thought of interpreting cost overruns as mistakes in cost estimation was supplanted by viewing them as defective project management: the designs for the project are discordant with the budget, which is to say that the designs are too expensive and need to be refined. The most significant change was made in the composition parameters for the budget: the target price is determined by the project programme rather than the designs proposed by the project. In this way the design can also be evaluated and managed. In this procedure the pricing covers the overall space designated by the programme, instead of the building types, which leads to a broad range of use and adaptability for different types of projects. The prices for the spaces are public, and initially they were determined computationally. The usability of the prices was meticulously tested using mathematical statistic methods and calibrated with the contract-price level of completed projects. The Finnish Building Element Estimate (BEE) was developed synchronically with the TPS. It is a conventional Element Estimate that is based on public unit prices. The BEE is used to estimate whether the designs conform to the budget.

Updating of the data was immediately set as a basic requirement in creating this system. Space requirements have been updated and the space pricing has been calibrated to the prevalent actual contract price levels. Thus, the updating procedure is cybernetic, in accordance with Stafford Beer’s principles (Beer 1966). The updating has been very successful; the space prices have been able to follow both the cyclic development of prices and the changes in design solutions and space requirements for 28 years.

The development work was done without extra funding through Master’s level theses. The target price methods are widely used in Finland and have become nearly standard method. The Target Price method was devised with an eye to the practical management of economic efficiency in a project, and it was launched in the industry through clients, counter to the popular opinions of experienced constructors. In this process, the management philosophy, methods, and the underlying data were all formed in unison. The data were tested statistically, and the updating is performed cybernetically.



PRICED ROOM SCHEDULE

Section	Room schedule	size	pc	quantity	ecu/m2	ecu
A	BASEMENT					
A	Near-by storage, big	49,0	1	49	858	42 065
A	Storage room	204,0	1	204	749	152 764
A	Cleaning rooms in average	4,0	1	4	1 741	6 964
B	GROUND FLOOR					
B	Office room, normal	18,1	14	254	1 247	316 673
B	Open space office	50,0	1	50	1 164	58 224

ROOM REQUIREMENTS Meeting room 1214 €/m2

1 SIZE AND SHAPE				
Size of the room	44,0 m2			
Dimension * dimension	4,7	x	9,3 m	
Special floorstructures	0 ecu/m2			
Floor to floor height	3,3 m			
Height of the room	3,0 m			
Span	9,0 m			
2 INTERNAL CLIMATE				
Controlling the temperature	+24...26 C, cooling, high req.			
Thermal load	35 W/m2			

7 FURNITURE, EQUIPMENT		10 ecu/m2
Working desk	0 m	0 ecu/m
Self	0 m	0 ecu/m
Cupboard	0 pc	0 ecu/pc
FIxed chair	0 pc	0 ecu/pc
Window equipment	0,20 win/m2	1 ecu/wim2
Other furniture, equipment		9 ecu/m2
8 PARTITIONS INSIDE		
Partitions inside the room	0 m2	0 dB
Doors inside the room	0 pc	0 dB
Laminated partitions	0 m2	

Figure 1: A part of priced room schedule and an example of room requirements (Kiiras 2008a)

Advanced Line of Balance (ALoB)

The ALoB or Time-Place Diagram or Flow Chart or “slope line technique” was developed in the late 1980s. The development was triggered by empirical observations; computer schedules were beautiful, but often poor in content and prone to disturbances. Project or site engineers tried desperately to update the schedules to match the deviations in the execution of those schedules. The literature in the field is still clearly oriented towards planning theory, striving for “the best possible” or “optimum” schedule. We started to chance the paradigm to control theory. The real problem, however, is the production itself and the disturbances therein, not the plan. If the execution of the plan is allowed to just happen freely, then the plans must follow the execution. This was the pattern we sought to change. Hence, the possibility for supervision and control were set as the core target. One Master’s student put it appropriately: “It takes me a day to draw up the schedule, but who’s going to execute it for 15 months?” When a deviation is discovered, which is always bound to happen, the production is amended, NOT the schedule.

The ALoB method resembles the conventional LoB, but it is suitable for projects where repetition is imperfect. The sections may vary in size and in task content. Systematic task dimensioning and synchronisation that would create a less sensitive schedules were important issues. A new feature within the ALoB is location-oriented planning and monitoring. The sectioning also facilitates appropriate overlapping and a schedule that is qualitatively manageable as a whole (Kankainen, Seppänen 2003).

The method was developed through several stochastic simulations (Kiiras 2008); for instance, the placing and length of the buffers were determined using Monte Carlo simulation. The method was tested and developed in a number of large building projects (such as a large hospital, a few major city centre office and commerce buildings, an airport building, a hotel, a shopping centre, and even the Great Moscow Circus). Scheduling for the sites and managing the production were done as a part of the testing. Mostly, this work was done through Master theses done at TKK.

“Slope line” scheduling and location-specific “vignette control” are widely used in Finland. It has also been applied in many schedule software programs, for example in the internationally noted VICO CONTROL. This matter is currently being debated in doctoral dissertations (Firat et al 2008).

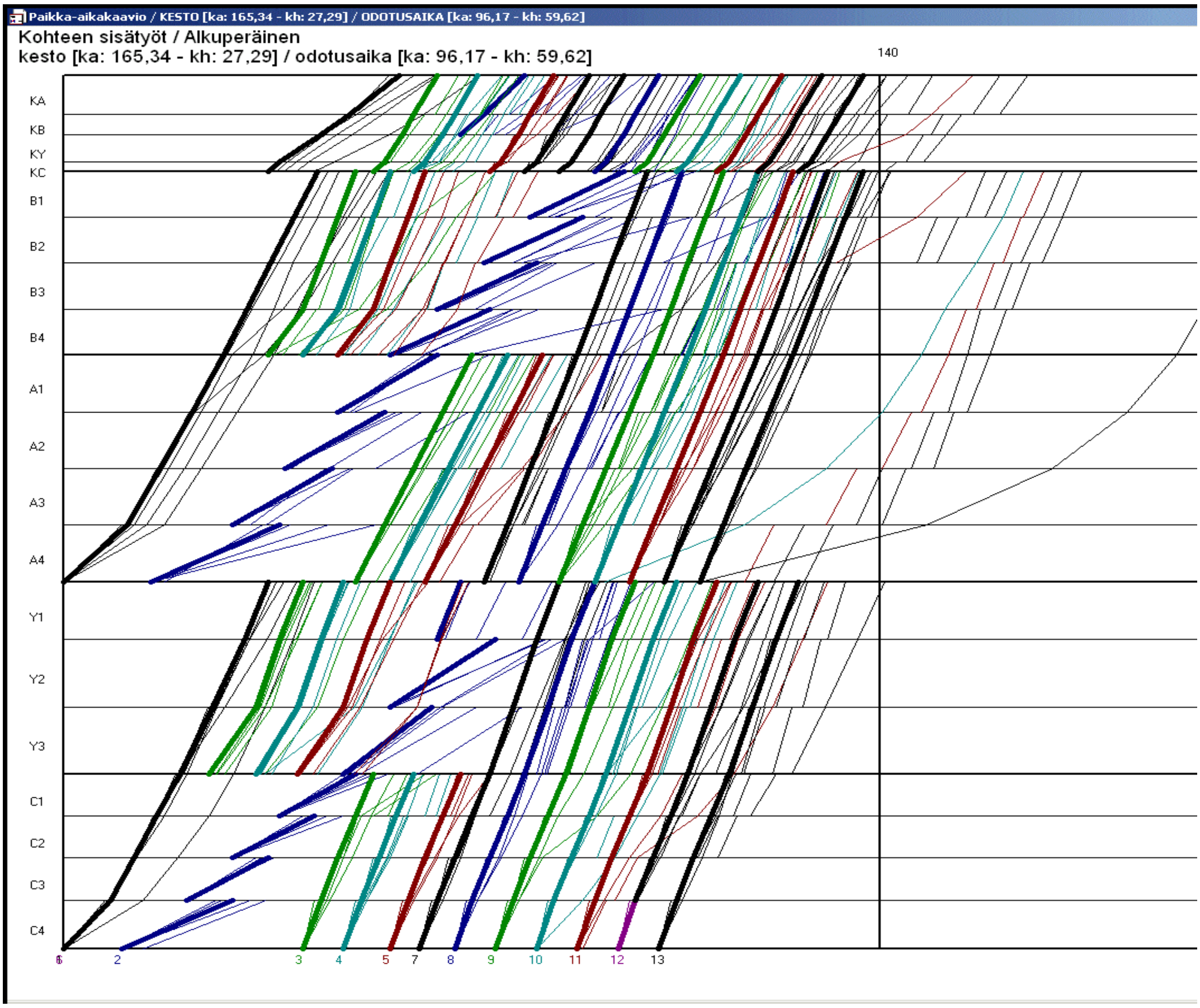


Figure 2: An example of time-place diagram, planned thick lines, simulated thin lines (Kiiras 2008).

Finnish Construction Project Management (FinCPM)

Finnish CPM models were developed during the deep depression of the 1990s (Kiiras et al. 2002). The large construction companies were failing and agile CM consultants and CM contractors were springing up in their stead. At TKK we drew up contract models and operation protocols for these newcomers. Generally, contracting is seen as an opposition of the parties. In CPM the central new concept was service and cooperation; the project manager would side with the client and look after their interests. A CPM manager divides the project into multiple contracts and construction product procurement. The detailed design is then overlapped with the procurement and construction. A CPM manager also directs the design solutions, and the timing of the designs. The Finnish model contains both a consultant form (CM for fee, CM Agency) and a contract form (CM at risk).

For the contractual solutions we analysed models that were widely in use, both domestic and foreign. There was an existing demand for new contract models and they were launched through clients and CM service providers. Now there are published Finnish standards for the contracts.

The CPM models became established practices and have gained a prominent market share, particularly in large and difficult projects (for example, shopping centres and the Vuosaari Harbour). A fitting example would be the Helsinki Music Centre, where the CPM model aims to earn savings of 25 per cent in construction costs.

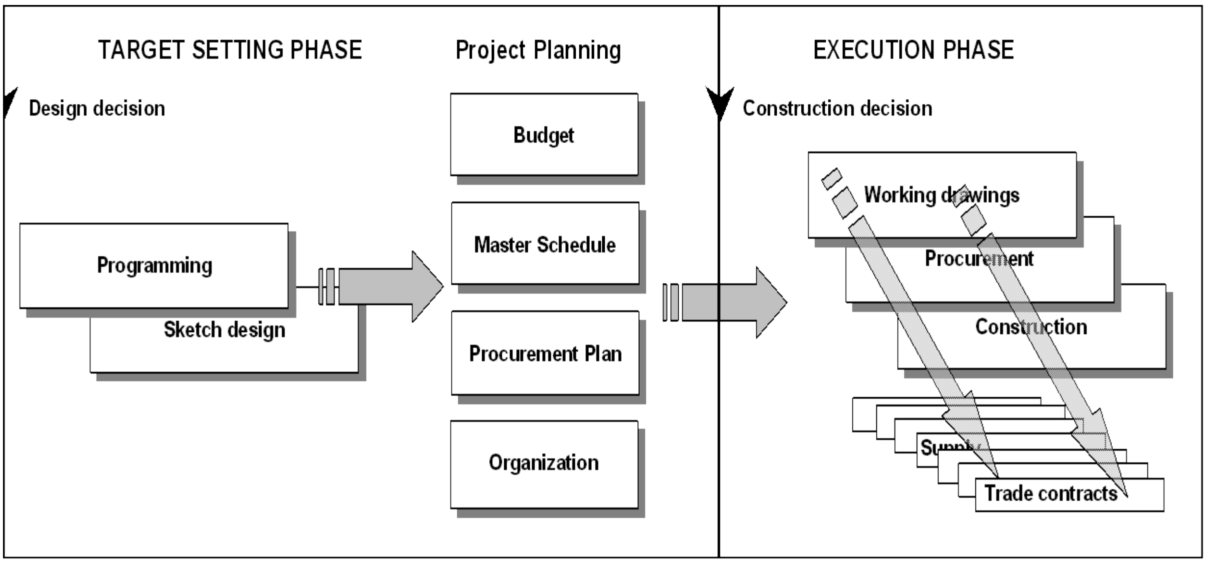


Figure 3: The two-phase model of a Finnish Construction Management project (Kiiras et al 2002)

Design Management for CM projects (FinSUKE)

Over the course of this decade we have been developing design management within project management. This time we canvassed the problems through a survey. In project management the key problem is formed by difficulties in design management. In this so-called FinSUKE project (Kruus et al. 2005, Kiiras et al. 2005) we had strong hypotheses about the causes and a clear vision of how to counter them. Instead of laying the design conventionally as early as possible, we created a management system which allows the design to be set down as late as possible, after the users have defined their requirements.

We created five constructs to enhance design management: Open Building, Design Packages, a Selection Procedure for concerned parties, Bid Packages and Procurement Strategy and Supplements to the Scopes of Profesional Work for implementation. All the constructs were tested both retrospectively and prospectively in case studies. A significant testing milestone was passed when both Open Building and Design Packages were included in a national scopes of professional work for project management and design. The Scopes of Professional work are used in Finland as appendices to define the scope and content of requests for tendering and contract agreement. The subsequent launch of this programme was all the time promoted through presenting the results broadly in various, sometimes corporation-specific events (thus far ca. 50 presentations). This project marked the first time we deliberately also wrote international papers (eight altogether, e.g. Kruus et al. 2006). These methods are just now being implemented. Thus far, there has been no international interest.

Perceived Problems	Hypotheses on Reasons	Hypotheses on Solutions	Solutions, Instructions	Hypothesis of Effects
Delayed Documents	Late User Requirement Specification	Phasing, Design Docs in Advance	Procurement Strategies of Bid Packages	Design Documents on Time
Schedule Overruns, Change Orders	Design Process Driven by Suppliers	Open Building (Permanent Support; Infill)	Open Building in Concurrent CM Model	Process on Schedule, No Change Orders
Process Frustration	Tendency for Final Bidding Design Docs	Documents by Design Packages	Design Packages	Design Process Manageable
Clients Are Unsatisfied	Data Transfer Is Inefficient	Schedules Driven by Design Packages	Supplements to the Scope of Work (RT)	Clients Are Satisfied

Figure 4: Hypotheses and solutions in FinSUKE development of the design management (Kruus et al 2006)

Present reseach and development project (CM-risk)

At the moment we are in the middle of a research and development project for risk management in contruction management forms of contract. We are following our preferred course; the problems are charted through a survey, the cooperating firms develop their own risk management systems, and the implementation takes place through establishing public standard requirements for project risk management, to be used in contracts and requests for tenders for construction management services. We are also revising the risk management paradigm; the project management contractor is required to produce high-quality investications, planning and monitoring to go along with the conventional identification, assessment, countermeasures approach, while not forgetting professional reporting. International papers have been prepared throughout (e.g. Palojärvi et al. 2008).

Conclusions

Through long-term cooperation in research we have profoundly influenced the public and private sectors. The practices in the field have been renewed and improved through newly launched methods such as the so-called target price method for determining the cost frame for house construction projects, the time-place diagram and sectioning technique, i.e. the “slope line technique”, for project scheduling, models for construction management contracts, and the design management methods for concurrent construction.

Our impressions of the requirements for successful practical applications in the light of the aforementioned examples could be summarised as follows:

- the problem statement needs to be aimed so as to produce usable results
- the implementation must be considered from the onset
- the director of the research project must have a vision of the causes of the problem, and from a solution standpoint
- surveys and interviews are only to be used to verify the problem (and for marketing the research)
- if the result is data, the system schould be designed, using the updating as a starting point
- the development results should be tested from early on and developed further within the pilot testing, and
- in addition, the professional journals, presentations in corporations, and training events must be used as publishing channels

The results must be carried over to academic education early on, so that the students can feel that they are in the forefront of development.

REFERENCES

Ackoff Russell L. A Concept of Corporate Planning. 1970. John Wiley & Sons, Inc.

Beer, S. (1966). Decision and Control. Wiley, Chichester, UK.

Firat, C.E., Kiiras, J., Huovinen, P. (2008), “Solving Fundamental Problems in Model Based, Semi-Automated Building Project Scheduling” The 5th International Conference on Cybernetics and Information Technologies, Systems and Applications: *CITSA 2008*, June 29th – July 2nd, 2008 - Orlando, Florida, USA June, 2008

Kankainen J., Seppänen O. (2003) A line of balance based svchedule planning nad control system. Proceedings of the 11th Internal conference of Lean Constructiuon, Blacksburg , Virginia USA

Kiiras, J., Stenroos, V. ja Oyegoke A.S. (2002) Construction Management Contract Forms in Finland, TKK/CEM Paper No. 47. Helsinki University of Technology, Construction Economics and Management, Espoo.

Kiiras J., Kashiwagi D., Huovinen P. ja Kruus M.(2005a) Better Buildings by Performance Based Construction Management (CM) Contracts, 2005 CIB W92/T23/W107 International Symposium on Procurement Systems. February 7th – 10th ; 2005 Las Vegas NV USA.

Kiiras, J., Kruus, M. ja Huovinen, P. (2005b) Cost Management under Construction Management (CM) Contracts - in The Case of Large Building Projects in Finland, Third International Conference on Construction in the 21st Century (CITC-III) "Advancing Engineering, Management and Technology" 15-17, September 2005, Athens.

Kiiras J. (2006a); The Finnish Target Price System based on building programs (briefs) - not on design solutions, International workshop Price and Life Cycle of Building Construction, Brno University of Technology, Brno Czech Republic.

Kiiras J. (2006b); The Principles of Cost Databases for Construction Managment, International workshop Price and Life Cycle of Building Construction, Brno University of Technology, Brno Czech Republic.

Kiiras J. (2008) Development of Construction Project Scheduling by Monte Carlo Simulations, IPMA Word Conference Rome Italy.

Kruus M. ja Kiiras, J. (2005a) Advanced Design Management as Part of Construction Management (CM), In Kazi, A. S., ed., Systemic innovation in the management of construction projects and processes, Proceedings of the 11th Joint CIB W55, W65 International Symposium on Combining Forces, Advancing Facilities Management and Construction through Innovation, June 13-16, 2005, Helsinki. Book Series, VTT and RIL, 272-283.

Kruus M., Sullivan K., Kashiwagi D. ja Kiiras J. (2005b) Ensuring Design Documents Fitness in Construction Management (CM) Projects, In Wang Y., Shen Q,. International conference on construction & real estate management, Challenge of Innovation in Construction and Real Estate, December 2005, Penang Malaysia, 258-264.

Kruus, M., Kiiras, J., Hämäläinen A. ja Sainio J. (2006a) Flexible working drawing process and delivery method selection for building services (heating, plumbing, air conditioning), Adaptables2006, TU/e, International Conference On Adaptable Building Structures Eindhoven The Netherlands 03-05 July 2006.

Kruus M., Sullivan K., Kashiwagi D. ja Kiiras J., (2006b) Selection process of Construction Management Service Provider, In International Conference in the Built Environment in the 21st Century " ICiBE 2006", 13-15 June 2006, Kuala Lumpur, Malaysia.

KruusM., Raveala J., Kiiras J. (2008) Managing Design in Concurrent Projects through Open Building and Design Packages, Sao Paolo.

Oyegoke A., Kiiras J. (2006) Two generic perspectives of CM contracting systems: a case of the US, the UK and Finland, Jourmal of construction procureemnt 2006 vol 10.

Oyegoke A. S. (2001) Features and Classification of Construction Management Contracting Systems- a case of the USA, the UK and Finland, TKK/CEM Report No. 193, Helsinki University of Technology, Construction Economics and Management: Espoo, Finland.

Oyegoke A. S. (2007) Specialist Task Organisations Procurement Approach for Re-engineering Construction Project Processes, TKK/CEM A Recearch reports 4. Doctoral dissertation. Helsinki University of Technology, Construction Economics and Management: Espoo, Finland.

Saari, A., Kruus, M., Hämäläinen, A, Kiiras, J., 2007. Flexibuild – a systematic flexibility management procedure for building projects, *Facilities*, 25 (3/4), 104-114.

Palojärvi L., Kiiras, J., Huovinen ,P. (2008), Role of Expert Knowledge in Managing Risks in the International Growth Projects of Construction Contractors and Suppliers. Joint CIB Conference 2008 , Helsinki, June 3-6,2008. 3-5.

EXPLORING THE 'HIDDEN' IN ORGANISATIONS: METHODOLOGICAL CHALLENGES IN CONSTRUCTION MANAGEMENT RESEARCH

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There has been recognition of the limitations of technocratic approaches to construction management research, and critical theorists in the field have often rejected prescriptive explanations of social phenomena. Thus, there has been a rise in the use of interpretive methodological approaches and a proliferation of qualitative research methods in the construction management literature. Still, interpretive research that requires interaction between the researcher and her informants often confronts the age-old, fundamental challenge that is posed to social science research: that is, what really does go on in organisations, beyond what is (and can be) said and seen? Through post-hoc reflection of a recent study into innovation in construction, it was found that multiple perspectives matter in shaping our understanding of how innovative practices manifests in construction. An observation was also made regarding the hidden agendas of senior management participants in recognising, rewarding and promoting innovation, which potentially contribute to disconnections between theory and practice of innovation in construction. Questions are raised as to how researchers can help articulate these 'hidden' agendas and methodological challenges discussed here points to the virtues and limitations of the ethnographic approach.

KEYWORDS: ethnographic research, interpretive research, innovation, methodological challenges.

INTRODUCTION

Researcher: Do you employ women on your construction site?

Site manager: We certainly do… we employ quite a lot of women here actually.

Walking around the site, the researcher noticed however that there was only one female toilet on a site that employed a few hundred workers during the peak of operations. Intrigued by this observation, the researcher proceeded to ask the site manager, "Just how many women do you currently employ on this site?" To this question, the site manager responded with "Six!"

This excerpt, taken from notes and recordings of casual conversations emanating from a research project investigating the nature of construction labour productivity (see Chan and Kaka, 2007), reveals the fundamental problem faced by many social scientists; that is, the verification of the reliability and validity of research findings. Had the researcher not consulted his sense of sight and subsequently mobilised to ask the site manager further questions, the true extent of diversity on the construction site in question and more importantly, the site manager's conceptualisation of just how many women is "quite a lot", would have remained ‘hidden’ in the research process. Often, there is the danger that such ‘hidden’ aspects could result in incomplete findings being presented; at its worst, such findings could even be false. Uncovering the ‘hidden’ aspects in organisations is essentially important in the ensuring the integrity of research findings, especially in the investigation of social relations that are pivotal in the field of construction management. An attempt is made, therefore, in this paper to examine what researchers in construction management need to consider when addressing ‘hidden’ aspects in construction, in view of the growing interest in more interpretive and qualitative research in construction management. In particular, the focus of this paper centres on the virtues and methodological challenges of exposing such ‘hidden’ aspects.

The paper is organised in two main parts. In the first part, the key methodological debates in construction management research initiated by Seymour and Rooke (1995) will be outlined. It is suggested that challenging traditional, positivistic and rationalistic research approaches in construction management has resulted in increasing acceptance of more qualitative research. Yet, it is argued that a lot of qualitative research in construction management remains deeply rooted in positivistic traditions that maintain the supremacy of the researcher’s position to determine what is included or excluded in the conceptual frameworks that are produced in research. Thus, it is debatable as to whether there is a genuine shift towards more interpretive research in construction management and whether a holistic understanding of the relationship dynamics in construction remains the Holy Grail. The second part of this paper draws on the post-hoc reflection of a recent research project investigating the materialisation of innovation across all levels of a construction organisation. Through this reflection, the challenges of uncovering ‘hidden’ innovation in construction are discussed. These challenges include researcher resistance to operating in ambiguity and to keep an open mind, and material concerns over the time and effort needed to proverbially not leave every stone unturned. It is intended that the critique offered in this paper will help clarify key issues and pitfalls for construction management researchers confronted by the task of uncovering ‘hidden’ aspects in organisations.

BRIEF OVERVIEW OF METHODOLOGICAL DEBATES IN CONSTRUCTION MANAGEMENT RESEARCH

In this section, the development of methodological debates in construction management research is outlined. This discussion traces the origins of the debate on positive-interpretive divide ignited by David Seymour and John Rooke in 1995. They were especially critical of the predominance of positivism in construction management research as they called for a paradigm shift towards engaging in more interpretive, qualitative research to study social relations in construction. There is undeniably greater acceptance of qualitative research reflected in the study of a whole range of issues from gender relations to the understanding of construction risks, health and safety, and social networks. However, it is observed that many contemporary studies that purport to explore concepts in a qualitative manner still abide dogmatically with a positivist regime, often promulgating the perspectives of a narrow subset of stakeholders in construction, i.e. managerial perspectives (see Alvesson, 2002). Notwithstanding laudable developments in qualitative research in construction, restrictions placed by funding bodies (e.g. availability of financial resources) meant that deeper and richer examinations gathered from more time-consuming participant observations still remain the exception rather than the rule. It is suggested that this prohibits any effort to uncover the ‘hidden’ aspects in construction organisations, and researchers’ aspirations to develop sophisticated conceptual models about the social world in construction remain futile.

Challenging predominance of positivism in construction management research

In the mid 1990s, a debate on research methodology was sparked amongst the construction management research community in the UK. Seymour and Rooke (1995) bemoaned the predominant rationalistic assumptions of the positivistic paradigm adopted by, and which they felt were becoming institutionalised and deeply embedded within, the construction management research community. This, and the increasing focus on understanding the culture of the industry at that time, prompted them to put across a message for an alternative interpretivistic approach, for they felt that “[…] the rationalists takes for granted the interpretative frameworks that are used to organise and communicate perception, thus effectively ignoring them. Instead of investigating the interpretations of others, they simply assert one of their own (p. 513)”. They saw the problem as “[…] the rationalist paradigm […] does not require researchers to question their own position. Instead, rationalists put their faith in the use of particular methodological routines to guarantee their impartiality. The researcher’s values are regarded as either irrelevant or self-evidently correct (p. 521)”. Furthermore, they considered the egalitarian approach resulting from adopting the rationalist paradigm to be inappropriately dominant in attempting to understand the issues within construction management, since these locate within both the physical and social sciences.

When dealing with the social, philosopher Edmund Husserl (1970) warned against adopting the rationalistic (positivistic) paradigm in the study of humans, “[…] to be human at all is essentially to be a human being in a socially and generatively united civilisation; and if man is a rational being, it is only insofar as his whole civilisation is a rational civilisation, that is, one with a latent orientation toward reason or one openly oriented toward the entelechy which has come to itself, become manifest to itself, and which now necessity consciously directs human becoming (p. 15)”. To paraphrase in a way amenable to Seymour and Rooke’s (1995) argument, the dominant rationalistic paradigm is only rational insofar as the whole construction research and practitioner community is a rational community, and one in which its necessity is what Seymour and Rooke (1995) urged further contemplation. After all, human relations, along with its many peculiarities, are essentially vital in construction,

Critics of Seymour and Rooke’s (1995) recommendation of adopting *verstehen* sociology in addressing meanings of human interaction have considered this to be too unwieldy, undisciplined and unscientific (Runeson, 1997). Others have criticised Seymour’s *et al.* (1998) subsequent call for greater emphasis on “localised relevance in their accounts” by claiming this to be “consulting” and not research (Harriss, 1998). Still, Raftery’s *et. al.* (1997) remarks sounded conciliatory: “[…] it is fair to say that the majority of research […] is in the positivist/rationalist tradition. Although it is worth noting that when qualitative methods have been used […] there has been no consequent attack on the method used (p. 294)”.

Growing acceptance of qualitative research in construction management research

Since Seymour and Rooke (1995), there is progress in the development of more sophisticated analytical techniques in explaining the dynamics of social relations in construction. There is wider acceptance of qualitative methods and techniques like interviews and case studies regularly feature in research reported in the field. Amaratunga *et al.* (2002) suggested that there is increasingly more research reported that uses strong qualitative methods, even though they contended that quantitative methods still predominate. A notable example of research that utilises strong qualitative methods include Dainty *et al.* (2000), who undertook 41 pairs of in-depth interviews with males and females working in 5 out of the top 20 construction firms in the UK to illustrate organisational career development issues, structural and cultural dimensions of careers in construction, so as to understand the limitations of the diversity in construction agenda.

Other examples include Hare *et al.* (2006) who conducted a literature review and a series of focus group interviews with experienced practitioners, which led to the development of a conceptual model that integrated health and safety considerations in construction planning. Baiden *et al.* (2006) interviewed managers of nine award-winning projects to examine the extent of team integration needed for successful projects. Lingard and Francis (2008) also adopted the interview technique; they interviewed 31 participants that originated from an earlier survey phase to explore adaptive strategies of working families in the Australian construction industry context. It must be added that 7 out of their 31 interview participants were domestic partners, thereby extending perspectives to include the personal lives of those who work in the industry, which is rare in studies reported in the construction management literature.

The use of qualitative methods in construction management research has seen increasing sophistication over time. Sustrina and Barrett (2007) adopted rich picture diagrams co-produced between researchers and stakeholders to model case studies of construction projects. Another area that has seen much sophisticated development is the exploitation of social network analysis in construction. Pryke (2004) found social network analysis appealing because it allowed for a more accurate and dynamic exposition of project structures and process that sheds light on "networks of contractual relationships and networks of performance incentive relationships (p. 795)". Other researchers have also employed social network analysis to examine the interactions between people in construction. Swan *et al.* (2001), for instance, explored how trust manifests in construction in their quest to develop a trust inventory for construction as they sought to identify key players where trust matters. Others have attempted to see how innovation happens in the web of inter-personal relationships that evolve across typical supply chains (see e.g. Dodgson *et al.*, 2008).

The missing link of participant observations and engaged scholarship

The critique provided by Seymour and Rooke (1995) signified a turning point in the way research in construction is undertaken. They challenged the dominant positivistic research approach adopted by construction management researchers and argued that idiosyncrasies associated with understanding social relations in construction have to be accounted for; asserting "[…] the objective of practitioners, for example, quality, efficiency, productivity or profits, cannot be taken to be self-evident by the researcher. An essential purpose of research is to establish what participants in the situation under study, managers, engineers or steelfixers, mean by these terms and what values and beliefs underlie such meanings. Researcher may well share some of the understandings of some of the participants, but it is imperative that they suspend their own understandings. Only by doing so can they allow practitioners to speak for themselves (p. 522)".

However, far too often, the voice(s) of all participants in construction across various organisational levels remain silenced in the research findings. For example, Hare's *et al.*

(2006) selection of experienced managerial practitioners to participate in their focus group discussions on health and safety in construction planning meant that the perspectives of other practitioners, e.g. less experienced workers who would actually benefit from improvements in health and safety, might have been excluded. Similarly, Baiden's *et al.* (2006) collaboration with managers of award-winning projects might have neglected richer stories of what might really happen in practice from those who delivered those very projects at the grassroots. Sustrina and Barrett's (2007) rich picture methodology also runs the danger of researcher's imposing their own position without articulating their value system transparently. Even the sophistication of social network analysis requires some level of researcher discretion in 'quantifying' relationships that can result in a somewhat simplistic analysis (Pryke and Pearson, 2007). Furthermore, the reliance of the interviewing technique as the dominant form of qualitative research in construction runs the risk of participants offering an idealised account, thereby hiding the details that matter in reality (Alvesson, 2002). Thus, researchers have often considered the need to triangulate using multiple methods to strengthen qualitative analyses with quantitative methods (see Amaratunga *et al.*, 2002).

Nonetheless, the need for expedience can often compel researchers to succumb to over-simplification and reductionism when reporting their research findings (see e.g. Alvesson, 2002). In principle, researchers should maintain a wider long-term view of the issues faced by the industry and not consumed by short-term, quick fixes. Yet, the pressures of meeting research funding requirements and increasing commercialisation of academic work constantly creates hurdles in attempts to adopt more interpretive research approaches that are often time consuming. Baiden *et al.* (2006), for instance, emphasised the need for adopted methodology to "[…] create typologies, find associations, and seek explanations for the emerging phenomena. It also allows the sifting, charting and sorting of data into key issues and themes and enables rapid comparison of research findings across cases investigated (p.16)." It is not surprising therefore that quick wins are often sought through quantitative analysis obtained through surveys or a 'grab-and-go' approach to analysing case study material, rather than the notion of engaged scholarship (see Van de Ven, 2007) through much slower, but richer and deeper ethnographic methods.

Indeed, deep ethnographic studies in the field of construction management are becoming increasingly rare. Examples include LeMasters (1975) seminal work exposing the personal lives of construction workers stemmed from intensely, if covertly, observing the behaviours and capturing the conversations of patrons at a working-class American tavern over a five-year period. Elsewhere, Michael Burawoy's own involvement as a worker in industrial workplaces across Zambia, Chicago, Hungary and Russia provided fruitful insights on the changing nature of workplace organisation, particularly focussing on post-colonalism and the transition from state socialism to capitalism (see Burawoy, 1998). Unlike many studies examining social phenomena in construction that can often result in prescriptive, if speculative, recommendations for government and corporate policy-makers, it is interesting the examples of LeMasters (1975) and Burawoy (1998) sought only to describe the state of affairs. But, in so doing, they have diligently sought to uncover aspects that would be otherwise 'hidden' if conventional quick-fix methods are perpetuated. Bruno Latour, a sociologist who specialises in the study of science and technology and founding member of Actor-Network-Theory, warned against social scientists' endeavours to merely contribute to policy recommendations as an outcome of social science research (see Latour, 2007). Instead, Latour (2007) contended, it is far more fulfilling and honest to trace the associations that matter between subjects and objects, humans and non-humans, and describe how these associations help shape our understanding of the social. Accordingly, this "reassembling of the social” provides a more holistic picture of social relations that can be helpful in efforts to uncover the ‘hidden’ aspects in organisations. There is clearly more scope for doing this in construction management research. We will now turn to a recent study into construction innovation to examine the critical issues one encounters in doing so.

REFLECTIONS OF A RECENT STUDY INTO CONSTRUCTION INNOVATION

The motivation behind the study derived from the second author’s frustration when working in the product manufacturers’ sector of the UK construction industry. Her personal background is diverse; having worked in a sales environment for the pharmaceutical and healthcare industries, she became alarmed by the resistance to change and new ideas by her new co-workers in the construction sector. Inspired by the writings of Woudhuysen and Abley (2004), she was convinced that the construction industry mostly lacks the drive for innovation and wanted to explore reasons for this problem. This was of course not a new line of inquiry. However, at the time, the National Endowment for Science, Technology and the Arts (NESTA) published a report in 2007 entitled *Hidden innovation*. NESTA (2007) argued that some sectors that were considered to be ‘low innovation’ sectors, including the construction industry, were potentially undertaking innovative activity that did not fit conventional policy definitions of innovation. Therefore, the study evolved into an investigation of where innovation happens across a typical construction supply chain. It must be added that the second author was working as a project manager in a glass manufacturing company that provided products and services for the construction industry. So, her line of work necessitated collaboration with architectural and engineering designers and contractors, managers and operatives in the delivery of construction projects.

The research inquiry encompassed a series of interviews with managers (senior, middle and line) and a range of operatives working for the product manufacturer, contractor and subcontractor organisations. A total of 20 interviewees participated in in-depth interviews lasting between 1 and 2 hours, aimed at uncovering multiple perspectives of what innovation really means in practice, the implications of such innovative practices on business and individual performance, and the critical issues surrounding their perspectives of innovation (see Littlemore and Chan, 2009 for more details on methodology). Another critical feature of the methodology consisted of the participant observation process engaged by the second author. Emergent findings were regularly discussed at meetings with the first author. This section will highlight two of the critical findings – namely the *commonalities in defining innovation*, and the *discrepancies in recognising innovation* – for the purpose of highlighting the challenges of uncovering the ‘hidden’ innovation in the observed context.

Commonalities in defining innovation

One of the most striking findings made is how similar the term innovation was defined by participants across all levels of an organisation. Whether the definition came from a senior manager/director or an operative at the grassroots, the key characteristics of novelty and exploitation featured in the innovation literature (see e.g. Dodgson *et al.*, 2008) seemed to be corroborated by the interview data. So, Participant G, a senior design manager at a contractor organisation suggested that “Innovation is trying to bring new processes and products into the business that will allow us to build more efficiently and preferably more quickly.” At the same time, Participant D who manages health and safety at the same organisation indicated that innovation was “[…] probably finding a new way or an improved way of doing something that you were doing already it's not inventing something new necessarily it's just finding a better way." In a simpler way, Participant K, an operative working for a subcontracting organization stressed, "Moving on, new ideas which truthfully I'm all for. It makes the jobs a lot easier for people to do because the way things are at the moment time is money."

However, aside from the definitions, the way innovation materialises in practice for each of these participants can differ somewhat. For operatives, as alluded to by Participant K, the raison d'être for innovation is to make jobs a little easier for people to do. This was supported by an example provided by Participant C, a charge hand at a subcontracting organisation, "One lad has started to build a storage bay for the card board boxes. It's generally speeding up the floor by putting materials altogether." For Participant D, because managing health and safety was his line of responsibility, innovation was exemplified in "Toilets… on all the mirrors there is a sticker on all the mirrors saying you are looking at the person responsible for your health and safety just to reiterate and that is on every mirror in the building." On the other hand, the exploitation of new technology was, for Participant I (Construction manager of the contracting organisation), of critical importance: "I don't know whether you have seen the XXX building I didn't like the idea of scaffolding round a curve be of all the facets you have and the open edges so we have used Mobile Elevated Working Platforms (MEWPs) and its not something that I've ever done before as a company we could be using MEWPs on a lot of projects but we're MEWPs throughout so we are having to programme so as every time someone's finished with a MEWP which is the elevated platforms then someone else is ready to come and use that again. So we try to make that as economical as scaffolding would have been but for me a lot safer."

What is critical in the observations made here is how participants at every level of an organisation can easily relate to the notion of innovation and readily identify an example of innovative practice for researchers to chew upon. Of course, we may never know whether these stories represent an idealised account of innovation. However, much of the innovation literature have often only valued innovation from the performance basis of policy and managerial perspectives, usually couched in some form of comparable metrics that can then be used to measure one's competitiveness at the macro level (e.g. patent activity and R&D investment). A corollary of this is the neglect of innovative practices that could potentially happen at the grassroots, and researchers who do not actively seek out such examples simply banish such innovative practices into the 'hidden' domain. Uncovering 'hidden' innovation therefore requires, first of all, the researcher's recognition that such practices exist. This was certainly enabled by the researcher's personal participation in the context of this research project. Nonetheless, the recognition of innovation, particularly 'hidden' innovation is not always unproblematic, a point which we shall now turn to in the next section.

Discrepancies in recognising innovation

When discussing recognition of innovation, it is interesting to come across the phrase "a pat on the back" in some of the responses. So, Participant J, a mechanical engineer working for the contractor organisation, he noted, "I think it is recognised if you've come up with an idea you know you get a pat on the back sort of thing but it's a superficial reward. That's what you are paid for at the end of the day I suppose." Another construction engineer from the same organization, Participant L, also shared this view, "You might get a pat on the back but I don't think you get rewarded." For Participant F, a site engineer, "[…] getting a job finished quicker without any problems" was considered to be an adequate reward. Interestingly, the contractor organisation that Participants F, J and L all work for does have a system of rewarding innovative practices by means of a bonus scheme. However, when these participants were asked about the awareness of such a scheme, they unanimously claimed no knowledge of this. In fact, they had all thought that the “bonus” was for finishing the work much quicker, and not for “innovation”.

Another observation was made regarding the disconnection between senior managerial discourse on innovation and the material concerns exhibited by the grassroots. For senior management of the contractor organisation, the idea of innovation was often used as a marketing tool to promote to prospective client organisations on how their supply chains seamlessly gets involved in generating innovative products and services. However, such seamless integration is far from the reality of ad hoc interventions outlined in the preceding sub-section where participants come up with ‘innovative’ solutions out of necessity of the job. This observation was only made possible because the researcher deployed on this project was a participant observer working for the supply chain. Had this not been the case, this disjointed aspect of innovation thinking would have escaped the research team and remained but a ‘hidden’ aspect of construction innovation.

CONCLUDING REMARKS

The complexities of social relationships especially in multi-organisational, project-based construction imply that it is likely that aspects of what goes on in reality could potentially remain ‘hidden’ from academic researchers. Shortcomings of the traditional, positivistic and rationalistic approaches that have dominated methodological approaches in construction management research have been acknowledged. Consequently, there is wider acceptance, and increasingly sophistication, of more qualitative methods in construction management research. Nevertheless, many of these studies remain doggedly positivist. In uncovering ‘hidden’ aspects in organisations, it has been argued, necessitates deeper ethnographic approaches that cut across various levels of organisational stakeholders. One such approach is participant observation.

Operationalising such an approach is far from straightforward though. From the post-hoc reflection of the recent project into construction innovation, a number of lessons can be learnt. First, it takes a certain degree of open-mindedness on the part of the researcher to broaden their perspectives. Had the second author not been convinced at the onset that innovative practices could have been ‘hidden’ especially at the grassroots levels in organisations, the concept of ‘hidden innovation’ would have remained elusive. Consequently, what would have resulted from a study into the reasons for a lack of innovation in construction would merely reinforce the rhetoric found in the extant literature and lead to yet another research project that does not add much value to the body of knowledge. Of course, the critical findings presented here have benefitted from the participant observation process undertaken by the second author, who is concurrently an insider. The discussion here does not consider the ethical implications; this will be considered in future publications. However, Rooke and Kagioglou (2007) and Van de Ven (2007) argued for researchers adopting interpretive approaches to first learn the ropes of practice before immersing in the observational process. Our findings have been enriched by the fact that an insider was involved with the participants in the process of shaping the mutual understanding of construction innovation across a supply chain. Arguably, this has made it easier for us to identify the pragmatic challenges encountered by those who work in the coal-face of practice. The outcome of the research, and the extent of uncovering ‘hidden’ aspects, might have been severely limited if the researcher was totally green to the field, e.g. a career scholar.

Indeed, the main limitation of the research project is the lack of time to undertake a truly longitudinal analysis of the issues. At some point, as pointed out by Alvesson (2002) *inter alia*, the research process has to conclude and the findings written up. So, there is a point in the process when categories have to be locked in and aspects revealed. Without a doubt, some aspects will remain ‘hidden’. However, what is important is the ability for researchers to remain honest and transparent by articulating the limits of the findings. By placing these critical findings in the public domain, it is not the intention here to offer prescriptive explanations of the concept of construction innovation. Rather, the purpose is to describe, in Latourian sense, the phenomenon at the point of reporting; and in good academic manner, there is always room for further research. The uncovering of ‘hidden’ aspects in organisations will forever remain an emergent, lifelong learning process.

REFERENCES

Alvesson, M. (2002) *Postmodernism and social research*. Buckingham: Open University Press.

Amaratunga, D., Baldry, D., Sarshar, M. and Newton, R. (2002) Quantitative and qualitative research in the built environment: application of “mixed” research approach. *Work study*, **51**(1), 17 – 31.

Baiden, B. K., Price, A. D. F. and Dainty, A. R. J. (2006) The extent of team integration within construction projects. *International journal of project management*, **24**, 13 – 23.

Burawoy, M. (1998) The extended case method. *Sociological theory*, **16**(1), 4 – 33.

Chan, P. and Kaka, A. (2007) The impacts of workforce integration on productivity. *In*: Dainty, A. R. J., Green, S. and Bagilhole, B. (Eds.) *People and culture in construction: a reader*. London: Spons. pp. 240 – 257.

Dainty, A. R. J., Bagilhole, B. M. and Neale, R. H. (2000) A grounded theory of women’s career under-achievement in large UK construction companies. *Construction management and economics*, **18**, 239 – 250.

Dodgson, M., Gann, D. M. and Salter, A. (2008) *The management of technological innovation: strategy and practice*. 2 Ed. Oxford: Oxford University Press.

Hare, B., Cameron, I. and Duff, R. (2006) Exploring the integration of health and safety with pre-construction planning. *Engineering, construction and architectural management*, **13**(5), 438 – 450.

Harriss, C. (1998) Why research without theory is not research: a reply to Seymour, Crook and Rooke. *Construction management and economics*, **16**, 113 – 116.

Husserl, E. (1970) *The crisis of European sciences and transcendental phenomenology*. Carr, D. (Ed.). Northwestern University Press.

Latour, B. (2007) *Reassembling the social: an introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

LeMasters, E. E. (1975) *Blue-collar aristocrats : life-styles at a working-class tavern*. Madison: University of Wisconsin Press.

Lingard, H. and Francis, V. (2008) An exploration of the adaptive strategies of working families in the Australian construction industry. *Engineering, construction and architectural management*, **15**(6), 562 – 579.

Littlemore, M. and Chan, P. (2009) Recognising and rewarding innovation in construction: exploring disconnections in managerial discourse. *In*: Global innovation in construction conference, Loughborough University, 13 – 15 September, in press.

National Endowment for Science, Technology and the Arts (2007) *Hidden innovation: how innovation happens in six 'low innovation' sectors*. June. London: NESTA.

Pryke, S. (2004) Analysing construction project coalitions: exploring the application of social network analysis. *Construction management and economics,* **22**(8), 787 – 797.

Pryke, S. and Pearson, S. (2007) An analytical Anglo-French comparative study of construction procurement and management strategies. *RICS research paper series*, **7**(5), July. London: RICS.

Raftery, J., McGeorge, D. and Walters, M. (1997) Breaking up methodological monopolies: a multi-paradigm approach to construction management research. *Construction management and economics*, **15**, 291 – 297.

Rooke, J. A. and Kagioglou, M. (2007) Criteria for evaluating research: the unique adequacy requirement of methods. *Construction management and economics*, **25**(9), 979 – 987.

Runeson, G. (1997) The role of theory in construction management research: comment. *Construction management and economics*, **15**, 299 – 302.

Seymour, D. and Rooke, J. (1995) The culture of the industry and the culture of research. *Construction management and economics*, **13**, 511 – 523.

Seymour, D., Crook, D. and Rooke, J. (1998) The role of theory in construction management: reply to Runeson. *Construction management and economics*, **16**, 109 – 112.

Sutrisna, M. and Barrett, P. (2007) Applying rich picture diagrams to model case studies of construction projects. *Engineering, construction and architectural management*, **14**(2), 164 – 179.

Swan, W., Cooper, R., McDermott, P. and Wood, G. (2001) A review of social network analysis for the IMI trust in construction project. *In:* Akintoye, A. (Ed.), *17th Annual ARCOM Conference*, 5 – 7 September 2001, University of Salford. Association of Researchers in Construction Management, **1**, 59 – 67.

Van de Ven, A. (2007) *Engaged scholarship: a guide for organizational and social research*. Oxford: Oxford University Press.

Woudhuysen, J. and Abley, I. (2004) *Why is construction so backward?* Chichester: John Wiley and Sons.

FOSTERING RESEARCH DEVELOPMENT AND INNOVATION IN CONSTRUCTION COMPANIES

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Innovation is the key factor for construction company competitiveness in the international market nowadays. This has been recognized by the European Union and European governments and triggered a set of policies aiming at encouraging the construction industry actors to pursuit an innovative approach for their operations. At the EU level, it is worth mentioning a set of resolutions supporting the innovative effort of the industry. As for governments, it is relevant to consider the standards for research, development and innovation (R&D&I) carried out in Spain and Portugal and the specific policies put into force by these countries. The impact of these initiatives in the construction industry is still to be evaluated but the receptiveness of the leading companies deserves to be looked at. Firstly, at the certification level, it is interesting to measure their adhesion to R&D&I management systems. Secondly, at the implementation level, it is relevant to investigate how innovation effort is understood by their staff. Thirdly, at the production level, it is essential to observe the projects effectively developed and how they are recognised within the companies and externally. This paper reports the main topics of R&D&I standards and focuses on the innovation areas considered in their scope. It further reports two promoting projects taking place in one Construction Company in each country since 2007.

KEYWORDS: certification, innovation, management, R&D, standardisation.

INTRODUCTION

The innovative capacity of a country depends on several key factors as: public policies favouring the development of businesses and scientific and technological projects; economic stability; better private investment; intellectual property protection laws; permanent dissemination of technological advantages for the society; improving collaboration between universities and companies; and first-quality higher education. However, several reports detect various weaknesses of Spanish and Portuguese innovation systems. Despite the merits of governmental efforts made by both countries, available performance indicators reveal outcomes below expectations. For example, according to COTEC (2007), Spanish internal expenses in R&D&I were 10,197 million euros in 2005; this accounts for 1.13% of the GDP and represents an increment of 14% in respect to 2004. Nevertheless, this percentage is far from the European goal for R&D&I 2010: 3% of the GDP for the whole EU-25 (CICYT, 2003).

The construction industry in developed countries approximately stands for 10% of the GDP; however, the Spanish figure is as high as 17.8% (SEOPAN, 2007) and the Portuguese reaches 15.6% (SEOPAN, 2008). Nevertheless, investment in innovation in the construction industry is just 0.48% of the industry turnover. In spite of this low percentage, some organisations (large contractors, universities and research centres) actively contribute in important international research projects: Tunconstruct, Manubuild, Intelcities, I-Stone and Enable. The survey to the industry carried out by the Spanish Ministry of Infrastructures in 2006 shows its innovation potential. Out of 460,452 companies, only 1.944 performed R&D&I activities and the investment was less than 0.15% of the total. It is a low percentage when compared to the European Union average which is more than 1%; this is still worse if compared with other sectors like the pharmaceutical or the information technology sectors where investment can be twenty times more than that of the construction industry.

In spite of the above figures, it would not be realistic to conclude that Spanish and Portuguese contractors are not innovative. Actually, they have been implementing relevant technological milestones in singular difficult projects and effectively solving a variety of demanding technical problems. But this accumulated knowledge has seldom been systematised and has not been disseminated through their organisations. Besides, this effort is barely recognised. Therefore, it may be said that companies are innovative but lack effective and efficient systematisation and standardisation procedures for their activities.

By applying the agreements assumed by the European Union at Lisbon in 2000 (CICYT, 2003), the governments of both countries are trying to reduce the R&D&I gap with other western economies. In Portugal, effort was first placed in diffusing innovation concepts and supporting companies to implement innovation policies. In the scope of that process, COTEC has conducted the following four projects: identification and diffusion of models and mechanisms inducting innovation sustainable development; creation of a classification methodology for research, development and innovation activities; R&D&I management certification; creation of an Innovation Scoring System. The testing of standards has taken place in 15 companies that volunteered to adopt them in their normal operations and to feedback results for standard improvement. In Spain a similar procedure has been adopted. Main problems detected in adherent contractors relate to the lack of diffusion of the company's management system and the poor participation of the companies' staff.

Additionally to diffusion and support, the governments of both countries adopted a set of initiatives aiming at enhancing the attractiveness of developing innovation and innovation projects at the construction company level. Some examples of this are as follows:

> In Spain, construction companies investing in R&D&I can apply for fiscal benefits through Corporate Income Tax Law 43/2005. Additionally, since 2006, public agencies are evaluating innovation through the bidding process for work and service contracts issued by the central government; this may turn up to 25% of the final bidding score.
>
> The Portuguese Code of Public Contracts, which became into force in 2008, contains an interesting incentive measure aiming at the development of research and

innovation. For contract values of 25ME or more, the contractor must develop one or several R&D projects directly related with the contract objectives, reaching 1% of the contract value, at least. These projects must be performed in the national territory either by the contractor or by third parties.

SPANISH AND PORTUGUESE STANDARDS

In order to induce the systematic innovation in the Spanish economy, the experimental standards UNE 166000 were issued in 2002 and 2003 by AENOR (the responsible body for developing Spanish standards); in 2006, the main standards were edited in a definitive version. Based on the above Spanish standards, the Portuguese Institute for Quality published in 2007 four new standards on R&D&I management. Both, the Spanish and the Portuguese standard numbers, are displayed in Table 1.

Table 1. R&D&I Standards in Spain and Portugal

CONCEPT	SPANISH STANDARDS	PORTUGUESE STANDARDS
Terminology and Definitions	UNE 166000:2006	NP 4456:2007
Requirements for R&D&I Management Systems	UNE 166002:2006	NP 4457:2007
Requirements for R&D&I Projects	UNE 166001:2006	NP 4458:2007
Competence and Evaluation of R&D&I Auditors	UNE 166003EX:2003 UNE 166004EX:2003	NP 4461:2007

CERTIFICATION FOR R&D&I MANAGEMENT SYSTEMS

Standards UNE 166002:2006 and NP 4457:2007 set up the systematisation of an R&D&I management system in a construction company, enabling certification by an independent body. These standards are designed to integrate R&D&I management systems with other existing management systems in the company: quality (ISO 9000), environment (ISO 14000) and safety and health (OHSAS 18000). The requirements of both standards (UNE 166002:2006 and NP 4457:2007) are based on the management of processes, using the PDCA ("plan-do-check-act") methodology, similarly to quality management systems. According to the standards, the company top managers are responsible for developing, implementing, improving and reviewing the R&D&I management system. This is because they are also responsible for meeting the expectations and needs of different stakeholders: suppliers, clients, employees, shareholders, regulation bodies, etc.

Some basic issues are catered for in R&D&I standards: policy; management system; stakeholder responsibility; resource management; R&D&I activities; and control and improvement. Some considerations follow:

R&D&I policies, planning and responsibility are put into action with reliable communication channels and a good hierarchy. However, in most cases, an R&D&I management unit is set up for running the system and the R&D&I emerging projects. Additionally, there may be cases where other subordinate R&D&I units can function for executing specific projects, developing new technologies or generating knowledge.

An R&D&I management system has to be established, documented, implemented, maintained and continually improved by the company where it applies. Documentation includes statements of R&D&I policies, internal procedures and control records. Procedures comprise planning, operation and monitoring of R&D&I activities. It is required to control documents and records similarly to the ISO 9001 standard.

R&D&I management needs skilled resources that have to be properly allocated. Personnel motivation and training are essential to achieve the goals. Material resources and infrastructure are also important parts of this scheme.

There are several tools provided by the standards in order to develop the R&D&I activities: technological survey and forecast, creativity, internal and external analysis, among others. Additional activities proposed are: identification and analysis of problems and opportunities; analysis and selection of R&D&I ideas; planning, monitoring, and control of project portfolio; technology transfer; R&D&I products; purchasing; R&D&I process results; and protection and exploitation of the outcomes of R&D&I activities.

Planning and implementation of the monitoring process includes measuring, analysing and continuous improving of the R&D&I management system. These may be perfectly integrated in the quality management processes described in the ISO 9001 standard.

Certification is an important issue and aims at enhancing R&D&I activities in companies and organisations by reducing uncertainty, improving the image and increasing competitiveness. Additionally, the following advantages apply: resource allocation to R&D&I, knowledge management focus, result valuation, access to new technologies, transparency, generation of company specific technology, identification of improvement opportunities, motivation of employees, etc.

The certification process for R&D&I management systems is shown in figure 1. Once the candidate company sends the application form, the certification body analyses the documentation, visits the company's headquarters and performs a preliminary audit of the system. If the requirements are not met, then an extraordinary audit will be proposed to the company.

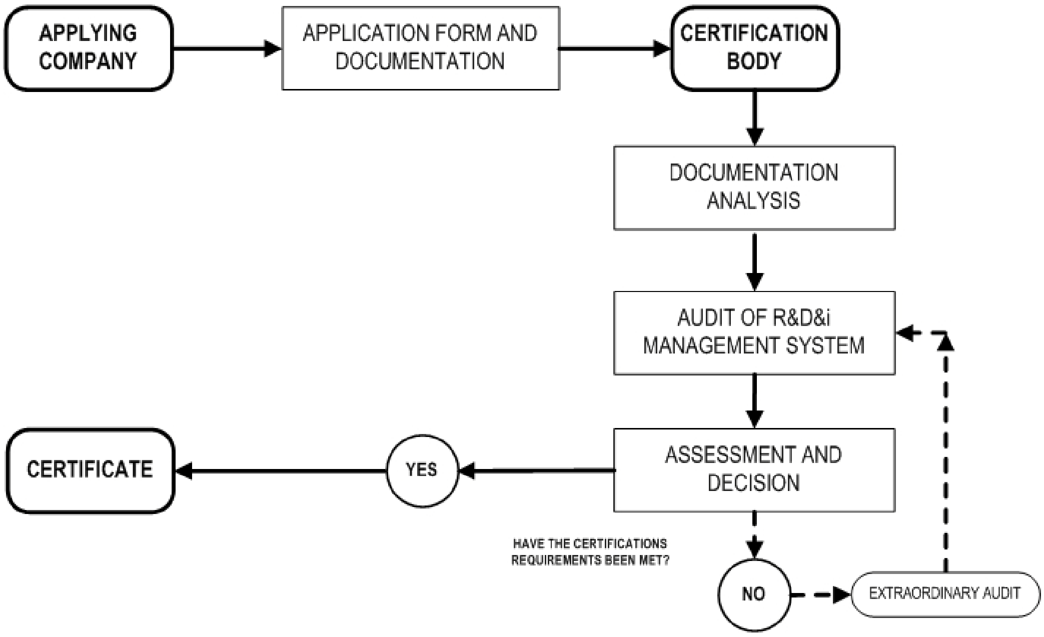

Figure 1: Certification process for R&D&I management system (Pellicer et al., 2008)

CERTIFICATION FOR R&D&I PROJECTS

Standards UNE 166001:2006 and NP 4458:2007 are the references for defining, documenting and developing R&D&I projects. The above standards aim to facilitate the systematisation of R&D&I projects, and include relevant aspects of how to manage them and how to benefit from results. Thus, every type of Spanish or Portuguese organisation, especially medium and small companies, may identify innovative activities, develop and document them methodically, therefore obtaining sound and recognized R&D&I achievements. Furthermore, this innovation effort can be certified and displayed for recognition, if required.

A potential project needs a person responsible for it. Besides, the R&D&I project is documented as follows: (1) main report; (2) budget; (3) document control; (4) project monitoring; and (5) exploitation plan. The main report includes: summary, scope of work, goals, methodology, impact and opportunity regarding R&D&I, literature review including limitations and gaps, technical advance and results forecasted and planning. The latter covers general planning by phases, description of activities and deliverables, Gantt chart including critical milestones, resources, organisation and responsibility chart.

The project budget is based on cost estimating and previous scheduling. Resources, task duration and their relation through the work breakdown structure are needed to obtain actual costs; cost traceability is also essential. Document control and project monitoring close the project management cycle. Project monitoring, according to this standard, demands regular reports to explain results, costs and deviations.

Finally, the standards ask for exploitation of results in order to use, disseminate and protect them. The plan includes: identification of the new product or process, definition of stakeholders and markets interested in their use, protection of outcomes (if appropriate), economic exploitation of results, foreseen costs according to several scenarios, and benefits of the project related to business competitiveness.

Figure 2 makes clear the certification process for R&D&I projects. The process starts when the applying company sends an application form and documentation to the certification body. The next steps follow: the application is processed and the documents are analysed; the certification organisation reports on compliance with UNE 166001; an external expert is selected (if adequate). This expert evaluates the project and hands out a technical report; if it is positive, the certification body issues a proposal for certification.

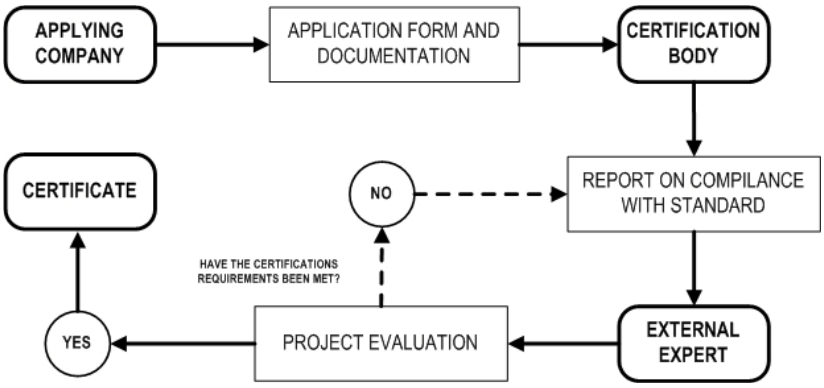

Figure 2: Certification process for R&D&I projects (Pellicer et al., 2008)

Besides profit, R&D&I activities are key factors that can enhance the economy of a country and its competitiveness. From the point of view of the company, they not only ease the assimilation of new technologies, but also improve its competitiveness in the global economy. Other advantages include the reduction of uncertainty and risk in projects and achievement of fiscal benefits.

PROMOTING R&D&I IN CONSTRUCTION COMPANIES

Following the pilot experiences conducted in both countries by volunteering companies, some lack of adhesion to the R&D&I effort has been detected within their organizations. This has been mainly characterized by low commitment from top managers, poor diffusion of R&D&I objectives and benefits to companies, lack of participation of relevant staff members, indifference from potential contributors of ideas for new projects, lack of diffusion of ongoing projects conducted by each company, and so on.

Realising the need to encourage more participation from their staffs, one company of each country addressed the institutions of the authors for launching a promoting action to improve the R&D&I performance in their organizations. Despite the different realities of the two companies, the coincidence in time, the similarity of Portuguese and Spanish standards and the collaboration of the authors in previous research projects, encouraged both institutions to work together in order to establish the basis of a similar programme for achieving the results aimed by both companies. The programme was meant for further development in each company's organization and best fit to each one's reality, taking into consideration their specific objectives, timings and resources. Table 2 summarizes the action plan of the programme.

Table 2: R&D&I Action Plan

Actions	Topics
Develop, implement and maintain a specific R&D&I page in the company main site; introduce R&D&I information in the main page of the company; produce posters and flyers.	Strategic R&D&I topics
	Messages from company's board
	R&D&I projects conducted by the company
	On-going R&D&I projects in the company
	Technological survey
	Selected ideas for R&D&I projects
	Miscellaneous
	Adverts
Direct personal messages to the staff; encourage bi-directional communication.	Selected ideas for R&D&I projects
	Various messages
Participate in the company's communication media (newsletters and/or magazines).	Technological survey
	Strategic topics
	Messages from company's VIPs
	Ideas for new R&D&I projects
Create and maintain on-line repository.	R&D&I projects conducted by the company
	On-going R&D&I projects in the company
	R&D&I projects conducted by other institutions
	Innovative technologies
	New materials and new systems
	Conferences and workshops
	Publications
	Various information
Promote diffusion and motivation actions to the company's staff; encourage technical visits and participation in technical meetings and workshops.	Construction sites and company departments
	Partner institutions in R&D&I projects
	Meetings for promoting the innovation culture
	Production meetings
	Interviews to the staff
	Discussion of ideas with staff members
	Thematic workshops
	Other
Create and maintain an R&D&I board involving relevant company staff.	Technological, market and organizational interfaces
	Management of innovative ideas
	R&D&I projects conducted by the company
	On-going R&D&I projects in the company
	Innovative ideas
	Diffusion
	Revision of the R&D&I system
Make inquiries to the company staff; promote a discussion forum.	Revision of the R&D&I system
	Continuous improvement

CONCLUSIONS AND FUTURE WORK

According to Portuguese and Spanish recent experience, the impact of R&D&I was enthusiastic at construction company level. A number of the best quoted ones in both countries rapidly volunteered to developing specific management systems according to the new standards released. This has been strongly encouraged by governmental institutions that also supported certification of their R&D&I systems. These have been successfully integrated in quality, environment and health and safety management systems that companies have long been dealing with in their current operations. But the practical effect of introducing those systems has been below expectations in some of them. Actually, despite the innovative attitude of their staff in challenging projects throughout their history, it revealed lack of motivation in participating with innovative ideas possibly leading to R&D&I projects. This is possibly because activities related to this have not been traditionally in their scope of action.

One company from each country realised that institutions of the authors could possibly help design an action plan for developing R&D&I in their organizations. This was an excellent opportunity to develop stronger links between academy and the industry, much in line with recent governmental initiatives in both countries. A similar programme could be devised which was intended for further development in each company taking into account its specifics. The action plan presented in the paper shows the main actions and topics covered.

The implementation of the plan is still going on at the moment. It includes an inquiry to each staff which will help refine the plan and extract conclusions for refining the R&D&I management system.

REFERENCES

CICYT (2003) The Spanish National Plan for scientific research development and technological innovation for the period 2004-2007. Summary. Ministerio de Ciencia y Tecnología, Madrid.

COTEC (2007) Tecnología e innovación en España. Fundación COTEC, Madrid (in Spanish).

European Commission (2005) European trend chart on innovation – innovation strengths and weaknesses. European Commission, Brussels.

Ministerio de Fomento (2006) Atlas estadístico de la construcción en España: 2004. Ministerio de Fomento, Madrid (in Spanish).

Pellicer E., Yepes V., Correa C., Martinez, G. (2008) Enhancing R&D&I through standardization and certification: the case of Spanish construction industry. Revista Ingeniería de Construcción, 23 (2), pp. 112-119.

SEOPAN (2008) Spanish construction activity report 2007. SEOPAN, Madrid.

ICPMA KNOWLEDGE MANAGEMENT CENTRE – SHARING KNOWLEDGE IN THE INTERNATIONAL CONSTRUCTION PROJECT MANAGEMENT COMMUNITY

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In 2007, The International Construction Project Management Association (ICPMA) established a Knowledge Management Centre (KMC) the objective of which is to share experiences of construction project management amongst academics and practitioners across the globe. A strategy for the KMC was developed and a number of areas were identified as being relevant to the members of the international construction project management community. This paper examines the development of the KMC to date and establishes the achievements to date. The difficulties encountered in the development of the KMC are identified and the causes of these difficulties established. The plan for the future development of the KMC is outlined.

KEYWORDS: knowledge management, ICPMA.

INTRODUCTION

The objective purpose of this paper is to inform the global construction research community of the development of a knowledge management project amongst construction project management professionals. The paper begins with some background information which led to the initiation (Phase 1) of the project. This is followed by an account of the work that has been carried out to date, the milestones that have been achieved, the problems that have been encountered and an assessment of the status of the project at the end of Phase 1. The planning and development of Phase 2 is then addressed and an account of the current progress of this Phase is presented. The paper concludes with an identification of emerging factors that must now be addressed if the project is to be brought to a successful outcome.

BACKGROUND

The International Construction Project Management Association (ICPMA) developed from the International Construction Project Management Forum (ICPMF), which met for its first Congress in Cannes in 2001 to discuss best practice in current regulations and applied project management practices with representatives of International construction project management organisations and suppliers. The participants in the Cannes Congress represented leading professional associations from Germany, Great Britain, Spain and the USA as well as enterprises and universities from Germany, the Netherlands, Switzerland and the Czech Republic. The Forum formed a number of working groups, which would concentrate their efforts on topics such as:

- Forms of contracts;
- Training and further education;
- Certification
- Knowledge Management within the construction project management.

The Forum held a further Congress in London in 2002 to develop these objectives. At the 2003 Congress in Berlin, a formal structure was adopted and the name of the organisation was changed to the ICPMA. This new structure based its membership on countries and by now seven countries were represented. By 2004, at the Madrid Congress, clear working groups were beginning to emerge in:

- Forms of Contract
- Knowledge Management
- The Development and Promotion of the Association

In the area of Knowledge Management, structures were to be developed to gather knowledge using the following means:

- Clear definition of topics for the annual forum, ensuring that the articles and presentations delivered were defined into distinct knowledge areas;
- Presentations to concentrate on case studies and examples to give a better idea of structure and problems in projects in member countries;
- Invitation of speakers and delegates beyond the membership of the ICPMA;
- Each country member now required to identify specific experts that would contribute to the knowledge of the Association;
- CVs of all ICPMA members, outlining their areas of expertise, to be available on the internet.

The dissemination of knowledge would be facilitated through the annual forum and the services of a webmaster would be employed to ensure that the structure and continuous administration of a website would be maintained.

The 2005 Congress, held in Prague, concentrated on gathering knowledge in the areas of Risk Management and Legal Issues. However, it was now becoming apparent that the Knowledge Management structure was not fulfilling its objectives. Further change was introduced at the 2006 Congress in Bern, at a wide ranging gathering of views which saw all of the relevant material being gathered and made available on the web. However, it was the formal establishment of the Knowledge Commission (whose name was subsequently changed to the Knowledge Management Committee) at the seventh Congress in New York (2007) that finally led to the development of a workable structure for Knowledge Management in the ICPMA.

Work to Date – Phase 1

The Knowledge Management Committee initially comprised three individuals who set out a work plan for developing and delivering the structure. The Knowledge Management Centre (KMC) was established as a web based platform for the collection and dissemination of CPM knowledge as shown in Figure 1.

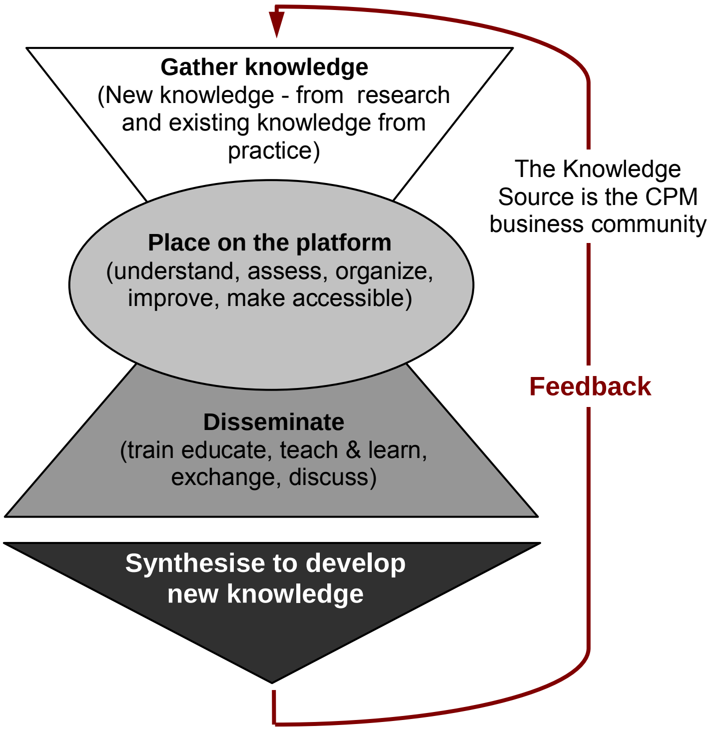

Figure 1: KMC Platform

The knowledge gathered would address specific CPM scenarios. Within each scenario it would be necessary to address the CPM issues that would arise under the modified PESTEL or SLEEPT headings as:

- Managerial;
- Technical;
- Legal/Contractual;
- Economical/Financial;
- Environmental/Sustainable;
- Political;
- Social/Cultural.

The knowledge gathered under all of these headings would be expected to be inter-related as illustrated in Figure 2. As there are numerous types and sizes of construction projects, it was decided that existing CPM knowledge would be classified as:

- National – applicable only to the country in which it had been gathered;
- Continental / International Region – applicable to a group of countries e.g the EU, Pacific Rim, etc;
- Global – applicable anywhere in the globe.

This would insure that those seeking knowledge of a particular size of project would quickly establish whether or not the KMC could cater for their specific needs.

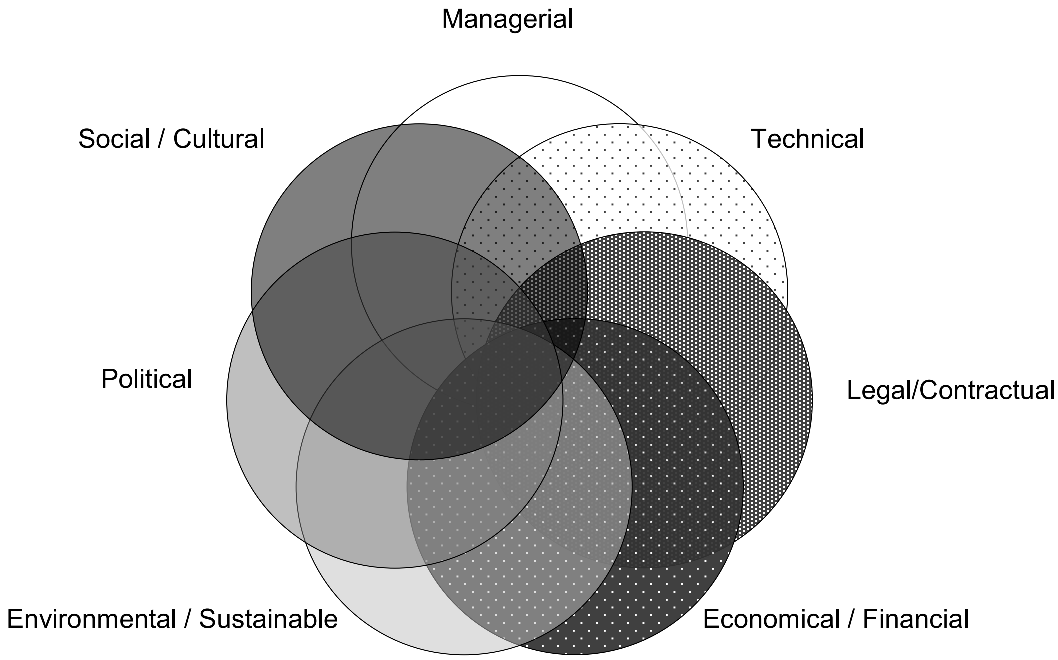

Figure 2: Headings under which CPM Knowledge would be gathered

The process knowledge gathering and knowledge dissemination was debated and three options were considered. The first of these options - outlined in Figure 3 - was an open model, based of the Wikipedia approach, where numerous contributors could independently add and edit information to the database. This approach had the advantage of being inexpensive and easy to establish. It would also be attractive to users as the knowledge would be freely available. However, as ICPMA required the security that all of the knowledge on its database was accurate and factually correct, the open model was considered as a means of meeting the requirements of ICPMA. Nevertheless the proposition that at least some of the knowledge would be freely available was considered attractive as a means of promoting ICPMA and it was therefore envisaged that some parts of the knowledge management database would be open access.

The second option considered adopted the approach of limited access with all of the knowledge contributions being filtered and reviewed before being made available. This is outlined in Figure 4.

Effectively, all contributions of knowledge would be subjected to a peer reviewing exercise. This would require a much wider professional membership within ICPMA than already existed and would result in considerable set-up costs to ICPMA. To offset this, those requiring the use of the database would be required to pay a contribution for use of the facility. On reflection, it was decided that this option may be considered for some specific knowledge in the future, but it was not a suitable option at this time.

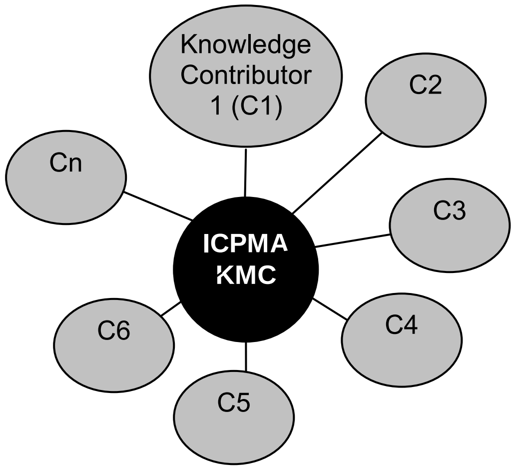

Figure 3: Open Source Model

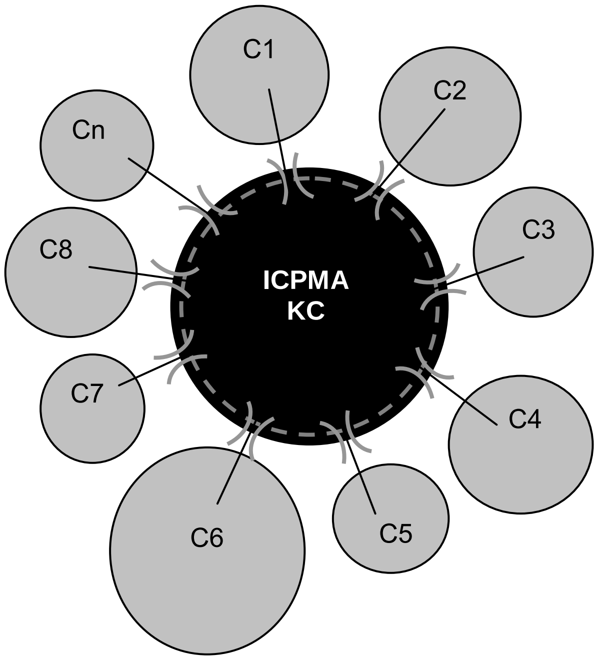

Figure 4: Limited Access Model

The third option needed to provide a means of ensuring that the knowledge placed on the database was factual whilst avoiding the high cost that would be incurred in option 2. Option 3, illustrated in Figure 5, therefore concentrated on a series of knowledge domains for which individual members of the Association would take development responsibility as domain leader.

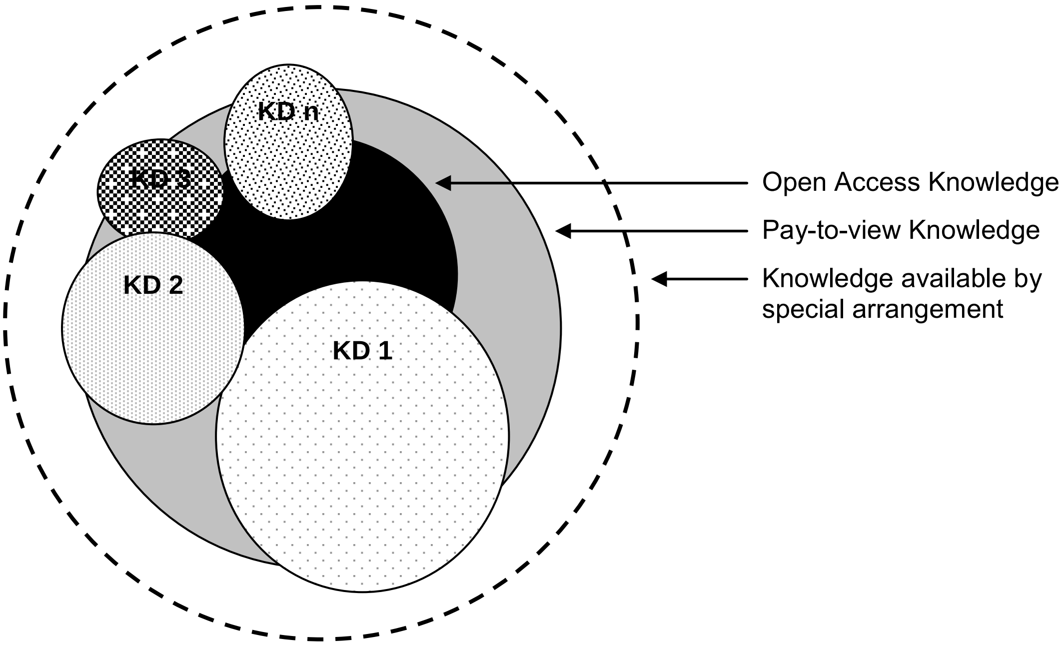

Figure 5: Preferred KMC model

This model comprised three levels of knowledge, namely:

- Open-access – that which is already in the public domain and is freely available to everyone;
- Pay to view – peer-reviewed knowledge stored elsewhere where links would be provided to a portal through which potential users could individually arrange to pay for access;
- By special arrangement – whereby those seeking the information would be freely given the contact details of a 3rd party who would have specific terms under which the information could be arranged to view.

It was anticipated that some, if not all of the domains would contain all three levels of knowledge. All knowledge would be fed through the domain leader and placed on the database.

The KMC section of the ICPMA website would operate as a portal for accessing the knowledge placed on the database. Where possible, the open source knowledge would be provided through direct weblinks to the relevant websites. Further knowledge would be submitted by ICPMA members and stored online. Initially, three knowledge domains were proposed:

- CPM of Urban Transport systems;
- Public Private Partnerships;
- Sustainable/Life Cycle Construction.

The CPM of Urban Transport Systems would be developed as a pilot to establish the issues that would arise in further developing the KMC.

All of these decisions were taken in series of meetings that took place between July 2007 and June 2008 during which the structure of the web portal was designed and developed. The portal went live in July 2008 and the development of the first domain (Phase 2) commenced.

Problems Encountered and Assessment of Phase 1

The difficulties that emerged during Phase 1 were concerned more with the structure of ICPMA in general rather than the project in particular. ICPMA was an association of CPM organisations, University level institutes and Professional bodies. During the early phases of this project, ICPMA had no individual members. Consequently, organisations allowed their employees to give time to the project but the priority allocated to this time invariably was lower than that allocated to the business of the organisations themselves. Progress therefore occurred in short, intense bursts, with long periods of inactivity in between. In addition, those not specifically involved in the development of the structures of the KMC did not respond to calls for input. Despite this, Phase 1 was completed within 12 months and had produced a credible working structure for the KMC. It was obvious however by July 2008 that the structure of ICPMA would require review, as the membership numbers had remained static and some of the larger organisations were beginning to question their future in the Association.

Phase 2 – The development of the First Knowledge Domain

Following the 8th Annual Congress in Dublin in May 2008, the focus of the KMC moved from development of the Knowledge Management Platform to the development of the Urban Infrastructure Knowledge domain. This domain would be structured to reflect the elements shown in figure 6.

Figure 6: Urban Infrastructure Knowledge Domain

It was intended to address an intended project in Dublin with knowledge gained from previous projects in Vienna, London, Berlin, New Delhi and New York. However, loss of the UK and US members early in 2009 and difficulties in establishing the necessary contacts in New Delhi and Berlin meant that the only material collected in the first six months was the initial project brief from Dublin and the existing information from Vienna. The loss of these members subsequently precipitated a major review of the structure of ICPMA, resulting in all of the efforts of the association being diverted to the organisational restructure. This reorganisation was approved at the 2009 AGM in Berlin with the association now having two areas on which it would concentrate, namely; administration and knowledge. As part of the reorganisation, membership would in future be based on individuals, who would be either professional (academics and practitioners) or post-graduate student members. The immediate effect of this was to open entry to membership up to a much wider base and to empower this membership to develop the KMC. In addition, the level of membership fees were set at a very low level but a condition of entry is that all would accept the principle of active membership. In doing so, an applicant is asked to define the contribution in effort that he/she will bring to the association. Renewal of membership will be contingent on achieving the criteria that the individual has set out on application and the setting of new goals for the next year.

From May 2009, therefore, a Knowledge Domain would have a specific defined structure, as illustrated in figure 7.

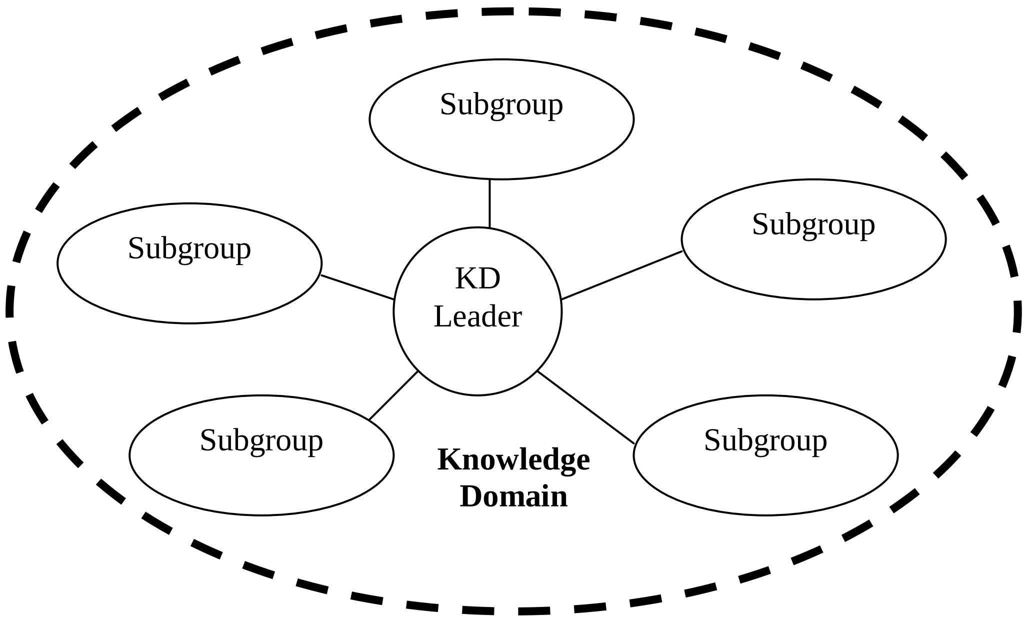

Figure 7: Organisation Structure of a Knowledge Domain

Each Knowledge Domain (KD) would be led by a single individual who would be supported by a KD team of professional members. These professional members would lead subgroups of student and further professional members. The subgroups would concentrate on gathering the knowledge required within the KD. They would be organised on the basis of the knowledge type required - i.e political, technical, economical, legal/contractual, environmental, social/cultural, etc., - as decided in Munich in October 2007. One subgroup would take responsibility for the webpages for the KD. The KD leader would be responsible for the recruitment of the relevant professional members, the co-ordination/interaction of the subgroups and for the progress of the work of the domain. Each of the subgroup leaders would be responsible for the recruitment of the members (professionals and students) of the subgroup. By mid May 2009, work had recommenced on the development of the Urban Infrastructure Knowledge Domain.

CONCLUSION

The ICPMA is focussed on knowledge sharing, rather than being concerned with power. This philosophical approach has caused difficulty for some of its members in the past, sometimes resulting in these members leaving and concentrating their resources on other organisations more suitable to their individual needs. But in an era of continued closer co-operation between countries, companies and individuals, ICPMA continues to build networks of CPM practitioners around the globe through the sharing of knowledge.

Through the KMC, ICPMA is building a platform for interaction of practitioners, academics and students in a variety of CPM related areas. For a small annual fee – set at a level to cover the running costs of ICPMA – and a commitment to the philosophy of knowledge sharing, individuals can now become members of this network, thereby bringing synergies in knowledge and greater value to the CPM profession through the dissemination of knowledge.

The ICPMA can be contacted through its website at www.icpma.net.

STANDARDIZATION OF PROCUREMENT: NATIONAL OR INTERNATIONAL?

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The ISO has issued a Draft International Standard on construction procurement and the British Standards Institute is drafting a standard based upon this for use in the UK. Three questions arise from these observations. First, what kind of consultation processes would be adequate to ensure that such a standard meets the requirements of an industry as diverse as construction? Second, why would an international standard be inappropriate for use in a country like UK? Third, what sort of issues should such a standard seek to cover? There are strong precedents for process standards, such as quality assurance, design management and workmanship on building sites. So the idea of a standard on procurement is not unusual. Moreover, there are many differences in tendering and procurement practice that are wasteful and even collusive or illegal. These issues are explored with a view to offering insights and suggestions for guidance based on the experiences in UK. The research method is first-hand observation of the drafting committee who are dealing with the British Standard. As an example to test and inform the standardization concept, six different standard guidance documents on tendering procedures are compared. This reveals a significant degree of diversity, and based on this, nine stages for implementing a tendering procedure are derived.

KEYWORDS: procurement, procurement standard, tendering procedures, UK.

INTRODUCTION

The International Organization for Standardization (ISO) has circulated a draft International Standard on construction procurement (Draft ISO 10845-1 Construction Procurement) to its member countries for consultation. This development has led to the setting up of a Procurement Committee by the British Standards Institute (BSI) to draft a national standard for construction procurement for use in the UK. On the face of it, the idea of applying a generic standard to construction procurement may seem plausible. However, the construction sector is diverse in nature and projects are procured and managed within distinctively different national contexts. Specifically, there are major differences in the legislative environments, economic environments and business processes in different countries. This raises the question of why such a generic standard will be suitable for a country like the UK. The purpose of this study is to explore four broad aspects of the ongoing work of the ISO and BSI in developing a standardized approach for procurement in construction. First, the concept of ‘standardizing’ the process of procuring construction work is examined. Second, the draft ISO standard on construction procurement is described; here, the rationale for the standardization move is also examined to ascertain why such a generic standard would be suitable for use in the UK, and potential challenges to such a move. Third, the ongoing work of the BSI in developing a British standard for construction procurement is described based on direct participant observation; the nature and adequacy of the consultation process required for a comprehensive document is explored. Fourth, as an example to test and inform the standardization concept, six different standard guidance documents on tendering procedures in the UK are compared: NJCC (National Joint Consultative Committee 1996); RIBA (Royal Institute of British Architects 2007); Aqua Group (Hackett, *et al.* 2007); a typical UK local authority (LA) procedure, providing an example of a procedure compliant with EU public procurement legislation (Law and Administration Department 2003); CIB (Construction Industry Board 1997); and JCT (Joint Contracts Tribunal 2006). This showed a significant degree of diversity in the prescriptions, and based on this, stages for implementing a tendering procedure are derived.

STANDARDIZING APPROACHES TO THE PROCUREMENT PROCESS IN CONSTRUCTION

Procurement can simply be understood as a method of buying goods and services (as articulated in a research textbook on construction procurement by Hughes *et al*., 2006). It is generally an important issue both at national and international levels. Procurement is a core element of the operations of government and private institutions in different countries. International institutions like the World Bank, International Monetary Fund (IMF), World Trade Organization (WTO) and Transparency International all have procurement and financial transparency policies. Thus, one primary driver for standardization of procurement processes is to avoid corruption and increase transparency and accountability. The World Bank[1]for example, has policies covering four specific areas of procurement: (1) information for borrowers; (2) bidding/consulting opportunities; (3) public procurement; and (4) policies and procedures. Indeed, public procurement reform of the kind envisaged by Hawkins *et al.* (2006) is promulgated by the World Bank through its “Country Procurement Assessment Reports”. The World Bank follows the UNCITRAL (1994) processes. Procurement is also an important subject in international trade (see WTO[2] which cites the government procurement market at 10-15% of GDP). So clearly procurement is important and probably merits an ISO standard for guiding its activities.

Standardization is the process of developing and agreeing upon technical standards and a standard is a document that establishes uniform engineering or technical specifications, criteria, methods, processes, or practices (www.iso.org). Therefore, it would appear that the idea of an international standard for construction procurement is to prescribe a set of procedures for approaching the procurement of construction work across different countries so that there is consistency of practice. However, procurement is complex. The research by Hughes *et al*. (2006) showed that, in theory, there could more than 15,000 different permutations of procurement variables. Thus, a standardized approach to a wide range of procurement practices would seem difficult. However, although there has never been a British Standard around procurement issues, there are strong precedents for process standards, such as quality assurance (ISO 9000), project management (ISO 21500, BS 6079-1:2002), design management (ISO 9001) and workmanship on building sites (BS 8000: 1-10). What is particularly new in the proposed standards are the options to select bidders on some basis other than price, such as quality. So the idea of a standard on procurement is novel in many ways but not completely new ground, and there are probably areas that should indeed be standardized in order to enhance efficiency and eliminate waste in the procurement process. For example, the study by Hughes *et al*. (2006: 101) called for a systematic and standardized

[1] http://web.worldbank.org/wbsite/external/projects/procurement.html
[2] http://www.wto.org/english/tratop_e/gproc_e/gproc_e.htm

approach to pre-qualification practices in tendering, because of the complexity and costs involved and diversity of pre-qualification procedures.

The danger of standardization of processes is that it may discourage participants from discussing key strategic project issues (Hughes and Greenwood, 1996). However, the problem of complexity is perhaps more dangerous because it may negate any attempts to communicate meaningfully in an organization (Galbraith, 1967). Previous research by Hughes et al. (2006) concluded that there was a need to standardize the processes of tendering, especially pre-qualification, in order to remove waste from the process.

The importance of standardization is that it institutionalizes the way the market operates. All markets are governed through "rules of exchange" that are usually informal, and govern the continuity and dissolution of relationships between businesses (Baker, Faulkner and Fisher 1998). Markets become institutionalized as these rules of exchange are formalized, and the standardization of tendering processes would be a major step in institutionalizing the construction market. The frequent problems of exploitation and pressure to reduce prices in the supply chain are an inherent part of the recent preoccupation with the collaboration agenda (e.g. Office of Government Commerce 2006, Constructing Excellence, etc).

But this is important not just because of the need to focus on value rather than price, but also because historic practices represent an unfair wielding of power where the rights of some parties in the supply chain are not properly recognized. Casson (1994) argues that standardization brings about the recognition of the rights of everyone involved in the process. This is the reason why it is so important to attempt to codify best practice in terms of recent developments to the organization of market relationships in construction.

There are precedents for standards in construction procurement. Standards South Africa has published four national standards for procurement in recent years: (1) SANS 1914 (2002), Targeted construction procurement (Parts 1-6); (2) SANS 10396 (2003), Implementing preferential procurement policies using targeted construction procurement procedures; (3) SANS 10403 (2003), Formatting and compilation of construction procurement documents; and (4) SANS 294: 2004, Construction procurement processes, procedures and methods. The Construction Industry Development Board in South Africa argued that the standardization of construction procurement will enable those engaged in procurement activities to perform their duties in a uniform and generic manner; procurement documents to be readily compiled; and curricula to be developed to capacitate those engaged in a range of procurement activities. It further stated that the standardization of procurement documents will lead to cost savings, improvements in quality, improved efficiencies and tenderers being able to more easily determine the scope and extent of risk. Standardization furthermore, allows governments to readily develop an internal procurement skills base, which is not lost when staff moves between different departments or levels of government (www.cidb.org.za). However, the arguments of the CIDB are yet to be proven empirically.

INTERNATIONAL STANDARD FOR CONSTRUCTION PROCUREMENT

ISO, accepted a proposal from the South African Bureau of Standards, supported by the Institution of Civil Engineers, the Institution of Structural Engineers, the South African Institution of Civil Engineering, the African Engineers Forum and the Construction Industry Development Board (CIDB) to develop a series of international standards for construction procurement based on the South African National Standards and the Standard for Uniformity in Construction Procurement. CIDB argued that the objective of the procurement standards was to provide a generic and standard set of processes, procedures and methods for a procurement system that is fair, equitable, transparent, competitive and cost effective and which may be used to promote objectives additional to those associated with the immediate objective of the procurement itself (www.cidb.org.za).

CIDB also stated that an international standard on construction procurement could be especially relevant for developing countries that lack experience and instruments in this field and may be used to improve international trade. For example, one of the main responsibilities of the World Bank's procurement sector is to help borrower countries improve their procurement systems as it is believed that sound public procurement policies and practices are essential to good governance (www.worldbank.org). This is one area where the ISO standard could probably help since its purpose is to provide a framework around which public, private and international organizations may develop their procurement systems to achieve fair competition, to reduce the possibilities for abuse and to improve predictability in procurement outcomes. ISO 10845 is prepared by ISO Technical Committee 59, Building construction, and consists of 8 parts, under the general title of Construction procurement:

- Part 1 (Processes, methods and procedures)
- Part 2 (Formatting and compilation of procurement documentation)
- Part 3 (Standard conditions of tender)
- Part 4 (Standard conditions for the calling for expressions of interest)
- Part 5 (Participation of targeted enterprises)
- Part 6 (Participation of targeted partners in joint ventures in contracts)
- Part7 (Participation of targeted enterprises and targeted labour: local resources in contracts)
- Part 8 (Participation of targeted labour in contracts)

At the time of writing, only Part 1 is at the DIS stage and is currently in circulation to member countries for consultation. Generally, international standards may be used either by direct application or by a process of modifying an international standard to suit local conditions (www.iso.org). The adoption of international standards often results in the creation of equivalent, national standards that are substantially the same as international standards in technical content, but may have (i) editorial differences as to appearance, use of symbols and measurement units, substitution of a point for a comma as the decimal marker, and (ii) differences resulting from conflicts in governmental regulations or industry-specific requirements caused by fundamental climatic, geographical, technological, or infrastructural factors, or the stringency of safety requirements that a given standard authority considers appropriate (www.iso.org). It is not yet clear whether the UK would seek a national version or adopt the draft international standard on construction procurement. However, looking at the arguments advanced by the CIDB in proposing the idea of an international standard, there is a strong argument for Britain to develop its own standard for use in the UK, although the emphasis in the British Standard would be at a different level, more connected with best practice than with the procedural issues covered by the DIS.

BRITISH STANDARDS INSTITUTE (BSI) NATIONAL STANDARD FOR CONSTRUCTION PROCUREMENT

The British Standards Institute (BSI) is drafting a national standard for construction procurement in the UK based on ISO 10845. The account in this section draws from and builds upon the ongoing work of the BSI Procurement Standard Committee. The BSI standard on construction procurement being developed will cover public and private sectors; experienced and inexperienced clients; and a wide scope of works (construction, civils, and process). It is expected to be a client driven document. The BSI Committee are considering the spate of "best practice" guidance on procurement that has emerged in recent years. Is this something that can or should be codified? Indeed is it targeted at the same issues as the ISO on procurement? This indicates that perhaps there are two different things going on. First, the ISO and similar guidance provides systematic steps to be followed in all instances. Second, much of the rhetoric of best practice is more about behaviours and attitudes. This is equally important but different.

The development of a procurement standard for the UK needs to be carefully considered. In a sector as diverse as the UK construction sector, one question that arises is the kind of consultations necessary to ensure that such a standard covers sufficient ground to make it operational and effective in implementation. Given the aim of covering public and private sectors, and considering the diversity of professional and technical roles in the myriad processes of distinct construction sub-sectors, a comprehensive consultation process would be a daunting task. It is also important to consider the question of whether such a standard is indeed appropriate for a country like the UK (in the context of the initial arguments given by the CIDB in proposing the idea of an international standard on procurement). Given peculiarities exclusive to the UK construction sector, one more question is the sort of issues that such a standard should cover. Fundamentally, it is important to understand that the ISO DIS is based on a proposal from the South African Bureau of Standards[3]. Therefore, it is important to assess the SA argument for developing a National Standards for Construction Procurement (based on the Standard for Uniformity in Construction Procurement[4]) to ascertain how this supports the development of a similar document for use in the UK. The South African Standard for Uniformity in Construction Procurement is a document that establishes minimum requirements for: promoting cost efficiencies through the adoption of a uniform structure for procurement documents, standard component documents and generic solicitation procedures; providing transparent, fair and equitable procurement methods and procedures in critical areas in the solicitation process; ensuring that the forms of contract that are used are fair and equitable for all the parties to a contract; and enabling risk, responsibilities and obligations to be clearly identified. The Standard establishes a uniform framework for procurement and minimum requirements for four main areas of procurement.

The BSI Committee should to take into account one of the considerations made in drafting the South African Standard: construction procurement involves not only engineering and construction works contracts, but also supply contracts that involve the purchase of construction materials and equipment, services relating to any aspect of construction including professional services, disposals of surplus materials and equipment and disposals in the form

[3] http://www.cidb.org.za/procurement/procurement_toolbox/overview/int_sta_proc/default.aspx
[4] http://www.cidb.org.za/procurement/procurement_toolbox/standard_uniformity/default.aspx

of demolitions. The SA standards as such cover the full range of commonly encountered procurements in both the public and private sectors in most industrial sectors.

At the time of writing, the BSI Committee is focusing on five outputs: (1) Necessary British amendments to ISO/TC59. The focus here will be on identifying client priorities and approaches to tendering. This is expected to cover a wide scope including best value and scope of works. It will be customized to British context; (2) Identification of and cross-reference to generic regulations such as the Construction Act, Health and Safety legislation and EU procurement regulations; (3) Identification of relevant clients and sectors and cross-references to specific regulations. This will cover regulations applying only to particular clients or particular industries such as local government, education, utilities; (4) Standardization of key British standard. Here, the idea is to convert best practice (e.g. OGC) into British Standard. One idea in being discussed is to bring in aspects that are missing in ISO/TC59 for British context e.g. life cycle work, collaborative working, and integrated supply chains; and (5) Bibliography – the idea here is to signpost the standard being developed to other standards/guidance in order to avoid unnecessary duplication.

STANDARDIZING PROCUREMENT: AN EXAMPLE FROM TENDERING PROCEDURES

In examining the concept of standardizing procurement, we chose to examine the difficulty (or ease) of standardizing a single subset of procurement such as tendering procedures. This would give an indication of the diversity in approaches and practices within the UK context. Six different standard guidance documents on tendering procedures in the UK are compared: NJCC (1996), RIBA (2007), Aqua Group (2007), LA (2003), CIB (1997) and JCT (2006). This showed a significant degree of diversity. From the analysis in Table 1, a series of stages for implementing a tendering procedure is derived. The horizontal lines represent distinct stages of the tendering procedure that appear to take place in all of the documents. The first thing that is revealed by this table is the very small commonality across six descriptions of something as routine as invitations and evaluating tenders. This is not just the use of different vocabulary but may be a question of different levels of detail. The interesting features between of Table 1, that raise important questions for those who are drafting standards, are:

- Only one (1) mentions the preparation of a tender timetable;
- Detailed design (2);
- Initial cost estimate (1)
- Basis of contractor selection (3)
- Preliminary enquiry (3);
- Statutory approvals (2)
- Establishing each tenderer’s financial standing and record (1);
- Establishing each tenderer’s recent experience and general skill (1);
- Establishing fluctuations mechanism (1);
- Establishing each tenderer’s technical and management structure (1);
- Establishing each tenderer’s approach to quality assurance systems (1); etc.

Clearly several questions arise to show how even with a small subset of procurement, significant differences exist in approaches and prescriptions. There are only four main areas of strong agreement on activities that should happen in a tendering procedure (see horizontal lines). It would be important for the BSI committee to recognize the diversity of practices that may exist in the industry. The research by Hughes et al. (2006) showed that there could be more than 15,000 different permutations of procurement variables. It would be important to consider how best to synchronize diverse practices into a single standard; clearly this poses a significant challenge. And how well this is done will go a long way to determining the practical usefulness of the standard being developed.

Table 1: Summary of tendering guidance documents compared

NJCC 1996 Code of procedure	RIBA 2007 Plan of work	AQUA GROUP 2007 Guide to tendering	LA 2003 Public Procurement Guidance	CIB 1997 Code of practice for the selection of main contractors	JCT 2006 Note 6 Main contract tendering
-	-	-	Prepare a timetable	-	-
-	PRODUCTION INFORMATION	PRE-CONTRACT	-	-	-
-	-	Develop the brief	-	-	-
-	-	Feasibility report	-	-	-
-	-	Sketch scheme	-	-	-
-	-	Initial cost estimate	-	-	-
-	-	-	-	-	Initial list of contractors
-	-	-	-	-	Preliminary enquiry
Identify basis of selection	-	Method of choosing contractor	-	-	Basis of assessment
Preliminary design	-	-	-	-	-
-	-	-	-	-	Tender list / final shortlist
-	Detailed information	Detailed design	-	-	-
-	Statutory approvals	Statutory and other approvals	-	-	-
-	Prepare further information	Final design proposals	-	-	-
-	-	Re-examine timetable	-	-	-
-	Review information from specialists	-	-	-	-
-	-	Drawings / large-scale details	-	-	-
Preliminary specification	-	Specifications	-	-	-
Prepare pricing documents	Prepare tender documentation in sufficient detail	Produce bill of quantities	Prepare tender documents	Tender enquiry documents	Tender documents
-	-	-	Design a specification	-	-
Establish fluctuations mechanism, obligations, programme for 2nd stage, price, scope of contractor involvement.	-	-	-	-	-
-	-	Approach specialist subcontractors and suppliers	-	Preliminary enquiry	-
-	-	-	Draft price and payment clauses	-	-
-	-	Quality assurance and mgt. system	-	-	-
-	-	-	Advertise notice of the tender	-	-
List of tenderers	Identify and evaluate potential contractors	Tender list (less than six plus two reserves)	Select tenderers	Qualification / tender list	-
Establish each tenderer's financial standing,	-	-	-	-	-

Table 1: Summary of tendering guidance documents compared

NJCC 1996 Code of procedure	RIBA 2007 Plan of work	AQUA GROUP 2007 Guide to tendering	LA 2003 Public Procurement Guidance	CIB 1997 Code of practice for the selection of main contractors	JCT 2006 Note 6 Main contract tendering
experience, skill, reputation, mgmt structure, competence, resources re H&S, QA, capacity.					
Preliminary enquiry	-	Preliminary enquiry	-	-	-
Preliminary invitation to tender	-	-	-	-	-
Final shortlist of tenderers	-	Finalize tender list	-	-	-
Tender documents	-	-	-	-	-
Invitation to tender	-	Invite selected contractors	Invitation to tender	Invitation to tender	Invitation to tender
-	Obtain / receive tenders	Receive acknowledgement from contractors	-	-	Tender submission and acknowledgement
-	-	Ensure tender compliance	-	-	Tender compliance
-	-	Open all tenders	-	-	-
-	-	-	-	-	Withdrawal and lapse of tenders
-	Appraise tenders	Examine the priced documents	Evaluate tenders	Select preferred tenderer (and next preferred ones)	Tender assessment
-	Submit recommendations to client	-	-	-	-
-	-	-	-	Accept successful tenderer	-
-	-	Negotiate reduction of tender price	-	-	-
-	-	Notification of results	-	-	Notification to tenderers
-	-	-	-	-	Examine priced docs and errors
-	-	-	Award contract	-	-
-	-	-	-	Notify unsuccessful tenderers	-
-	-	-	-	Prepare formal record	-
-	-	-	Implement the contract	-	-

Based on the comparison of six different standard guidance documents on tendering procedures in the UK, nine stages for implementing a tendering procedure were derived: (1) prepare a timetable and identify basis of contractor selection; (2) prepare tender documents; (3) preliminary enquiry to potential tenderers; (4) design a specification and draft price and payment clauses; (5) develop list of tenderers; (6) invite selected contractors; (7) obtain and evaluate tenders; (8) award the contract; and (9) execute the contract – agree terms and sign them. Comparing six various standard guidance documents on tendering procedures in the UK, the main finding is that there is no general agreement among the different stakeholders in the industry (RIBA, CIB, JCT, Aqua Group, LA and NJCC) on how tendering processes should be approached. This raises important questions.

The most recent research on tendering produced a series of recommendations about how to organize the procurement process (see Hughes *et al*. 2006: 98-101). The study called on practitioners to:

- Pursue early involvement of contractors;
- Reimburse costs of cancelled projects;

- Select on value rather than price;
- Desist from striking off contractors who cannot bid;
- Tender only 2-3 for collaborative projects;
- Standardize prequalification processes;
- Tell bidders who they are competing with; and
- Produce timely informative documents.

Table 1 shows that most of these recommendations are not dealt with in the guidance documents. These issues should be addressed if the problem of wasteful practices in procurement is to be avoided.

CONCLUSIONS

Nine stages for implementing a tendering procedure have been derived. But importantly, no general agreement was found between the tendering process guidance prescriptions published by six major stakeholders in the UK construction sector. This might not be a strange situation in itself considering that tendering processes are different and the fact that different people draft prescriptions from their own point of view and interest. But what it does indicate is the significant diversity in approaches and prescriptions which makes the idea of a standardized approach to the procurement of construction work difficult and even elusive. It also renders comprehensive consultation difficult. The analysis of guidance documents and previous research reveals that the nine steps outlined in the previous section should be a minimum process for any construction tendering episode.

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REFERENCES

Baker, W.E., Faulkner, R.R. and Fisher, G.A. (1998), Hazards of the market: the continuity and dissolution of inter-organizational market relationships, *American Sociological Review*, **63**(2), 147-177.

Casson, M (1994) Economic perspective on business information, In: Bud-Frierman, L (Ed.), *Information acumen: the understanding and use of knowledge in modern business,* London: Routledge, 136-67.

Construction Industry Board (CIB) (1997) *Code of practice for the selection of main contractors* London: Construction Industry Board.

Galbraith, J (1967) *Designing complex organizations*, London : Addison-Wesley.

Hackett, M, Robinson, I and Statham, G (2007) *The Aqua Group guide to procurement, tendering and contract administration*. London: Blackwell.

Hawkins, J., Herd, C. and Wells, J. (2006) *Modifying infrastructure procurement to enhance social development.* London: Institution of Civil Engineers.

Hughes, W.P. and Greenwood, D.G. (1996) The standardization of contracts for construction. *International Construction Law Review*, **13**(2), 196-206.

Hughes, W. P., Hillebrandt, P., Greenwood, D. G. and Kwawu, W. E. K. (2006) *Procurement in the construction industry: the impact and cost of alternative market and supply processes*, London: Taylor and Francis.

JCT (2006) *Practice Note 6 Main Contract Tendering* (2006), Joint Contracts Tribunal

Law and Administration Department (2003) *EU public procurement guidance.* Forfar: Angus Council.

National Joint Consultative Committee for Building (1996) Code of Procedure for Single/Two Stage Selective Tendering, London: NJCC.

Office of Government Commerce (2006) Framework agreements: OGC guidance on framework agreements in the new procurement regulations. London: The Stationery Office.

Royal Institute of British Architects (2007) *RIBA Outline Plan of Work*, London: RIBA.

UNCITRAL (1994) *Model law on procurement of goods, construction and services with guide to enactment*. New York: United Nations Commission on International Trade Law.

PERCEPTION OF LEADING, LAGGING AND PERCEPTIVE PERFORMANCE MEASURES IN CONSTRUCTION

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Construction industry is seen as the worst, ineffective, inefficient… Poor performance management is one of the main reasons for such a poor performance. Key Performance Indicators (KPI) should be at the heart of performance system as the vehicles for managing performance. This paper elaborates distinction among three types of KPIs: leading, lagging and perceptive, and explains their role in construction processes. Literature review showed that world's practice still does not recognize the distinction, even though many authors emphasised its importance. Survey, taken across Croatian construction industry, showed that: 90% of proffesionals understand KPIs' importance, 71% used some kind of performance indicators, 63% used KPIs for internal benchmarking, 43% showed high interest in such systems, but only 28% understood above-mentioned distinction. We found that if construction companies want to be able to conduct benchamarking, appropriately align strategic objectives and set realistic goals, they should start using all three types of indicators.

KEYWORDS: performance, management, KPI, construction, measures.

INTRODUCTION

Even though there has been a huge amount of research done in the area of project management, construction industry has issues with poor performance (Latham, 2004; Eagan, 1998; Beatham et al., 2005…). The industry suffers from many problems, e.g.: high level of fragmentation, dispersed structure…, and is falling behind other industries. In 1999, construction engineers spent more than 1 billion £ on rework (Nicholson, 1999). In 2003, private companies have spent a 1,5 billion £ on tools for performance measurement (Edwards and Thomas, 2005).

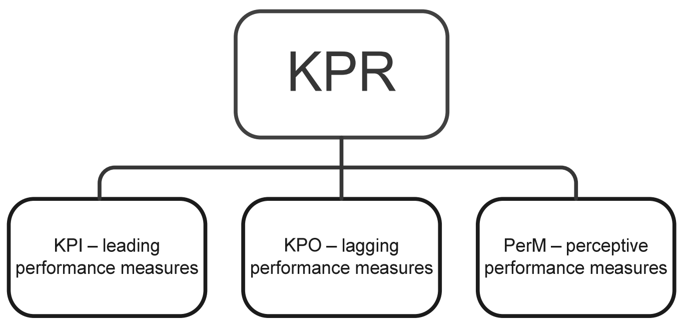
Concept of performance management is still young and has emerged in last two decades (Sharif, 2002) as a logical response to questions such as: "How are we doing business?", "How are our projects (firms) performing?", and "Are we investing in the right project and what benefits are we gaining through them?"... Neely (1999) stressed out seven reasons for managing performance: growth of competition, specific initiatives of improvement, national and international quality awards, change in organization roles, change in external demands and power of information technologies. Latham (1994) and later on Egan (1998) concluded that construction industry must replace the standard market competition with long-term relations based on transparent measurement of quality and efficiency. Through the last decade, there has been a lot of research activity in this area, but a small number of articles covered critical (key) performance indicators and even smaller studies concentrated on construction. Literature review showed that traditional systems, based on financial measures, cannot integrate all factors that are affecting performance of projects and organizations (Freeman and Beale, 1992; Kaplan, 1983.; Kaplan, 1984)

Performance indicators are compilations of information that are used to: measure and assess performance (Edwards and Thomas, 2005) and to give the final mark of company's efficiency and effectiveness. Construction managers deal with a large amount of performance indicators. Often they are measuring the right ones wrong, and vice versa, and so form a distorted image of performance. The fact that only 34% of projects meet their time objectives and 51% have issues with cost (Standish Group, 2003) shows the importance of improving the performance.

This paper brings the importance of KPIs closer to the reader and examines their definition, structure, purpose and role in construction processes. It sumarizes efforts gained in the area of KPIs untill today and compares them with results gained trough a structured survey taken across Croatian construction industry.

Key performance indicators (KPI) or Key performance results (KPR)?

Figure 1: KPR classification



Performance management is just part of larger system of business improvement. For an effective system, managers need a balanced set of performance indicators (Beatham et al., 2005; Kaplan and Norton, 2001; Neely, 1998, …). The results should be: benchmarked, incorporated into strategic priorities and then transferred, and cascaded in to activities and processes. Still, the majority approach to performance management in intuitive and "ad hoc" fashion.

The Royal Society of Arts, Manufactures and Commerce (RSA), for more than 15 years ago, gave a vision of a modern business system: "*To achieve sustainable business success, on a demanding World's market, company must…, use the relevant set of performance indicators"* (www.thersa.org). KPIs represents basis for measuring business and project success. The purpose is to enable the measurement of performance within companies and the industry, and to initiate benchmarking. Besides direct advantages, KPIs are used as means of communication within stakeholders to inform them about constant improvement endeavors. The largest performance association in UK, The construction excellenceworking group, defined KPIs as: *"A Key Performance Indicator (KPI) is the measure of performance of an activity that is critical to the success of an organization"*

(www.constructingexcellence.org.uk).

The majority, including EFQM, named the whole set "KPI", even though the lagging measures all called the same. We will name the whole set as Key Performance Results (KPR) to avoid the confusion (see figure 1).

KPR structure

If one observes the list of company's reports and tries to find out who gets the information and is that person able to affect it, he/she will often find a small number of such correspondences. Thus, the information is slowing system's efficiency and effective decision-making. Managers must primarily focus only the information on which they have direct influence. To help managers in the maze of chaotic reports, during our last research (Vukomanovic, 2006), we derived a list of elements that every KPR should include. These are: 1 Name, 2 Purpose, 3 Goal, 4 Formula, 5 Frequency of measurement, 6 Source of data, 7 Who is responsible for KPR, 8 What is their role, 9 Alignment with the strategy and other processes, 10 Impact on other KPRs. It is crucial to involve strategy alignment (ad 9) for effective performance management systems. Often this link is conducted trough Critical Success Factors (CFS) as the representation of higher business objectives.

KPR classification

We have devided indicators on leading (KPI), lagging (KPO) and perceptive (PerM) measures. Only few models made such a distinction (e.g. EFQM excellence model). We found quite confusion among authors with defining and classifying KPRs. In most cases they are confuse KPIs for KPOs and only few acknowledged importance of PerM (Vukomanovic, 2007).

Construction industry, nowadays, mainly criticizes KPRs because of their incapability to change the processes, but only to signalize the performance of already finished activities (Beatham et al., 2004 and 2005). In addition, we have found places where goverments forced down KPRs on to companies, (e.g. in UK) which afterwards produced resistance and antagonism. Managers mainly use KPRs as "lagging" (KPO) or measures that fall behind. "Leading" measures (KPI), unlike "lagging", give a possibility to influence the result and should be used to provoke future decisions and to change result.

KPI – leading measures

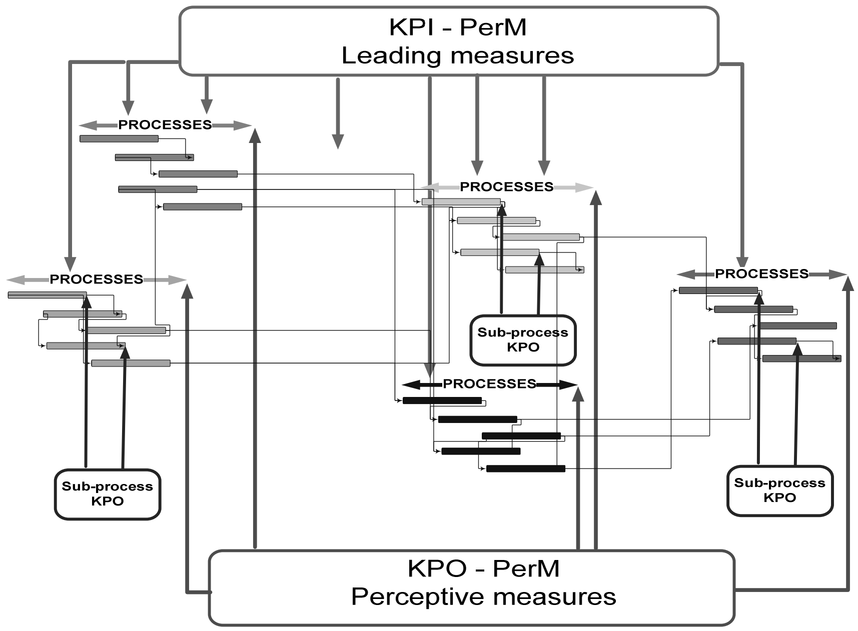
KPIs are *indicative* performance measures that assess unfinished processes. KPIs are not in a direct correlation with project outcomes (like time, cost, defects), but are indirect factors (like absence from work, motivation, communication…) that *lead* to the result. Let us use the following example. High level of absence from work can be associated with lack of moral, which can be than connected with week leadership, absence of work, poor work conditions, and lack of motivation… Encouraged with these kinds of indicators managers can introduce corrective measures in order to reduce absence from work and improve the performance.

To implement KPIs properly and set realistic goal, the system must rely on benchmarking (1st, 2nd and 3rd level). Following question explains this prerequisite: "What level of absence is acceptable on our construction site". If managers do not have the information from other sites - and the best practice – they will only assume the threshold and hold on to our intuition and "ad-hoc" management.

KPO – leading measures

KPOs are measures that report accomplished performance and final outcomes and as such do not enable ability to change the future outcome. In most cases, managers use KPOs as KPIs, even though they are not aware of it (Beatham et al., 2004, Beatham et al., 2005). Companies traditionally observe business performance from financial perspective (e.g. profit, yearly income, share value…). Financial perspective cannot point the key problems and opportunities, but only the outcomes. Following example explains previous prerequisite. For assessing projects success, managers often use: time, cost and quality – the iron triangle". 10% time breach can easily lead to conclusion that the project's level of efficiency is not satisfactory. However, this KPO does not explain why the delay happened, what caused delay and, especially, on which areas managers must concentrate in order to mend the deviation.

Figure 2. Distribution of KPIs throughout the project



KPOs can be also assigned to a sub-process to affect the outcome of it successor (Beatham et al., 2005). Example of building a concrete framework of a 10-storey building can clarify such conclusion. If time of embedded concrete is measured after each storey, the whole picture becomes more and more visible as project continues. In that way KPOs becomes KPIs or a sub-process KPO (figure 2).

PerM – perceptive measures

PerMs are measures that report stakeholders' perception in projects and can be lagging or leading. (e.g. Construction Best Programme Practice - CBPP, uses PerM as lagging indicators). E.g. Client satisfaction measured during the execution becomes leading measure. PerMs are usually generated trough interviews and questionnaires.

Still managers should carefully implement them since they can cause repulsivness within project stakeholders (Beatham et al. 2004, Kaplan and Norton, 2000,..). Construction still has not accepted PerMs, probably because of traditional and qualitative approach on solving problems.

Figure 2 shows the applicability of each indicator on the project. KPIs are applied during business processes, because of their ability to anticipate future performance. Even though they do not define the causal connection, they show corrective measures and focuses management on problem areas. KPOs and sub-KPOs are applied on the end of each process or sub-process, respectively.

Insight from practice

The evidence from present researches in area of KPIs - UK

During literature review, we analyzed papers from science databases (e.g. Science direct, Springer…), case studies and publications form performance clubs and tried to find best practice. The review showed low level of awareness of performance management tools, especially KPRs (less than 30% - Robinson, 2002; Cox, 2003). That fact is alarming because of construction's low image (Xiao-Hua and Ling, 2004) and low performance. Furthermore, authors and professionals mainly did not recognize the difference between factors and criteria that Lim and Mohamed (Lim and Mohamed, 1999) so comprehensively explained. The review produced following conclusions:

- In most cases, KPOs were used as leading as well as lagging indicators. Performance clubs in UK (e.g. Respect for people, Satisfaction of service, The MGC, CPI…) mainly used KPIs. "Environment issues" and "Safety at work" were only two KPI that were present in most of the cases, but because of legislative obligations, we did not consider them as innovative and novel. "Respect for people" has mainly developed leading indicators such as: absence from the work, migration, loss of staff qualifications, training, etc… and had most of leading indicators.

- KPRs were not designed to fulfil specific organization needs but specific association's aspirations. We have also found more than 25 various KPR sets, where each one was proclaimed as the best practice. That kind of chaos can act destructive in terms of benchmarking and strategy alignment.

- Many authors (Latham, 1994, Ng et al., 2002, Ugwu, et al., 2005…) observed importance of procurement routes in construction projects and various contracting models. CBPP had an opening role in introducing such indicators throughout different project phases, e.g.; completion of design documentation in design & build contracts is obviously not suitable KPR.

The insights from Croatia

The aim of the research was to assess weather Croatian project managers understood the difference among KPRs. The data was collected trough surveys and interviews, on representative pattern of construction firms in Croatia (Vukomanovic,

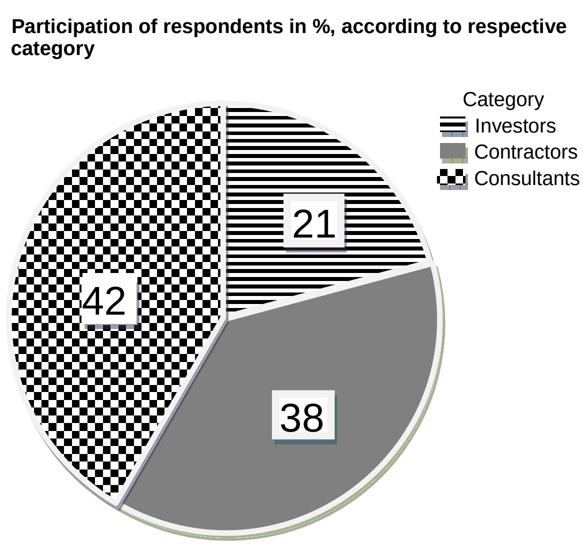


Figure 3: Distribution of respondents

2006). We divided companies on Investors, Contractors and Consultants. Since the industry is relatively small, there was not a large amount specific category to analyze it separately. The distribution of respondents (all executives) is shown on figure 3.

After initial pilot questionare (sent to three professors and three CEOs of Croatian construction companies), the final survey (see Appendix 1) was issued. The survey was consitent of two sections. In the first, respondents needed to give general information, like: Name of company, annual income, Construction category, Name of respondent, Function in the company, etc… In the second, respondents had to answer on questions that related to use of KPRs. Likert scale was used, from 1 to 6, to assess the importance of a given term. Felows and Liu (1997) observed the benefits of using a set of even numbers in scale, with removing the subjectivity by choosing the neutral value. The survey questions were genrated from hypothesis H1 and H2:

H1. Croatian construction industry, regardless to company's category, does not recognize the set of KPRs, as vital part of performance management system.

H2. Managers classify KPRs on leading (KPI), lagging (KPO) and perceptive (PerM).

Interpretation of results

In total, 26 out of 100 targeted Croatian construction firms responded. We found the 26% response rate acceptable, which was compliant with world practice (Fellows and Liu,1997; Zelenika, 2000).

Table 1: The responses on questions generated form hypothesis H1:

Questi.:	**Respondents (construction firms)**																							**AVG**
q1	5	5	4	5	5	3	3	6	4	4	3	3	4	4	4	5	5	4	5	6	5	5	5	6	4,50
q2	1	1	0	1	1	0	0	1	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0,71
q3	0	0	0	1	1	0	0	1	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0,63
q4	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	1	0,33
q5	5	5	4	5	5	3	6	5	4	4	3	3	4	6	6	5	5	2	5	6	6	4	6	5	4,67

Note: **q1, q5** **– Likert scale [1-6]**
q2, q3, q4 **– yes=1, no=0**

Responses on questions, based on H1 (table 1), showed the following:

- Construction firms recognized relatively high (4,50) level of KPR's influence on overall business success.
- 71% of respondents showed that they were using some kind of performance indicators.
- 63% of companies compared internal performance results as improvement initiatives.
- 33% of respondents answered that they use performance or quality management system.
- 43% of respondents showed relatively high interest in such systems even though did not implement such systems.

These results showed that Croatian construction companies did not recognize a set of KPRs. Thus, **hypothesis H1 was rejected.**

Table 2: The overview of responses on question generated from hypothesis H2

Questi.:	Respondents (construction firms)																							AVG
q6	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	1	1	0,28

Note: **q6 – yes=1, no=0**

Responses showed that the majority (72%) of construction firms still did not understand the distinction among leading (KPI), lagging (KPO) and perceptive indicators (PerM). Low level of understanding, among practitioners (28%), **rejected the hypothesis H2**.

Disscusion

This paper clarified the distinction between three types of performance measures: KPI – leading indicators, KPO – lagging indicators and PerM – perceptive indicators; and stressed-out their importance in construction processes. Unfortunately, we have found that world practice, as well as Croatian construction industry, still suffers from lack of knowledge from performance management, especially in the area of Key Performance Results and benchmarking.

High amount of different KPRs, promoted by different performance clubs, resulted with a vague picture of the indicators and repulsiveness within the industry. The worst scenario would be to force down indicators on to companies (e.g. UK case, which resulted with high level of rejection of KPRs) and expect them to comply. Terms like: KPI, KPO and PerM are still not harmonized in literature, which causes communication problems. Furthermore, KPRs are mainly not designed for different procurement routes and specific markets.

This kind of situation makes it very difficult for construction companies to implement benchmarking, try to initiate strategic control and start managing performance; as many authors so harshly stress out (Latham, 2004; Egan, 1998; Beatham, 2005…). Many companies also developed their own sets of KPRs. Main weakness in this kind of approach is the inability to conduct benchmarking and initiate performance management (French, 2009).

We have found that Croatian construction industry uses some kind of lagging indicators, but far from a methodologically and scientifically based KPR set. High level of interest among professionals showed a good foundation for further improvement. On other hand, even though many companies implemented some kind of quality systems (i.e. ISO), they were not aware of its dependence to performance management system and KPRs.

KPRs in construction are still evolving and there are still quite of areas to be covered, e.g.: perceptive measures, leading measures, different procurement routes, target setting, measures selection... In the period to come, the greatest benefit for construction companies would be to acknowledge one common set of KPRs, use them in order to encourage benchmarking (internal as well as external), and thus improve construction's week performance.

CONCLUSION

We can conclude that Croatian practice still falls behind results gained trough researches in the last two decades. Many construction companies are still using only lagging (mostly financial) indicators, developed at the beginning of the last century (Eccles, 1991). We have found that Croatian construction does not acknowledge KPRs as the means improving performance or as the means for benchmarking. Furthermore, few companies showed awareness of distinction among three types of indicators (KPIs, KPOs and PerMs).

Causal connection within causes and consequences is highly complex in business environment (Beatham et al., 2004, Beatham et al., 2005, Kaplan and Norton, 2000,…), especially in construction. Companies should generate every performance indicator from strategic objectives and should try to aligne them with current business environment. Only thus, companies can control strategy implementation, according to their aspirations, i.e. mission and vision. Since strategy should change, companies need external benchmark of performance, i.e. an external set of KPRs. This issue raises the question of how will internal KPRs reflect onto external ones.

Models like European Foundation for Quality Management, Malcom Baldridge National Quality Award, and such initiatives, represent examples of non-biased external KPR sets. In following years, researchers should try to integrate performance measurement systems (e.g. The Balanced Scorecard, The Performance Prism…) with external KPRs and thus form a holistic model for performance management.

If construction industry wants to improve performance and be an example for the others, it ought to implement KPRs more systematically.

REFERENCES

Beatham, S. et al (2004) KPIs: a critical appraisal of their use in construction Benchmarking: An International Journal, 11(1), pp. n/a

Beatham, S. et al. (2005) Insights from practice: An integrated business improvement system (IBIS) for construction Measuring business exellence, 9(2), pp. n/a

Cox, R. F, Issa, R. A., Ahrens, D, (2003) Management's perception of key performance indicators for construction, Journal of construction management and engineering, 142-151

Eccles, R. G., (1991) Performance measurement manifesto, Harvard Business Review, Vol.69, January-February, 131-7.

Edwards, D. and Thomas, J. C. (2005): Developing a municipal performance measurement system: reflection on the Atlanta dashboard, Public Administration Review, 65(3), 369-76.

Egan, J., (1998) Rethinking Construction, Department of Enviroment, Transports and the Regions, UK., pp. n/a

Fellows, R. and Liu, A., (1997) Research Methods for Construction, Blackwell Science, Oxford.

Freeman, M. and Beale,P. (1992) Measuring project success, Project Management Journal, 23(1), 8-17.

Frencf, S. (2009) Re-thinking the foundations of the strategic business process. Journal of Management Development, 28, 51-76.

Kaplan, R. S., (1983) Measuring manufacturing performance: a new challenge for managerial accounting research, The Accounting Review, 58(4), 686-705.

Kaplan, R. S., (1984) Yesterday's accounting undermines production", Harvard Business Review, 62, July-August, 95-101.

Kaplan, R.S., (1994): The evolution of management accounting, The Accounting Review, Vol. LIX No. 3, pp. 390-418.

Kaplan, R.S. and Norton, D.P. (2000) Having trouble with your strategy? – Then map it, Harvard Business Review, September - October, 167-76.

Kaplan, R.S., Norton, D (2001) The Strategy-Focused Organization. Harvard Business School Press, Harvard, pp. n/a

Latham, M. Sir, (1994) Constructing the Team: Final Report of the Government/Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry, HMSO, London, UK, pp. n/a

Lim, C. S. and Mohamed, M. Z., (1999) Criteriaof project success: an exploratory re-examination, International Journal of Project Management, 17(4), 243-8.

Ng, S.T. et al. (2002): A dynamic e-Reporting system for contractor's performance appraisal, Advances in Engineering Software, (33), 339–349.

Neely, A., (1998): Three models of measurement: theory and practice, International Journal of Business Performance Management, 1(1), 47-64.

Neely, A., (1999) The performance measurement revolution: why now and what next?, International Journal of Operations & Production Management, 19(2), pp. 205-228.

Nicholson, R. (1999) Egan – rethinking construction, paper presented at the Construction Productivity Network Seminar, Royal Institution of British Architects, Birmingham, 1999.

Robinson, H. S., Carrillo, P. M., Anumba, C. J. and Al-Ghassani, A. M. (2002) Business performance measurement and improvement strategies in construction organizations. Loughborough Univ., Loughborough, U.K., pp. n/a

Sharif, Amir M. (2002): Benchmarking performance management systems, Benchmarking: An International journal, vol 9. No. 1, 628-642.

Standish Group (2003) Chaos Report, www.standishgroup.com

Xiao-Hua Jin, FYY Ling, (2004): Engines for change in Singapore's construction industry: an industry view of Singapore's Construction 21 report; Building and Enviroment, 39, 699-711.

Ugwu, O. O., Kumaraswamy, M. M., Wong A., Ng, T. N., (2005): Sustainability appraisal in infrastructure projects (SUSAIP): Part1 Development of indicators and computational methods, Automation in Construction pp. n/a

Zelenika, R., (2000): Metodologija i tehnologija izrade znanstvenog i stručnog djela, Ekonomski fakultet u Rijeci, Rijeka.

Vukomanovic, M., (2006): Key performance indicators in project oriented construction system (M.Sc.), Faculty of civil engineering, University of Zagreb.

Vukomanovic, M.; Ceric, A. and Radujković, M. (2007) BSC-EFQM Based Approach for Performance Benchmarking in Construction Industry, ARCOM 23rd Annual Conference 2007 Proceedings, Reading, ARCOM 2007., 631-641
http://www.constructingexcellence.org.uk
http://www.thersa.org/

APPENDIX 1 – THE SURVEY

Faculty of civil engineering, University of Zagreb, Department of construction management and economics, made this survey. All data contained, will be classified and used only in purpose of academic research.
If You have any question regarding the survey, please contact Mladen Vukomanović, M.Sc., M.Eng., C.Eng., on 01/4639-270 or mvukoman@grad.hr .
Thank you in advance on your consideration to research.

THE FIRST PART: GENERAL INFORMATION ON RESPONDENTS

Please fill in:

Name of the company:	
Phone, fax, e-mail:	
Construction category (civil, infrastructure,…):	
Investor, Consultant, Contractor	
Annual income (€):	
Name, Surname:	
Function (site engineer, project manager, project director, executive board):	
Years of experience:	

THE SECOND PART: INFORMARTION ABOUT KPRs AND PERFORMANCE MGMT.

1. What is the level of KPR influence on overall success of a construction company?
   LOW HIGH
   1 2 3 4 5 6
2. Does Your company implement a set of KPR as indicators of business assessment?
   Yes___No___
3. Does Your company use a set of KPI in order to compare and assess the performance of various business section within?
   Yes___No___
4. Does Your company implement a model of performance management and/or quality management?
   Yes___No___
5. Please, select the level of KPR importance in performance or quality management system.
   LOW HIGH
   1 2 3 4 5 6
6. Do You recognize the difference between leading (KPI), lagging (KPO) and perceptive measures (PerM)
   Yes___No___

NOTES:
A Key Performance Result (KPR) is the measure of performance of an activity that is critical to the success of an organization

A Key Performance Indicator (KPI) is indicative measure of performance of an unfinished processes or activity
A Key Performance Outcome (KPO) is the measure of performance of an activity or process that report accomplished performance and final outcome and as such do not enable ability to change the future outcome.
A Perceptive measures (PerM) is the subjective measure of performance of an activity or process, wich generated trough surveys and interviews.

Please be free to make any comment regarding this survey or key performance indicators. If You feel that we have forgotten something, send us your remarks.

Thank You in advance.
Mladen Vukomanović, MSc, MEng, CEng

REDEVELOPMENT OF PORTFOLIO PROPERTIES: A DECISION MODEL FOR THE DETERMINATION OF OPTIMAL SOLUTIONS

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The majority of the invest volume in Germany is spent on portfolio properties, and no longer on new buildings. This proportion will continue to increase in future. The research work "Redevelopment of portfolio properties – a decision model for the determination of optimal solution" describes an approach for the renewal of portfolio properties. Based on the decision theory, a model is designed that helps to identify and select the best action. The research's main contribution consists in dealing with a general procedure which is able to take into consideration the unique portfolio property, the individual type of use and the associated constraints. Hence, it is possible to find suitable solutions that fit the actual property and furthermore preserve and increase its value.

KEYWORDS: redevelopment, decision model, portfolio properties.

INTRODUCTION

Current sources quote that the majority of the investment volume in Germany is spent on portfolio properties, and no longer on new buildings (Bundesamt für Bauwesen und Raumordnung, 2008). This proportion will continue to increase in future as there are many portfolio properties like housing and commercial properties that are functional but do not fit to the actual users' preferences (Heinze Marktforschung, 2006, 2008). The reasons for this are diverse and vary from different kinds of obsolescence to the lack of technical qualities like special communication technology. Therefore, the aim of the renewal measurement is to bring the real condition and the demand of the building in congruence by adapting them to the new requirements.

The optimal building measure for a single portfolio property is difficult to establish. It is not only the economic or technical demand, but also legal issues and restrictions or the well-being of the user of the building that have to be considered as well. Because of the multitude of influences and factors involved, the decisions-making process is very complex (Selk/Walberg et al., 2007). Compared to new constructions, there are much more constraints that have to be taken into consideration.

In the past, the decision making often occurred not rational and took long periods of time. Therefore, the purpose of this research work is to develop a methodology, which helps in a rational and comprehensible way to identify the measurements that fits the unique demands and expectations the most. Hence, a theoretical methodology has to be identified and adapted to the special case of portfolio properties. The primary object of this methodology is to identify optimal renewal measures for the specific case of a single portfolio property. The method shall demonstrate a general procedure that exemplifies how the optimal solution can be found. In fact, there will be no general solutions as there are different circumstances that have to be considered in every individual situation.

Renewals within the life cycle of real estate

The lifespan of real estate on the basis of the life cycle is the point of origin of the research. This approach considers the different parties concerned, corresponding responsibilities as well as the different phases of planning, construction and utilization of real estate (Harlfinger, 2006). Starting from the consideration based on life cycle of real estate the different types of obsolescence have been analyzed. The result of the analysis is that there are different characteristics of the obsolescence and they will lead to interruption of utilization subject to the extent of the obsolescence. It is possible to distinguish the obsolescence in a strict sense and in a wider sense (see table 1).

Table 1: Differentiation of obsolescence

Obsolescence	
…in a strict sense - Structure - Components - Engineering	…in a wider sense - Fashion - Market

Obsolescence in a strict sense means that the building, e. g. with its components and elements, is directly involved and the aging process is discernable at the building. The obsolescence in a wider sense is describable with outside influences, which are not caused by the building.

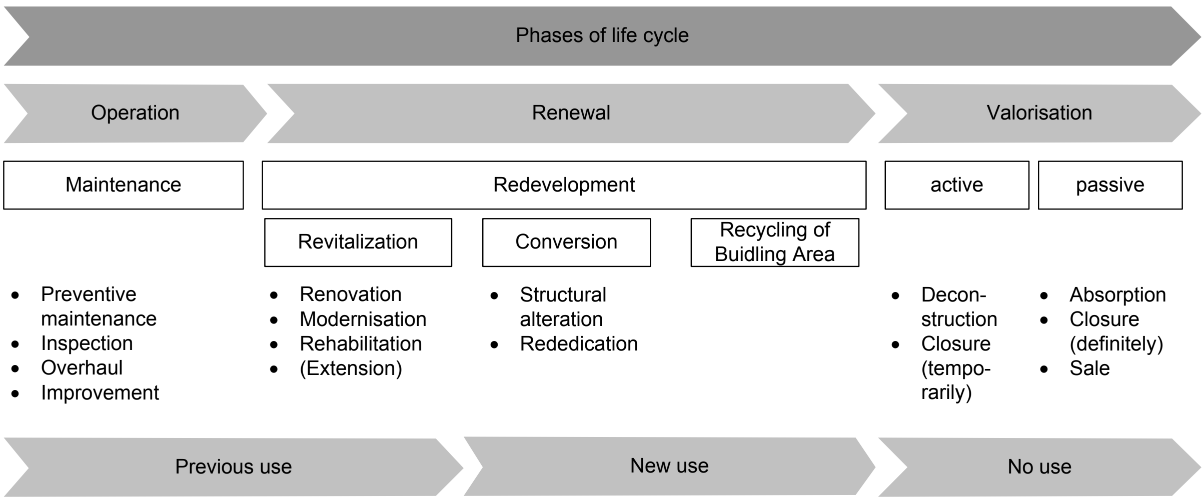

Figure 1: Renewals in the life cycle of real estate (Huff, 2009)

All measures and their chronological classification in the life cycle of real estate are illustrated in figure 1. A differentiation ensues with regard to the extent of the necessary construction works as well as of the continuation of the type of use of a building. Particular importance takes the aspect occupancy, segmented in the following three main parts: maintenance, redevelopment and valorisation. The differentiation occurred in consideration of the circumstances, if the previous occupancy of the building will continue, will be modified or no other use will be available. The main parts are associated with individual measures, e. g. inspection or overhaul. These individual measures are not strictly assigned to the phase of utilisation so they can appear in all three phases. Additional to this conception Ringel (2000) considers additional measures of reconstruction; this means the reconstruction of a building following the historical existence as well as the transfer of a building. Within the frame of this research these measures are not observed.

The descriptions of the consequences of the renewals show the strong interdependence of the impact. A special renewal will always involve several consequences of different characteristics and has to be appraised in a holistic approach (see table 2).

Table 2: Consequences of Renewals

Consequences	Examples
Technical consequences	- Modifications of the building's structure (absolute data, efficiency) - Facilities - Condition of the property
Financial/economic consequences	- Modification of the occupancy costs - Changing of the revenues - Fungibility - Fiscal influences
Legal consequences	- Planning law - Federal State Building Order - Third-party rights
Occupant-related consequences	- Modification of the degree of performance of the user requirement - Modification of attractiveness - Modification of marketability
Consequences of construction management	- Costs of renewals - Duration of renewals - Adverse effects

As apposed to new constructions the consequences of construction management are very important because of the very negative effect of annoyances or interruptions of the existing occupancy. For this reason in practice the renewals will be realized at the time of a break of occupancy, e. g. if a change of tenants is planned.

Decision model for portfolio properties

The special decision model for portfolio properties, which has evolved from general decision model, is shown in figure 2.

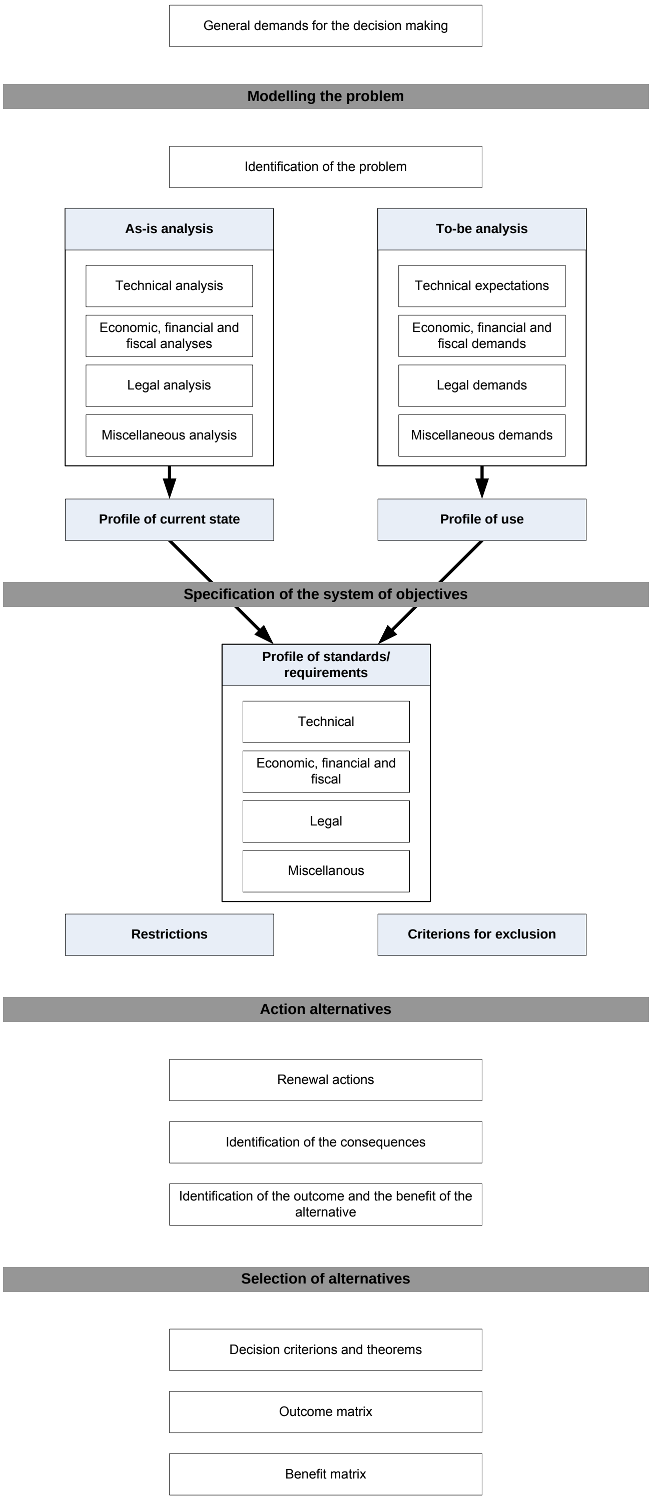

Figure 2: Structure of the decision model (Huff, 2009)

After articulating reason and general demands for the renewal, the first step of the decision model is the formulation of the problem. Based on the real estate due diligence, the decision maker has to do several as-is analyses like technical, economic, financial, fiscal and legal investigations. These analyses assess the building and its relations to and dependencies on the environment as well as its use. The results of these analyses are captured in the so-called "profile of current state". On the other side, there is the to-be analysis. It includes the technical expectations that the building should comply with after the redevelopment and furthermore, the economic, financial, fiscal and legal demands that have to be taken into consideration. These analyses are captured in the "profile of use".

The spread between these two profiles represents the problem that features and qualities of the building do not meet the expectations of the owner or the user.

This is the start of the next step, the specification of the system of objectives. This means that the objectives for the renewal have to be identified and documented as a target system. For this purpose, the profile of standards and requirements is generated on the basis of the two previous profiles. The investigated aspects, for example technical and legal, follow the same structure, so that the spread between the profiles leads directly to the characteristics that have to be realized by the measurement.

Beside the profiles of standards and requirements, the restrictions and criteria for exclusions have to be identified. They limit the possible actions and mark those situations, when the decision making has to be aborted, e. g. for reasons like contaminations or regulatory constraints.

After documenting the requirements, the renewal action alternatives can be developed and designed. This is creative work that can be done by planners like architects and specialized engineers, e. g. for building automation. The extent of this work differs greatly. Simple renewals like refurbishments only need a list of the affected areas and the work that has to be done. However, actions like demolition and new construction require at least a complete new design of the building.

Subsequently, the consequences of the alternatives referring to the system of objectives have to be identified or calculated. These consequences usually cover different aspects like expected yield, technical compliance or gross floor space. The methods for calculating these consequences are described in this section. These are for example the methods of investment analysis, mathematical methods or expert systems like the cost-benefit analysis, which determine the compliance of the users' requirements. At the end of this step, each action should provide results for the considered aspects – the target quantities (see table 3) – which can be of qualitative or quantitative nature.

Table 3: Target quantities

No.	Target quantities		Criteria
1	**Monetary target quantities**	Z_M	
1.1			Life cycle costs
1.2			Rate of return
2	**Area- and volume-based target quantities**	Z_F	
2.1			Absolute geometrical data
2.2			Efficiency of areas
3	**Target quantities of technical standards**	Z_T	
3.1			Payload
3.2			Spatial structure
3.3			Materials
3.4			Kind and amount of media supply
3.5			Design
3.6			Ecological sustainability
4	**Target quantities of the satisfaction of occupancy**	Z_N	
4.1			Comfort
4.2			Safety
4.3			Low utility-cost for the occupants
5	**Target quantities of risks**	Z_R	
5.1			Risks of the environment
5.2			Legal risks
5.3			Technical risks
5.4			Risks of timing
5.5			Financial risks
5.6			Management risks
6	**Target quantities of construction management**	Z_B	
6.1			Construction costs
6.2			Construction period
6.3			Deficiency of occupancy
6.4			Emissions due to construction
6.5			Generated waste
6.6			Consumption of resources

These results are the prerequisite for the core process of the decision theory, the selection of the alternatives. The outcome of the calculations on the basis of the target quantities is exemplary shown in table 4. The calculation is based on the following five alternatives:

- Alternative a_1: renovation without extension
- Alternative a_2: renovation with extension
- Alternative a_3: rehabilitation without extension
- Alternative a_4: rehabilitation with extension
- Alternative a_5: deconstruction und new building.

Table 4: Outcome of the calculations

	Monetary target quantities Z_M	**Area- and volume-based target quantities Z_F**	**Target quantities of technical standards Z_T**			**Target quantities of the satisfaction of occupancy Z_N**	**Target quantities of construction management Z_B**
	Construction costs (net)	Floor space	Design Z_{T1}	Representative Entrance area Z_{T2}	communication technology Z_{T3}	Comfort	Construction period
Alternative	[€]	[m²]	Degree of performance [-]	Degree of performance [-]	Degree of performance [-]	Degree of performance [-]	[Months]
a_1	879.900	2.514	6	4	10	2	10
a_2	1.319.100	2.880	6	4	10	5	10
a_3	3.016.800	2.620	8	7	10	7	8
a_4	3.456.000	2.910	8	7	10	7	7,6
a_5	3.817.500	3.250	9	10	10	9	4

Different methods and criteria depending on the specific situation can be applied to solve the problem. These situations can be under risk or under certainty. Otherwise, there are systems of objectives with a single target quantity or with multiple target quantities. At first, the quantities that can only be described verbally have to be transformed by special functions to achieve a measurable and comparable system. Ideally, each quantity is displayed by a numeral figure. In figure 3 functions of transformation are shown on an example.

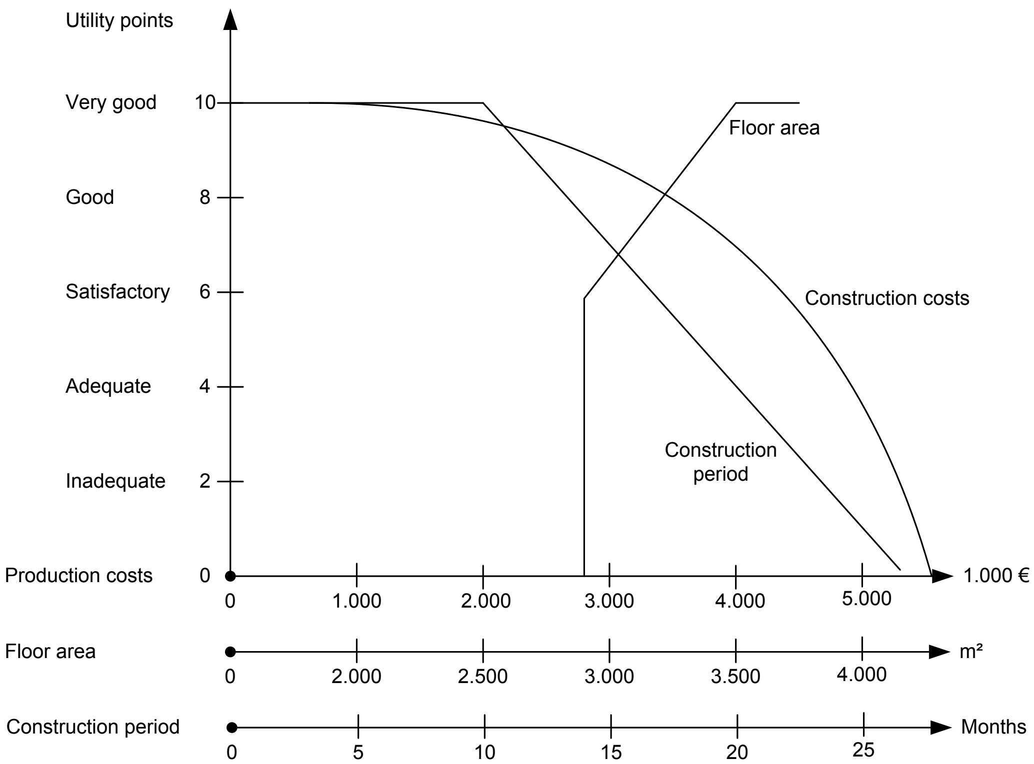

Figure 3: Functions of transformation shown on an example

The functions of transformation result from the following verbal described assessment of the decision-maker, which are arranged with the owner of the portfolio property.

- There are at least 2.800 m² necessary for the floor space. This is a satisfactory benefit. Floor space less than 2.800 m² will be assessed without a numeral figure. The benefit increases linear, if the floor space is more than 2.800 m² and reach the maximum from more than 3.500 m.

- With regard to the construction period more than 10 months are rated as very good. After this period the benefit decreases linear.

- The benefit of the construction costs acts progressive decreasing. Costs up to 2.000.000 Euro are classified as very good, from 3.000.000 Euro the benefit decreases very strong.

The results can then be represented within a matrix. There are two kinds of matrices. The outcome matrix describes the outcome of each action and associated quantities. The further developed benefit matrix describes the actual benefit for the decision maker. The latter provides the base for the determination of the best action, in connection with suitable decision criteria (see table 5).

Table 5: Benefit matrix

	Z_M	Z_F	Z_{T1}	Z_{T2}	Z_{T3}	Z_N	Z_B	u_{ges}
w_m	0,2	0,4	0,1	0,05	0	0,05	0,2	
a_1	10	0	6	4	10	2	10	4,90
a_2	9,8	6,1	6	4	10	5	10	7,45
a_3	8,6	0	8	7	10	7	8	4,82
a_4	8	6,5	8	7	10	7	7,6	7,22
a_5	7,5	8,4	9	10	10	9	4	7,51

The weighted values of usage are performed in the column on the right side in table 5. The calculation of the alternative a_1 is displayed as follows:

$$U_{1,\,ges} = 0,2 \text{ x } 10 + 0,4 \text{ x } 0 + 0,1 \text{ x } 6 + 0,05 \text{ x } 4 + 0 \text{ x } 10 + 0,05 \text{ x } 2 + 0,2 \text{ x } 10 = 4,90$$

The alternative with the highest value of usage is the optimal solution. By this example the alternative a_5 is insignificant advantageous than alternative a_2.

Development of the decision process

After the single decision model is presented and described, it is integrated in a wider process of decision-making, which is shown in figure 3.

This is necessary since in praxis a solution of the decision making in a single step would be too voluminous and complicated. Thus, the model is divided into several decision levels with an increasing level of accuracy. The complete model of the decision process includes the single decision model in various steps as well as additional prerequisite actions and decisions. The single decision is comparable to the presented one in figure 2. The additional decisions include the determination of the assessed time and area of application, e. g. if only parts of the building have to be redeveloped.

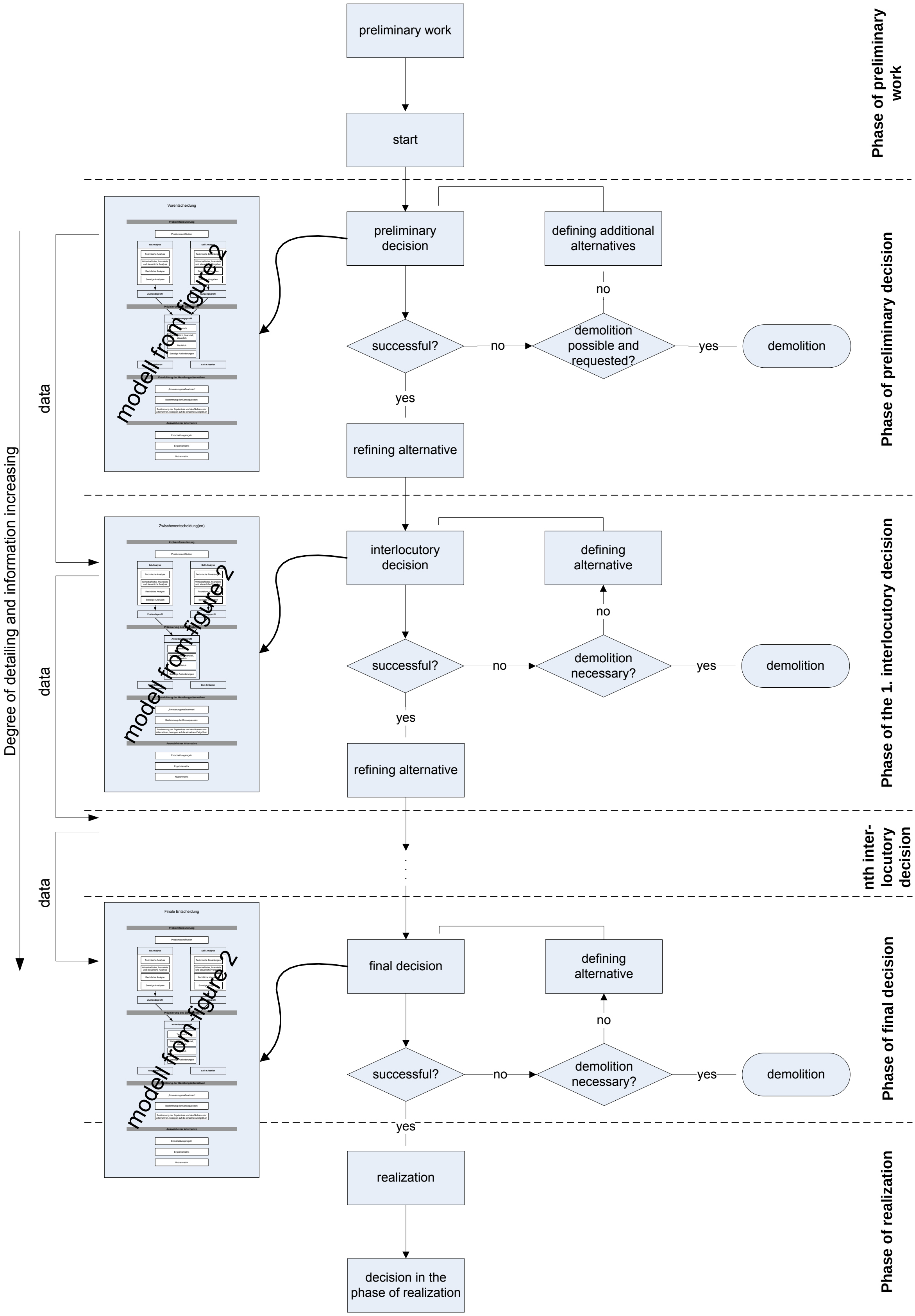

Figure 3: Scheme of the decision process (Huff, 2009)

DEVELOPMENT OF PROJECT MANAGEMENT SOFTWARE IN A CROATIAN CONSTRUCTION COMPANY

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The paper reviews implementation of construction management computer software in a Croatian construction company. Implemented software was modified as the company's organizational structure changed to the higher level. Modifications and development were in planning, monitoring and controlling of the projects, especially in the phase of project realization. Modifications and improvements that are specified in the paper are based on specific standards of the construction company and on specified demands of the top management and project managers.

KEYWORDS: project, computer software, control.

INTRODUCTION

Numbers of researches carried out in the world and Croatia are pointing to increasing trend of deadline's extensions and delays. For example, World Bank researches on around 1600 projects show 70% average extensions and delays of initial deadline in 88% of projects. Similar researches are carried out in Croatia too. In goal of project realisation within planed time, costs and resources, construction companies should in their development switch initial line organizational structure to functional and finally to matrix organization that provides higher flexibility in project management. Parallel with organizational structure development, also organizational knowledge and tools for planning and control of projects should develop supported by development of computer software. This paper reviews development of project management computer software Maris that was installed by the company IPC Međimurje from Čakovec in Croatia. The initial idea for choosing this software was the fact that the employees from IPC Međimurje Co. were ready to develop and adjust the software following the requests of the users from construction company. This is very important fact because the market is full of project management software that are in general very good but in details that are specific to each construction company's organization, it often happens that organization in company should adapt to the software, instead other way around.

DEVELOPMENT OF COMPANY ORGANIZATIONAL STRUCTURE

In early 1990s new state modes appeared in Eastern and Middle Europe, also in Croatia. The socialism was replaced by the capitalism, in some countries peacefully and in some by the means of war. Here is a review of the establishment and development of one Croatian construction company. As it is mentioned after establishing state of Croatia, lots of construction company giants disappeared and new small one were established.

As the small construction company in the early years employs around 20 to 30 people the projects can be led by using paper, pencil and calculator. The projects are small by the size, also value, and are actually led by director or his first assistant. Only few projects are contracted as turn key model. Usually the company constructs a part of the building, for example only construction part. The employees are carpenters, masons, plasterers and no skill labours. The company hasn't its own accountancy and bookkeeping, but instead it uses external firms. The company grows as the greater and more demanding projects were contracted. As the company starts with realization of greater projects, so it develops organisationally. To achieve successful project realisation, line and functional organisational structure of company develops to matrix. Surely, part of functional structure that related to General affairs and administration was kept, while in part of project preparation, realisation and investment, company is organised as matrix. In that time more and more worldwide known computer software are used in planning and controlling projects.

Project consists of group of linked activities determined with goal, descriptions and technical conditions that must be realized with usage of resources in defined time with limited availability of money for their financing. Project management is usage of knowledge, skills and techniques on project activities with the purpose of realization project goals. Project manager is a leading person of the team responsible for success of the project and participates in the project from earliest preparation phase that is identification of problem and defining a concept. Since that moment he constantly leads project through all phases till the end. Actually he is in fact a general director in miniature, responsible for managing and success of the project.

Project manager's job is influential, responsible, demanding, hard and professional so it requires extremely quality individual, person of specific profile of knowledge, character and skills. Although project manager disposes with state-of-the-art software tools project management is very complex and arduous job. However, the thing that is common in today's projects and projects realized decades before are people. For successful realization of project it is necessary to organise exact number of adequately skilled people, who are forming project team and are available to project manager when the project needs them the most. Successful project manager is aware of his weaknesses and knows when to lean on his project team. Except that, it is important for project manager to have good information system, because without good communication system that kind of information is missing when it is necessary. Computer software Maris was developed in that way, to help project managers and also top management in making the right decisions in time.

PROJECT MANAGEMENT SOFTWARE

Maris is integrated business information system that includes the most business processes of production companies. It contains modules that enable usage in different activity companies but it is mostly used in civil engineering construction companies. Some of the biggest Croatian construction companies use Maris information system.

Modules of Maris are:

- Finance and accounting
- Permanent properties and small inventories
- Sale, procurement and commerce
- Storage

- Human resources and salary accounting
- Management subsystem
- Production
  - Civil engineering construction
  - Metal and food industry
  - Communal systems
  - Hotel systems

Maris is a multiple user system. Each user has a strict defined role in system that defines access rights in different parts of the system. Each data is entered in Maris only once in the particular place and other modules are using the entered data for their needs.

Construction module

Construction module is integrated in the system and creates data that are used by other modules. Also it uses the data entered in other modules. Integration is the greatest advance of Maris.

Functions of construction module are:

- creation of catalogue of works and standards + existing standard database
- creation and standardization of bill of quantities
- transferring bill of quantities from MS Excel and transferring it back to MS Excel
- registering and monitoring contracts
- subcontractors database, creating bill of quantities for subcontractors and selecting subcontractors
- contracting and monitoring subcontractors
- creating of term plan
- transferring data to MS Project and transferring processed data back to the system
- reports of resources through time
- creation and monitoring finance plan
- material ordering on the basis of term plan
- working hours register + automatic transfer of hours to salary accounting module
- making the programme and progress record
- creation of payment certificates (invoices)
- monitoring and control of subcontractor's payment certificates
- monitoring and control of mechanization
- monitoring and control of labour working hours and time related costs
- analysis of planed and used materials
- material and mechanization consumption
- financial analysis of projects
- management portfolio of all projects

Data base

Data base contains catalogue of 8000 standards for construction, craft and installation works. Each work from catalogue is assigned to one or more standards depending on technology that is used for work performance. Standards use labour, material and mechanization resources from resource data base. More different price lists can be created, depending on for example state regions of site constructions. Standards can be referred to specific price list.

Standardization and bill of quantities

Standardization of bill of quantities is a programme for fast, efficient and high quality creation of unit prices on the basis of standard data base and used price list. Except for creation of unit prices, standardization of bill of quantities generates different features:

- reports of resources for each item in bill of quantities
- part of each kind of resource in unit price
- reports of required resources for total bill of quantities
- reports of time related standards for each item in bill of quantities or for group of work

It is often requested for changing the unit prices in biding phase of project and it can be done in different ways in Maris:

- changing the unit price of individual resource means automatic recalculation of all items in bill of quantities that contain that particular resource
- changing the factor of item or work group it can raise or low the unit price of each item in bill of quantities referring to standard unit price
- while biding the discounts can be applied to each item, working group or total price

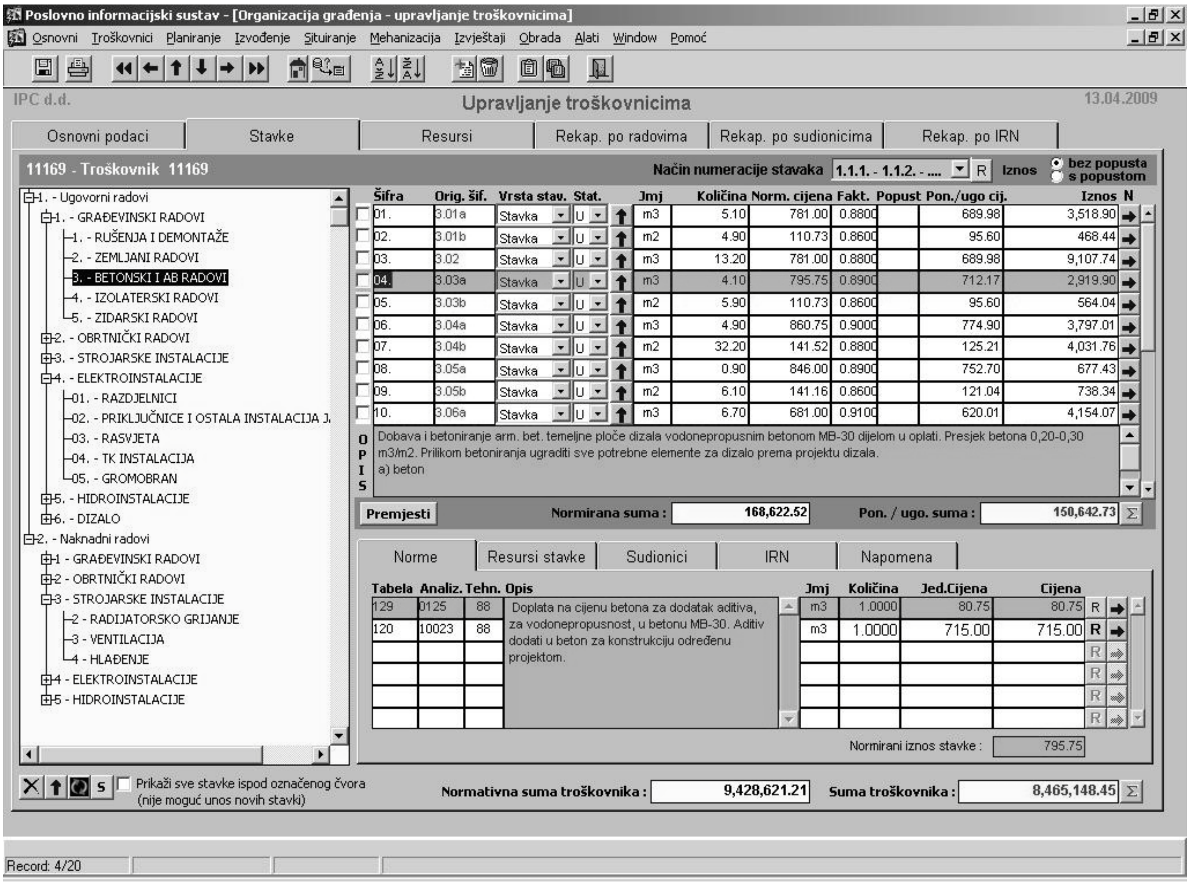
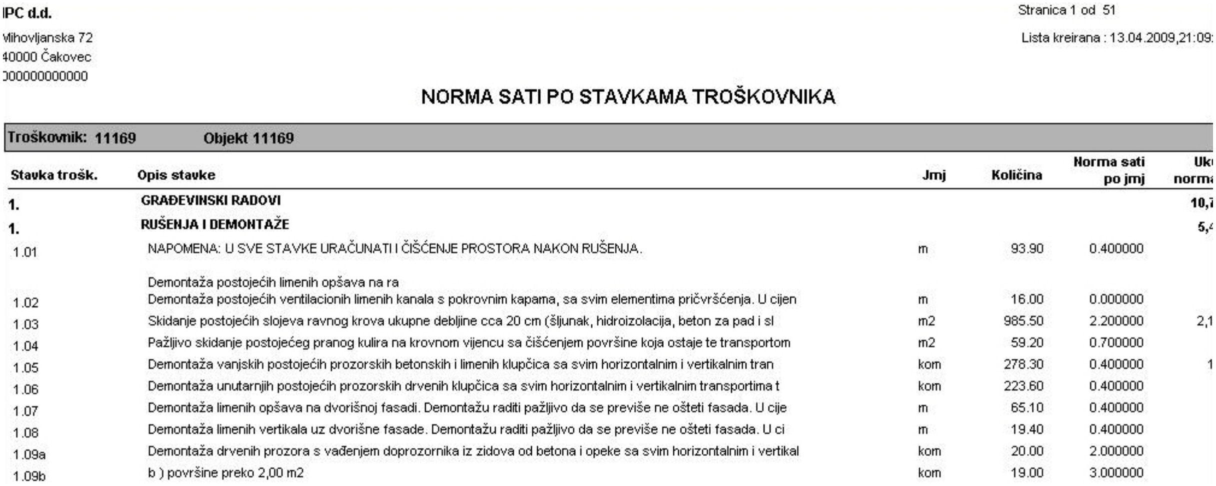


Figure 1: Standardization of bill of quantities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NORMA SATI PO STAVKAMA TROŠKOVNIKA

Troškovnik: 11169 Objekt 11169

Stavka trošk.	Opis stavke	Jmj	Količina	Norma sati po jmj	Uk norm
1.	GRAĐEVINSKI RADOVI				10,
1.	RUŠENJA I DEMONTAŽE				5,
1.01	NAPOMENA: U SVE STAVKE URAČUNATI I ČIŠĆENJE PROSTORA NAKON RUŠENJA. Demontaža postojećih limenih opšava na ra	m	93.90	0.400000	
1.02	Demontaža postojećih ventilacionih limenih kanala s pokrovnim kapama, sa svim elementima pričvršćenja. U cijen	m	16.00	0.000000	
1.03	Skidanje postojećih slojeva ravnog krova ukupne debljine cca 20 cm (šljunak, hidroizolacija, beton za pad i sl	m2	985.50	2.200000	2,1
1.04	Pažljivo skidanje postojećeg pranog kulira na krovnom vijencu sa čišćenjem površine koja ostaje te transportom	m2	59.20	0.700000	
1.05	Demontaža vanjskih postojećih prozorskih betonskih i limenih klupčica sa svim horizontalnim i vertikalnim tran	kom	278.30	0.400000	1
1.06	Demontaža unutarnjih postojećih prozorskih drvenih klupčica sa svim horizontalnim i vertikalnim transportima t	kom	223.60	0.400000	
1.07	Demontaža limenih opšava na dvorišnoj fasadi. Demontažu raditi pažljivo da se previše ne ošteti fasada. U cije	m	65.10	0.400000	
1.08	Demontaža limenih vertikala uz dvorišne fasade. Demontažu raditi pažljivo da se previše ne ošteti fasada. U ci	m	19.40	0.400000	
1.09a	Demontaža drvenih prozora s vađenjem doprozornika iz zidova od betona i opeke sa svim horizontalnim i vertikal	kom	20.00	2.000000	
1.09b	b) površine preko 2,00 m2	kom	19.00	3.000000	

Figure 2: Work hours standards report

Transferring the bill of quantities from MS Excel

Nowadays MS Excel is most used tool for creating the bill of quantities so it can be structured and transferred in short time to Maris. Also the other way around, bill of quantities created in Maris can be easily transferred to MS Excel.

Registering and monitoring subcontracts

For every construction contract one is opened in Maris. Also supplementary contracts can be registered in Maris. The most important information can be registered and assigned to each contract like names of project managers, site construction engineers, beginning and ending date of project etc. Results of such evidence are series of reports. Also subcontracts are registered.

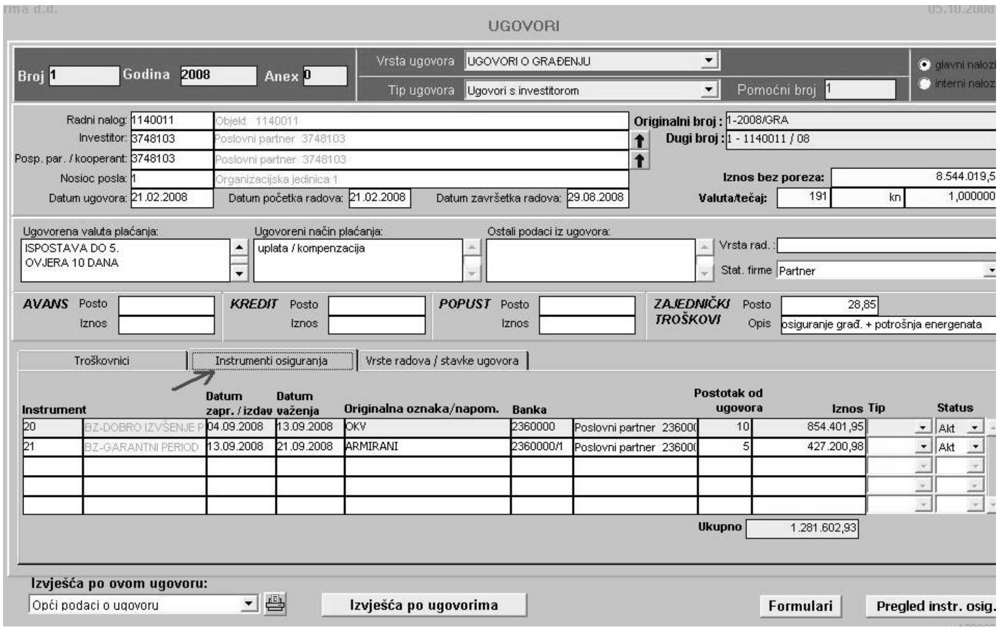

Figure 3: Subcontracts register

Subcontracting

Subcontracting is a very complex and demanding process that has a great influence for financial result of the project. Maris has data base of subcontractors where they are registered by the work group factor with all needed attributes. Subcontracting process begins with allocation of items of bill of quantities by the work group representatives that creates MS Excel bill of quantities that is sent via e-mail to the addresses of chosen subcontractors from whom the offer is requested. Returned offer are transferred back to Maris where program compares each unit price and total price and enables the select of lowest price subcontractor or offers numerous comparations reports that are used for making decision for negotiations. Chosen subcontractor is transferred in allocation of bill of quantities that provides the access of finance effects also basis for monitoring and control.

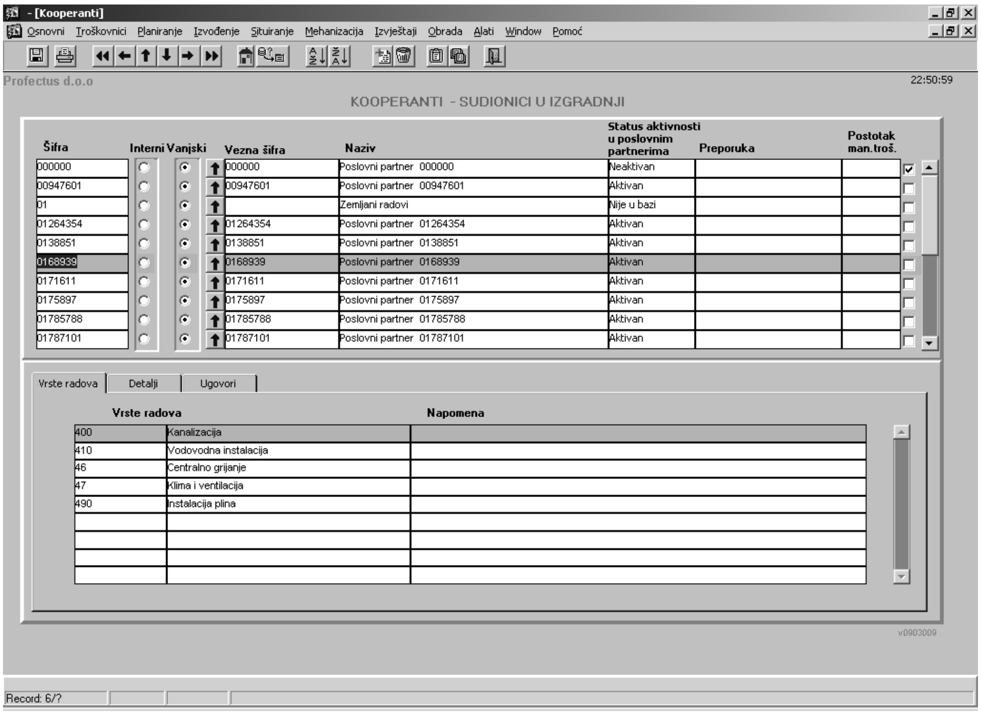

Figure 4: Subcontracts

Creating a term plan

Term plan is created in Maris in the way that bill of quantities is grouped in activities that follow the way of project realization. On the basis of assigned standards program calculates the activity duration. The activities that aren't assigned to standards the activity duration can be entered manually. Term plan created in Maris can be transferred to MS Project where it can be improved and returned back to Maris. On the basis of term plan lists of resources through time are available for each project or for more projects parallel.

Orders and supplies

On the basis of created term plan lists of resources are available and can be automatic distributed to centralized procurement for in time supply.

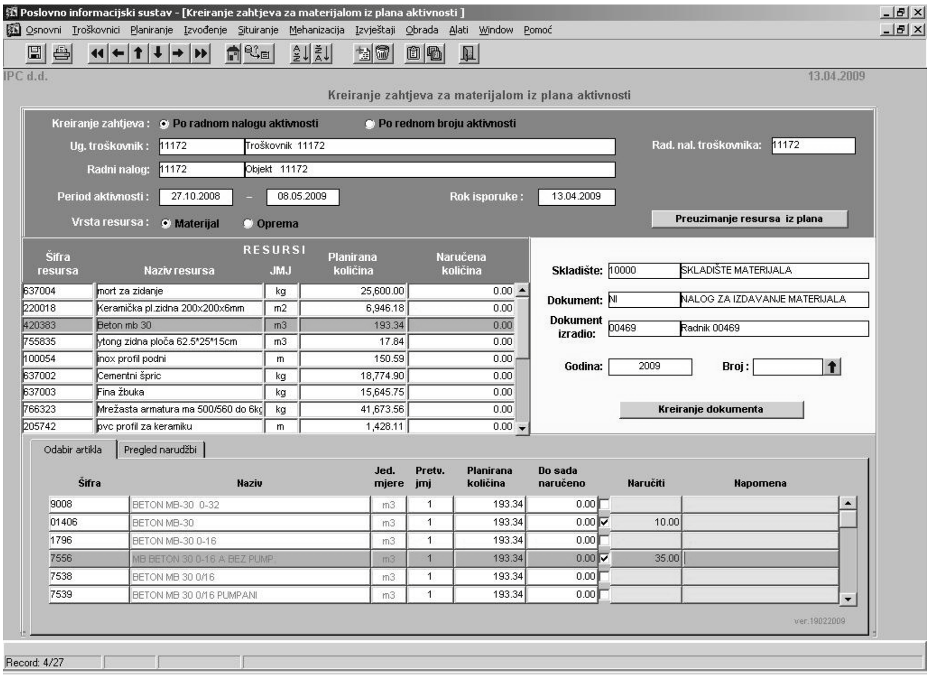

Figure 5: Material orders

Register of work hours

Evidence of labour work hours provides the exact time related costs in the project and offers comparation of planed and actual costs by the standards and exact total cost of labour work in each project. Entered labour work hours are basis of salary accounting in human resources module.

Costs

Evidence of site construction and project costs contains regularly (daily, weekly or monthly) evidence of costs and assigning them to incoming invoices in company. This method provides in time overview of currently finance result that could be faked because of late arrived invoices.

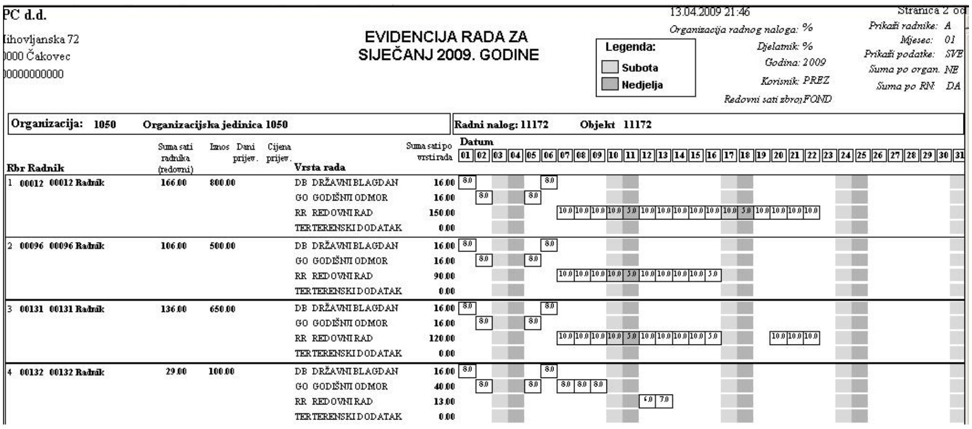

Figure 6: Labour work hours report

Invoice

Programme and progress record can be managed on the basis of bill of quantities by entering or calculating the realized quantities. Also drawings and pictures can be attached. Entered and calculated quantities are the basis for making the interim payment certificate that can be made by the quantities from programme and progress record or by directly enter of realized quantities. Interim payment certificate can be printed like bill of quantities with all needed elements for creating the invoice.

Subcontracting invoices are monitored and controlled in a program for creating the interim payment certificate for investor in the way that program automatic transfers realized quantities and assign them to the subcontractors by the allocating key that was done when subcontractor was chosen and entered. This way enables the site construction engineers, project managers and finance department the easy control because program automatic alarms the exceeded quantities of subcontractors.

Mechanization

Mechanization monitoring module registers services on construction projects. Services are registered by quantities and costs. Registered services are automatic assigned to the costs of project and as realization of mechanization. This method provides monitoring the actual mechanization costs in the projects and costs effectiveness of company’s own mechanization.

Project analysis

Results of method above this text described are various analysis of project. Resource analysis show the comparation of planed (calculated) and actual required quantities. Finance analysis show achieved incomes, costs and the result of project, also comparation of these parameters with finance plan.

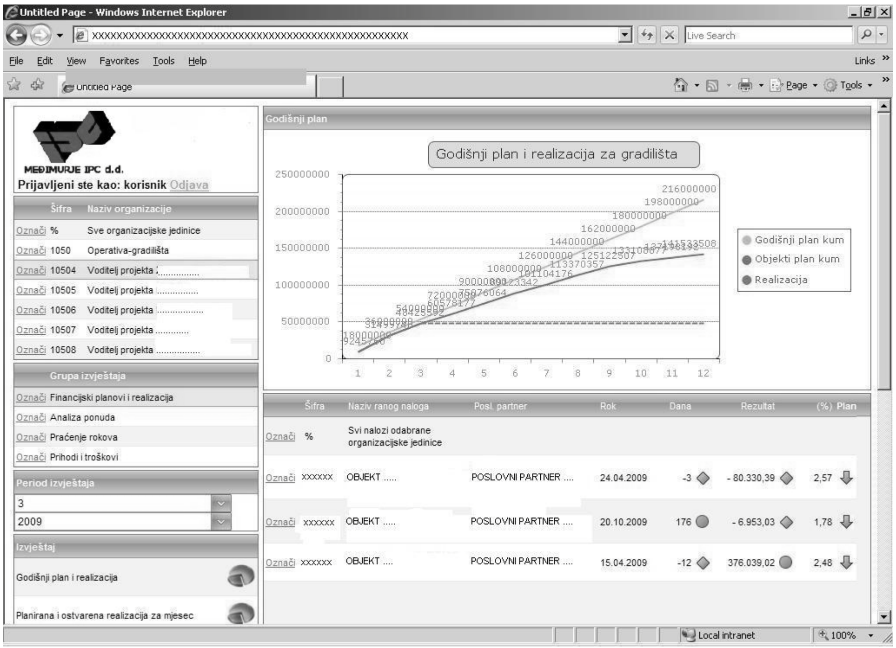

Figure 7: Project portfolio

Project management portfolio

Project management portfolio is the latest upgrade of program Maris that is intended for project managers and also top management like director or president of the board that don't have time or need for entering the Maris modules. All information for all company projects that are showed are mostly graphically (S-curves, histograms, pies), also as indicators of project success or as summary lists.

Troškovi

Stavka	Planirano	Realizirano	Udio u ukup. %
10 - Materijal	0,00	816.066,87	11,82
11 - Neknjiženi materijal	0,00		
20 - Rad	0,00	1.095.618,29	15,86
30 - Kooperanti	0,00	648.977,16	9,40
40 - Pogoni Team	0,00	724.707,48	10,49
50 - Iznajmljeni kapaciteti	0,00	2.730,00	0,04
60 - Prijevozne usluge	0,00	1.262.684,76	18,28
70 - Ostali direktni troškovi	0,00	198.666,07	2,88
81 - Ostali troškovi	0,00	-60.720,00	-0,88
82 - Nedospjeli troškovi	0,00	1.564.734,24	22,66
UKUPNO:	**0,00**	**6.253.464,87**	**90,55**
80 - Opći troškovi poduzeća	0,00	652.984,02	9,46
83 - Planirani troškovi	8.415.308,54	0,00	0,00
UKUPNO:	**8.415.308,54**	**652.984,02**	**9,46**
SVEUKUPNO:	**8.415.308,54**	**6.906.448,89**	**100,00**

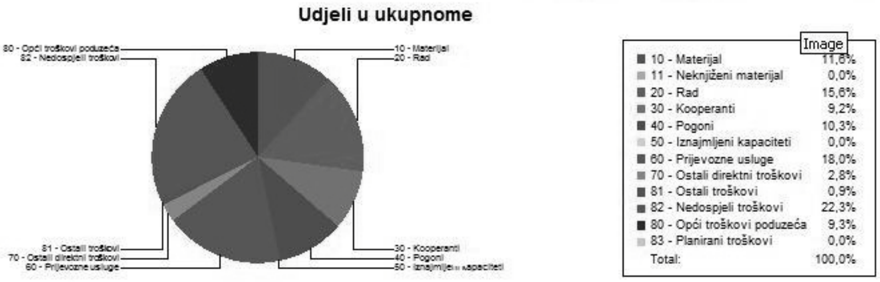

Figure 8: Cost analysis report

Figure 9: Cost significant activities report

CONCLUSIONS

As it was mentioned and described in the text, nowadays project manager disposes with state-of-the-art tools but his work is very complex and arduous job. Programme Maris followed the development of the organization structure of the construction company to provide project managers and top management a good information system that provides information to intervene if it is necessary in time because all information is available to the top management in real time. The main achievement of software was the reducing of the time delay costs information for a month. It provided to have results of project in the first week of the month that followed for the month before. As it is known that the picture speaks thousand words so was the primary idea to develop an upgrade Maris to make portfolio of projects as much as it was possible to be graphical tools like S-curves, histograms or pies. Programme is adapted to the organization of company, and not the other way around. Software also provided transparency of information and faster data flow because each data is entered only once, placed in it's particularly place and can be used by various programme modules. This is one of the main goals of programme, also saving time. Data entered by civil engineer manager is available to the finance manager and also other way around.

REFERENCES

Ivković, B., Popović, Ž. (1995) Upravljanje projektima u građevinarstvu, Beograd: Nauka

Lester, A. (2007) Project management, planning and control, Oxford: Butterworth-Heinemann

Marić, T., Radujković, M., Cerić, A. (2007) Upravljanje troškovima, vremenom i kvalitetom izgradnje u građevinskim projektima. Građevinar 59 (6), 485-493

PMI (2000) A Guide to the Project Management Body of Knowledge, Upper Darby PA USA: Project Management Institute

Radujković, M. (2000) Voditelj projekta. Građevinar 52 (3), 143-151

Raković, R. (2007) Kvalitet u upravljanju projektima, Beograd: Građevinska knjiga

CASE BASED REASONING AND INFRASTRUCTURE PROJECTS KNOWLEDGE BASE

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Proposals for public infrastructure investments invariably exceed the resources available. The systematic appraisal and professional management of all projects helps to ensure that the best choices are made and that the best value for money is obtained. Government institution responsible for public project life-cycle management should collect, analyse and use relevant information for the effective management of their investment projects and programmes. Institutions process protocols have to set out the main steps which should be followed in evaluating and managing national infrastructure investment plan. Case Based Reasoning System applied for selection and retrieving of quality Integrated Project Databases stored at public projects Knowledge Base could be considered as a decision support for selection and appraisal phase. Development of public projects Knowledge Base, aims to assist public sector managers dealing with infrastructure projects to ensure that experience gained can be used for better project appraisal and management.

KEYWORDS: cased based reasoning, knowledge base, public sector, infrastructure, process protocol.

1. INTRODUCTION

Ministry for National Investment Plan – NIP, Government of the Republic of Serbia, is responsible for all the phases of public projects life-cycle management: project appraisal and approval (according to development and transition impact), NIP funding (public funds, IFI soft project loans and grants), project financing (different funding streams and structures for national, regional and local projects), procurement procedures and project monitoring (NIP and IFI procedures) and post-project review.

According to EBRD Transition Report for 2008, Serbia needs to build infrastructure, face essential reforms in energy, transport and telecommunications sector and consider soft project loans and PPPs for infrastructure development. IFI project loans and IPA and IPF grants are new investment mechanisms and sources of finance for NIP projects. Project appraisal, selection and approval need to be redesigned according to national and IFI standards. New NIP application form is developed according to international standards. NIP public project monitoring is going to be implemented according to IFI procedures. Post-project review will give important feedback information for new NIP project cycle for 2010. NIP 2009 project portfolio consists of 431 projects (64% are infrastructure projects). The five stages of NIP projects appraisal and management process (set out in Figure 1) are:

> **1. Initiation and application –** NIP application form, Public invitation for project proposals, project proposals submitted on-line through tailor made IT application.

2. **Selection and Appraisal -** Preliminary Appraisal aims to assess if the project has sufficient merit to justify a full detailed appraisal, aims to provide a basis for a decision on whether to drop a project or to approve it in principle.

3. **Planning and Approval -** This involves detailed planning and costing of the project, no commitment to finance a project should be made until this stage is completed and a decision taken on whether to proceed is taken.

4. **Implementation and monitoring -** This requires clear arrangements for monitoring progress and cost control, securing project standards and timely delivery.

5. **Commissioning and Post-Project Review -** A review to confirm whether project objectives have been met, the project has been delivered to required standard, on time and within budget and to ensure that experience gained can be used on other projects and possibly in the continued use of the new asset.

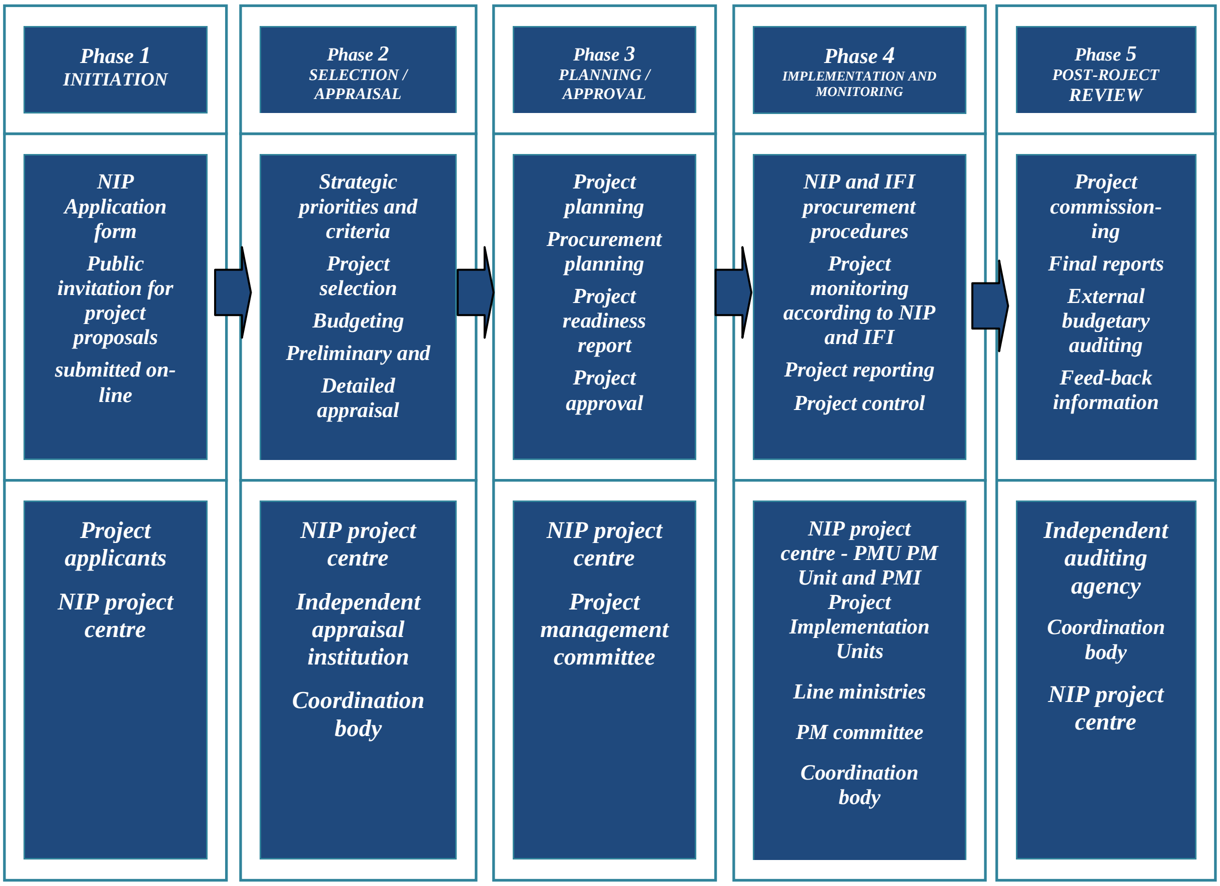

Figure 1: Five stages of NIP project appraisal and management process

It is very important to be more strategically oriented in IT management in construction industry, using process approach to activities (Betts et al., 1995). Development of process and IT protocols, and the results of post-project review (whether project objectives have been met and delivered to required standard, on time and within budget), aims to assist public sector managers dealing with infrastructure projects. Different off-shelf and tailor made IT tools is going to be implemented in IT Protocol. Case Based Reasoning– CBR System applied for selection and retrieving of quality Integrated Project Databases - IPDB stored at public projects Knowledge Base – KB could be considered as a decision support for project management. Above presented IT support is one kind of process approach to investment project activities.

2. PUBLIC INFRASTRUCTURE PROJECT LIFE-CYCLE

Ministry for NIP has developed a new application form according to European Commission Instruments for Pre-Accession Assistance - IPA standards. Project proposals are submitted on-line through tailor made IT application. Project centre and project applicants are responsible for this stage. An important task of any public sector organisation is continually to reassess public needs and objectives. New projects should only be undertaken where there in a clearly established public need for the projects or service provided. Existing services should be reviewed to ensure that the kind of service provided is the kind of service required, and is on the appropriate scale. Important data from initiation and application phase have to be stored in IPDB. Project centre, independent Appraisal Institution and Coordination Body are responsible for selection and appraisal phase. The basic purpose of systematic public infrastructure project appraisal is to achieve better investment decisions. The appraisal stage normally involves two separate tasks, preliminary and detailed appraisal. The preliminary appraisal leads to a recommendation on whether to proceed to the detailed appraisal stage. Detailed appraisal leads to a recommendation on whether to approve a project in principle. All data from selection and appraisal phase have to be stored in IPDB.

At detailed appraisal stage, it is important to select appropriate national or IFI procurement procedure to be used. The planning stage involves seven steps: establishment of project management structure, preparation of a project brief, detailed planning and design, review of proposal, using information provided by the planning process, obtaining approval, obtaining tenders for projects, review of proposal and using tender prices. The information system should reflect the nature of the public infrastructure project but should deal with all of these points. Data from planning and approval phase have to be stored in IPDB.

The implementation stage begins once final approval for the award of a contract has been secured. The critical tasks at this stage are to manage and monitor the project to ensure that it is executed satisfactorily. Implementation of the project is the responsibility of project centre, Project Management Unit - PMU, Project Implementation Units - PMI, Project Management Committee and Coordination Body.

Contract Placement should arrange to procure the services of a contractor in accordance with EU and national procurement requirements. All public projects must be monitored according to NIP and IFI procedures on an on-going basis to ensure that they are being completed to the required cost, quality and time profiles. Project data from implementation and monitoring phase have to be stored in IPDB. A post-project review aims to draw lessons for the future. A post-project review should be undertaken once sufficient time has elapsed to allow the project to be properly evaluated with sufficient evidence of the flow of benefits and costs from it. There are two separate focuses of review: project outturn and appraisal and management procedures. Port-project review conclusions can be applicable to other project, to the ongoing use of the asset, or to associated policies. Data from commissioning and post-project review phase have to be stored in IPDB.

3. PROCESS PROTOCOL

There are three main elements in all definition of Business Process Re-engineering – BPR: Process, Redesign and Information Technologies–IT. According to Venkatranam (1991)".BPR involving the reconfiguration of the business using IT as a central lever. Insted of treating the existing business processes as a constraint in the design of an IT infrastructure the business process itself is redesigned to maximally exploit the available IT capabilities". IT will only achieve profound change if its introduction and use are linked to changes in the overall conduct of the design and construction processes. Development of appropriate Process and IT protocols can support an improved design and construction processes. Working within a process framework/process protocols context is becoming the norm in many manufacturing firms. Process protocols can be defined as a way in which the processes involved in infrastructure public investments are arranged so as to produce an efficient, effective and economical way of undertaking realization of projects.

Process protocols can help in the development of their equivalent IT protocols that position the technologies which enable and support the processes involved within the business environment (Aouad et al., 1998). NIP process protocol is shown at figure 2. NIP IT protocol is going to implement following IT tools: Off-shelf Computer Aided Planning - CAP software, Tailor made Project Management software, Risk analysis and "What if ?" Analysis software, Project simulation techniques, CBR, Multimedia software, Cost planning software, CAD, Visualisation and Cost control software. Process wide IT applications are: KB, IPDB, Internet/intranet and Document management.

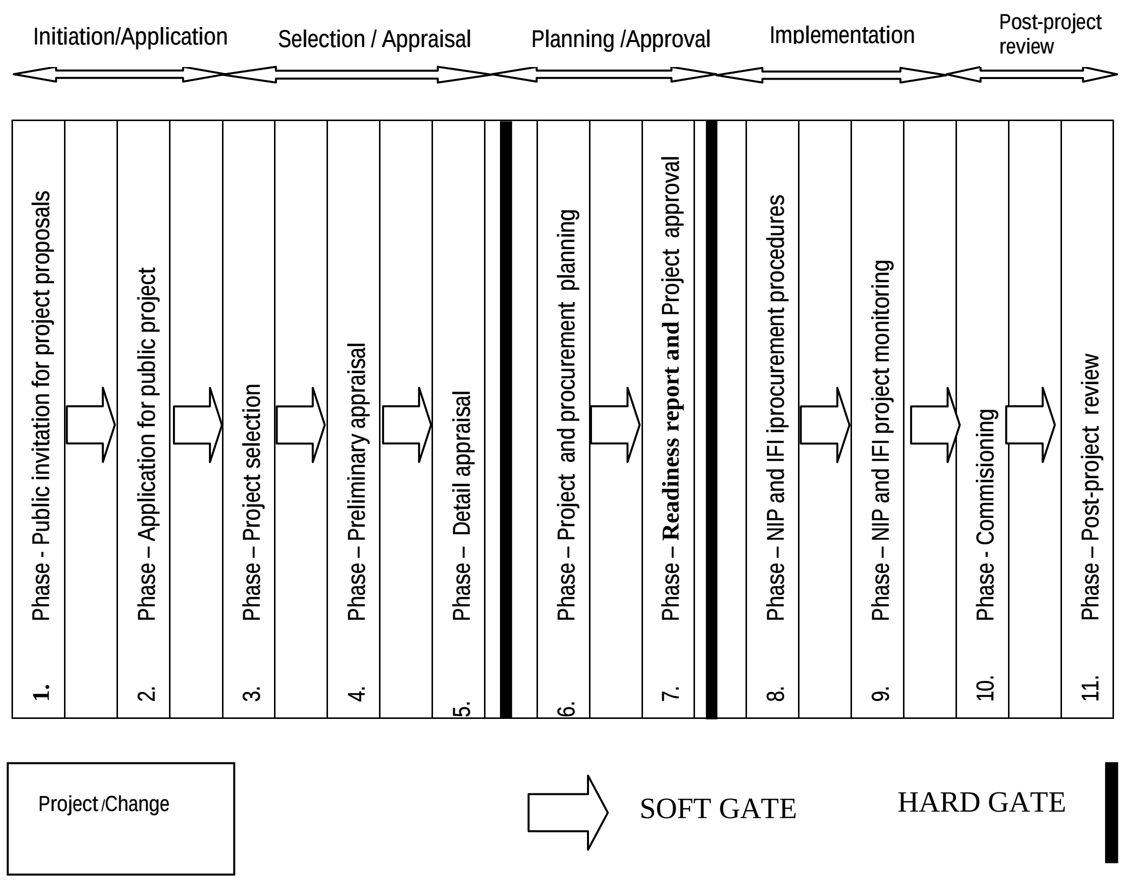

Figure 2: NIP Process protokol

Model breaks down project process into eleven distinct phases which are grouped into four broad stages. A soft and hard gate ensures that mayor decisions are assessed and evaluated. The soft gate implies that decisions could be conditional, in that public project is not stopped for one or two non-critical activities, thus ensuring concurrency and reduced timescales. The hard gate indicates firm and final decisions regarding whether or not to proceed to the next phase within the process (Cooper et al.1998). After the study at University of Salford (Aouad et al., 1997), communications and networking will be a major topic in construction IT over the next ten years. IT applied in IT protocols are coordinated with results of this study, but process phases are based after NIP procedures. IT tools presented in IT protocol must be integrated to provide the right mechanism for a technology push of the process and will finally result in improved interface process which will take advantage of the technology and the new ways of performing businesses (Kaglioglou et al., 1998).

4. IT SUPPORT FOR PORTFOLIO MANAGEMENT

Government institution responsible for public project life-cycle management should collect, analyse and use relevant information for the effective management of their investment projects and programmes. The quality-related NIP Information systems - IS are expected to cover the institution's own key performance indicators to compare themselves with other similar organisations and to extend the range of their self-knowledge.

4.1 Integrated Public Project Database and Knowledge Base

Integrated public project database - IPDB is integrated database containing data from appraisal, selection, planning, approval, implementation, monitoring, commissioning and post-project review phases of public project life cycle (Figure 3).

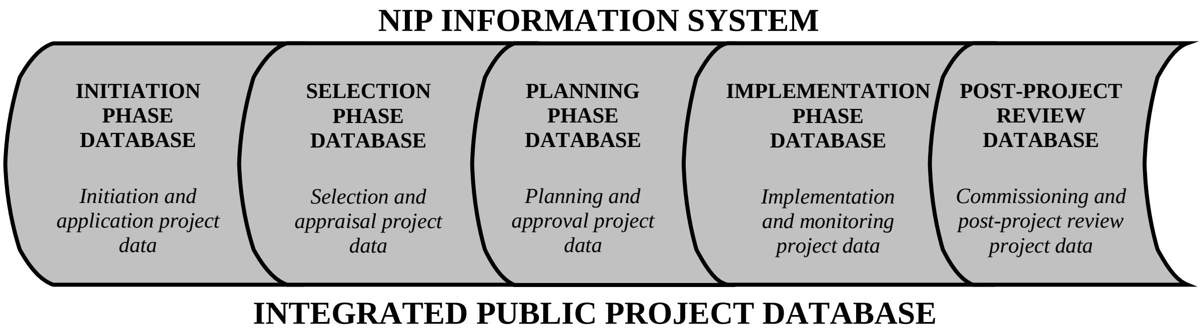

Figure 3: Integrated public project Database

In order to preserve, spread and manage the knowledge accumulated in previously realized public projects, all IPDB can be gathered and stored in a newly created Knowledge Base – KB. KB Systems should preserve developed and rare knowledge in such form that can be efficiency distributed to anyone who needs it (Dutton et al. 1996). KB is shown in Figure 4. KB is intended to be conected with NIP Information system.

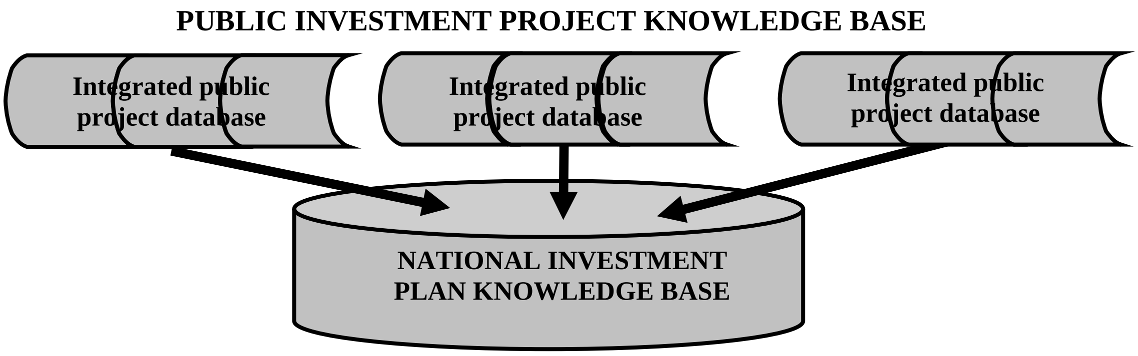

Figure 4: NIP Knowledge Base

The basic concept of the KB is that of “Information Gateway" acting as a single entry point to a set of distributed databases. KB should preserve developed and rare knowledge in such form that can be efficiency distributed to anyone who needs it. The aim is to realize more robust, more general, more efficient and more effective KB that perform more complete reasoning cycles and cope with deficient data and other anomalies. Mathematical theory that can provide such approach is RST.

4.2 Case Based Reasoning

One of the less well-known sub-fields of Artificial Intelligence-AI is Case-Based Reasoning-CBR. With CBR, past problems and their solutions are stored as individual case histories, and reasoning is based upon the retrieval and use of similar problem descriptions. In this manner, CBR systems in their simplest form can be thought of as external memories for humans, thus providing decision support (Dutton et al., 1996).

CBR offers a different slant to the more conventional KBSs, e.g. *Rule-Based Systems-RBS*, and may overcome some problems associated with rule-based systems (e.g. *Knowledge Acquisition-KA)*, and encoding this knowledge in rule form. Thus it would appear that CBR offers the potential to develop true 2nd generation expert systems which employ multiple representation and reasoning methods (David et al., 1993). As a Decision Support for projects appraisals phase, NIP is planning to implement CBR and KB systems (Figure 6).

To make that possible, this model should be based on the following hypothesis: Past project proposals and data from whole public project life cycle have been stored as individual case histories in IPDB; KB can be created by gathering and storing IPDB from previous public projects; KB and retrieval of earlier project proposals using CBR system can be used as IT support for public projects selection process; It is possible to create and use CBR model based on RST; Reasoning is based upon the retrieval and use of similar project descriptions; Using this model it is possible to discover quality proposals stored in historical IPDB, which according to its salient characteristics best match present public needs, criteria and priorities characteristics;

4.3 Rough Sets Theory

Data from KB can be interpreted using the Rough Sets Theory-RST, which is one of the latest mathematical approaches to definition and analysis of imprecise, unreliable and indefinite data (Pawlak, 1982). Indefinite notions differ from precise notions since they could not be characterized as information.

This Relation of Undifferentiating is the mathematical foundation for RST. According to that, Elementary Set represents any set of objects that do not differ from each other. Sharp (precise) set is any union of some elementary sets; on the contrary the set is rough. Sets of objects that could not be precisely characterized as set members, or his complement, represent boundary examples of Rough Sets – RS (and are situated on the boundary line). On the other hand, sharp sets do not have boundary elements. Any indefinite notion is characterized with couple of definite notions: lower and upper approximation of indefinite notion. Lower approximation consists of all objects that certainly belong to the set.

Upper approximation consists of all objects that could belong to the set. Difference between these two approximations represents boundary area of indefinite notion. Undifferentiating and approximation in RS can be presented in mathematical way. From the calculation point of view RS application philosophy is represented as Tables of Data, or Attribute-Value Tables, or Decision Tables. Conditional and decision attributes are presented in these tables.

The main advantage of RST is that it does not require any previous or additional information about data, as is the case with possibility degree in Fuzzy Sets Theory (Zadeh, 1965) or probability of events in statistics. The main shortage of RST is that in any possible case of decision analysis it prevents getting all determining rules (Pawlak,1995).

4.4 CBR and KB as a Decision Support for Public project proposals selection

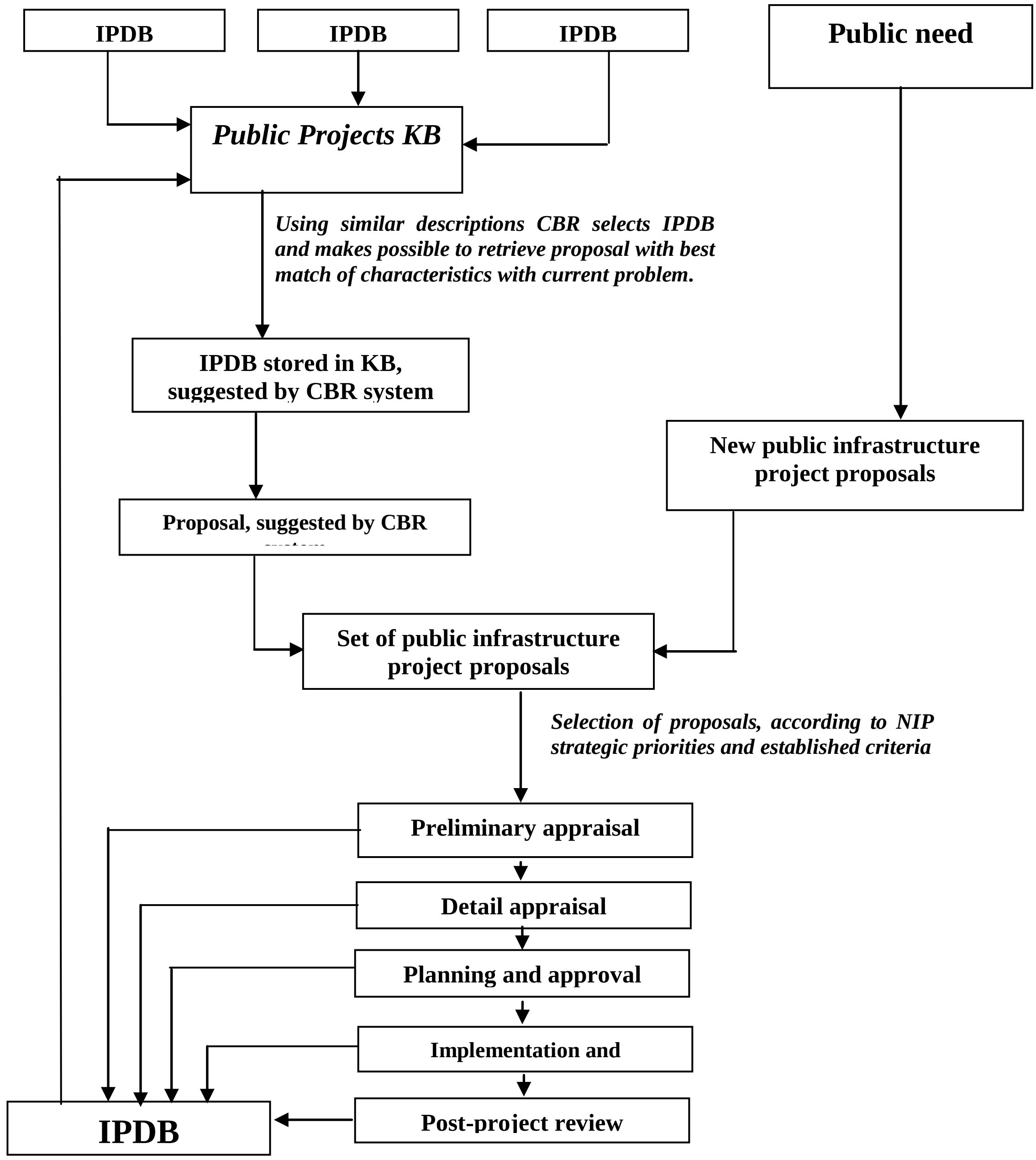

Figure 5: CBR and KB as a Decision Support for Public project proposals selection

5. WORKED EXAMPLE

Public need for urban bridge is stated in this paper as a worked example for CBR system. In selection phase manager has to make decisions about appropriate project proposal for urban bridge, which are most suitable to meet current public needs. Considering the public needs and established NIP criteria and priorities, public manager states criterions and salient characteristics for urban bridge design that have to be matched with salient characteristics of previous projects. Similar problem description and CBR model make it possible to retrieve projects with best match of salient characteristics.

Result of the application of CBR model is one potential solution for the current public needs. Solution suggested by CBR system could be considered as IT support for decision-making process. CBR model is intended to discover and retrieve quality IPDB stored in KB. Manager describes public needs with its salient characteristics, and CBR system matches salient characteristics of present problem with salient characteristics of project proposals stored in KB. IPDB of previous project proposals with best match of salient characteristics are retrieved, becoming possible solution for the current public needs. CBR system could be based at RST (Cirovic and Cekic, 2002).

Criterions stated in this example are: *Fast Construction - FC, Low Construction Cost - LCC* and *Possibility for Prefabricatio*n - *PFB* (assembling). These criterions represent *conditional attributes*. Applicability of previous projects for present public needs represents decision attribute. Values of attributes are presented linguistically. In this example it is assumed that there are four bridge projects in stored in KB: Pre-stressed concrete bridge, Composite steel and concrete bridge, Reinforced Concrete Bridge and Steel Bridge.

Conditional attributes and decision attributes are presented in table 1. This table represents attribute value table or decision table. Columns in the table represent attributes (characteristic of projects). Every row of the table is considered as information about particular bridge design. For example, Pre-stressed concrete bridge is characterized with the following set of attribute-value: (Fast Construction, Yes), (Low Construction Cost, No), (Possibility for Prefabrication, Good). This set of attribute values represents the information set about bridge project 1.

Table 1 Attribute value table (decision table) for previous bridge projects

Previous bridge projects	**Fast Construction**	**Low Construction Cost**	**Possibility for Prefabrication**	**Applicability of bridge design**
1) Pre-stressed concrete bridge	**Yes**	**No**	**Good**	**Yes**
2) Composite steel and concrete bridge	**Yes**	**No**	**Good**	**No**
3) Reinforced concrete bridge	**No**	**Yes**	**Poor**	**No**
4) Steel bridge	**Yes**	**No**	**Excellent**	**Yes**

Solutions 1, 2 and 4 do not differ from each other compared to attributes *Fast Construction* and *Low Construction Cost*, while solutions 1 and 2 do not differ from each other compared to attributes *Fast Construction*, *Low Construction Cost* and *Possibility for Prefabrication*. Attributes *Fast Construction* and *Low Construction Cost* generate two elementary sets {1, 2, 4} and {3}, while attributes *Fast Construction*, *Low Construction Cost* and *Possibility for Prefabrication* generate three elementary sets {1, 2}, {3} and {4}. Solution 1 represents *applicable solution*, while solution 2 represents *inapplicable solution,* although these solutions do not differ from each other compared to attributes *Fast Construction*, *Low Construction Cost* and *Possibility for Prefabrication*.

That means that it is not possible to characterize applicability of solutions 1 and 2 compared to attributes *Fast Construction*, *Low Construction Cost* and *PFB*. Analyzing decision table 1 the following conclusions can be drawn. Solutions 1 and 2 are *boundary cases* (situated on boundary line) and could not be correctly classified according to accessible knowledge. Remaining solutions show characteristics according to which they can be classified. It is obvious that solution 4 is applicable. It is also obvious that solution 3 is not applicable. For solutions 1 and 2 it is not possible to exclude that they are not applicable. *Lower approximation* of "*Applicable Solution*" (solution that can be retrieved during the work on present project) is set {4}. *Upper approximation* of these sets is set {1, 2, and 4}. Boundary cases are solutions 1 and 2. Solution 4 is applicable and decision is to retrieve it, while solution 3 is not applicable and decision is not to retrieve it. Lower approximation of notion "*Inapplicable Solution*" is set {3}. *Upper approximation* of this notion is set {1, 2, and 3}. *Boundary area* in this case is set {1, 2}.

Selection and retrieving of quality IPDB, stored in KB, facilitate the shortening of project selection and appraisal process. Projects suggested by CBR system sets the Standard of Quality for public manager, which should be maintained or exceeded during the selection and appraisal process. Although the application of created model is in selection phase, the results of this application are far-reaching and continue in the next phases of project life cycle.

Direction for further development of the suggested model is in the further expertise of the existing project solution, which has to adopt previous experience to the current needs, since CBR systems could not rely only on the historical cases of project solutions. That can be achieved using the general rules, models, etc. In that way it is possible to provide responses in cases where similar project solutions in the past do not exist. One of possible solutions, which can provide further development of KB, is in application of RST in CBR systems, for overcoming the problem of imprecise, unreliable and indefinite data.

6. CONCLUSIONS

Government institutions in charge of public project portfolio management have to develop and implement a strategy for the continuous enhancement of quality of their process and IT protocols. Different off-shelf and tailor made IT tools could be implemented in IT Protocol. Case Based Reasoning System applied for selection and retrieving of quality Integrated Project Databases stored at public projects Knowledge Base could be considered as a decision support for selection and appraisal phase of public infrastructure projects. The systematic appraisal and professional management of all public projects helps to ensure that the best public infrastructure project proposals have been selected and that the best value for money is obtained.

LITERATURE

Aouad,G., Cooper,R., Kaglioglu,M. and Sexton,M. (1999)."An IT-supported new process", *Strategic Management of IT in Construction*, (editor Martin Betts), Blackwell Science, pp 363-375

Aouad,G., Hinks,J., Cooper,R., Sheath,D., Kaglioglou,M. and Sexton, M. (1998). "An IT map for generic design and construction process protocol", *International Journal of Construction* Procurement

Betts, M.; Atkin,B.; Clark, A.: Best Practice report: Supplier Management, Construct IT - Centre of Excellence, 1995.

British Airports Authority (1994): "*The Project Process*", *BAA*, London

Cekic,Z. (2002).“Process and IT Protocols Applied in Construction Project Process Redesign”, *Proceedings of the Conference “Procedures, Regulations and Management in Construction”*, 22-24 May 2002, pp. 318-328, Arandjelovac, Serbia and Montenegro

Cirovic,G. and Cekic,Z.(2002)."Case Based Reasoning Model applied as a decision support for construction projects", *Int. J.of Systems and Cybernetics “Kybernetes*”, No.6, Vol.31, pp. 896-908

Cooper,R.,Kaglioglou,M.,Aouad,G.,Hinks,J.,Sheath,D.and Sexton,M.(1998):"Development of a Generic Design and Construction Process", *European Conferece on Product Data Technology,* pp 205-214

David, J.; Krivine, J.; Simmons, R.: Second Generation Expert Systems, Springer Verlag, 1993

Dutton, D.M.; Amor, R.W. and Bloomfield, D. P. (1996) Knowledge-Based Systems and the Internet: A Future Perspective, W78 International Conference "Construction on the Information Highway", Bled

Gallagher, J.P.: Knowledge Systems for Business, Prentice-Hall, New York, 1988.

Kaglioglou, M., Cooper,R. and Aouad,G. (1999): "The Process Protocol: Improving the FrontEnd of the Design and Construction Process for the UK Industry", *Harmony&Profit, CIB Working Commision W92, Procurement Systems Seminar*, Chiang Mai, Thailand, January 25-28

Kaglioglou,M., Aouad,G., Cooper,R. and Hinks, J. (1998): "The Process Protocol: process and IT Modelling for the UK Construction Industry", *Proceedings of the Second European Conference on product and Process Modelling in the Building Industry*, Building Research Establishment, Walford

O' Brien, J. (1999). "*Management Information systems*", Mc Graw-Hill

Pawlak, Z.: Rough Sets, International Journal of Computer and Information Sciences, No11, (pp. 341-356), 1982.

Pawlak, Z.: Rough Sets Aprouch to Knowledge-Based Decision Support, Invited Lecture, In: Slowinski R. (ed.), Semi-Plenary Papers, 14th European Conference on Operational Research (EURO XIV), Jerusalem (pp. 225-235), 1995.

Venkatranam, N. (1991). "*IT-induced Business Reconfiguration in the Corporation of the 1990s: Information Technology and Organisational Transformation*", Oxford University Press

Zadeh, L.A.: "Fuzzy sets", Information and Control, 8, (pp. 338-353), 1965.

MANAGING COMPLEX INVESTMENT PORTFOLIO IN LARGE EXPANDING COMPANY – ADRIS EXAMPLE

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Adris Grupa is a holding company that has entered a period of substantial capital investments five years ago. In order to effectively manage its complex investment portfolio amounting to about 100 million EUR per year in industrial, touristic, office and residential development, Adris has filtered and gathered most experienced employees creating unique competence centre as separate entity – Abilia. Abilia is generally responsible for project development, planning, budgeting, then design management, construction management, contract management, warranty management, maintenance and hand-over process.

After employing missing resources, Abilia adopted matrix organization providing all required functional competences as organization verticals in a typical project management organization with project managers in horizontal layers. Planning, follow-up and reporting tools were installed while organization remained flexible in terms of number of projects by usage of external specialist as part of project management teams.

This paper provides an overview of company growth, evolution steps, applied methodology, control processes, delegation of authority and achievements but also some learning points.

KEYWORDS: project management, portfolio management, organizational experience, Primavera software, methodology.

INTRODUCTION

In year 2004 Adris was formed in an effort to develop a business from exclusively tobacco oriented business (known as TDR) into a holding with diversified businesses. Actually, few years before, TDR has acquired majority shares in Jadran Turist and Anita, large touristic companies. Both tobacco and tourism required extensive capital investments at that time: new cigarette factory, new paper factory (producing mainly for cigarette production) and whole new resorts and hotels investments. In addition to that, Adris had numerous real estate's that needed development in the most economical way. Strategic five year plan comprised capital investments ranging up to total over 500 million Euro's.

The need

Adris recognized a need for experienced project management team. Due to long life-cycle of planned investments Adris decided for an internal team that should handle project development, planning, budgeting, design management, construction management, contract management, warranty management, maintenance and hand-over process.

Steps

Project management was given high level of responsibility as project manager had authority to work in name and in account of sponsors. This approach was somewhat new for the company and required a structured creation process.

1. **Testing the model.** In addition to logic of creating internal team for complex and long-term investment cycle instead of external, Adris was aware of substantial competences already existing in most of its companies. In year 2004, for first two urgent and major projects, cigarette and paper factory, Adris formed a team from its internal resources that finally delivered project as planned. This team established initial methodology for investment project management in form of written procedures defining methods, authorities, contracting rules, time-planning, approving and reporting.

2. **Norming.** Universality and confidence in deliverables that methodology introduced lead to idea of rolling-out this methodology not only for cigarette but for all businesses Adris controlled. Demanding task very quickly required detailed separation of responsibilities. Especially as project management team consisted of employees of several companies. This could be done by contracting such services for each project. In an effort to find right form to resolve these issues in a long run, Adris considered two options: small team of experts in each of the companies in the holding or one centralized team.

3. **Scaling-up the model.** Centralized team meant better resource utilization, clearer separation of responsibilities so decision was made in favor of forming separate company providing investment project management services for the rest of the group. As part of preparations for creating new platform, complete set of procedures and contracts has been developed and prepared. Centralized database of project statements, contracts, acceptance documents, responsibility grids, job descriptions and target setting was established. This is when Adris, in 2006, established Abilia and gathered all experienced project managers into one single competence centre. Abilia contracted its services with eight companies within the Adris that extensively required investment project management.

4. **Learning organization.** After fundamental training of twelve project managers at very beginning performed in order to assure common language in project management, additional education was required. IPMA training and certification was done providing platform for constant education and retraining through cyclic recertification.

5. **Performing.** Today, Abilia has dozens of projects valuing to 250 million EUR and just finished its own development projects started in 2007 combining Abilia's competences and experience with Adris financial strength.

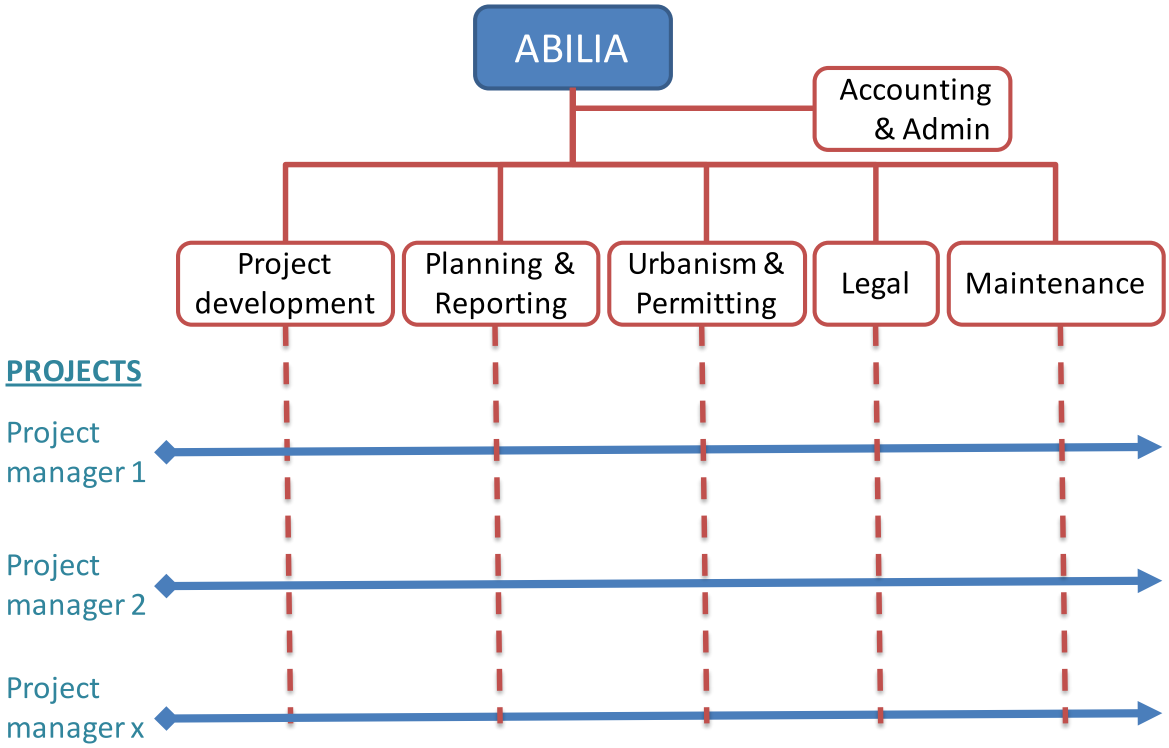

Figure 1: Abilia matrix organization (Source: Authors)

Results

Centralized investments project management for a company that spends over 100 million EUR each year proved to be good concept. There are several main strongpoints:

- Better utilization of expert knowledge and experience over range of projects in an matrix organization (Figure 1).
- Complete cash flow control over capital investments in complete Adris Group.
- Additional lever with most designers, suppliers and construction companies.
- Low overall ratio of project management costs of below 2% of total investment.

Next steps

In next phase of improvement of Abilia's project management Primakon and Abilia will develop and implement system that will achieve more reliable inputs from third parties resulting in even better overall project performances.

Implementation of the system will be done in 4 phases:

1. **Workshop.** Abilia's core team of project managers will participate to workshop where will they together with Primakon consultants define model for project and contract management. During workshop participants will learn how to use software for planning and controlling project (Oracle's Primavera P6 Professional Project Management i Primavera Contract Management). Final workshop result will be pilot project developed as a result of brainstorming techniques based on theoretical knowledge combined with Abilia's core team practical experience. This phase will conclude with accepted model (pilot project) for project management in Primavera software.

2. **Verification of pilot project.** Verification of model will last up to 6 months (6 interim statements). In this phase model will be modified and/or upgraded if it is necessary and parallel with that will start development of project portfolio methodology. Methodology will be represented trough minimal numbers of project procedures realizable in Primavera software which in this phase represents medium for defining and modeling optimal procedure. It contains procedures for planning, tracking and updating realization, reporting and re-planning. Result of second phase is evaluation of represented solution.

3. **Enterprise implementation.** After positive evaluation of pilot project and project portfolio methodology implementation will apply at enterprise level for all Adris projects.

4. **Strategic management.** This phase can start with a little delay form beginning of third phase. It contains implementation of a tool for globally prioritizing, planning, managing and executing projects, programs and portfolios – Oracle Primavera Portfolio Management which is advanced tool for strategic planning and synchronization of company goals with products portfolio. Besides cost management, it contains important information's about project benefits (all plusses and minuses for each project from portfolio) and also ensure setting up different project scenarios for each project.

Estimated time for achieving results described in those 4 phases is two years.

CONCLUSIONS

Abilia practices investment project management of quite complex portfolio in practice and it is able to control its own resources and have an overview and impact on performance of other participants in project. Currently, control of other participants is based on their own reporting which is done by their own project teams. Primakon and Abilia will implement system and methodology for project portfolio management based on Primavera software trough four phases in next two years. During first six months pilot project will be tested and improved if necessary. After verification of pilot project, system will be implemented on enterprise level.

REFERENCES

Rastovski, T; Delić, D.; Meštrović, H.: Primastep Methodology for Project Management in Public Administration, Proceedings of 7th International Conference Organization, Technology and Management in Construction, pg. 347-354, September 2006.

D.Delić, T.Rastovski , H.Meštrović: "Risks in Implementation Process of Managing by Projects in Construction Companies", Proceedings of 8th International Conference Organization, Technology and Management in Construction, Umag, Croatia, September 2008

Delić, D.; Meštrović, H.: It Model for Project ang Contract Management in Construction, Proceedings of 2nd Senet Conference on Project Management pg. 236-241, April 2002.

Meštrović, H.; Delić, D.; Arar V.: Contract Documentation Management System on Jakuševac (Zagreb) Landfill Rehabilitation Project, Proceedings of 2nd Senet Conference on Project Management pg. 270-277, April 2002.

Primavera's Six-Step Implementation Methodology, http://www.primavera.com/services/implementation.asp

Primavera 2008 Project Management Report: Standardized Best Practices and Technology Adoption in the AEC Industry; http://www.primavera.com/transportation/documents/AEC_Survey_Report.pdf

TenStep Project Management Process, Tom Mochal, TenStep Inc. USA, 2003, www.tenstep.com

Project Management Body of Knowledge, Third edition, Project Management Institute Inc., USA, 2004

UNDERSTANDING RESOURCES WASTE REDUCTION PRIORITIES IN SWEDISH CONSTRUCTION: A CONTRACTOR'S PERSPECTIVE

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This paper concerns the constant struggle faced by contractors to increase the efficiency of their production processes. The study on which it is based took a long-term view by looking at a contractor's whole portfolio of projects instead of looking at the efficiency of a single project, with the aim of identifying how production managers perceive their company's efforts to prioritize resources waste reduction activities. Interviews were conducted with fifteen production managers, in three medium to large size construction companies, who were asked to indicate on a scale of how closely their company complied with thirty-one specific recommendations for reducing waste that had been identified from a previous study by Josephson and Saukkoriipi (2009). The managers perceived that their organisations focus most on activities related to defining the customer's true needs, stimulating further education for all employees, and striving for long-term customer-supplier relations. They also perceived that their organisations focus least on activities related to the best use of the weekly working hours, supporting main suppliers in their development, and scheduling time for reflection and training. There are some trends that also emerged from the study, one of which is that experienced managers consider that their companies work harder to reduce waste more so than less experienced managers do. Other trends are that contractors establish long-term supplier relations without supporting suppliers' development, and that improvement processes are not really considered to be part of the leadership role. The study confirms the short-term view that is generally accepted to exist in construction companies. Moving site managers' minds to more long-term perspectives may be one of the greatest challenges in the quest to successfully reduce waste in construction.

KEYWORDS: attitudes, cost reduction, leadership, recommendation, site manager.

INTRODUCTION

The empirical-based study on which this paper is based was concerned with contractors' constant efforts to increase the efficiency of their production processes. A long-term view was taken by looking at a contractor's portfolio of projects instead of looking at the efficiency of a single project. The focus of the paper is on reducing waste, which Liker (2004) defines as activities which absorb resources without adding value to the customer. Looking at this definition several valid questions come to mind: What is a resource? What is value? Who is the customer?

It could be argued that waste is almost non-existent in a production process because every activity has a meaning and every activity includes learning aspects. On the other hand, it could be argued that waste is 99% of any given process because it is only at the point when a component is actually assembled that the process does not involve waste of any kind. Fearne and Fowler (2006) claimed that there are many construction practices that may be considered inefficient because they involve waste but that in a project environment, which is subject to considerable levels of uncertainty, many of these practices are logical and enable projects to be effectively completed. It is generally accepted that the waste of resources on construction projects could be reduced by 1/3 of the total resources used. For example, Josephson and Saukkoriipi (2007) found that waste in construction processes are in the region of 30-35% of what the customer pays for. They categorized waste into four groups: defects and checks, use of resources, health and safety, and systems and structures. In a later study, they reported that the majority of contractors believe that cost savings of 10-30% could be achieved within ten years by reducing waste (Josephson and Saukkoriipi, 2009). However, as most waste is hidden, before it can be reduced or eliminated it has to be identified.

The research described in this paper is part of a wider and more comprehensive study being conducted by Chalmers University of Technology in collaboration with R&D-West (a group of contractors within the Swedish Construction Federation) and the Centre for Management of the Built Environment, the purpose of which is to help contractors increase their efficiency and effectiveness. The first phase of the study focused on identifying and quantifying various kinds of waste. The second phase focused on what companies should do in order to reduce waste and came up with 31 recommendations (Josephson and Saukkoriipi, 2009).The third phase, which this paper reports some initial findings from, focuses on supporting construction companies who wish to implement waste reduction processes. The paper also reports the findings from interviews with fifteen production managers that were conducted for the purpose of identifying how they perceive their company's waste reduction activities.

COMPLEX CAUSES OF WASTE

All activities that managers and other employees perform, irrespective of organizational level, are aimed at conducting business efficiently and fulfilling their customers' needs. All decisions are made in order to minimize waste. Discussions with customers aim at increasing the understanding of their needs and to define their goals more precisely. Organizing aims at shaping an efficient organization including all necessary competences for the task. Planning and controlling aims at using available resources in the most efficient way. Follow up activities aim at identifying non-conformances and guide corrective measures in ongoing as well as future projects. So why does waste exist at all?

Since, according to Morgan (1998), practitioners have the benefit of discovering new knowledge and understanding different opinions, Josephson and Saukkoriipi (2009) held discussions with them in order to develop recommendations for waste reduction. The first meeting of the focus groups into which the practitioners had been formed concentrated on understanding the concepts of waste in construction, while the second meeting of the groups focused on discussing the causes of waste. Each participant described a specific example of waste followed by a discussion of its possible causes, a process that produced a long list of what the practitioners viewed as causes of waste. These causes were then placed into five groups that were summarized in the form of a pyramid as shown in Figure 1.

The holistic view, which includes fulfilling customer needs and considering the life cycles of the products, was placed at the top of the pyramid. The other four groups of causes were placed as corners in the base; structure includes managerial activities such as planning and organizing; culture includes employees' values that guide their performance; competence includes employees' abilities to perform the specific activities; and leadership includes the leader actions at all organisational levels that influence employees' and suppliers' values. If any one or more of these corners is lacking the pyramid may collapse.

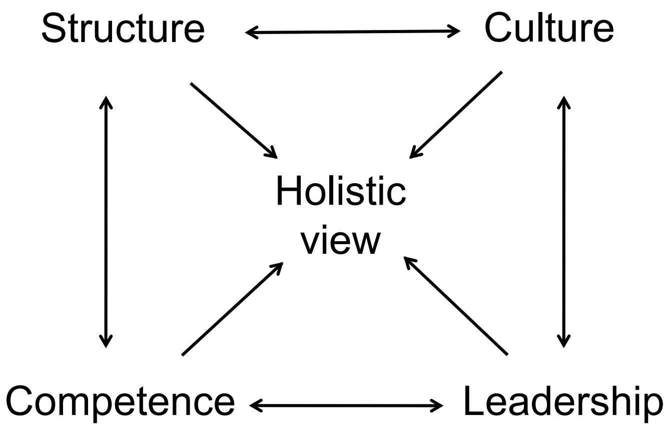

Figure 1: Five groups of causes of waste illustrated as a pyramid.

The causes of waste are complex such that all the groups of causes influence each other to a greater or lesser extent. Based on the common understanding of why waste occurs, the next three meetings of the focus groups ultimately produced 31 recommendations for reducing waste that are presented in Table 1. It was agreed that companies as well as projects generally add uncertainty to most situations and most activities, which leads to higher risks and variations in the processes as well as in the products. One strategic principle should therefore be precision in all activities. It was also agreed that project organizations use only a small amount of their total available time, so a second strategic principle should therefore be short lead-times and maximum use of the 168 hours in a week. As these principles are based on managers' as well as workers' attitudes and personal values, which are hard to change, a third strategic principle should therefore be implementation of ongoing waste reduction orientation and training programs for all employees.

METHODOLOGY

The data was collected from face-to-face interviews with 15 individuals in three large and medium-sized construction companies with their main business in Scandinavia. All participants had managerial roles in production: twelve site managers, two project managers, and one manager of improvement activities. The part of the interviews on which this paper is based, focused on the 31 recommendations proposed by Josephson and Saukkoriipi (2009).

For each recommendation the managers were asked to respond to the question "*how much does your organisation work to achieve this recommendation*" by making a mark on a 20 cm long line with "very little" on the extreme left and "very much" on the extreme right and verbally justifying their statement. The recommendations were divided into five groups. The recommendations related to the product were marked on one line, the recommendations related to the process were marked on a different line on another sheet of paper and so on. That meant that a respondent's perception of one recommendation could be put in relation to other recommendations in the same category. This affected the answers since the first answer was often used as a measure of the other answers in the same category. "We are better on this [recommendation] than this one, but worse than this one, thus we are here" was a common statement during the interviews. For each recommendation the interviewees were also asked to comment on whether they thought that their organisation does more or less than their main competitors. Follow up questions were asked to encourage the interviewees to continue their line of argument outside the boundaries of the specific recommendations and for that reason the interviews varied from 100 to 130 minutes in length, while the part relevant for this paper varied from 25 to 45 minutes.

In the first two interviews three researchers participated in order to share the experience and achieve a common understanding of the process for later analysis. In the remaining interviews, two researchers participated except the last four interviews that were conducted by a single researcher. All researchers present took notes during the interviews and after each interview thoughts and ideas were discussed among the researchers. Finally, the marks were measured and transferred to a scale from 0 (very little) to 10 (very much).

RESULTS

The results are summarized in Table 1. The average of all the recommendations is 6.40, which can be used for comparison. All five recommendations concerning leadership (recommendations 23-27) are above the average, while all four recommendations concerning improvement activities (recommendations 28-31) are below average.

The production managers perceive that their organisations focus mostly on activities covered by recommendation number 6 - defining the customer's true needs (8.48), number 20 - stimulating further education for all employees (8.39), and number 8 - striving for long-term customer-supplier relations (8.37). They perceive that their organisations focus least on activities covered by recommendation number 9 - using all 168 hours during a week (3.25), number 28 - measuring performance in order to discover waste (4,25), number 16 - supporting your main suppliers in their development (4.45), and number 22 - scheduling time for reflection and training (4.68). Although the results do not reflect the perceived importance of the recommendations, they do show how much organisations are perceived to focus on the recommendations. The results also make it possible to identify where effort needs to be directed in order to meet the requirements of the industry. Reflections on four of the recommendations are provided below.

Stimulate further education for all employees (recommendation number 20). Education for all employees in the organization is in accordance with what the interviewees consider to be important and which organizations focus upon. Some interviewees complained that "it can be too much education from time to time" while others accused their organization of giving blue collar employees too much education thereby leading to a shortage of personnel on the sites. However, the views on education were mainly positive with the opportunity to go on management and leadership training courses appreciated by the majority of interviewees. "I don't think I have ever been denied a course I have applied for," was a common comment; although, with the exception of courses relating to new regulations and standards, most claimed that they had to ask.

Table 1: Production managers' perceptions of their companies' prioritization of waste reduction activities

Recommendation	*Average*	*STD*
Standardize the product based on a holistic view		
Consider costs during use when defining the product (1)	5,86	2,64
Prioritize sustainable systems for bearing and installations (2)	6,87	2,26
Develop technical solutions that can be used in several products (3)	6,44	2,19
Reduce the number of components (4)	5,99	2,61
Standardize components (5)	6,90	1,77
Sharpen and standardize the process		
Define the customer's true needs (6)	8,48	0,94
Ensure that all project members know and understand project goals (7)	6,58	2,91
Strive for long-term customer-supplier relations (8)	8,37	1,98
Use all 168 hours during a week (9)	3,25	2,08
Use standard procedures in all projects (10)	6,68	2,36
Standardize tools for managing information (11)	6,54	2,38
Plan more detailed and follow up continuously (12)	7,18	1,74
Reduce weather influence by prefabrication and sheltered assembly (13)	4,74	2,80
Discipline the structure of meetings and information flow (14)	6,83	2,07
Structure the material flow for efficient assembling (15)	6,23	1,83
Develop the organisation and it's competence		
Support your main suppliers in their development (16)	4,45	3,00
Choose employees with right competence and right attitude (17)	7,52	2,17
Strive for well teamed project organizations (18)	6,14	2,60
Consider new competences (19)	6,09	2,63
Stimulate further education for all employees (20)	8,39	1,44
Support employees developing their personal efficiency (21)	6,76	2,49
Schedule time for reflection and training (22)	4,68	2,39
Discipline the leadership		
Base decisions on a long-term philosophy (23)	7,53	1,80
Strive for structured and clean construction sites (24)	7,58	2,07
Provide clear instructions that cannot be misunderstood (25)	7,04	1,99
Decide and communicate high demands that pushes improvements (26)	7,01	1,57
Reward performance conducive to long-term organizational goals (27)	6,92	2,41
Lead continuous improvements		
Measure performance in order to discover waste (28)	4,25	2,88
Measure performance in order to control improvement activities (29)	5,19	2,56
Gather and use successful experiences systematically (30)	5,49	2,47
Relate all improvement initiatives to the value-adding process (31)	5,58	2,23

Strive for long-term customer-supplier relations (recommendation number 8). All three organizations from which the interviewees were drawn have outspoken and clear goals with regard to long-term customer relations. Participants perceived their organization as better than their competitors in this field and considered it to be of the outmost importance to encourage clients to return and to ensure their satisfaction so that good working relations would be established. Discussions in the groups often turned towards client continuity and satisfaction, which confirms the view that large and medium-sized Swedish construction companies cultivate long-term customer relations, even though in Sweden public clients must follow specific rules for procurement in every new project.

Use all 168 hours during a week (recommendation number 9). This question was often initially misinterpreted. “What do you mean by this” was the common response when it was asked. The background to the recommendation is that although construction involves a heavy investment in time and money, especially during the production stage, most construction work in Sweden is carried out between the hours of 6.45am and 4.00pm thereby leaving the sites empty most of the time. There are, however, firms that use the opportunity to do work on the site when it is less crowded. One such example is a relatively new logistics company, which half of the interviewees had experienced using, that handle material on the site after 4pm using trucks, elevators and other equipment that are already on site. Furthermore, one interviewee described how, in his current project, they work double shifts in order to ensure meeting the completion deadline.

Support your main suppliers in their development (recommendation number 16). There is a trend among Scandinavian large and medium-sized contractors to focus at a strategic level on reducing the number of suppliers in their organizations. It is common practice to include in supplier contracts an agreement that the contractor will continuously use the supplier and that in return the supplier will always provide the best possible price. However, support for good suppliers is seldom offered, even though it is a common strategy in many other businesses. With such a background it is not surprising that this recommendation is perceived as one of the lowest priorities. Most of the reasons for this situation relate to the construction industry’s unique products, which require the establishment of temporary organisations and the necessary use of many specialist sub-contractors and suppliers who, due to the geographical dispersion of projects, are often chosen for their local proximity. Another reason is that many components are standardised and therefore suppliers’ offerings are similar in price and product characteristics. Since price is often the main focus for both the contractor and the client, short-term cost savings are usually focused upon rather than the long-term collaborations that are required to reduce waste.

DISCUSSION AND CONCLUSIONS

The study presented in this paper is part of a major research project focusing on increasing the understanding of how waste reduction processes can be initiated in large and medium-sized construction companies. As the results are based on interviews and subsequent group discussions in workshops with relatively few participants from only three participating construction firms, statistical analysis and scientific conclusions were not considered appropriate. Also, as the recommendations on which the interviews and discussions were based could be interpreted in different ways, the responses varied greatly between participants; even participants working in different divisions of the same company. However, there are some trends that can be learned from the study.

There is a trend that experienced managers perceive their companies as working harder to reduce waste than less experienced managers perceive their companies do. One experienced manager considered his company to be doing a lot on most recommendations and so he marked as many as 20 recommendations on the high end of the scale (10) giving him an average score of 9.24. The second most optimistic person, also an experienced manager, scored an average of 7.90. The youngest and second youngest managers, who had both recently graduated from university where they had studied efficiency in construction, scored an average of 4.79 and 4.84 respectively; the manager coordinating improvement activities also scored low. Managers tend to evaluate their company's efforts based on what they perceive to be relevant opportunities and waste is generally not regarded as such. Also, younger managers seem to see more opportunities than experienced managers because the longer you work in production the more familiar you become with the common practices and the less able you are to see alternatives. A conclusion that can be drawn from this is that firms wanting to initiate waste reduction processes should plan activities for developing their employees' abilities to see the management of waste as an opportunity for improvement.

A reflection on the results of the study relates to the customer-supplier relationship. Firms are perceived to put a lot of effort into establishing long-term relations with both their clients and their main suppliers. This recommendation got the third highest score (8.39). But they are perceived to be not particularly interested in supporting their main suppliers. This recommendation got the third lowest score (4.46). It is an interesting fact that contractors establish long-term relations with suppliers but are not yet ready to support their development. Since suppliers perform 70-80% of the work on site in most large and medium-sized projects, there seems to be a great opportunity for waste reduction that has not yet been realized.

Another reflection concerns the gap between the recommendations related to leadership and those that are related to improvement activities. Successful improvement processes is generally considered to be a question of leadership. Here, it is perceived that decisions are based on long-term goals to a great extent, while all four recommendations related to improvements are rated low. Most improvement processes have a long-term orientation. Does it mean that improvement processes don't really exist in the minds of the production managers? Irrespective of the answer to that question, this study confirms the short-term view that exists in construction companies. Getting production managers to take a long-term view may be one of the true bottle-necks to successfully reducing waste in construction.

REFERENCES

Fearne, A., and Fowler, N. (2006) Efficiency versus effectiveness in construction supply chains: the dangers of "lean" thinking in isolation, Supply Chain Management: An international journal, 11(4), 283-287.

Josephson, P.-E., and Saukkoriipi, L. (2007) Waste in construction projects – call for a new approach, The Centre for Management of the Built Environment (CMB), Chalmers University of Technology, available at www.chalmers.se/cmb.

Josephson, P.-E., and Saukkoriipi, L. (2009) 31 recommendations for increased profit in construction – reducing waste, The Centre for Management of the Built Environment (CMB), Chalmers University of Technology, available at www.chalmers.se/cmb.

Liker, J. K. (2004) The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer. McGraw-Hill Professional, New York (NY), USA.

Morgan, D. (1988) Focus groups as qualitative research, Sage Publications, Newbury Park.

LEARNING FROM PROJECTS: MACEDONIAN EXPERIENCES WITH INTERNATIONAL CIVIL ENGINEERING PROJECTS

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This article presents authors experiences collected during working on some international civil engineering projects. The purpose of the article is to present possible obstacles during working on international projects, resulting from differences in levels of design, application of different standards and models for civil works, as well as different engineering practice. A special attention is given on problems connected with project management, technical documentation and construction projects determining factors. Main idea is to give possible way of overcoming the differences that can arise from different application of mentioned project elements. A main conclusion is that, before starting on working with international civil engineering projects, a detailed analyse of all law aspects, standards, technical legislative, local practice and culture is necessary. Authors believe that the gathered experiences can serve as a learning example for foreign parties and for improvement international cooperation in construction.

KEYWORDS: learning from projects, international project, construction, standards.

INTRODUCTION

During last 10 years, the number of the international civil engineering projects in Republic of Macedonia is increasing. Such trend is expected in a future, due to the tendency of the contry to be a part of European comunity.

The foreign participants in the Civil Engineering Projects, pursuant to the Macedonian Law on Construction (Assembly of the Republic of Macedonia, 2005) can undertake all the positions as the domestic participants. According to the relevant Laws legislative, Tendering for the larger Macedonian Civil Engineering Projects must be international. This leads to the increasing in number of foreign companies which apply on Civil Engineering Projects.

On the other side, Macedonian Civil Engineering Companies and Institutions also participates in foreign countries in a different Design Projects, Strategies for Development, Construction works etc.

A brief overview of the ongoing or future large international projects in Republic of Macedonia is given here. See Table 1.

Table 1: Short list of ongoing and future large Civil Engineering Projects in R.Macedonia

Project	Investor	Designers	Contractor	Stage of the project
Arch dam "Sveta Petka"	Public enterprise for electricity AD "ELEM"	RIKOM-Skopje, Energoprojekat-Serbia	RIKO-Slovenia with local subcontractors	In a phase of construction
Hydro system "Zletovica" (earth fill dam "Knezevo" with asphalt core is main element of the system)	Public enterprise for water supply "Zletovica" sponsored by Japanese bank	PCI-Japan, Coyne and Belier-France, Faculty of Civil Engineering (FCE) from R. Macedonia	Domestic companies "Granit" and "Beton"	In a phase of construction
Gasoline network in Republic of Macedonia	Ministry of transport and communications of R. Macedonia	Domestic company "Prostor" with Bulgarian subcontractor	-	Feasibility study and general project design in the phase of preparation
Arch dam "Cebren" with height 186-190 meters (depending on the project variant)	Public enterprise for electricity AD "ELEM"	Energoprojekat-Serbia, FCE and others	-	Basic Design Project exists
Pan European corridors (highways and railways) K-8 and K-10	Agency of State Roads	Several domestic and foreign companies	-	In different phases of design

Positive element is that this leads to the increased competition between participants, working with competitive prices and interchanges of knowledge and experiences. Anyhow, the effective realization of the such international projects is connected with numerous problems. Sometimes problems are from formal aspects, but sometimes they are connected with differencies in a law legislative, different civil engineering standards and differencies in an engineering practice. The participation of companies with different engineering experience and references which earlier never worked together, working labor with different culture and tradition creates additional problems in coordination of the works and management of activities during the phase of project realization. Beside positive experiences from presence of international companies on an domestic market, there are serious problems and obstacles for both sides, domestic and foreighn parties. Analysing the existing situation, it can be noted that the foreighn companies are more competitive compared with domestic one, while the domestic companes usualy works as subcontractors, for lower prices, or they doesn't participate at all. In order to perceive the major problems and reasons for occurrence, the authors carried out an analysis of present conditions in the realization of international construction projects. The gathered experiences were the basis for this article. The analyses are based on the author's experiences by participation in several international projects in a revision council, consultants or designers. Special overview id given on the projects as Hydro-system "Zletovica", arch dam "Sveta Petka" (See Table 1) and prepairing of the Strategy for Civil Engineering Development in Montenegro (Cvetkovska at all., 2008).

ANALYSIS OF KEY INTERNATIONAL PROJECT PROBLEMS IN MACEDONIAN CONSTRUCTION

The main aspects can be systematized into three key group interaction issues and problems. They refer to the Project Management Problems, Technical Documentation Problems and Construction Projects Determining Factors Problems.

Project management problems

Such problems can be classified in groups of interconnected aspects as follows:

- Application of new models and unified standards for project management,
- Project management functions,
- Problems with management of Project Processes

Application of new models and unified standards for project management

The country has no accepted models, concepts and standards for quality of management with construction projects that would result from one's individual research, based on contemporary project management methods, techniques and software and that would correspond to the actual conditions for the project realisation, regulated by appropriate legal regulations (Zileska-Pancovska, 2006). That is the reason why domestic participants in international projects usually use foreign concepts, models and standards, mostly ISO 10006 (International Standard ISO 10006, 2003) or PMBOK (A Guide to the Project Management Body of Knowledge, 2004) for project management or their work is based on their own experiences, education and intuition. Foreign participants in projects use their own approaches. This leads to different understanding in application of modes and standards for project management.

The *Learning from projects* in Macedonian Civil Engineering is not used as it can be. The Macedonian experiences from previously finished and from ongoing international projects usually are not presented in front of the public and civil engineering practitioners. Results of this, is a situation when the “same” or similar mistakes are repeated several times.

Project management functions

From the author's experiences, all sides in project usually use its own *organization structure*, mostly based on so-called functional organization scheme. Usual problems for domestic participants are low motivation of expert teams, which comes out from low degree of information on all necessary contractual and technical elements of the project. Most commonly used techniques for *planning* in the country are Gantograms and Network technique. Software support is based on MS Project or Primavera packages. On the other side, our practice shows that after *controlling* and *monitoring*, schedules for all international projects have been changed several times.

Problems with management of Project Processes

Risk management analyses usually absent in Macedonian parts of international projects, which mean that the risks managements during constructions needs further improvement. Most common risks come from organization nature. Importance of *costs, time, resources and* *procurement* influential factors, comes from the facts that international projects are usually of large scale, and needs high level of investments. To insure project realisation, the financial and other support come from our Government or stronger Public enterprises. Sometimes, this is connected with some inadequate requests by the Investor side, which can be a problem for domestic constructional companies. Here, we can note that tendering procedure sometimes involves factor time of construction as wining criteria. So, to fulfill this criterion, the time planning is inadequately presented in the offers. This has a direct influence on the resource incoming, and finally leads to the longer time construction. Looking backward, Investor or Government, force the initial terms, and this can lead to numerous misunderstandings. This deserves detailed analyses, which overcomes the frame of this paper.

Problems connected with project *strategy,* projects *scope,* and *inter connected processes* are not typical. But, at all international projects with authors' participant, because of the large scope of the projects, always new or not predicted activities arise during the working.

The *personal* is being chosen by each participant in the construction independently. In this sense, each participant applies individual criteria and procedures for selection of staff. The staffs selected by international participants are usually foreign persons that have appropriate certificates and licences. Disadvantages of selecting such staff, especially project managers are the insufficient awareness of the actual situation, when carrying out construction works in Republic of Macedonia. Additionally, problems arise if the project management team is occupied with more activities in a same time, or if the starting team is changed during construction. For an instance, during the construction of the arc dam "Sveta Petka", main manager is changed. In a case of dam "Knezevo", the whole design team from French company Coyne and Belier cancelled the participation in consultant services during the construction because of its own reasons.

When our engineers applied for work in foreign companies, obstacles came because of the fact that Macedonian construction Licenses for Design, Supervision and Revision are not recognized in other countries. When the foreign architects or engineers want to apply as a person in some projects in the country, obstacles came from the fact that the Directive 2006/123/EC for services in an internal market (Directive 2006/123/EC of the European Parliament and of the Council, 2006) is not fully accepted in our Law for Construction. Additional problems occur because of the fact that in Republic of Macedonia lacks National Certification Program in the area of construction project management that would be in line with similar international programs. Also, Republic of Macedonia does not have stages of competences and qualifications, as well as phases of the certification process. As a result, large problems exist concerning project managers appointment and the work of staff that works as project managers is based on their own experiences, education and intuition. The majority of project managers are civil engineers having experience with construction of structures at home and abroad and they are familiar with the planning, regulations, technical specifications, negotiations in the construction business, construction management and IT. They also have a good knowing of English. It should be mentioned that there are project managers in Republic of Macedonia with foreign license, especially those who work for foreign companies. The majority of them are also foreign managers, who have modest knowledge of the real construction situation in Republic of Macedonia.

The *communication* problems arise from the fact that the participants are usually with different culture, tradition and way of working. Sometimes, foreign experts needs longer time to accept all necessary project data. The organization of working meetings, different ways for preparing of reports and other factors sometimes leads to the misunderstandings in realisation. Just for an illustration, in a process of construction of HS "Zletovica", the teams from Japan, France, Macedonia and Norvey are involved, and all of them have its own way of working and managing of the problems. In a project for arch dam "Sveta Petka", the teams from Slovenia, Serbia and Macedonia are involved, and here the problems with not resolved contractual arrangements are present. But, there are cases of well established communication. We will note the way of working during the preparing of the Strategy for Civil Engineering Development in Montenegro (Cvetkovska at al., 2008). Here, the main leader of the Project is Faculty of Civil Engineering. Also, local partners from Montenegro was involved, and participants from Serbia and Germany.

The problems with information managements, language of communication etc shall be also noted. The feed back of information's is not satisfactory while the main language for communication is English, usually not mother tongue language for all participants. So, some optional solutions are involved. For an example, in a case of project "Sveta Petka", all participants are from Former Yugoslavia countries, so the Serbo-Croatian language is used informally on a meeting sessions.

According our experience, the weak points in international projects are the factors given in Figure 1.

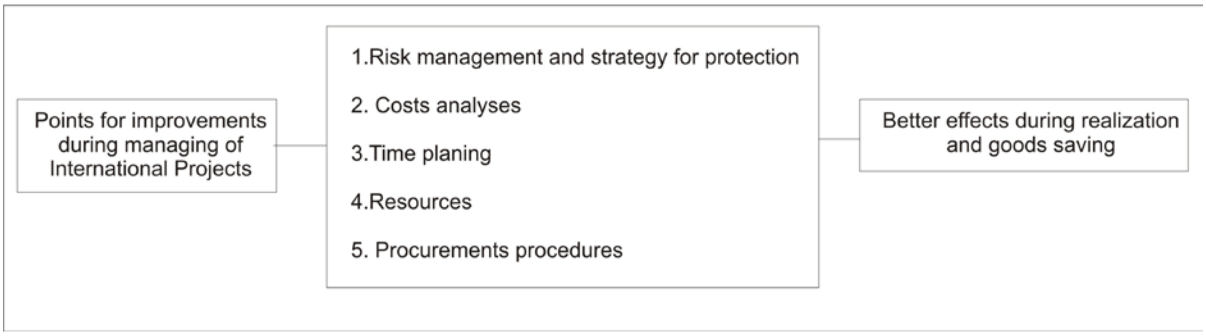

Figure 1: Weak points in international project

Technical documentation problems

In accordance with the Law for Construction (Assembly of the Republic of Macedonia, 2005), the structures are divided in five categories according their type, specifics, complexity and technical-technological conditions for their construction. The law prescribes several types of documents which are necessary to be prepared in several design phases (Figure 2). Depending on the structure category, not all levels of design are necessary for each structure. This is defined in the mentioned Law on Construction, but unfortunately, not all sub-law procedures are finished. So, there are not well defined aspects in the law framework, which is as a basis for misunderstanding for foreign contractors. The need of more detailed explanations about the project content and design details for different level of design is evident. For an example, this produce a lot of problems with design team from Energoproject-Serbia in a case of arc dam "Sveta Petka". The Serbian team insists on the former Law on construction, which was similar for Former Yugoslavia countries, and which prescribes different phases of design.

The levels of Macedonian technical documentation and its scope are not harmonised with the contemporary regulations used in other countries in the relevant field. For an example main levels of technical documentation, depending on the type of construction and level of design, in accordance with Montenegro' Law for space planning and construction (Law on space planning and construction, 2008) are: Preliminary Design; Basic Design; Main design and As Built documentation. This is somehow different from Macedonian practice (Figure 2).

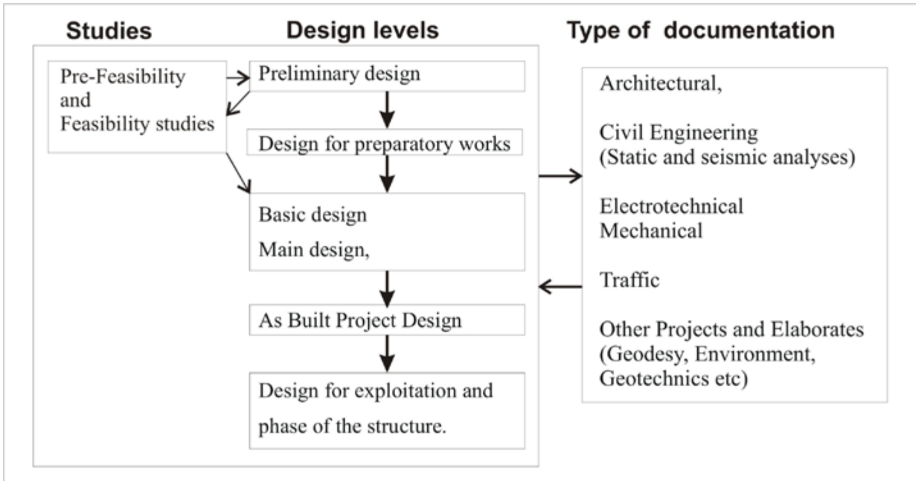

Figure 2: Main levels of design and type of documentation according to the Law on Construction

Macedonia has not accepted technical specifications and standards for all civil engineering works. The Council Directive 89/106/EEC (The Construction Product Directive, 1989) and other Directives relevant for the Civil engineering projects are not transposed in all relevant Macedonian regulations. Also, there are problems with the harmonization of Euro Codes EC1 to EC9, which deals with Civil Engineering. But, the process of harmonisation is also not easy in the EU countries. Almost all EU countries have their own National Annexes, which can differs a lot from case to case. If we transform this into the Project Design level, then in international civil engineering projects in Macedonia, all participants can force their own view about the applicable standards, content of documentation etc. Such situation is not easy to be managed, and needs high effort from all project participants in order to fulfil all necessary criteria about safe and economical construction.

Construction determining factors problems

The realization of international projects is determined by numerous interconnected and mutually connected complex set of time dependent factors. In Figure 3, we introduce a concept of three-tier approach in Macedonian Civil Engineering, in a similar way as it is given by Hudson (Hudson, 1993) for other problems. The influence of each factor is different at each project, but for all named projects, experience shows that some of them are usually underestimated. For an example, during realization of HS "Zletovica", an archaeological-historical factor stopped the construction for several months, because uninvestigated archaeological localities were found at the zone of working. The other example is a case connected with changing in design (from clay to asphalt impervious core in a dam' body). Having in mind that the domestic companies do not has an experience about this type of dam, a Norwegian company is involved in the construction. For the project arch dam ″Sveta Petka″, the uncompleted investigations of geotechnical factors have a large influence because of the heavy terrain conditions and slope-stability problems for the access road.

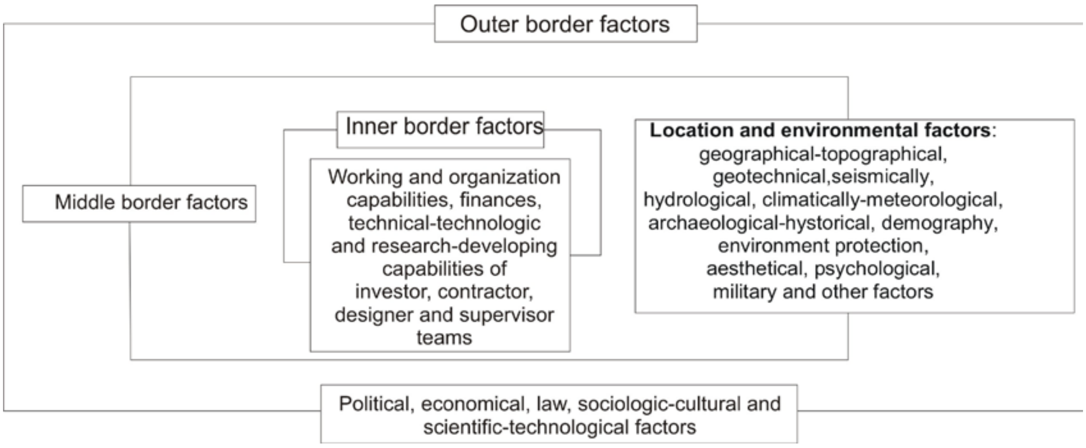

Figure 3: Illustration of three-tier approach for construction determining factor problems

POSSIBLE SOLUTIONS

What can be learned from the international projects in R. Macedonia and if it is possible to offer some acceptable solution?

It is evident, that, mutual influences between elements in international projects, needs complex detailed strategically, economical, technical and other type of analyses. This means that the problem can be resolved in an apropiate way for all involved parties, when it is accepted as a multidicsiplinary problem. At a first step, the country itself, must establish in a clear way it's perspectives in Civil Engineering. One possible scheme, applicable for developing countries in the region is given in a Figure 4.

Figure 4: Seven strategic points for improved management with Civil Engineering Projects

Authors believe that so-called interaction matrix method can be useful device. The method is introduced by Hudson (Hudson, 1993) in rock-engineering analyses. In a frame of this article, we will shortly introduce possible application in Project Design Management problems for international projects. One example of conceptual matrix with three elements in a leading diagonal is given on Figure 5.

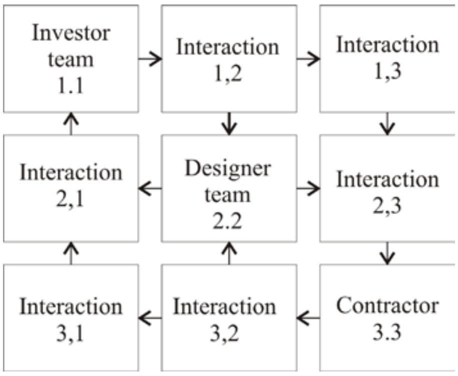

Figure 5: Conceptual matrix of interaction with three main factors during the project realisation

Here, the most important step is to establish the objectives of the project and the analysis. The relevant variables must be chosen in a first place and they are placed along the leading diagonal of the interaction matrix. In this case, these variables have to be more conceptual in nature. Then, all the interactions are established so that the problem structure is developed. When the variables are conceptual in nature, the off-diagonal interactions can be assessed using qualitative explanations (See Table 2).

Table 2: Qualitative explanation of the interactions

Interaction case	Description of possible interaction elements and influences
Interaction 1,2	Investor team gives basic expected elements of the Project for detailed further analyses to the Designer team, notes the applicable Laws and Standards, gives the data about Involved Public enterprises, level and content of documentation that he needs etc.
Interaction 1,3	Investor team prepares contractual arrangements and present them to the Contractor, with detailed instructions about time-schedule, payment details, rights and penalties based on the tender dossier for construction and project elements etc.
Interaction 2,1	Designer team suggest to the Investor options in the project solutions, optional applicable standards and technology for constructions, based on the analyses of the market conditions and contractors capabilities etc.
Interaction 2,3	Designer team explains the project elements to the Contractor (if necessary), especially some most-critical project elements.
Interaction 3,1	Based on the detailed analyses of the contractual arrangements, Contractor suggests Investor some changes in the contractual arrangements and optional ways of constructions, which in general doesn’t change financial estimation for the project costs.
Interaction 3,2	Contractor based on detailed analyses of the project elements and real field conditions, suggest to the designer possible optional ways of constructions, that in general doesn’t change the safe and economical exploitation of the structures.

This, at a first view 'simple' scheme indicates that not only the group factors covered by the Investor side (from investment point of view) influenced the scale of the project, but also designer team can introduce its own view for optimal project realisation. In this scheme, contractor plays very important role, and with well analysed project data, can offer its own view during construction phase. These leads in most-appropriate application of designer's solutions on the site according to the real conditions defined during working.

It is very useful if such approach will be arranged at the beginning of the projects, but this shall be accepted as an ongoing process during all time of project realisation. It insures all time communication, resolving of problems and development of understandings between different teams. All methods that give a positive reflection earlier in the practice shall remain. Some positive experiences are connected with application of known and widely accepted international documents. For an instance, in Macedonian Civil Engineering Practice, juridistical arrangement and internal contractts or sub-contracts are based on FIDIC Books, which is allowed by the Law in the country. This can be noted as a positive experience.

CONCLUSIONS

The international construction projects in Republic of Macedonia and presence of foreign companies has an increasing trend. Main reason for this, is the fact that the Law prerequisites gives equal level for participations on an Macedonian market. With a full acceptance of European Directive for services on internal market in our Laws, the main prerequisites for integration of Macedonian civil market will be established.

Unified and standardised methodology for construction project managements, which would cover all the activities and phases of the project life cycle, is not applied. In addition, little attention has been paid to issues related to construction project management in the Law on Construction and the Manuals deriving from it, as well as in the remaining legal regulations. An additional problem is that the phases in preparing of technical documentation and its content that are not equal with the contemporary regulations used in other countries. This is not only Macedonian, but international problem.

Problems related to international construction project had their effects on increasing expenses for project realisation and postponement of realisation deadlines. This directly affects the Macedonian civil construction business.

However, the public concerned with the area of international construction projects is becoming aware of the need to take practical steps for improving the situation. Furthermore, the inevitability of paying more attention to all significant issues and problems concerning international construction project realization was acknowledged. Their resolution will create conditions for eliminating the causes for many other problems emerging during realization of international construction projects in Macedonia. Condition will also be created for quality, cost-effective and efficient construction of facilities at home, and the possibilities for international cooperation of the Macedonian civil construction engineering will be increased. All this will allow faster integration of the Macedonian within the international construction business.

We believe that the given analyses and recommendations in this article will help in capacity building of domestic institutions, as well as it can serve as a kind of guideless for foreign companies which shall apply in some future large scale civil engineering projects.

REFERENCES

A Guide to the Project Management Body of Knowledge, Third Edition, (2004) Project Management Institute, PA

Assembly of the Republic of Macedonia (2005) Law on Construction, Official Gazette of the Republic of Macedonia. No. 51, (4-5)

Cvetkovska, M., Trpeski, S., Zileska-Pancovska, V., Jovanovski, M., and others (2008) Strategy for Civil Engineering Development in Montenegro, FCE, Skopje

Directive 2006/123/EC of the European Parliament and of the Council of 12-th December 2006 on services in the internal market, (27-th December 2006) Offical Journal of the European Union L 376/36

Hudson, J. A. (1993) Comprehensive Rock Engineering, Pergamon Press, Oxford, 4407 pp.

International Standard ISO 10006, (2003) Second edition: Quality management systems-Guidelines for quality management in projects

Law on space planning and construction, (2008) Official Gazette of Montenegro, No 51/08

The Construction Product Directive (Council Directive 89/106/EEC) (1989), OJ L40, 11.2.1989

Zileska-Pancovska, V. (2006) Project Management in Construction of Investment Facilities-Theoretical Aspects (in Macedonian), Faculty of Civil Engineering, Skopje, Republic of Macedonia

PPP IMPLEMENTATION THROUGHOUT THE WORLD: A GENERAL SELECTION/IMPLEMETATION SCHEME

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Endemic budgetary constraints have led governments in several developing and developed countries to seek new ways to finance the ever-increasing need of new infrastructure networks. A solution is for the public to partner with private investors and to use private sector finance and expertise to procure public infrastructure systems through the arrangement known as public-private partnership (PPP or P3). The main benefit of private investor involvement in public infrastructure is the proven private sector capacity of meeting the infrastructure service needs while securing the best value for money. However, efficiency gains will depend critically on the right allocation of risks between the private and public sectors. The aim of this study is to present the main typologies of PPP arrangements, their characteristics, new trends, and analyze how they have been adopted throughout the world. The analysis of their main characteristics is centered on the three most important aspects of the PPP transaction: the risk transfer to the private partner, the use of the private financing, and the use of private expertise and management skills. Furthermore, the discussion on the strength and weakness of the PPP procurement in some countries in the world sketches a theoretical framework in the implementation of PPP/PFI, which could be very useful for both who wants to improve the models currently used and who approaches PPP for the first time.

KEYWORDS: public private partnership, risk, private finance, private expertise.

INTRODUCTION

In recent years, the increasing need for the development of infrastructure and budgetary constraints in several developing and developed countries have led governments to seek new ways to finance the facilities of public utility. One of the options is to involve private sector finance and expertise in the provision of public infrastructure through various schemes, widely known under the term public-private partnership (PPP).

The expression “public-private partnership” is commonly used throughout the world, but is often not clearly defined. In the broadest sense, PPPs can be defined as “arrangements typified by joint working between the public and private sector” (HM Treasury, 2008). Therefore, they can cover all types of collaboration between the public and private partner, involving collaborative risk sharing in order to deliver services and infrastructure to the community. PFI (Private Finance Initiative) is one of these arrangements and is the principal vehicle for delivering PPP in the UK (McKenzie, 2008). Under such a scheme, the public sector contracts with the private sector to deliver services on its behalf for a long period (often between 15 to 30 years). In exchange, the private sector receives regular payments (unitary payment) from the public sector on the basis of effective levels of the demand (such as traffic flows on public, but privately financed, roads). The unitary payment is dependent on the private firm's performance during the life of the contract; that payment is reduced if performance falls below the required standard. Such a mechanism, therefore, is able to ensure high quality service provision for the whole life of the contract (HM Treasury, 2008).

The reasons for the increasing role of the private sector in the financing and provision of services that were traditionally provided by the public sector are multifarious (Chege and Rwelamila, 2001). One of the key factors is the possibility to improve the quality of public services by the use of the private expertise in meeting the customer needs while simultaneously developing value for money. However, efficiency gains will depend critically on the right allocation of risks between the private and public sectors. According to Perry and Hoare (1992), in complex projects, risks should always be allocated to the part more competent to manage them. Another reason, even more important, is the government's incapacity to meet the rising popular demand for better public services in a period of slow economic growth or even regression, and depressed tax revenues (Harris, 2004). The adoption of a PPP gives the governments the possibility to obtain these advantages but without losing the control of the public services, that is one of the major concerns of public authorities. In fact, the appropriate control mechanisms from the public party ensure the exploitation of the management qualifications and the efficiency of the private sector without giving up quality standards of the output (Renda and Schrefler, 2006). Thus the government can achieve the right trade-off between the quality and efficiency in the provision of a particular service (Hemming, 2006). In fact, the government is generally able to provide a desired quality standard, but it has difficulties in doing so while also containing costs. On the other side, the private sector has the ability and management skills to innovate and reduce costs, but this can often compromise the service quality. Hence, the collaboration of the public and private sectors through a structured and well-defined agreement can ensure the trade-off between quality and efficiency, avoiding also the risks of monopolistic behaviours of the private firms. This works better when the government is able to specify the quality standards required and translate them into measurable output indicators.

Nowadays, PPP/PFI is used all over the world in a broad spectrum of sectors, both for "infrastructure" services, such as roads, bridges, railways and utilities, and for "social" services, such as schools, hospitals, prisons and transport. Although very attractive, the development of PFI/PPP transactions has had to overcome (and is still overcoming) several political, fiscal and institutional challenges in order to move from conventional procurement to new delivery solutions based on the collaboration between public and private sectors.

The aim of this study is to present the main typologies of PPP arrangements and their characteristics, and analyse their adoption throughout the world, both in developed and developing countries. The discussion about the strength and weakness of the PFI/PPP procurement in some countries in the world sketches a theoretical framework in the implementation of PPP/PFI. This will be very useful for both who wants to improve the models currently used and who approaches PPP for the first time.

PPP MODELS

PPPs come in a wide variety of models characterized by a different involvement of private and public sectors. In reality, there is often no clear agreement on what does and what does not constitute a PPP (Hemming, 2006). The definition of PPP depends also on the country concerned (Turina and Car-Pusic, 2006). In fact, the term can cover a variety of transactions between traditionally procured government projects and full privatisation. These arrangements range from management contract (with little or no capital investment) through concession contracts (which may encompass the design and build of assets along with the provision of a range of services and the financing of the entire construction and operation), to joint ventures characterized by the sharing of ownership (and sometime also management) between the public and private sectors.

In general terms, as proposed in the 2004 Green Paper on public-private partnership by European Commission, PPPs can be divided into two main categories based on the legal structure that characterized the transaction: institutional PPPs and contractual PPPs. Institutional PPPs are characterized by the creation of an institutional entity jointly held by the public and the private partners in order to supply an infrastructure or a service to the community. Contractual PPPs, on the other side, are based on "an agreement between the public sector and the private partner to provide a service in exchange of some form of compensation from final users or through regular payments by the public authority". From an economic and managerial point of view, the institutional PPPs do not differ so much from the contractual ones. So, in this paper, the focus is on this last category of PPP; some of the best known contractual arrangements are the following:

- Management contracts
- The leasing model or Build-Lease-Transfer
- Design-Build (and Design-Build with warranty)
- Design-Build-Operate-Maintain
- Design-Build-Finance-Operate
- Build-Operate-Transfer
- Build-Own-Operate-Transfer
- Build-Own-Operate

Management contracts are common ways of privatising existing services and utilities. The private sector is paid a fee for operating and maintaining a government-owned business which has previously been operated by the public sector. Under the lease arrangement, the facility is typically designed, financed and constructed by the private sector, and is then leased back to government for some predetermined period of time at a pre-agreed rental. During the period of the lease the private sector has the legal ownership of the facility, and at the end of the leasing period government typically has the option to renew the lease, to buy out the private partner for a lump sum or to simply walk away from the contract, leaving the facility in the private partner hands (Morledge et al., 2006). The Design-Build delivery approach, in several aspects similar to the traditional procurement method, combines the design and construction phases into one, fixed-fee contract. Under a DB contract, the design-builder, not the project sponsor, assumes the risk that the drawings and specifications are free from error (March, 2007). This approach differs from the traditional form of project delivery (Design-Bid-Build, DBB), because in DBB, the design and construction of the facility are awarded separately to private sector engineering and contracting firms. The Design-Build-Warranty (DB-W) approach is a variation of DB, where the design-builder guarantees to meet material, workmanship, and/or performance levels for a specified period after the project has been delivered. The Design-Build-Operate-Maintain (DBOM) model gives the selected contractor the responsibility for the design, construction, operation, and maintenance of the facility for a specified time. Those approaches potentially increases incentives from the private partner to delivery a higher quality project than for usual procurement systems because the design-builder has to operate the facility for a specified period and therefore is responsible for its performance. A variation of DBOM model is the Design-Build-Finance-Operate (DBFO) delivery approach. In this case, in addition to the design, construction, and operation of the project, the contractor is also responsible for all or a major part of the facility financing. DBFO model provides for transferring the financial risks to the design-builder during the contract period. The term DBFO was coined in 1990s by the UK Highways Agency to describe their concession-based schemes under the UK Government Private Finance Initiative (Morledge et al., 2006). Under such a scheme, no rights of ownership are typically conferred on the project sponsor, and the project sponsor cannot acquire, at any point, any interest in the land. Build-Operate-Transfer (BOT) is often used as a generic term for concession-based agreements where the facility is designed, financed, operated and maintained by the concession company for the period of concession, typically between 10 and 30 years. Under this arrangement, the project sponsor retains facility ownership as well as the operating revenue risk and any surplus operating revenues. Under the standard BOT, at the end of the concession period, all operating rights and maintenance responsibilities pass to the government. The basic difference between DBFO and the BOT models lies in the fact that for the former, the Government (or more often the local self-government) pays a fee for the service to the sponsors on a regular basis during the whole duration of contract (after completion of construction once services start being delivered), while the BOT contracts are most often funded by the users of the facility (Turina and Car-Pusic, 2006). Under the Build-Own-Operate-Transfer (BOOT) approach, the design-builder has the responsibility for the design, construction, operation, and maintenance of a facility, while asset transfer occurs after a specified operating period when the private partner transfers ownership to a public agency. Build-Own-Operate (BOO) model differs from BOOT because under BOO, the asset ownership is not transferred to a public agency. The contractor has all operating revenue risk and any surplus revenue for the life of the facility and not for a limited period.

CLASSIFICATION OF PPP MODELS. CASE STUDIES ANALYSIS

In order to analyse the characteristics of the PPP arrangements throughout the world, this paper analyses the PPP implementation and policy in some developed and developing countries. A set of case studies from various counties and sectors was considered and analysed. The number of cases studied is obviously small compared to actual projects realised all over the world. Thus results cannot be understood in the statistical sense. However, several important considerations can still be drawn.

Case study data has been collected from a variety of sources, and they are listed in Table 1.

Table 1: List of case studies

Name	Location	Sector
TransMilenio Bus Rapid Transit system	Latin America	Transportation
The Martin Garcia Channel	Latin America	Transportation
Rural Electrification Project	Latin America	Power
Cartagena Water Supply, Sewage, and Environmental Management Project	Latin America	Water

Yitzhak Rabin Trans-Israel Highway 6	Asia	Transportation
Colombo, Sri Lanka Port Expansion	Asia	Transportation
Manila water service project	Asia	Water
Expansion of port of Aqaba, Jordan	Asia	Transportation
Stormwater Management and Road Tunnel	Asia	Mixed use tunnel
Bangkok Rapid Transit System	Asia	Transportation
Renovations to Pelonomi and Universitas Hospitals	Africa	Healthcare
Rural households electrification project	Africa	Renewable E nergy (Solar Power)
The N4 toll road	Africa	Transportation
Gabon Water and power project	Africa	Water and Power
BerlinWasser	Europe	Water
Dublin Bay Waste Water Treatment Plant	Europe	Water
Nessebar "Golden Bug" Landfill, Bulgaria	Europe	Solid waste management
Beiras Litoral / Alta Shadow Toll Road, (SCUT IP5)	Europe	Transportation
Wijkertunnel Randstad,The Netherlands	Europe	Transportation
Perpignan – Figueras Rail Concession, France & Spain	Europe	Transportation
Union Power Station and Gila River Power Station	North America	Power
South Bay Expressway (SR 125)	North America	Transportation
Gordon and Leslie Diamond Health Care Center	North America	Healthcare
Britannia Landfill Gas to Electricity Project	North America	Power
Durham Veterans Affairs Medical Center	North America	Healthcare
Dulles Greenway	North America	Transportation
Indiana Toll RoadTransMilenio	North America	Transportation
Britannia Mine Water Treatment Plant	North America	Water
The new Royal Children's Hospital	Australia	Healthcare
Victoria School's Project	Australia	School
Barwon Water Biosolids Management Project	Australia	Water
NSW Schools 1 PPP Project	Australia	School
EastLink	Australia	Transportation

To allow a common analysis of those cases, three parameters have been selected. They are the most important factors that should characterize a PPP agreement and that also determine, as previously discussed, the main reasons of a PPP implementation:

- Risk transfer to the private partner. Risk allocation is a very important aspect of PPP transactions, maybe the most important one. The principle is to transfer the risks to the party that is best able to manage them. The aim, therefore, is (or should be) to optimise, not maximise risk transfer.
- Use of the private financing to provide infrastructure. The possibility to privately finance public infrastructure and projects traditionally funded by public finance allows governments to cope with the ever-increasing demands on their budgets. However, PPP differs from privatisation both for the temporary nature of the agreement and the degree of control enjoyed by the public sector.
- Use of private expertise and management skills. This parameter refers to the complexity and importance of the operational phase (in front of the design and construction phase) in the contract. The public sector can exploit the private sector expertise in project, operational and risk management in order to provide a higher quality service to the community.

All these aspects allow the government to achieve "value for money," which is the main goal of a PPP route. Value for money can be defined as "the optimum combination of whole-life cost and quality (or fitness for purpose) to meet the user's requirement" (HM Treasury, 2008). Value for money, however, is not synonymous with "cheaper," although that may well be the case. It is a relative concept, because it is measured in terms of a comparison with potential or actual outcomes of other delivery methods, such as the public conventional procurement.

These cases were also analysed in terms of sector, project delivery method and geographic area. For the lack of space, Appendix shows only one "emblematic" case per geographic area. Each variable was measured on a 1 to 5 scale, as explained in Table 2.

Table 2: Criteria and scale of the radar diagram

Criteria/Scale	1	2	3	4	5
Risk transfer	Fully public	70/30	50/50	30/70	Fully private
Use of private financing	Fully public	70/30	50/50	30/70	Fully private
Use of private expertise	Fully public	70/30	50/50	30/70	Fully private

The quantitative variables for projects in the same region are close, with the average values shown graphically in the radar diagram in Figure 1. The variability of the values of the three parameters for projects in the same area (measured by the standard deviation) is low (less than 1) in almost all cases, except for the use of private financing in Latin America and Europe where the standard deviation is slightly higher (about 1.5 and 1.6 respectively).

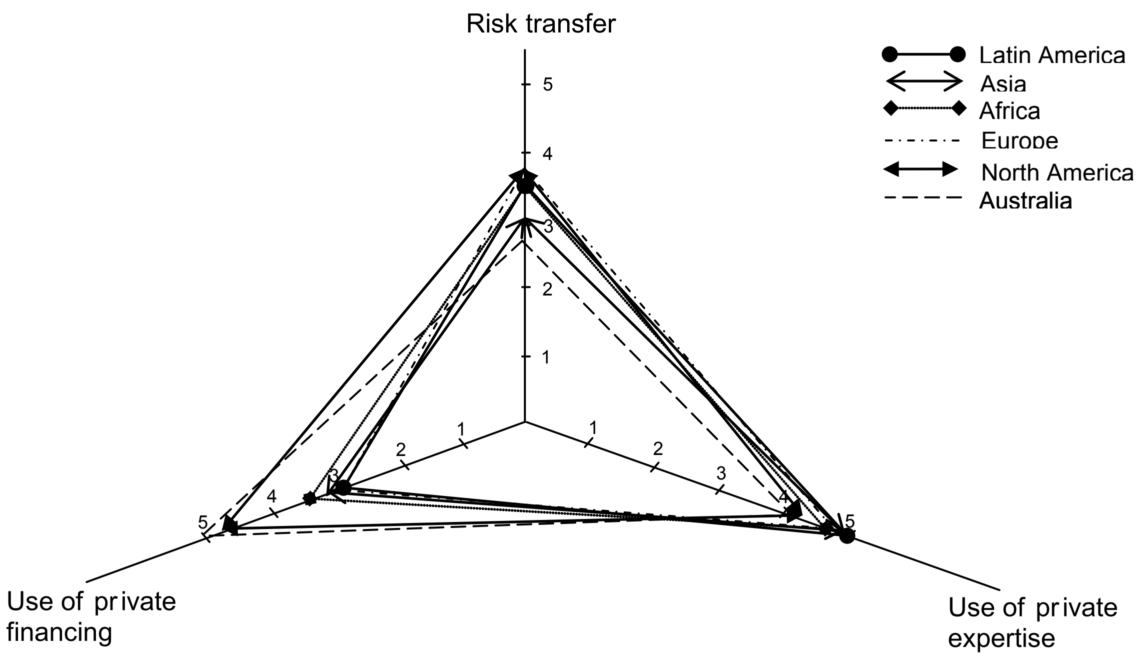

Figure 1: Radar diagram

The comparison of the six areas' average values shows a relative similarity in the use of private expertise and in the degree of the risk transfer. Greater variability is seen in the use of private financing, with larger values in Western economies (North America and Europe).

DISCUSSION

PPPs are used in a variety of models that differ from country to country and, within the same geographic region, from sector to sector. The analysis of some case studies in terms of some important parameters that should characterize the use of PPP, however, highlights some interesting aspects in PPP implementation around the world.

As for the risk transfer to the private party, both developed and developing countries present similar values (between 50/50 and 30/70). The result is in line with the fundamental principle of the risk transfer in PPP. The risk transfer should not be maximized, but optimized since the risk should be borne by the party that is best able to manage it. This is one of the most important aspects for the success of a PPP project. Sometimes, in fact, governments provide guarantees to the private party, such as minimum revenue guarantees, in order to reduce risk taken by the private. Of course, the degree of risk transfer and the actions that should be undertaken to allocate risks to the right party depend on the specific project and context. For instance, the Martin Garcia Channel project in Uruguay and Argentina provides an important lesson in this sense. The stability of the economic and political environment, and therefore the right allocation of political risk, is extremely important for the long-term success of a PPP. The channel was successfully constructed, and operated as designed for several years. All parties thought the risks to the private partner were minimal since Argentinean and Uruguayan governments gave supplemental payments for maintaining the channel. However, when Argentina and Uruguay suffered financial crises, both countries made unilateral decisions to cease or reduce the contractually-required payments to the private party. Thus, relying wholly or in part on a country's government as a form of risk reduction to the private should only be undertaken if the government and its economy are stable, or otherwise if international guarantees are provided.

As for the use of the private financing, there is a greater variability between developed and developing countries. In developed countries, such as North America and Australia, the use of private financing to deliver new facilities is stronger. PPP is seen from these countries as a way of coping with their budget constraints while delivering infrastructure to the community. On the other hand, in developing countries, the public funding is used in almost all projects. This can be due to the need of attracting private investment, despite the political and economic instability of these countries. The economic size of the infrastructure that has to be realized in developing countries can often require public intervention. The average value of this parameter in Europe is medium (50/50). This can be due to the great differences that exist in the use of PPP in the various (developed and developing) countries within Europe. The degree of the private financing used can also be explained by analysing the different goals and approaches in the infrastructure development of governments throughout the world. Particularly, Table 3 shows the rank of various regions in terms of success rate of PPP projects in several sectors (Public Works Financing, 2008). The success rate is defined as the ratio between realized and planned projects from 1985 to 2008.

Table 3: Rank of regions by success rate of different types of PPP projects

Rank /Sector	Road		Rail		Airport		Seaport		Water		Building		Total	
	#	$	#	$	#	$	#	$	#	$	#	$	#	$
1	A&M	LA&C	NA	A	E	A	E	A	E	E	NA	NA	NA	A
2	LA&C	A&M	E	E	A	LA&C	A	E	NA	A	E	E	E	E
3	E	A	LA&C	A&M	NA	NA	A&M	A&M	A	NA	A	A&M	A	LA&C
4	NA	E	A	NA	LA&C	A&M	NA	NA	LA&C	LA&C	A&M	A	LM&C	NA
5	A	NA	A&M	LA&C	A&M	E	LA&C	LA&C	A&M	A&M	LA&C	LA&C	A&M	A&M

NA= North America; A= Asia; E= Europe; A&M= Africa + Middle-East; LA&C= Latin America + The Caribbean

From Table 3, we can highlight that, in terms of the percentage of cases successfully funded and realized, Europe and North America, the developed regions, have a higher success rate than the developing regions, such as Asia, Latin America & Caribbean and Africa & Middle East. Conversely in terms of the amount of planned investment that actually becomes realized, the developing regions have higher success rate than developed regions. Finally, for transportation infrastructure, the ranking of the previous two criteria appears to be very different, while for environmental and residential infrastructure, the same result can be achieved that developed countries have higher success rate. From the above three observations, we may conclude that: the government of developing countries are more willing to implement large scale transportation infrastructure development, while the government of developed countries are more interested in relatively small-scale and environmentally friendly ones. Therefore, public funding can be seen as a form of guarantee of the sustainability and, therefore, the success of these large infrastructure projects. Furthermore, regions where PPP is a mature delivery project method – which entails a public administration system more prepared in handling partnering issues with private sector - have shown a higher success rate (Figure 2.a). While at global level, the types of PPP infrastructure systems with higher implementation rate have been building and water systems (Figure 2.b) where it is more straightforward to identify, quantify, and price the risk transfer.

As for the use of private expertise and management skills in PPP projects, the radar diagram shows that it is high all over the world, but particularly in developing countries, where governments have to develop, often for the first time, new infrastructure to aid the economic growth of the country. They often rely on the involvement of foreign private companies in order to exploit private sector expertise and provide a higher quality service to the community. Representative of this phenomenon is the different approach to the management of social services, such as schools and hospitals, adopted by developed and developing countries. For example, the cases of the new Royal Children's Hospital, Victoria School's Project, and NSW Schools 1 PPP Project in Australia, or the case of Gordon and Leslie Diamond Health Care Center in USA, show that the private party is only involved in the design, construction and maintenance of the facilities, while all education and school curriculum services as well as healthcare services will continue to be publicly delivered in accordance with government policy that core services should be provided directly by the government. Differently, the PPPs for the upgrades and renovations to Pelonomi and Universitas Hospitals in South Africa show the government will exploit the private expertise in providing better healthcare service to the population by having private and public operators located in the same facilities. Doctors and staff in both the private and public hospitals are able to share their knowledge more easily because they are located in the same facility. A better level of healthcare for all South Africans (partially insured and uninsured people) can be delivered.

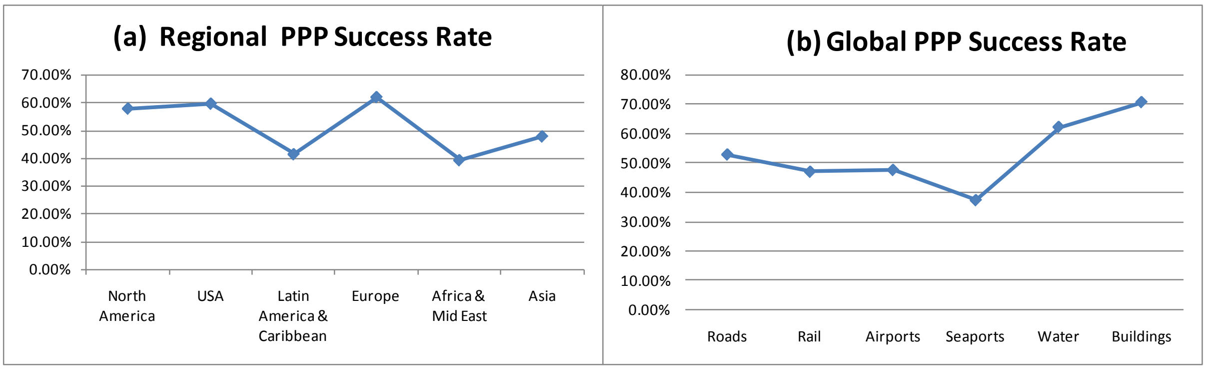

Figure 2: (a) Aggregate PPP success rate by regions; (b) Global PPP success rate by sectors

REFERENCES

Chege, L.W., and Rwelamila, P.D. (2001) Private Financing of Construction Projects and Procurement Systems: An Integrated Approach. Proceedings of the CIB World Building Congress, Wellington, New Zealand.

Davids, H. Project Finance: Practical Case Studies, 2nd Edition, Volume 1.

European Commission (2004), Green Paper on public-private partnerships and Community law on public contracts and concessions. Brussels, COM(2004) 327 final.

European Commission (2004). Resource book on PPP case studies.

Harris, S. (2004) Public Private Partnerships: Delivering Better Infrastructure Services. Washington, D.C.: Inter-American Development Bank, Sustainable Development Department.

Hemming, R. (2006) Public-Private Partnerships, Government Guarantees, and Fiscal Risk. Washington D.C.: International Monetary Fund.

HM Treasury (2008). Infrastructure procurement: delivering long-term value.

March, J.W. (2007) Case Studies of Transportation Public-Private Partnerships around the World. U.S. Department of Transportation.

McKenzie, D. (2008) PFI in the UK and PPP in Europe 2008. IFSL Research.

Morledge, R., Smith, A., and Kashiwagi, D.T. (2006) Building Procurement. RICS Research, Oxford: Blackwell Publishing.

Partnership Victoria. “Projects”, available at: http://www.partnerships.vic.gov.au/

Partnerships British Columbia. “Project”, available at: http://www.partnershipsbc.ca/

Perry, J.G., and Hoare, D.J. (1992) Contracts of the Future: Risk and Rewards. Proceedings Construction Law 2000, London (U.K.).

Public Works Financing 2008 projects database (2008).

Renda, A. and Schrefler, L. (2006) Public – Private Partnerships: Models and Trends in the European Union. European Parliament.

The Canadian Council for Public-Private Partnerships (2003) The Canadian Case for Hospital PPP Projects.

The Canadian Council for Public-Private Partnerships (2003) The Canadian Case for School PPP Projects.

Turina, N. and Car-Pusic, D. (2006) Overview of PPP models and the analysis of the opportunities for their application. Proceedings of the 7th International Conference: Organization, Technology and Management in Construction, Zagreb, edited by Mladen Radujkovic.

U.S. Department of Transportation (2007). Case Studies of Transportation Public-Private Partnerships around the World.

U.S. Department of Transportation. "PPP case studies", available at: http://www.fhwa.dot.gov/PPP/

United Nations Development Programme. "Public-Private Partnerships: Case Studies for Sustainable Development", available at: http://www.ncppp.org/undp/

APPENDIX

GENERAL INFORMATION		PROJECT DELIVERY & FINANCE METHOD					SOURCES OF PROJECT SUPPORT (Monetary)		
Project Name Sector Status Year in operation Location	Brief Description Total cost of project	Project Delivery Method	Project Finance Method	Operational phase managed by private	Principal risk retained by public	Principal risk allocated to private	From Public Sources (Government)	From Private Capital Mkt as Debt	From producers as Equity
LATIN AMERICA									
The Martin Garcia Channel Transportation Contract expired in 2006 1999 The Rio de la Plata estuary, between Uruguay, Argentina, and the Atlantic Ocean	The project was aimed at deepening and widening the Martin Garcia Channel, between Argentina and Uruguay The total project budget was set at US$180 million to construct, operate, and maintain the channel and for the private consortium to collect the tolls.	Design-Build-Operate-Transfer. A ten-year contract required the design and construction of the channel, installation of navigational aids, collection of tolls, and maintenance of the system	Private Funding, and payments (in lump sum) from the Argentine and Uruguayan governments to the private consortium for the dredging and maintenance of the channel	YES	Regulatory risk	Design risk, construction risk, operating risk, third party revenue risk, environmental risk, maintenance risk, technology risk, political risk (government instability)	Since the toll payments were considered insufficient to cover all the costs related to capital recovery or maintenance, the private partner would also receive payments from Uruguay and Argentina. Overall bi-national government cost was estimated at $40 million	The total project budget was set at US$180 million to construct, operate, and maintain the channel and for the private consortium to collect the tolls. The cost of the capital dredging to deepen and widen the channel was estimated to be US$100 million, with the rest of the budget going to operation and maintenance. The consortium would collect a toll on vessels using the channel, and receive payments from governments. Split between debt and equity not disclosed.	
AFRICA									
Renovations to Pelonomi and Universitas Hospitals Healthcare In operation (16.5 year contract on 2002) October 2003 in Universitas Private Hospital. September 2005 in Pelonomi Private Hospital Bloemfontein, Province of Free State, Central South Africa	The Free State Health Department (FSHD) decided to combine and coordinate the operations of the two public hospitals in Bloemfontein, Pelonomi and Universitas, to renovate and upgrade some of their facilities, and lease out the extra space in each hospital to a private company The total capital investment by Community Hospital Management (private part) was R70.9 million.	Construction, renovations and upgrades of existing health facilities, and leasing beds and operating theaters within the existing public hospitals by the private company. The private partner is also required to maintain functional facilities at both hospitals, and return all facilities to the health dep. at the end of contract	All construction, renovations, and upgrades are paid by the private partner.	YES, but only for extra space (beds)	Some of the operational risks (private partner pays monthly concession fees for the bed and operating theater space it uses in both hospitals), regulatory risk	Construction risk, some of the operational risks, third party revenue risk (insured and uninsured people that use private healthcare), maintenance risk			All construction, renovations, and upgrades are paid by the private partner. The private partner consortium is made of two healthcare companies that hold a 40% stake and a 25% of shares respectively. The remaining 35% of shares were offered to investors, doctors, and the state at a later date
ASIA									
Colombo, Sri Lanka Port Expansion Transportation In operation	The creation of PPP is aimed to expand and modernize the Queen Elizabeth Quay (QEQ), one of the two terminals included in the Colombo Port facilities, both physically and in efficiency.	A thirty-year concession in the form of a BOT contract. The SAGT partnership (created with PPP) pays the Port Authority (public) lease payments for the terminal. The Port Authority also earns income from shares in the	The project was financed based on a debt/equity ratio of 60/40. The PPP of SAGT (equity) is comprises of eight partners: the public agency known as the Sri Lanka Port Authority (SLPA)(15%), a Sri Lanka investment group (26,25%), two port	YES	The public participates to investment by owning shares of the PPP company. Thus the risk are not completely transferred, rather are shared. They are the construction risk, third party revenue risk, operating risk, maintenance risk		The Government owned 15% of the shares of the PPP company through SLPA. Of the $92.4 million in equity, the public sector	60% from various lending institutions	Of the $92.4 million in equity, the private sector provided $60 million.

2002-2003 Colombo, Sri Lanka	The total cost of the project was estimated at US$240 million, but came in under budget at US$227.4 million.	company. SLPA benefits from fees charged directly to vessels using the port (i.e., tug service fees, piloting fees, and dockage fees)	management companies (26,25%), three lending institutions (7,5% each one), and a shipping company (10%)				provided $32.4 million.		
EUROPE									
Perpignan – Figueras Rail Concession, France & Spain Transportation In construction Est. early 2009 State of France & Spain	Provide link between French and Spanish rail systems, reduce travel times and transport bottleneck The technical parameters include 50km of line incorporating 5 bridges and an 8km long tunnel. The total investment is in the region of Euro 1 billion of which 32% is related to the tunnel.	BOT agreement over 50 year concession	State subsidies: Euro 540 million state subsidy shared equally between France and Spain and which includes EU grants (The strong government support and allocation of resources was a major factor in the successful conclusion of the tender). This is provided to the private party in 10 semi-annual payments. Concessionaire equity and loans: The private party will be required to invest its own equity (estimated at Euro 103 million) and will have to raise the remainder from private bank loans.	YES	Design risk (Responsibility for design remains with the States)	Construction risk, mitigated financial risk (the considerable state subsidy covering 57% of the construction cost and strong support of external financiers on the project and the concession contract, including bank guarantees), operating risk, performance risk, maintenance risk (The contract makes stringent requirements on maintenance and availability performance (>99.9%) and sets penalties for non-performance)	Euro 540 million state subsidy shared equally between France and Spain and which includes EU grants (The strong government support and allocation of resources was a major factor in the successful conclusion of the tender). This is provided to the private party in 10 semi-annual payments	The private party will have to raise the remainder (total cost - equity-state subsidy) from private bank loans.	The private party will be required to invest its own equity (estimated at Euro 103 million)
NORTH AMERICA									
Gordon and Leslie Diamond Health Care Center Health In operation 2006 British Columbia, Canada	The Gordon & Leslie Diamond Health Care Centre brings together Vancouver General Hospital's (VGH) outpatient care services – including specialty clinics, along with medical education, physician teaching clinics and research – at one site. The estimated capital cost of the facility is US$95 million.	Vancouver Coastal Health has enter agreement with Access Health Vanc two years, AHV will finance and con agreed-upon design specifications. I and maintain the facility for 30 years standards. VCH will be responsible f at the new facility. The UBC Faculty be responsible for educational servic construction, AHV's role will be that manager. VCH will own both the site During construction, the site will be l Upon completion of construction, the leased to AHV under a Building Leas operating period. VCH will then leas substantially all of the space from AH the agreement, responsibility for ope maintenance will revert to VCH. Pay be performance-based, with provisic resulting from circumstances where met.		YES	VCH assumes the risks and receives revenue associated with the parking and shares with AHV the risks related to vacancies in clinical, teaching and physician space. Areas of shared risk ensure that both partners are motivated to keep the facility fully occupied and operating efficiently.	AHV assumes most of the facility-related risks, protecting the public from extra costs that may arise due to such things as construction delays, design flaws or increases in labor costs, should those occur. AHV is also responsible for risks related to facility operation and maintenance, and for managing retail leases.	no	AHV was solely responsible for the financing	
AUSTRALIA									
The new Royal Children's Hospital Health contract let 2011 Victoria, Australia	The new $1billion RCH Project is the largest hospital redevelopment to be undertaken by the State. The Project involves the construction of a new facility adjacent to the north-western boundary of the existing site, with retention of the existing Research Precinct Building and Front Entry Building. The capital investment is US$1 billion	The State engages a private sector consortium to design and build the project, finance it and assume responsibility for facilities maintenance and asset replacement over a 25 years period.	The private sector financing requirements for the project comprises senior debt, subordinated debt, preferred equity and equity	YES	Plan risk, demand risk, parking revenue risk, utility input risk	Design, construction, facility maintenance risks, commercial activities risk, financial risk	no	Senior debt is comprised of underwritten CPI Indexed Annuity Bonds Subordinated debt is an underwritten inflation linked indexed annuity	Preferred equity is expected to be refinanced 13 years from financial close Common Equity is fully underwritten by the Project sponsor

DECISION SUPPORT SYSTEM TO URBAN INFRASTRUCTURE MAINTENANCE MANAGEMENT

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Life-cycle management of urban infrastructure projects is very complex process from both management and economic aspects. Focus of this research is on urban infrastructure maintenance phase of a life-cycle, especially on decision making in maintenance problems. Urban infrastructure maintenance management deals with complex decision making process. The reasons for a complexity are: lots of participants, multi-disciplinarity, huge quantity of information, limited budget, conflict goals and criteria. These facts indicate that decision making processes in urban infrastructure management undoubtedly belong to ill-defined problems. In order to cope with such complexity and to help project managers during decision making processes this research proposes an application of multicriteria methods. Multicriteria methodology proposed herein is applied on priority setting problem. It starts with goal analysis followed by definition of urban infrastructure elements and development of adequate criteria set. Evaluation of criteria importance (weights) is based on a set of experts' opinions processed by AHP method. An assessment of maintenance conditions of urban infrastructure elements is provided trough monitoring process. The way of using proper forms and procedures for data collection is presented as well. All collected data are processed by PROMETHEE multicriteria methods. The main result of a multicriteria process is priority maintenance list for urban infrastructure elements. The methodology is tested on road infrastructure of town of Split.

KEYWORDS: maintenance management, decision support, urban infrastructure, multicriteria methods.

INTRODUCTION

Ever growing urban infrastructure systems, such as water supply systems, traffic systems, sewage systems and others, contribute to the difficulty within a decision making process as regards their management that is very complex and social sensitive. City councils face the problem of managing big infrastructure projects, especially when is necessary to find solution which can meet requirements of all stakeholders and, at the same time, be a part of sustainable development concept. Maintenance phase of life-cycle management of urban infrastructure projects are not exception. Infrastructure maintenance process becomes even more both complex and demanding task in a case of its long-term planning. Therefore, long-term planning tasks should be supported by decision tools such as multicriteria methods or other operational research models thus becoming more efficient. Lots of authors research in the field of decision support to urban infrastructure management. In his work Bielli (1992) demonstrates DSS approach to urban traffic management. Its aim is the achievement of maximum efficiency and productivity for the whole urban traffic system. Cost and benefits evaluation aspect of potential infrastructure investments is also introduced in literature and several decision support models could be indicated (Guisseppi, A., Forgionne, G.A, 2002.). Quintero et al. 2005 described an improved DSS named IDSS (Intelligent Decision Support System) that coordinates management of urban infrastructures, such as sewage and waterworks. Authors introduce IDSS as a solution for future urban infrastructure management. Similar approach can be found in publications of other authors (Afraim, T., Jaye, A., 1995.; Burstein, F., 1995.; Leclerc, G. et al., 2001.; Pomerol, J. et al., 1996.).

This research is focused on routine and periodic (resealing and rehabilitation) maintenance activities which are either an integral part or a phase of infrastructure project life-cycle. Emergency and extraordinary maintenance activities like repairs of sudden and accidental damages and failures are not taken into account. Several authors research in various aspects of infrastructure maintenance. Maintenance technologies, types and approaches are some of researchers' topics. Rouse, P., Chiu, T. 2008. describe optimal life-cycle management in road maintenance setting in New Zealand. Their paper focuses on local road aspects of the highway system and aim to assess how local authorities have maintained their respective local road networks from a life-cycle perspective. Finally they provide a best practice indication of the optimal maintenance activity that must be undertaken. Development of a life cycle assessment tool for construction and maintenance of asphalt pavements was in focus of Yue Huang, Roger Bird and Oliver Heidrich, 2009 research. During maintenance decision making process it is important never to forget environmental assessments of maintenance activities impacts. A comparative study of the emissions by road maintenance works and the disrupted traffic using life cycle assessment and micro-simulation was elaborated in paper of Yue Huang, Roger Bird and Margaret Bell 2009.

A structure of the proposed urban infrastructure maintenance management system is based on the previous research (Jajac, N. et al, 2008), where "three decision levels" concept for an urban infrastructure management (strategic, tactical, and operative) is proposed (Figure 1). The modular concept is based on DSS basic structure: data, dialog, models. Interactions between modules are realised trough decision making processes at all management levels which serve as meeting points of adequate models and data. First management level supports decision-makers at lowest, operative decision level. It has three basic functions. The first is to support of decision making at the operative level, the second is to process data and information, and the third to provide information flows for higher decision levels. Likewise, the second level delivers tactical decisions and creates information basis and solutions or models for a strategic decision level. The decisions throughout the system are based on the generated knowledge at the first decision level. The aquatinted knowledge is structured in an adequate knowledge based system. At the second level, decisions are made by individual experts and expert teams as well as by employees from local political bodies and public companies with certain responsibilities. At the third level, based on the expert deliverables from the tactical level a future development of the system is carried out. Delivered strategies have to be sound with existing global development and urban plans for the city or a region. These strategies are frameworks for lower decision and management levels thus ensuring continuity of decision making processes throughout decision and management systems. Both strategic and tactical level uses more complex techniques and knowledge then operative one.

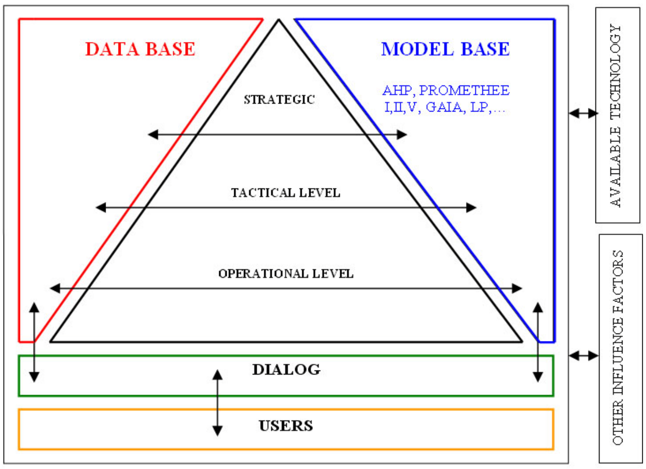

Figure 1: Architecture of the DSS for urban infrastructure management (Jajac, N., 2007).

Many outside factors influence an urban infrastructure system as it is shown on Figure 1. Besides technology, which obviously influences the system at all levels through diverse innovations and solutions, other factors like local behaviour (actual and traditional styles of management and decision making, local mentality, etc.) have huge influence to both decision making and management processes. (Jajac, N. et al, 2008). The described DSS is found to be adequate for an urban infrastructure projects because its structure easily supports all phases of project life-cycle. Since this research is focused only on maintenance phase, this concept is used to support urban infrastructure maintenance management system.

1. DSS for urban infrastructure maintenance management

Using previously described generic architecture of the DSS for urban infrastructure management, a concept of DSS for urban infrastructure maintenance management is developed. DSS for urban infrastructure maintenance management deals with lots of stakeholders and constrained resources. Since limited finances are usual main restriction, decision making problems at tactical level are generally priority setting. There are some crucial problems of maintenance decision making process that are recognised and modelled in the DSS. Herein, a step by step approach for maintenance priority setting and strategy selection is proposed (Figure 2).

The decision making process starts at strategic and tactical levels with a selection of both study area and type of infrastructure. At the first step, decision makers usually face a problem of the stakeholders selection. In order to provide good basis for efficient decision making process, stakeholders are divided into three groups: experts, local government and citizens representatives. Citizens group is generally formed from representatives of districts or similar city formations.

After the decision is made about the type of infrastructure and stakeholders, the next step is to define a maintenance model of an infrastructure system. The model consists of an infrastructure register and key characteristics of each infrastructure element. The infrastructure register requires decomposition of the system into manageable pieces herein called infrastructure elements. Definition of key characteristics for each element is very important for setting up criteria and their weights in the priority setting process and therefore directly influence final decisions. In further decision phases, the characterises are directly incorporated in hierarchy of objectives and criteria. Assessed values of the elements' characteristics are input data for multicritera priority setting.

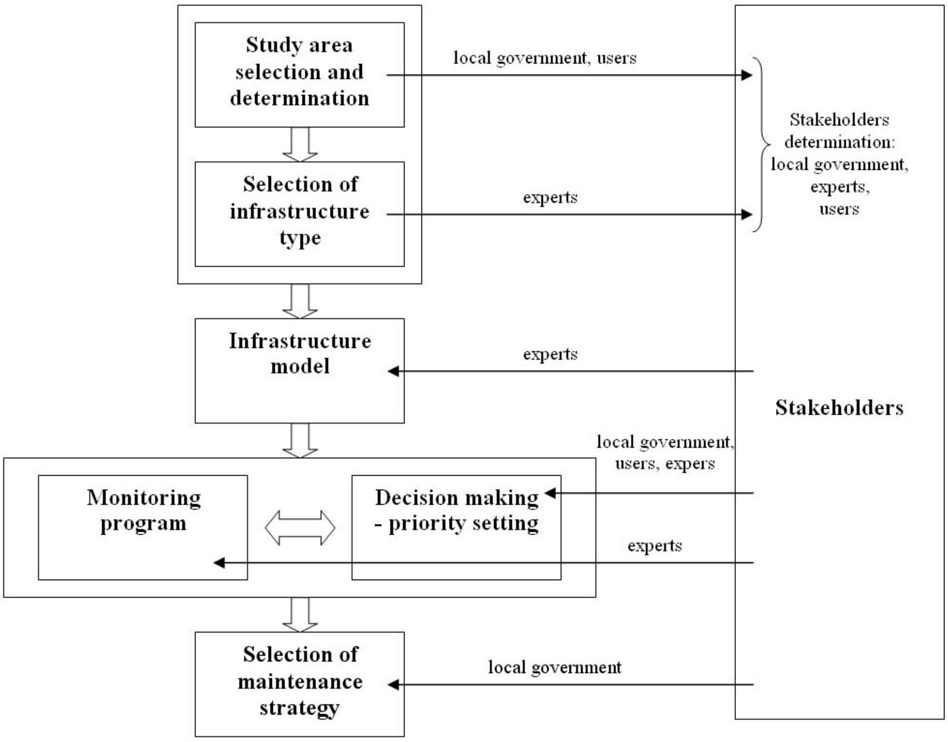

Figure 2: Maintenance decision making process flow diagram

In order to assess the characteristics a comprehensive monitoring program should be carried out. The program includes design of monitoring forms, monitoring scheduling (timing) and definition of an inspection process. Several monitoring forms for data acquisition are designed. Each form deals with one or more aspects of an element condition. Final form (Figure 3) represents summary of element condition for any kind of infrastructure. It consists of different aspects of element condition assessments. The most common are: equipment, element cross section and structures' characteristics. Inspection of infrastructure elements is a combination of a visual inspection and measurements methods resulting in element condition evaluation. Inspections and elements' conditions reassessment are repeated in periods from four months to one year in accordance with size of a city. For cities with over one million inhabitants it is continuous process. Monitoring plans must include re-inspection time schedules.

In parallel to preparation of a monitoring program, at tactical level of the DSS, a priority setting model is carry out. Due to ill-structured nature of the problem that emerges from incomparable data and conflict stakeholders' demands, multicriteria models are proposed. Therefore, a decision making model is multicriteria priority setting process that starts with goal analysis resulting in hierarchic structure of the goals, a goal tree. Since the goal analysis is the basis for a criteria definition, criteria are seen as an integral part of the goal tree. Criteria setting up process involves local government and experts' representatives while setting up of criteria weights involves opinions from all stakeholders groups. Using Analytic Hierarchic Processing (AHP) method (Saaty, T.L., 2001.) it is easy to assign weights through group decision making process by interviewing all stakeholders groups. Based on the authors' experience, in this research, among various multicriteria methods, the method PROMETHEE II (Brans, J.P., Vincke, Ph., 1984.) is proposed. Infrastructure elements act as actions in a multicriteria model. Data from monitoring/inspection process are input for multicriteria priority setting process. Multicriteria decision making is supported by several strategies i.e. scenarios. Each scenario consists of different combination of criteria weights values.

Priority setting decision making model and setting up of monitoring program are both parallel and interrelated processes. Precisely, design of monitoring forms include elements' characteristics that serves as criteria in muliticriteria decision model. Furthermore, data acquainted during inspections are using adequate forms serves as input for priority setting process. Local government selects the most compromised strategy according to multicriteria analysis results and actual policies. The proposed DSS concept is tested on maintenance problem for road infrastructure in town of Split.

2. Application of the model to road infrastructure in town of Split

Urban expansion as well as huge growth of vehicles on the roads raises the problem of maintenance of the road transportation infrastructure, especially in the densely populated centre of the town of Split. The study area is wider city centre with high concentration of both public facilities and pedestrian flows. The area was surveyed in detail and classification of infrastructure elements was established (infrastructure register). At the same time, an assessment of conditions of urban infrastructure elements is carried out during monitoring process. Monitoring includes inspection of urban road infrastructure elements like: road segments, parking places, bus stations, gas stations, crossroads and may other urban traffic structures (bridges, viaducts, overpasses, underpasses, tunnels, terminals, parking garages).

Evaluation of urban road infrastructure element conditions	
Traffic signs and signals	**Element condition**
Vertical signs	0
Horizontal signs (road markings)	0
Traffic signals	0
Road equipment	**Element condition**
Pavement edge marking equipment	0
Fence	0
Traffic calming equipment	0
Lightening	0
Cross section elements	**Element condition**
Pavement	0
Gutter and Drain	0
Curb	0
Pedestrian path	0
Traffic flow canalization elements	0
Shoulder	0
Side slope	0
Pipe man hole	0
Traffic structures (objects) characteristics	**Element condition**
Fracture	0
Other damages	0
Concrete armature cover	0
Displacement of main structure elements	0
Bearing	0
Installation	0
Fire protection equipment	0
Structural elements appearance	0

Figure 3: Final monitoring form for maintenance status evaluation

Monitoring process starts with on site inspection of elements in the study area during which inspectors are filling forms with perceived facts about conditions of elements. There are a several forms which need to be completed. Through specified process data is arranged and presented in final monitoring form of maintenance status showed on Figure 3. Maintenance status is defined as a evaluation of infrastructure element condition and its aim is the estimation of maintenance requirement. Form presented in Figure 3. expresses a finite summarized evaluation of one element condition. Monitoring process must be repeated every 6 months.

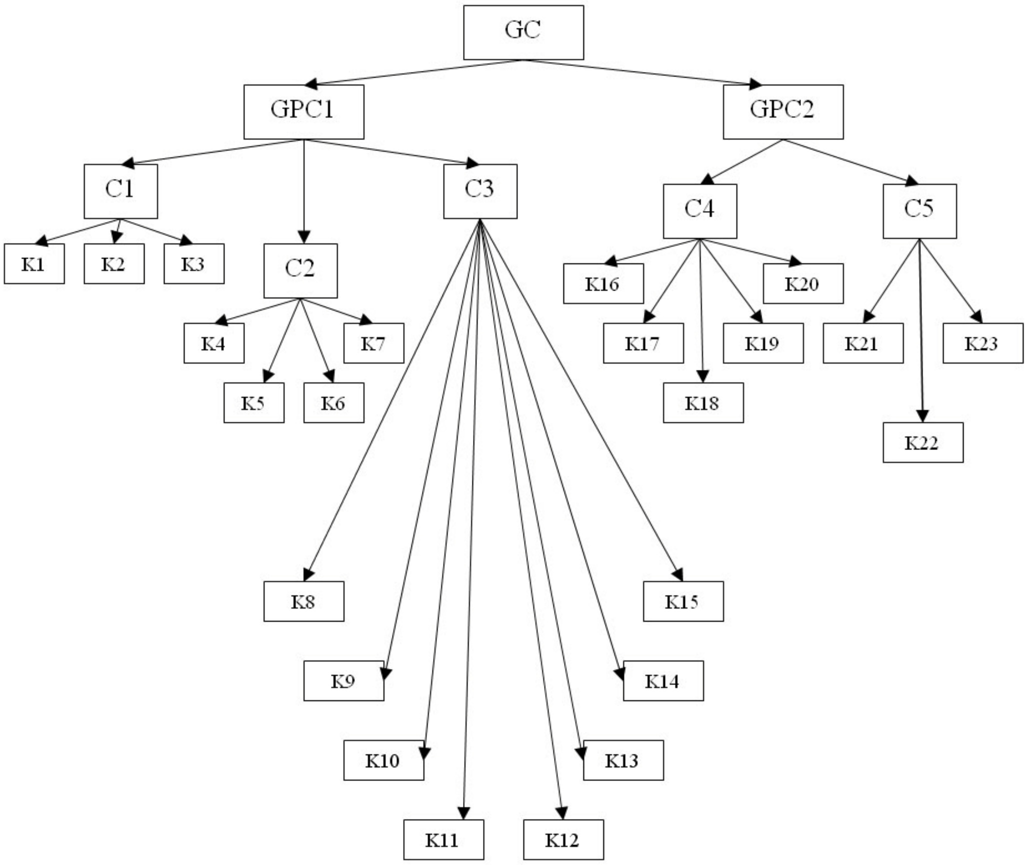

Figure 4: Hierarchy of the objectives as well as criteria for maintenance priority setting problem for road transportation infrastructure in town of Split

Both Figure 4 and Table 1 describe the goal hierarchy for the defined problem. As the main goal is “Sustainable maintenance of urban road infrastructure in the city of Split”, the solution is based on the stepwise approach to maintenance activities taking place on 392 road infrastructure elements. During the definition of the lower goals’ levels all stakeholders were involved and the objective tree is defined. As criteria for multicriteria analysis emerge form an objective tree, last hierarchic level of this particular tree represents the criteria set (Figure 4).

Criteria weights for the PROMETHEE method were evaluated by AHP method involving all stakeholders. According to the main goal of the stakeholders, three scenarios were developed (Table 2). The first scenario describes preferences of citizens (users), the second one of the transportation experts, and the third scenario represents how city authorities (local government) see the problem. The fourth scenario is an average value and stands as a compromised view to the problem.

Table 1: Hierarchy, code and description of goal, objectives and criteria

Hierarchy level	Code		Goal, objectives, criteria description
0	GC	Goal	Sustainable maintenance of urban road infrastructure in the city of Split
1.	GPC1	Objectives	Maximization of maintenance quality for main urban road infrastructure elements
1.	GPC2		Maximization of maintenance quality for specific urban road infrastructure elements and their structure characteristics
2.	C1		Maintenance improvements of traffic signs and signals
2.	C2		Maintenance improvements of road equipment
2.	C3		Maintenance improvements of cross section elements
2.	C4		Maintenance improvements of structure stability characteristic elements
2.	C5		Maintenance improvements of structure nonstability characteristic elements
3.	K1	Criteria	Vertical signs - maintenance status
3.	K2		Horizontal signs - maintenance status
3.	K3		Traffic signals - maintenance status
3.	K4		Pavement edge marking equipment - maintenance status
3.	K5		Fence - maintenance status
3.	K6		Traffic calming equipment - maintenance status
3.	K7		Lightening - maintenance status
3.	K8		Pavement - maintenance status
3.	K9		Gutter and drain - maintenance status
3.	K10		Marginal strip - maintenance status
3.	K11		Pedestrian path - maintenance status
3.	K12		Traffic flow canalization elements - maintenance status
3.	K13		Shoulder - maintenance status
3.	K14		Side slope - maintenance status
3.	K15		Pipe man hole - maintenance status
3.	K16		Fracture - maintenance status
3.	K17		Other damages - maintenance status
3.	K18		Concrete armature cover - maintenance status
3.	K19		Displacement of main structure elements - maintenance status
3.	K20		Bearing - maintenance status
3.	K21		Installation - maintenance status
3.	K22		Fire protection equipment - maintenance status
3.	K23		Structural elements appearance - maintenance status

Multicriteria model for ranking urban road infrastructure elements according to their "maintenance status" was created. Multicriteria model consists of 23 criteria and 392 alternatives. Regarding conflicts between the scenarios, compromised weights are set up by calculating simple average of scenarios' weights, thus giving equal importance for all groups of stakeholders. Table 3 shows the final compromised rank of (top 10) infrastructure elements for maintenance activities. Following this results a maintenance strategy will be delivered.

Table 2: Criteria values and scenarios

Criteria	Description of criteria	Scenario 1	Scenario 2	Scenario 3	Average weight	MIN/ MAX
K1	Vertical signs maintenance status	0.04	0.059	0.08	0.060	MAX
K2	Horizontal signs - maintenance status	0.068	0.058	0.041	0.056	MAX
K3	Traffic signals - maintenance status	0.027	0.06	0.083	0.057	MAX
K4	Pavement edge marking equipment - maintenance status	0.033	0.038	0.042	0.038	MAX
K5	Fence - maintenance status	0.042	0.039	0.038	0.040	MAX
K6	Traffic calming equipment - maintenance status	0.025	0.042	0.065	0.044	MAX
K7	Lightening - maintenance status	0.041	0.043	0.048	0.044	MAX
K8	Pavement - maintenance status	0.1	0.09	0.11	0.100	MAX
K9	Gutter and drain - maintenance status	0.032	0.06	0.07	0.054	MAX
K10	Marginal strip - maintenance status	0.037	0.045	0.038	0.040	MAX
K11	Pedestrian path - maintenance status	0.012	0.01	0.008	0.010	MAX
K12	Traffic flow canalization elements - maintenance status	0.047	0.032	0.021	0.033	MAX
K13	Shoulder - maintenance status	0.023	0.012	0.008	0.014	MAX
K14	Side slope - maintenance status	0.035	0.025	0.015	0.025	MAX
K15	Pipe man hole - maintenance status	0.082	0.063	0.041	0.062	MAX
K16	Fracture - maintenance status	0.041	0.045	0.05	0.045	MAX
K17	Other damages - maintenance status	0.039	0.04	0.042	0.040	MAX
K18	Concrete armature cover - maintenance status	0.027	0.043	0.053	0.041	MAX
K19	Displacement of main structure elements - maintenance status	0.047	0.049	0.051	0.049	MAX
K20	Bearing - maintenance status	0.027	0.037	0.046	0.037	MAX
K21	Installation - maintenance status	0.047	0.039	0.027	0.038	MAX
K22	Fire protection equipment - maintenance status	0.055	0.029	0.02	0.035	MAX
K23	Maintenance status of structural elements appearance	0.069	0.04	0.02	0.043	MAX

Table 3: Preference flows and PROMETHEE II complete ranking for the compromised scenario

Ranking	Φ	Code	Alternatives	Infrastructure element
1.	0.3191	R5	Domovinskog rata – Vukovarska ulica	crossroad
2.	0.2147	GUC3-1	Put Plokita	street segment
3.	0.2143	GM1-1	Domovinskog rata	street segment
	0.1794	AP-GM1-3	Domovinskog rata	bus station
4.	0.1759	R12	Mažuranićevo šetalište - Dubrovačka	crossroad
5.	0.1583	GM1-3	Domovinskog rata	street segment
	0.1538	AP-GM1-1	Domovinskog rata	bus station
6.	0.1389	GGU3-2	Ulica Slobode	street segment
7.	0.0931	R7	Put Supavla – Hercegovačaka – Put Stinica	crossroad
8.	0.0697	GGU3-1	Ulica Slobode	street segment
9.	0.0584	R10	Velebitska - Dubrovačka	crossroad
10.	0.0408	P5	Kragićeva	parking

CONCLUSION

Supporting complex and sensitive decision-making processes such as maintenance priority set up for urban infrastructure achieved without using DSS principles of connection of appropriate methods and data. Previously developed DSS for infrastructure management and project life-cycle methodology were a good starting point for considering such approach and solution concept. The DSS for urban infrastructure maintenance presented in this paper is a unique system for the priority setting strategy for infrastructure maintenance conceptualized as a conjunction of operational models and multicritera models. Applied to the road infrastructure of town of Split it seems to function well and it can be used for any other type of infrastructure. The DSS concept is applied to the problem of maintenance priority ranking for the selected road infrastructure elements in the town of Split. It was shown that maintenance decision making processes can be supported at all hierarchy levels by interaction of DSS modules. Monitoring program determination provide uniformed and scheduled data acquisition and evaluation processes for urban infrastructure element's maintenance status establishment. In addition, application of multicriteria analysis points out several methodological and socio-political advantages of this approach in resolving complex problems such as infrastructure elements maintenance priority ranking, regardless of decision level. Stakeholders are divided into three significantly different groups (citizens, transportation maintenance experts, city authorities) and are directly involved in a decision making process. Their opinions are expressed by criteria weights thus making a maintenance strategy selection process as well as its implementation much easier and clearing all mistrust and bias situations. Obtained solution, expressed in form of list of the highest ranked infrastructure elements according to the maintenance criteria serve as possible strategic alternatives in urban infrastructure maintenance management. Further research will focus on finding appropriate models at operative level like knowledge based tools for substitution of experts involvement (introduction of neural networks to maintenance management).

Acknowledgements

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REFERENCES

Afraim, T., Jaye, A. (1995) Decision Support Systems and Intelligent Systems. (5th ed.), Simon and Schuster Company, Upper Saddle River, NJ.

Bielli, M. (1992) A DSS approach to urban traffic management, European Journal of Operational Research, Volume 61, Issues 1-2, 106-113

Brans, J.P., Vincke, Ph. (1984) Preference Ranking Organisation Method for Enrichment Evaluations (The PROMETHEE Method for Multiple Criteria decision Making). Centrum voor Statistiek en Operationeel Onderzoek, Vrije Universiteit, Brussel

Burstein, F. (1995) IDSS: Incorporating knowledge into decision support systems. Burstein, F., O'Donnell, P.A., Gilbert, A. (Eds.), Proceedings of the Workshop on Intelligent Decision Support—IDS'95, Monash University, Melbourne, 93–96.

Guisseppi, A., Forgionne, G.A. (2002) Selecting rail grade crossing investments with a decision support system, Information Sciences, Volume 144, Issues 1-4, 75-90

Huang Y., Bird R. And Bell M. (2009) A comparative study of the emissions by road maintenance works and the disrupted traffic using life cycle assessment and micro-simulation Transportation Research Part D: Transport and Environment Volume 14, Issue 3, 197-204

Huang Y., Bird R. and Heidrich O. (2009) Development of a life cycle assessment tool for construction and maintenance of asphalt pavements Journal of Cleaner Production Volume 17, Issue 2, 283-296

Jajac, N. (2007) Oblikovanje sustava podrške odlučivanju u upravljanju infrastrukturnim sustavima urbane sredine. Magistarski rad, Sveučilište u Splitu Ekonomski fakultet Split, Split

Jajac, N., Knezić, S., Mladineo, N. (2008) DSS for Urban Infrastructure management, Parking Garages Case Study, Book of proceedings, 8th International Conference on Organization, Technology and Management in Construction, Umag, Croatia

Leclerc, G., Hmiya, S., Aïmeur, E., Quintero, A., Pierre, S., Ochoa, G. (2001) An intelligent decision support system (IDSS) for an urban infrastructure complaint management module. World Multiconference on Systemics, Cybernetics and Informatics, ISAS/SCI 2001, Orlando, Florida, vol. XVIII, 143–147.

Pomerol, J., Roy, B., Rosenthal-Sabroux, C. (1996) Development of an ‘intelligent' system for the evaluation of railway timetables: Problems and issues. Journal of Decision Systems 5, 249–267.

Quintero, A., Konaré, D., Pierre, S. (2005) Prototyping an intelligent decision support system for improving urban infrastructures management, European Journal of Operational Research 162 (3), 654–672.

Rouse P. and Chiu T. (2009) Towards optimal life cycle management in a road maintenance setting using DEA European Journal of Operational Research Volume 196, Issue 2, 672-681

Saaty, T.L. (2001) Decision Making for Leaders, The Analytic Hierarchy Process SFOR Decisions in a Complex World, Third Edition, University of Pittsburgh, 322 Mervis Hall, Pittsburg

TOLLING TECHNOLOGIES FOR PPP TOLL FACILITIES. THE CASE OF THE AUTOSTRADA CISPADANA

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Public Private Partnership (PPP) is a widespread way to build new public facilities, especially the most expensive ones, such as toll roads and bridges. Though manual collection of tolls for this infrastructure is still the most common collecting system in several countries all over the world, new systems are available to automate this activity (Electronic Toll Collection (ETC) technologies). In order to choose the preferred mechanism for tolling, an accurate analysis of cost and benefits of each technology should be conducted, both from public and private standpoints. The aim of this paper is to show how evaluating PPP projects, such as toll roads, from only one perspective (government or sponsor) can lead to a wrong choice and thus the failure of PPP implementation. A complete and integrated assessment, indeed, can lead to select the tolling technology, which is "financially sustainable" from both public and private sectors. This analysis is accomplished through the case of the Italian Autostrada Cispadana, a toll highway in Italy. The results show that radio identification would make the project more profitable for private investors (NPV), and would also allow regional government to reduce its funding to investors increasing Value for Money. GPS technology adoption, instead, would cause losses which could be avoided only by means of a substantial increase of the public funding.

KEYWORDS: PPP, Toll Facilities, Toll Collection Systems, VfM.

INTRODUCTION

Public Private Partnership (PPP) as a way to build new public infrastructure is getting more and more used. Regional and national governments all over the world often avail themselves of Project Financing to carry out public facilities, such as roads, bridges and tunnels. In these projects one of the most important (but not the only one) sources of revenues for private and/or public partners comes from tolling. The toll revenue can be used to recoup the costs of building, operating and maintaining the facility. Tolling is a "stable" source of finance because provides an ongoing revenue source, which is not tied to the annual Government budgetary process (The World Bank Group). Revenues from federal and state taxes do not often keep up with the growing demand for infrastructure. Thus, road pricing has been considering a more appealing means of funding transportation. In reality, there are other reasons for introducing tolls on the road network (Persad et al., 2007). Tolling, public or private, is a means of demand management because makes it possible to moderate the growth in demand on the transportation system and reduce road use (or move traffic from one road to another). In a similar way it encourages use of public transportation and carpooling, and allows governments to have a “sustainable” transport policy. Tolls are often introduced with the goal of internalizing the negative effects of road usage, e.g. congestion related prices. In this case, the toll increases with the level of congestion.

In the last years, several systems have been developed for toll collection. The main goal pursued in the development of tolling systems and technologies is allowing drivers to move in and out of the toll systems without delay, in a more efficient, environmentally friendly, and safe manner. Each solution has its own advantages and drawbacks, as well as its own costs and benefits. These differences among various technologies can be quite high and significant, and, therefore, should be designed, evaluated and figured into present worth calculations in order to choose the preferred mechanism for tolling.

The most common ways for assessing financial viability of a project are net present value (NPV), pay-back period, and internal rate of return (IRR) methods. However, they only take into account the private sector’s viewpoint. Since stakeholders in PPP projects are several (government, sponsor and lender, at least), this evaluation is not exhaustive. The adoption of one tolling technology rather than another one could be profitable for the private, but not for the public sector, and vice versa. Furthermore, since the goal of the government in PPP is to successfully deliver infrastructure to the community in the most efficient and effective way, the advantages and disadvantages of each tolling technology should be carefully examined and assessed, from both public and private standpoints.

The aim of this paper is to show how evaluating PPP projects, such as toll roads, from only one perspective (government or sponsor) can lead to a wrong choice and thus the failure of PPP implementation. A complete and integrated assessment, indeed, can lead to choose the better tolling technology, which is “financially sustainable” from both public and private sectors. Also, the integrated analysis can suggest the fair extent of public contribution (subsidy) to attract private capital and assure the success of the project. This analysis is accomplished through the case of the Italian Autostrada Cispadana, a toll highway in Italy.

TOLL COLLECTION TECHNOLOGIES

In the last 15 years, all over the world, increasing attention has been focused on the development of new technologies, or also on the improvement of the existing ones, to support the collection of tolls. Both the travelling public and Governments are more and more willing to avoid that vehicles stop or slow down to pay to use a toll facility. Thus the attempt is to pass from standard manual collection methods to more automatic systems such as Electronic Toll Collection (ETC) or even Open Road Tolling (ORT).

The traditional and most common toll collection method is the manual one (Washington State Transportation Commission, 2006). The driver has to stop and pay the required toll directly to a toll collector sitting in a tollbooth. The due toll is determined based upon the characteristics or classification of the vehicle. Sometimes gates in toll lanes are used to discourage drivers from driving straight without paying the toll. Other systems rely on the reading of the licence plate numbers of violators by toll collectors. Toll plazas can be located on highway mainlines or at entrances or exits to the facility. The payment means accepted by manual lanes are various, such as cash, credit/debit cards, and smart cards. Manual toll collection can accommodate up to 400 vehicles per hour if cash is the unique payment mode, while a free-flow freeway lane has a capacity of about 2,000 vehicles per hour (Washington State Transportation Commission, 2006).

An early step towards the automation was the introduction of the Automatic Coin Machines (ACM). Drivers put the required toll in a basket and the machine counts the amount automatically. This system allows the toll agency to improve productivity and reduce labour costs since lanes can be unattended. The lanes can process approximately 600 vehicles per hour. Enforcement is mainly addressed by the use of gates. The maintenance costs are quite high and this discourages the implementation of this system by the toll agency. Some newer systems use automatic card payment machines that allow drivers to pay by credit/debit card and smart cards.

The preferred mechanism for tolling is now Electronic Toll Collection (ETC). ETC systems use automatic identification technology in order to identify the toll customer when the vehicle passes through a toll plaza. Thus the driver pays the toll without stopping and tollbooths are not needed. ETC systems require several components in order to complete a transaction. Typically the two most important components are vehicle recognition and account identification, but violation enforcement is also important for an efficient working of the ETC system. Vehicle recognition may be accomplished through the Automatic Vehicle Identification (AVI) technology. A small in-vehicle device, called transponder, with a unique identification code must be attached to the toll-paying vehicle. When the vehicle enters the toll plaza area, the transponder which is a Radio Frequency Identification (RFID) unit transmits radio signal to a roadside electronic reader. The transponder contains the information required to identify the vehicle, such as an identification number, vehicle type, toll facility, etc. For ETC, after the in-vehicle device reading, the toll is deducted from the customer's pre-existing account or the customer is sent an invoice. The transponder reading process takes less than a second, thus vehicle speed through the plaza is limited only by safety concerns. Another way of identifying a vehicle is through the Global Positioning System (GPS) which is installed in the vehicle in order to locate it within a given charge area or network. The driver must get an On-Board Unit (OBU) which sends information to charging structure. The required toll can either be deducted directly from a smart card located in the OBU or stored for later charging on customer account or billing the customer. Another approach to vehicle identification involves the use of Licence Plate Readers to capture an electronic image of a vehicle's licence plate. If the customer has registered the vehicle in advance, then the customer's account is charged; otherwise, for not registered vehicles, the information is used to find the name and address of the vehicle owner and the customer is billed for the toll and a service fee that can be very high. Tollbooths are not required. Infrequent users can register their vehicle for the day over the telephone or Internet to pay their toll, reducing the administrative cost of finding the owner and sending an invoice. Irrespective of the vehicle identification technology used, where tolls depend on the vehicle class, the ETC system incorporates an Automated Vehicle Classification (AVC). AVC equipment automatically determines the classification of the vehicle (generally based on the number of axles) in order to charge the correct toll by using a variety of vehicle sensors. Enforcement in ETC is addressed by the deployment of technology to automatically identify violators. Cameras installed at the lane electronically capture images of the violator's licence plate. Then it is used to find the name and address of the toll evader. Then the customer will be billed for the toll if he registers his vehicles for the day, otherwise he will be prosecuted. An ETC lane can process about 1,200 vehicles per hour. As a result of better flow, congestion is reduced, fuel economy is improved, and pollution is reduced. Time savings, faster throughput, and better service attract more customers; hence, revenues increase. The less "slow-and-go" driving reduces the accident rates and improves safety (Gillen et al., 1999). Of course, there are also several costs in implementing an ETC system, such as high capital costs, significant operational and maintenance costs, etc.

Open Road Tolling (ORT) is the collection of tolls by purely electronic means. ORT is a form of electronic toll collection without any toll plazas. Customers pass through a highway toll collection zone at full highway speed without slowing down. In this case, instead of the traditional plaza, a gantry with readers and video enforcement systems is placed across the highway, allowing for the uninterrupted free flow of traffic at highway speed. ORT lanes allows up to 1,800 vehicles per hour (Tri-State Transportation Campaign, 2004).

Table 1 summarizes benefits and problems related to these collecting systems.

Table 1: A comparison among different ETC technologies

Toll collection technology	Capacity	Advantages	Disadvantages
Manual	400 vehicles per hour	Lower capital costs	Traffic congestion, increase of queue lengths, worse traffic flow
Automatic Coin Machines	600 vehicles per hour	Travel time reduction	High maintenance costs
ETC	1,200 vehicles per hour	Travel time reduction, fuel and emission reduction, improvement of traffic conditions, better service and increase of revenues, reduction of accident rates and better safety condition	Higher capital costs, significant operational and maintenance costs
Open Road Tolling (ORT)	1,800 vehicles per hour	Absence of "slow-and-go" driving, free flow lane	Large operation and maintenance costs

AN "EQUITABLE" FINANCIAL EVALUATION METHOD FOR CHOOSING TOLL TECHNOLOGIES

The methods commonly used to assess the financial viability of a project are the net present value (NPV), internal rate of return (IRR), and pay-back period. The limits of these techniques are mainly of two types. First, they are not often able to include the main characteristics and risks typical of a PPP project (Ye and Tiong, 2000). In the last years various methods have been developed in order to overcome this obstacle. Just to name a few, Ye and Tiong (2000) proposed a method, named NPV-at-risk, in order to incorporate risk analysis into project appraisal methods, or Ranasinghe (1999) described a methodology based on financial and risk analyses that a government can use to analyse the viability of private sector participation in new infrastructure projects. Second, the traditional methods only consider the benefits of the private sector, whose primary objective is to maximize profits. The stakeholders involved in a PPP transaction are several, such as government, sponsors and lenders. Since their perspective should also be considered in order to determine the feasibility of the project, an equitable financial evaluation method is required (Ke et al., 2008). The government, for instance, has a strategic role since he should decide how the infrastructure should be delivered. Particularly, when a government wants to carry out a new public facility by using PPP, it has to evaluate if this choice is more advantageous than building through the conventional public procurement. The financial instrument that has been developed to check the public convenience of the public partnership with a private subject is the Value for Money (VfM). VfM is the difference between the expense to build a facility by the most effective and efficient public procurement solution and that by PPP (Tanaka et al., 2005). The VfM criteria has been used to measure whether PPP allows the government to maximize benefits within the available resources. According to the definition, Value for Money should also compare qualitative features of public procurement with those of PPP solutions. However, some authors sustain that the model used in practice to assess VfM is only a quantitative estimation which does not care about differences between the two options, in terms of effectiveness and efficiency of the processes during the project life cycle, service quality to customers and bidders reliability (Grimsey and Lewis, 2005; Shaoul, 2005).

In assessing VfM, the cost of public procurement option can be estimated by Public Sector Comparator (Grimsey and Lewis, 2005). This is the sum of four contributions:

- Raw PSC: includes capital and operating cost to provide publicly the same level of service delivered by the facility carried out by PPP
- Transferable risks: the estimated economic value of all risks which are transferred to private partner in PPP
- Retained risks: the estimated economic value of all risks which government keeps on bearing even in PPP
- Competitive neutrality: adjustments to remove the government advantages coming from its public ownership

The cost of PPP consists of two components: the value of retained risks and the (possible) cost of service payments from public to private partner in PPP. PSC and PPP costs are expenses which occur during all the duration of the concessions, and consequently these are the sum of yearly cash flows discounted at an adequate rate, as Figure 1 shows.

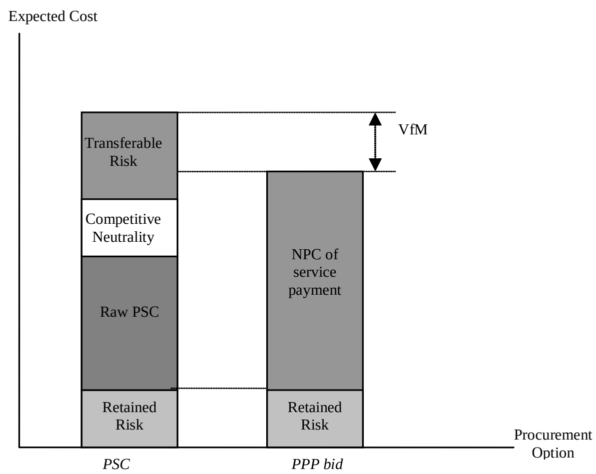


Figure 1: PSC vs PPP

If VfM is positive, the public administration gains an advantage to carry out the facility by means of a partnership with a private subject respect to build and operate it by itself. Thus, based on this, the government should select the preferred proponent or project to obtain the maximum VfM. In UK, an infrastructure project should be delivered using PPP only if it shows a better value for money (VfM) (HM Treasury, 2006). The same principle has been adopted by Australia (New South Wales Government, 2006) and Europe (Europe

Commission, 2003). However, the goal of governments is not only to obtain the maximum VfM, but also ensure the successful delivery of infrastructure to the community (social welfare). Thus, the government should also assess whether the project cash flows are likely to give a sufficient financial return to the sponsor or whether a subsidy is required. In other words, the government should care about the financial sustainability of the project for the sponsor (through the assessment of the project NPV). Finally, lenders are interested in measuring whether the project is able to service its debt. This is generally accomplished by the debt service cover ratio (DSCR) defined as the ratio of the operating cash flow (available for debt servicing) to the annual debt service.

The case study described in the next paragraph shows how the assessment of toll technologies from a single viewpoint can lead to wrong results. This paper focussed on the public and private perspectives, while does not consider the lenders' standpoint. Generally speaking, in fact, the debt structure can be very complex, highly project-specific, and involves numerous economic, policy and political considerations.

A CASE STUDY: ITALIAN "AUTOSTRADA CISPADANA"

"Autostrada Regionale Cispadana" is a 67 km highway which links Reggiolo to Ferrara, in Emilia Romagna, a region of northern Italy. The regional government wants to carry out this facility as a BOT concession (Build – Operate – Transfer) for 49 years and 6 months and has made a request for bidders to find a private PPP partner (ERMES, 2008). In our analysis, we assumed that concession duration is 50 years and that construction phase takes the first five years.

According to the early design, the highway has to be operated using the traditional Italian tolling system, which consists of a mix of manual collection, ETC systems like Telepass, an AVI disposal, and the Viacard automatic machines. In this paper, we made a comparison among the Net Present Value (NPV) of the project and VfM obtained in this base case (which we call Scenario 1) and other different tolling scenarios:

- Scenario 2: manual collection and automatic collection by GPS On Board Units (OBUs), which send data to a central server using GPRS technology
- Scenario 3: completely automated tolling by the Telepass AVI system, and an enforcement system (cameras) for cars without transponder
- Scenario 4: completely automated tolling by GPS OBU system, and an enforcement system (cameras) for cars without OBU

Table 2 shows the data used for the evaluation of the different tolling technologies from private and public viewpoints (NPV and VfM). We used the project data (ERMES, 2008), and we also made some assumptions based on similar cases discussed in literature (Gillen et al., 1999; Lubis et al., 2003; and others).

We supposed a 5 % increase of traffic in the third and fourth scenario as a consequence of the service improvement determined by less queuing time at completely automated toll plazas and thus a better flow. Moreover, we estimated the amount of every retained or transferred risks as a share of the cost interested by it. This share was evaluated as a mean of possible cost variations weighted on their occurrence probabilities (Partnership Victoria, 2003).

Value of risk = consequence x probability of occurrence

Table 2: Data of different tolling scenarios (ERMES, 2008; ANAS, 2007; Gillen et al. 1999; Lubis et al., 2003; Nowakowski, 2007)

<table>
<tr><th colspan="2"></th><th colspan="2">Scenario 1</th><th colspan="3">Scenario 2</th><th colspan="3">Scenario 3</th><th>Scenario 4</th></tr>
<tr><td colspan="2">Traffic (car*km)</td><td colspan="2">As in the original forecast</td><td colspan="3">As in the original forecast</td><td colspan="3">+5% than the original forecast</td><td>+5% than the original forecast</td></tr>
<tr><td colspan="2">Tolls (€/km)</td><td colspan="9">0,0733 (cars) - 0,1284 (trucks)</td></tr>
<tr><td colspan="2">Advertising and petrol station</td><td colspan="9">According to ANAS formulas</td></tr>
<tr><td colspan="2">Regione Emilia Romagna funding (€/year)</td><td colspan="9">19.800.000 during years 1 - 10</td></tr>
<tr><td colspan="2">ETC equipment cost (year 5)</td><td colspan="2">2.640.944</td><td colspan="3">2.075.085</td><td colspan="3">3.497.734</td><td>2.740.488</td></tr>
<tr><td colspan="2">Other project costs (€/year)</td><td colspan="9">38.325.874 (years 1 – 5)</td></tr>
<tr><td colspan="2">Road maintenance costs (€/km*year)</td><td colspan="2">19.000</td><td colspan="3">19.950</td><td colspan="3">19.950</td><td>19.950</td></tr>
<tr><td colspan="2">ETC equipment maintenance costs</td><td colspan="2">10% of ETC equipment cost</td><td colspan="3">10% of ETC equipment cost</td><td colspan="3">10,5% of ETC equipment cost</td><td>10,5% of ETC equipment cost</td></tr>
<tr><td rowspan="2">Labour costs (€/person*year)</td><td>Toll</td><td colspan="9">37000</td></tr>
<tr><td>Employees of data</td><td colspan="9">44000</td></tr>
<tr><td rowspan="2">Workforce (people)</td><td>Toll</td><td colspan="2">130</td><td colspan="3">130</td><td colspan="3">0</td><td>0</td></tr>
<tr><td>Employees of data</td><td colspan="2">0</td><td colspan="3">9</td><td colspan="3">25</td><td>34</td></tr>
<tr><td colspan="2">Telepass fee (€/year)</td><td colspan="2">2% of Telepass</td><td colspan="3">-</td><td colspan="3">2% of Telepass rev.</td><td>-</td></tr>
<tr><td colspan="2">Viacard fee (€/year)</td><td colspan="2">2% of Viacard</td><td colspan="3">-</td><td colspan="3">-</td><td>-</td></tr>
<tr><td colspan="2">GPS OBU (€/unit)</td><td colspan="2">-</td><td colspan="3">210</td><td colspan="3">-</td><td>210</td></tr>
<tr><td colspan="2">Commercial expenses</td><td colspan="9">1,5% of toll revenues at year 6</td></tr>
<tr><td colspan="2">General and administrative expenses</td><td colspan="9">2% of toll revenues at year 6</td></tr>
<tr><td colspan="2">Special Purpose Vehicle</td><td colspan="9">75.000.000</td></tr>
<tr><td colspan="2" rowspan="2">Construction costs (€/year)</td><td>Year 1</td><td colspan="3">Year 2</td><td colspan="2">Year 3</td><td colspan="2">Year 4</td><td>Year 5</td></tr>
<tr><td>81.876.172</td><td colspan="3">212.369.211</td><td colspan="2">239.201.025</td><td colspan="2">240.272.973</td><td>123.408.598</td></tr>
<tr><td colspan="2" rowspan="2">Operating fee to Regione Emilia Romagna (€/year)</td><td colspan="3">Years 6 - 10</td><td colspan="4">Years 11 - 15</td><td colspan="2">Years 16 - 50</td></tr>
<tr><td colspan="3">2,4% of annual toll revenues</td><td colspan="4">4% of annual toll revenues</td><td colspan="2">6% of annual toll revenues</td></tr>
</table>

The NPV of the project was assessed by using the Weighted Average Cost of Capital (WACC) as discount rate (5,87 %), while PSC and the cost of PPP were discounted at a rate of 6%. The results are shown in table 3.

Table 3: Project NPV and VfM in different tolling scenarios

Scenario	NPV (mln €)	Value for Money (mln €)
1	11,4	330,0
2	-64,6	433,2
3	110,6	228,4
4	-163,8	497,4

Switching from traditional collection (Scenario 1) to an ETC tolling system (Scenario 3), the project becomes more attractive for investors; in fact, the NPV of the project increases. At the same time, however, regional government convenience of using PPP decreases (VfM goes down). The government, in fact, allows the private partner to exercise a more efficient business against the same "public" cost. In reality, passing to Scenario 3, the government should reduce its funding to the project since there is less need to guarantee a profit for a project characterized by more revenues and less costs. Figure 2 shows the results of a sensitivity analysis on this factor: reducing public funding increases VfM .

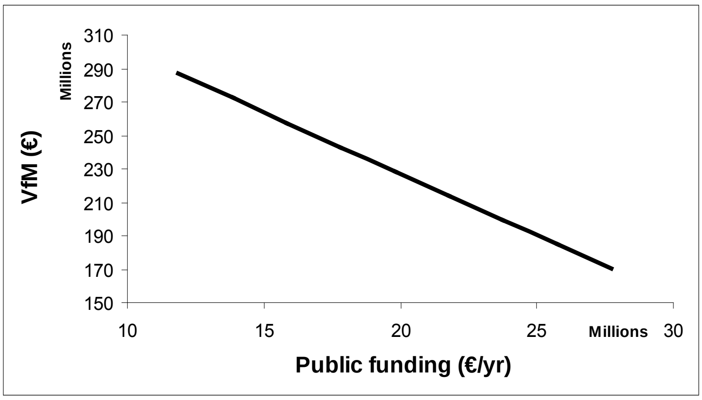


Figure 2: Sensitivity analysis of VfM varying public funding in Scenario 3

According to the Partnership Victoria VfM model (Partnership Victoria, 2003), cash flows of PSC and PPP cost should be discounted at different rates in order to consider the more risky position the government has in public procurement. Since both the indicators (PSC and PPP cost) are net present costs, the discount rates have to be exchanged in order to get a variation coherent with the level of risk. In other words, the discount rate used in assessing PPP cost should be higher than the rate used for PSC. Thus a sensitivity analysis on the discount rate used for evaluating PPP cost was conducted. Figure 3 shows that Value for Money for Government increases with the discount rate of PPP alternative.

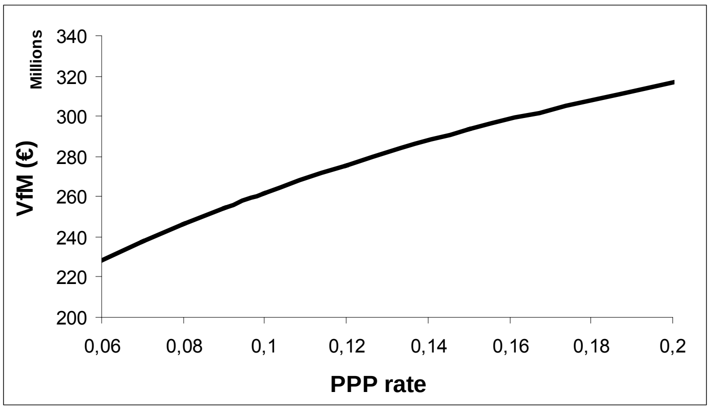
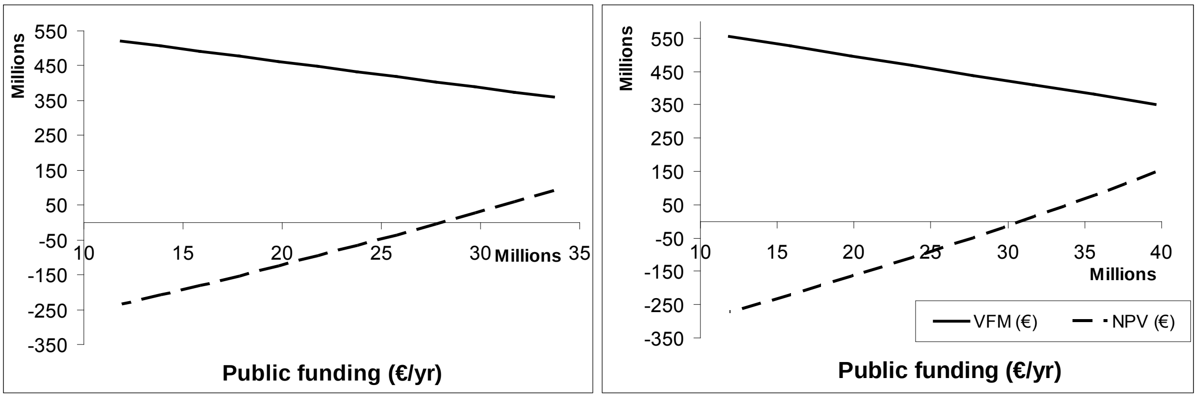


Figure 3: Sensitivity analysis of VfM varying the discount rate of PPP cost in Scenario 3

A preliminary analysis of GPS tolling scenarios, the second and the fourth, indicates that there is no economic convenience in carrying out the project using this kind of collection system. This can be explained by observing that all costs of GPS system have to be allocated exclusively to Autostrada Cispadana. Instead, Telepass society provides its service to users of all Italian toll roads, getting economies of scale and, thus, offering a cheaper service. Consequently, if regional government of Emilia Romagna wants to use this tolling system, it should make the investment more attractive to private partner by increasing funding to Special Purpose Vehicle (SPV) (Figure 4). Despite the higher levels of public funding, there is a good Value for Money to the public administration.



(a) (b)

Figure 4: Sensitivity analysis of VfM and NPV varying public funding in Scenarios 2 (a) and 4 (b)

CONCLUSIONS

Tolling can be considered one of the most important sources of revenue for private in carrying out public facilities, such as roads, bridges and tunnels. In the last years, several systems have been developed for toll collection. Each solution, with its own advantages and drawbacks, has a different impact on the value of the project, as well as on VfM created for the public sector under a partnership delivery method. In this paper we analysed the effects which the use of various tolling systems would have on an Italian highway PPP project, from the public and private perspective. We found that the complete use of AVI technology, in place of manual tolling, makes the project more profitable for the private partner. The higher value of the project, due to the more efficient technology, could lead the government to reduce public funding to investors. This way, Value for Money for the government would also be higher. Differently, GPS tolling system is too expensive because does not allow the private partner to reach economies of scale. Thus, it would deprive the private partner of convenience to carry out the project. If regional government would choose this solution, it should increase its contribution substantially in order to make the project attractive from private investors.

In evaluating different tolling alternatives, we did not analyse the externalities created by each scenario, such as the reduction of pollutant emissions, the improvement of traffic and safety conditions with a reduction of time spent on waiting in queues, fuel consumption and accident rates, social effects of workforce decrease in ETC scenarios, and so on. These represent costs and benefits for society, which is another important stakeholder of PPP projects. In general, VfM does not consider externalities, because this amount does not vary significantly switching from Public Procurement to PPP if the technology used is the same. However, when the adopted technology changes such as the case of different tolling solutions analyzed, social costs and benefits are not equal. Thus they should be quantified by a proper indicator in order to fairly compare and choose the tolling solution. So, further research will focus on including these effects in the analysis of the convenience of the tolling technologies to the regional government.

REFERENCES

ANAS (2007) Adeguamento dei canoni dei corrispettivi dovuti per l'anno 2008 per la pubblicità stradale, le concessioni e le autorizzazioni diverse.

ERMES Il portale della Regione Emilia Romagna (2008) Concessione per la realizzazione e gestione dell'Autostrada regionale Cispadana con la procedura del promotore. Procedura ristretta ai sensi dell'art. 155, comma 1, lett a) del D.Lgs. n. 163/2006 e smi., available at http://www.regione.emilia-romagna.it/wcm/ermes/canali/trasporti/strade/autostrade.htm.

European Commission (2003) Guidelines for successful public-private partnerships, Brussels.

Gillen, D., Li, J., Dahlgren, J., and Chang, E. (1999) Assessing the Benefits and Costs of ITS Projects: Volume 2 An Application to Electronic Toll Collection, California Partners for Advanced Transit and Highways (PATH), Institute of Transportation Studies, University of California, Berkley.

Grimsey, D., Lewis, M.K., (2005) Are Public Private Partnerships Value for Money? Evaluating alternative approaches and comparing academic and practitioner views, Accounting Forum, 29, 345 – 378.

HM Treasury (2006) Value for Money Assessment Guidance, UK.

Ke Y., Liu X., Wang S. (2008) Equitable Financial Evaluation Method for Public-Private Partnership Projects, Tsinghua Science and Technology, Vol. 13 No. 5, pp. 702-707.

Lubis H., Armijaya H., Takanashi I., Siswosoebrotho B.I. (2003) “The Development Of Traffic Information System and Electronic Toll Collection in Jabotabek Toll Road Network”, Proceedings of the Eastern Asia Society for Transportation Studies, Vol.4.

New South Wales Government (2006) Working with Government: Guidelines for Privately Financed Projects, Australia.

Nowakowski, P. (2007) Design of GPS-GPRS system module for localisation vehicles and cargo, Transport Problem, Vol. 2 No.1, Warsaw.

Partnership Victoria (2003) Use of Discount Rates in the Partnerships Victoria Process – Technical Note.

Persad K., Walton C.M., and Hussain, S. (2007) Toll Collection Technology and Best Practices, Center for Transportation Research, The University of Texas at Austin.

Ranasinghe M. (1999) Private sector participation in infrastructure projects: A methodology to analyse viability of BOT, Construction Management and Economics, Vol. 17 No. 5, pp. 613-623.

Shaoul, J. (2005) A critical financial analysis of the Private Finance Initiative: selecting a financing method or allocating economic wealth?, Critical Perspective on Accounting 16, pp. 441 - 471

Tanaka, D.F., Ishida H., Tsutsumi, M., Okamoto, N., (2005) Private Finance for Road Projects in Developing Countries: Improving Transparency Through VFM Risk Assessment, Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 3899 – 3914.

The World Bank Group, Toll Roads and Concessions, available at: http://www.worldbank.org/transport/roads/toll_rds.htm.

Tri-State Transportation Campaign (2004) The Open Road, The Region's Coming Toll Collection Revolution.

Washington State Transportation Commission (2006) Toll Technology Considerations, Opportunities, and Risks, Background Paper #8, Final report – Volume 2.

Ye S., Tiong R. (2000) NPV-at-Risk Method in Infrastructure Project Investment Evaluation, Journal of Construction Engineering and Management, Vol. 126 No. 3, pp. 227-233.

TRANSACTION COSTS FOR DESIGN-BUILD-FINANCE-MAINTAIN CONTRACTS

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This paper gives insight in how transaction costs arise and how in theory transaction costs can be reduced. A comparison between theory and practice has been made.

A study of a case in the Netherlands, the Second Coentunnel showed how transaction costs in practice appear, in which stage of the purchasing process these cost arise and also how transaction costs can be reduced. Cost specifications, handed by the public and private parties, make clear that in every phase of the process the client makes expenses. The client spends the most money during the initiative phase. The private parties start making costs in the first phase of the tender (prequalification). For contractors the most expensive phase is the dialogue phase.

Taking all the costs in overview, noticeable is that all of the costs are related to the duration of the different phases of the process and required capacity of personnel. Success factors from theory and practice have been identified in the process in which transaction costs arise. Theory and practice have been compared and resulted in a list of twelve success factors. By implementing these success factors in future projects the expectation is that transaction costs will not be unnecessary high.

KEYWORDS: transaction costs, purchasing efficiency, competitive dialogue, interaction.

INTRODUCTION

One of the goals of the Dutch government is to introduce and use Public Private Partnerships (PPP’s) on a structural base. Since the year 2004 different projects PPP projects have been started (Rijkswaterstaat, 2004). One of the PPP contract forms is Design-Build-Finance-Maintain (DBFM) in which the contractor has to design, build and finance the project and after finishing has to maintain the project for several years.

In the year 2005 the former Taskforce PPS concluded that: Transaction costs within PPP’s are a problem for the involved public and private parties. (Peijs, 2005) In the context of the research subject transaction costs are the costs that public and private parties make during the purchasing process until a contract is signed.

It is clear that making transaction costs should be minimized as far as possible. Both public and private parties would benefit from it.

The problem is that transaction costs are high, but none of the parties exactly know how high the total costs are.

The aim of this paper is to gain insight in how and where transaction costs arise and how they can be reduced.

Transaction costs

The Principal-Agent theory states that transaction costs arise in a hierarchical relation between a Principal (client) and Agent (contractor). It is a relationship in which the Principal hires an Agent for his expertise. In this relationship information asymmetry arises. To be sure that the Agent doesn't abuse this information asymmetry for his own strategic advantage (opportunistic behaviour) the Principal can implement so-called coordination mechanisms.

In the context of the Principal-Agent theory transaction costs are the costs for creating and managing these coordination mechanisms. These coordination mechanisms are (Welling, 2006):

- Contract
- Rewarding system
- Monitoring
- Bonding
- Phasing of the decision-making process

Purchasing

Purchasing theory can be used to define a good purchasing process in terms of organization and management. The theory describes how a good purchasing result can be achieved. Distinction has to be made between purchasing efficiency and purchasing effectiveness. Purchasing efficiency and purchasing effectiveness together determine the purchasing result. In the context of the research transaction costs can be reduced if the process is managed and organized more efficiently. To be able to use the theory, the purchasing process was set parallel to the construction industry/building process, according to Welling (2006). The research focus is on particular phases of this process (see Figure 1).

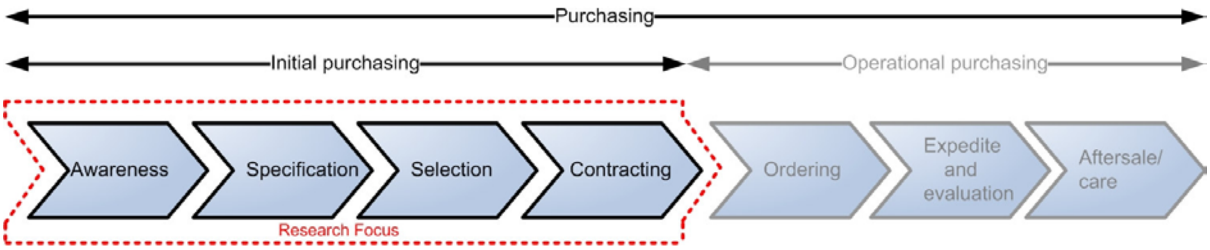


Figure 1: The purchasing process in the construction industry (Welling, 2006)

Literature study resulted in a list of success factors within the outsourcing and purchasing process. These factors from these two "different" processes have been compared with each other which resulted in a list with a total of fifteen success factors. Many of the success factors are related to the interaction between the buyer and supplier. Other factors are related to the goal and strategy of the buyer. In table 1, these success factors are shown.

Table 1: The Success Factors for the purchasing process

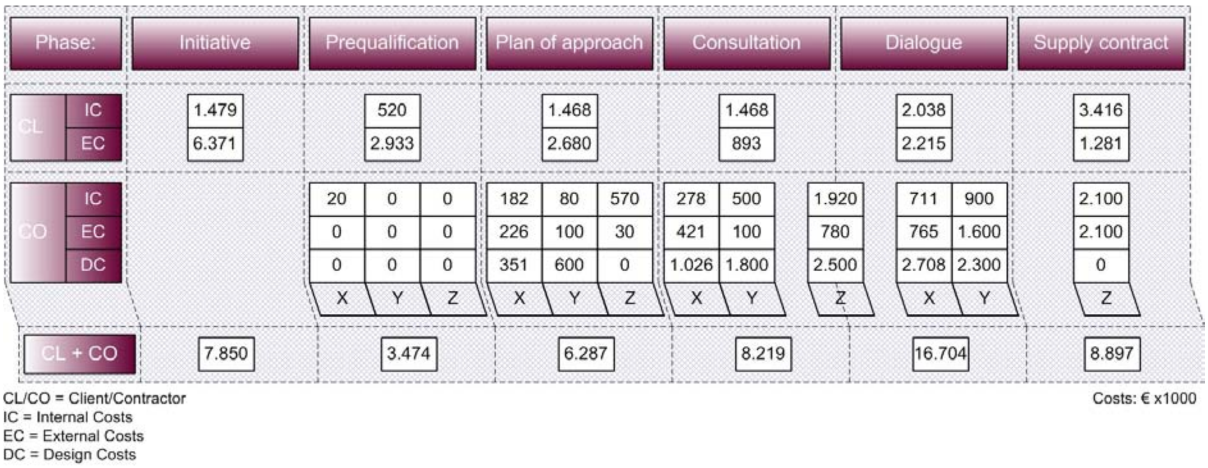
1	The motive and objective for the purchasing must match with the corporate strategy (Kamann, 2001);
2	The purchasing process must be made manageable (Van Weele, 2007) ;
3	The purchasing process can be made manageable by cutting it into several phases. The output of every phase must be determined in advance (Van Weele, 2007;Delen, 2004);
4	A team must be put together that is able to manage every aspect of the purchasing process and which the top-management supports (Van Weele, 2007);
5	Knowledge and awareness of the role of procurement and the factors influencing it;
6	Functional specifications have to be made in which performance has to be translated into objectively measurable indicators;
7	The specifications need to be supplier-neutral (Van Weele, 2007);
8	A decision methodology needs to be chosen in order to select the best supplier based on technical and managerial capacities (Van Weele, 2007);
9	Total Cost of Ownership is a good methodology to compare biddings (Kamann, 2001);
10	Performance-based contracts based on service-level-agreements have to be developed (Van Weele, 2007);
11	It is essential that firms have renegotiation option built into their contracts (Burdon & Bhalla (2005);
12	Openness and trust are important in the negotiating process (Jones, 1997) that need to be done by the key figures of the parties involved (Honess & Chance, 1996);
13	Communication among the parties involved needs to be done timely (Outsourcing institute, 1998);
14	Responsibilities and authority needs to be fixed (Outsourcing institute, 1998);
15	The process' progress needs to be registered (Outsourcing institute, 1998).

METHODOLOGY

In order to find the transaction costs in real projects, a case study has been performed. The case study is based on literature, interviews and project documents from public and private parties. The study has been done on a big tunnelling project in The Netherlands. The client of this project is The Ministry of Transport, Public Works and Water management in The Netherlands. The project will be executed in a DBFM contract and the tendering method is the Competitive Dialogue. There are multiple consortia involved in the tendering stage. The contract sum is around EURO 480.000.000,-.

RESULTS

As stated before the Principal Agent has been used as a base for finding transaction costs in the case study. Within the project the purchasing process has been analyzed. Cost specifications were handed by the public and private parties which made clear that in every phase of the process the client makes expenses. The client spends the most money in the Initiative phase. The private parties start with making cost in the first phase of the tender (prequalification). For contractors the most expensive phase is the dialogue phase (see Figure 2).



X, Y, Z = the three consortia; Internal costs: costs made by the own personnel; External costs: costs made by hired staff

Figure 2: The actual expenses made in the tendering process

This makes a total of transaction costs € 51.4 million. In this context it’s relevant to notice that the total contract sum for the project is €480 million. Which makes the transaction costs more than 10% of the contract sum.
The client also gives contractors compensation from the amount of €7.4 million (in total); this amount is not taken in account in the transaction costs.
Taking all the costs in overview noticeable is that all the costs are related to the duration of the different phases of the process and the required capacity of personnel.

After the analysis of the transaction costs, interviews have been held with experts that had been involved in the tendering process of this tunnelling project. The statements made by the interviewees, have been compared with the success factors from literature (see table 2). This comparison generated a list of 12 success factors which have a positive influence on reducing transaction cost. These success factors are:

Table 2: Success Factors

1	The process has to be cut into phases and has to be managed as a process. The process should be standardized as far as possible
2	The client needs to put together a team that is able to manage every aspect of the purchasing process and which the top-management supports
3	Functional specifications have to be made. The consortium has to given room for putting his own creativity in the design of the project
4	The specifications must be communicated clearly to the consortium
5	More projects on order to gain experience for both parties
6	Not all risks to the consortium
7	Reduce the number of consortiums that take part in the tendering process faster.
8	The consortium needs to get better and quicker understanding of the client's needs.
9	Openness and trust are important in the negotiating process that need to be done by the key figures of the parties involved
10	Communication among the parties involved needs to be done timely
11	The client should be aware of the costs that the consortia have to make
12	Try to hire as less as possible legal and financial advisors

As stated before all most all of the costs are related to the duration of the different phases of the process and required capacity of personal. More focus on the the twelve success factors will lead to a decrease of lead time.

DISCUSSION

Many theories can be used for analyzing phenomena in the construction industry. The two perspectives of the theories used in this research showed to be effective. The Principal-Agent theory from economic perspective can provide a good and solid framework for assessing the phenomena of transaction costs in the construction industry.

The project case that was analyzed encloses four out of the five mechanisms from the Principal Agent theory. Only costs for the monitoring mechanism weren't found in the case study. According to the theory these costs appear ex-ante. This means that these costs emerge after signing a contract. The contract is not yet signed which can explain why these costs were not found.

Purchasing theory from industrial industries describes how a good purchasing result can be achieved. Comparing some success factors which have been found in this theoretical framework with success factors that were mentioned during the interviews (practice) showed that the theory and practice have corresponding success factors. The case study showed also some factors which were not found in the (purchasing) theory.

CONCLUSION

This research shows that transaction costs in DBFM tenders are still high. The analyzed purchasing process which the public and private follow is not very efficient. This research made a first important step in making transaction costs, in a specific research subject, more transparent. It made clear that almost every cost component is related to the duration of the process. For next projects clients such as the Dutch Ministry of Transport, Public Works and Water Management should realize that it's a key issue to prevent that the process in time overruns the original planned process. The research resulted in a list of twelve success factors that should be used in future projects. Future research should focus on the success factors that were mentioned during interviews and were not found in the literature.

REFERENCES

Baarda, D.B. & Goede, M.P.M de, Teunissen, J. (2000) Basisboek Kwalitatief Onderzoek, Educatieve Partners Nederland BV, Houten.

Bogt ter, H. J., "Neo-institutionele economie, management control en verzelfstandiging van overheidsorganisaties", PhD, Proefschrift, Rijksuniversiteit Groningen. Ontvangen 29 Januari 1998, van Rijksuniversiteit Groningen. Digitaal proefschrift.

Burdon, S. & Bhalla, A. (2005) "Lessons from the untold succes story: Outsourcing Engineering and Facilities Management", European Management Journal. Vol. 23, No. 5, pp. 576-582.

Delen, G. (2004) "Zes faal- en vijf succesfactoren bij uitbesteding" Outsourcing. Nr. april, pp. 48-53.

Degraeve, Z & Roodhooft, F. (1999), "Improving the efficiency of the purchasing process using total cost of ownership information: The case of heating electrodes at Cockerill Sambre S.A.", European Journal of operational research. Nr. 112, pp. 42-53.

Essig, M. & Batran, A. (2005) "Public-private partnership – Development of long-term relationships in public procurement in Germany", Journal of Purchasing and supply management, nr. 11, pp. 221-231.

Jones, G. (1997) "Incentivising public service contracts: a methodology and recommendations", European Journal of Purchasing & Supply Management, Vol. 3, No. 4, pp. 233-240.

Honess, S. & Chance, C. (1996) "Outsourcing – A legal perspective on contract critical success factors" Information Security Technical Report. Vol. 1, No. 3, pp. 57-58.

Kamann, D.J.F (2001) "College Inkoop" Rijksuniversiteit Groningen.

Kamann, D.J.F. (2007) "Organizational design in public procurement: A stakeholder approach", Journal of Purchasing and supply management, nr. 13, 127–136.

Kumaraswamy, M. M. & Dissanayaka, S. M. (1998), “Linking procurement systems to project priorities ”, Building Research & Information, vol. 26:4, 223–238.

Outsourcing Institute (1998), Executive Survey: The Outsourcing Institute's Annual Survey of Outsourcing End Users. Used November 2007, via: www.outsourcing.com.

Peijs, K. (2005) Kamerstuk: Resultaten Taskforce PPS/infrastructuur. Via: www.minfin.nl.

Rijkswaterstaat (2004), Ondernemingsplan – Een nieuw perspectief voor Rijkswaterstaat. Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat, Utrecht.

Shanoum, G.N.(1994) “Critical Anlaysis of time and cost management”, Journal of Construction Engineering and management, vol. 120, nr. 4, pp. 687-705.

Welling, D. Th (2006), “Bouwen op gemeenschappelijk verleden aan een succesvolle toekomst”, PhD Proefschrift, Rijksuniversiteit Groningen. Ontvangen 20 december 2006, van Rijksuniversiteit Groningen. Digitaal proefschrift.

Weele van, A.J. (2007) Grondslagen van inkoopmanagement. Wolters Kluwer, Alphen a/d Rijn.

Yin, R. K. (1994) Case Study Research – Design and Methods. Sage Publications, London.

REAL ESTATE DEVELOPMENT STRATEGIES AND THEIR IMPACT ON THE RISK PROFILE OF A PROJECT

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This paper presents a real estate development framework that enables us to describe the complexity of the real estate development process realistically. The framework is fundamentally different from current theories on real estate development and is developed making use of empirical analysis of development projects and investment decision making processes in three Dutch real estate development companies. By making use of the framework five development strategies are distinguished as to how a project is delivered to the market. In addition this paper explores the relevance of the framework from a risk management perspective. The main risks in real estate development are categorised according to seven development aspects founding the framework and insight is given into the relative sensitivity of the development strategies to these risk categories. The real estate development framework provides a new starting point for further research on risks and opportunities - acting as an intermediary between management of risks on portfolio and operational level -, and can be of significant importance for determining real estate development companies' business strategies in practice.

KEYWORDS: real estate development; development strategies; risk management.

INTRODUCTION

Risk management is essential in order to manage real estate development projects successfully. In risk management literature a division can be made between risk management applied to a project (APM, 2004, ICE, 2005, IRM, 2002, PMI, 2000, RICS, 2003) and (financial) risk management applied to a firm or portfolio (Brealey and Myers, 1988). While project risk management focuses on implementing risk mitigation strategies that are directed at reducing the individual risks, financial risk management aims to spread and secure risks. However, little attention is paid to the strategic choices made at the start of a real estate development project, which determine to a large extent the risk profile of a project. In fact, there is a gap between the operational management of risks and the management of risks on portfolio level of a project-driven real estate development company.

To gain insight in what risks are involved in a real estate development process and how strategic decisions regarding the development process affect the risk profile of a project, it is necessary to develop a framework that enables us to describe the complexity of the real estate development process realistically. This paper presents such a framework, which is based on an analysis of projects and decision making processes of three Dutch real estate development companies (Gehner, 2008). Subsequently, by means of this framework different development strategies, which can be found in the current real estate development practice in the

Netherlands, and the risks in real estate development are described. Finally, a qualitative analysis is made on the relative sensitivity of the development strategies for the main risks in real estate development.

In the discussion the relevance of the framework, and the idea of development strategies as a means to strategically manage project risks, is further explored in terms of further research as well as implications for practice.

LITERATURE REVIEW ON REAL ESTATE DEVELOPMENT

Real estate development is the transformation of an idea for newly built space into a real property (Miles et al., 2000, Peiser and Frej, 2003, Nozeman, 2008) in order to contribute to a company's objectives, like making profit, establishing good relationships with clients, and winning awards. Transforming an idea into a real property may take several years. To manage such a project, the real estate development process is divided into development phases. In the literature, the development process is usually modelled as a series of sequential phases, such as 'evaluation, preparation, implementation, and disposal' (Cadman and Austin-Crowe, 1983: 3), 'evaluation, acquisition, procurement, and disposal' (Birrell and Bin, 1997), 'inception of an idea, refinement of the idea, feasibility, contract negotiation, formal commitment, construction, completion and formal opening, and property, asset and portfolio management' (Miles et al., 2000: 6), or 'planning and initiation, feasibility, commitment, construction, and management and operation' (Peiser and Frej, 2003: 20-21).

Many activities take place in each phase. All activities in a phase are aimed at reaching a certain end result. For example, in the feasibility phase a developer 'conducts or commissions a formal market study to estimate market absorption and capture rates, conducts or commissions a feasibility study comparing estimated value of project with cost, processes plan through government agencies' to demonstrate 'legal, physical, and financial feasibility' (Miles et al., 2000: 6). In the construction phase a developer seeks 'to keep all costs within budget' and 'resolves construction disputes, signs checks, keeps work on schedule' (ibidem) to deliver the building within budget and schedule".

The different activities in each development phase are not carried out in a sequential order, but they have a simultaneous character: the activities interact and in some cases are time dependent. Interaction means that 'a single activity can span several stages in the development process and several different activities will be ongoing in any particular stage. Second, the process is interactive in the sense that values of certain variables in the process are conditioned by the values of certain other variables' (Miles and Wurtzebach, 1977: 332); in other words the outcome of an activity influences another. Time dependency implies that one activity must be completed before another can start. For example, construction can only start when public authorities have given the building approval and financing is arranged. Moreover, various authors note that the development process is 'hardly straightforward' (Miles et al., 2000) and that 'development is an iterative process in which the developer obtains more and more precise information in each iteration' (Peiser and Frej, 2003: 19).

A REAL ESTATE DEVELOPMENT FRAMEWORK

This section presents a real estate development framework (see Figure 1) that explicitly makes a distinction between *development phases* – a time related division of a process – and groups of activities or *development aspects* (Gehner, 2008). In the framework the names of the phases are similar to these in the reviewed literature: initiation, feasibility, commitment, construction, and management. The activities are grouped into the following development aspects:

- land development: all activities concerning the preparation and control of the acquisition of land and making it ready for building, including site selection, investigation of land ownership and soil, land purchase, and site preparation;
- design: all activities concerning the preparation and control of the conceptualization/realization of a design, including idea inception, first spatial concept, physical feasibility study, selection of architect, selection of other consultants (engineers, landscape architect), management of the design process;
- entitlement: all activities concerning the granting of all building permits;
- financing: all activities concerning the raising of funds under the investments;
- construction: all activities concerning the physical realisation of the project, tendering and contracting, supervision of construction, and controlling planning and costs;
- leasing: all activities concerning the rental of the real estate project, including a market analysis, feasibility studies, promotional activities and closing rental agreements;
- sales: all activities concerning the sale of the real estate project, including a market analysis, appraisal, promotional activities, closing a sales contract and property management.

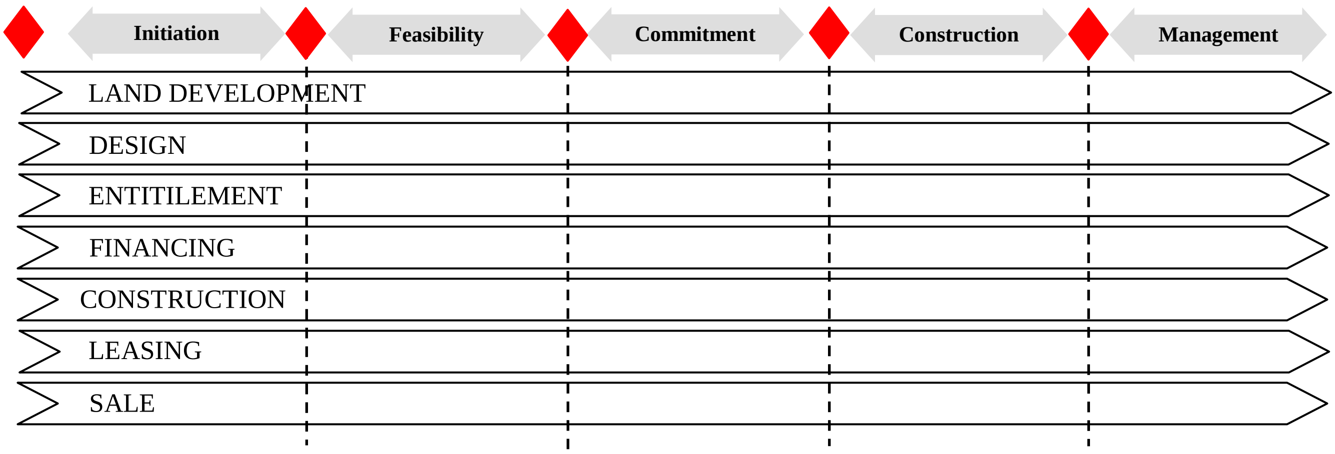

Figure 1: The real estate development framework consisting of development phases and development aspects

The addition of development aspects is fundamentally different from current theories on real estate development as it enables us to describe the interrelatedness of activities and the iterative character of the real estate development process. Like in other theories, the *development phases* divide the process in controllable timeframes. Unlike other theories, this framework focuses on the gates between two phases are so-called investment decision moments. Each investment decision moment is a ‘project review point where continuation or termination decisions are made’ (Schmidt and Calantone, 2002). In other words, at the end of each phase a project is integrally assessed to decide whether or not to allocate budget to a project and make further investments. The *development aspects* are the items to be evaluated in their mutual relationships at each investment decision moment.

More importantly, the framework enables us to give more insight into the variations in the order of the activities over the development phases. A real estate development project does not necessarily start with the acquisition of land; nor does a developer always start construction only if 60% of the project is rented out. In practice, many different development strategies can be observed over the real estate development companies. A *development strategy* can be defined as the sequence in which the activities related to land development, planning application, financing, design and construction, leasing and sale of a project, are carried out over the development phases. Although some activities are time dependent, development strategies can be developed with different sequences of activities over the development phases. In the following section five different development strategies are described. Subsequently, these development strategies are analysed as for the impact on the risk profile of a project.

FIVE DEVELOPMENT STRATEGIES

At the start of a real estate development project three questions rise: what product is going to be developed? Where is the location to develop the project? And how are the development activities are going to be executed? In practice a lot of market analysis is carried out to determine *what* and *where* should be developed. However, little attention is given *how* to design the development process, although the starting point and the sequence of activities determine to a large extent in what way 1) costs can be extended and kept low, 2) revenues may be secured early and maximised, and 3) flexibility can be retained to adapt to market circumstances. In other words a development strategy determines how value is created during the process and secondly how sensitive the development process is to the main risks in a project.

In the literature only two strategies to start a project are described, being 'site looking for a use' and 'use looking for a site' (Peiser and Frej, 2003). The first means that the development is driven by supply, the latter that a project is driven by demand. For both of these strategies no differentiation is made regarding the sequence of activities during the development process. Analysing current development practice in the Netherlands, we distinguish five different development strategies by the moments when the following essential commitments are made: land purchase, conceptual design choice, application for building permit, closing majority of leasing contracts, and closing sales contract. The moments when commitments are made related to the remaining development aspects, being start construction and closing financial deal, do not differ over the development strategies. The five development strategies are described in terms of its starting point, the sequence of activities and its historical background.

A. Supply driven strategy: site looking for a use

The starting point of this strategy is to obtain a development position by purchasing land. This may vary from a 'cold' site, when a current zoning plan is not according to the preferred development, or 'warmish', when a municipality has intention of changing the zoning plan form agricultural into land destined for building. When the political and economic climate look favourable, a conceptual design is made that meets the future demand in order to start the procedure to change a zoning plan or apply for a building permit. These procedures may take several years before the final design can be made and it is feasible to start renting out the building. A pre-rental percentage is nowadays a condition to obtain financing, which is necessary to be able to pay the constructor. During construction or even after completion the project is fully rented out and sold to an investor.

The strategy to start a project by first obtaining land is the traditional way of developing a project in the Netherlands and is most common in residential projects. Nowadays, this strategy has become less common because this asset becomes scarcer and thus precious and there is a shift from greenfield development projects to redevelopment of brownfields. Still, there are some substantial development companies in the Netherlands that own a lot of land, such as ASR and AM. In the 1990s this strategy culminated, when the government singled out large extension areas for greenfield housing development to be developed within ten years. In reaction many development companies speculatively purchased land despite the large claim on capital and the risks involved.

B. Demand driven strategy: user looking for a site and idea

This development strategy is the extreme example of a demand driven development. The development starts with a rental agreement with a user in answer to a housing need of a tenant. Initially a pre-rental agreement is signed. Usually, this agreement is conditional upon the ability to purchase the preferred site and the assignment of the zoning plan. Simultaneously, both parties agree upon the program of requirements and a first conceptual design. When the development agreement is signed, the design phase is followed by the financing, the construction and sale of the project.

This demand driven development strategy has been coming on in the Netherlands since the 2000s and is most common in the offices development sector. OVG made this development strategy its core business by developing projects for multinationals looking for a new headquarter, e.g. Unit 4 Agresso and ABB, but other companies also picked it up. ING Real Estate Development for example developed a new headquarter for Ernst & Young at the South-axis in Amsterdam.

C. Concept driven strategy: idea looking for a site and user

A conceptual development strategy starts with a concept or an idea that fulfils a market need. A concept is both about the functional program, the spatial image, public support and financial feasibility (Vos, 2005). Two types of concepts can be distinguished: location-product combinations (LPCs) and market-product combinations (MPCs). In a LPC the concept is derived from the characteristics of a known location. In a MPC the concept is developed on the basis of a certain market need; this type of concepts can be realised multiple times at different locations. Initial investments are made to develop a concept including internal costs and an architect fee (if not in-house); these investments are relatively low, and decrease the more a concept is used. This development strategy can be followed by either strategy A or B.

In the Netherlands development companies like Multi Corporation and TCN Property Projects can be characterized as conceptual developers. Multi and its in-house design group T+T Design develop LPCs for large shopping centres, and TCN PP develops MPCs, such as Trends & Trade, Brandboxx and Truck City. Their distinguishing core competence is creativity. This strategy is most common in the retail and B2B sector. In the USA many projects are developed based on concepts, such as resorts, retail parks, and outlet centers.

D. Development competition: planning problem looking for an idea and use

Entering a development competition is the fourth development strategy. In contrast with the other strategies, the initiative lies with a land owner or municipality. In fact the starting point is a planning problem on a particular site looking for a new idea and use. A municipality solicits private developers for solutions by a development competition. The deliverables in such a competition usually include a functional program, an urban or conceptual design and a price bid for the site. The winner of the competition closes a development agreement with the municipality. From that moment the planning application procedure, to which the municipality has committed oneself by writing out the competition, the design process and the leasing activities take place simultaneously. The moment the land is transferred from the municipality (or land owner) to the developer is agreed upon in the development agreement: most beneficial for the developer is to make the site purchase and the start of construction conditional upon a granted building permit and a fixed pre-rental percentage. Just before construction financing is arranged, and during construction a project is fully rented out and sold, similar to development strategy A.

In the Netherlands municipalities use development competitions to execute their land policy. Especially in the case of complex urban redevelopment projects or prestige objects, like a town hall, public library or theatre, development competitions are applied. Large development companies, like ING RED, MAB, and Multi, enter these competitions often in combination with smaller developers and/or contractors. It is government policy to further explore these cooperation strategies in PPP-formats.

E. Investment driven strategy: capital looking for a site, idea and use

This development strategy starts with an investor or an investment fund who is interested in new real estate assets to add to their portfolio for its capital and cash return. The involvement of an investor is either in the form of participating in a development company, like Morgan Stanley in Multi Corporation, or by participating in a single project as large investors and housing corporations often do. The investment strategy sets directions for the development company and guarantees the sales to the own investor. In the case an investor participates in a project, the commitment can take multiple forms. For example, sales conditions can be set at the start of a project in a pre-sales agreement or an investor can finance a strategic site acquisition and grants a developer the development once the zoning plan is changed. Apart from sales activities being brought to the fore of the development process the sequence of activities could be in line with any of the other development strategies.

All five strategies are in a different way sensitive to risks. Before indicating the risk profile of each development strategy, the risks in a real estate development process are identified.

RISKS IN REAL ESTATE DEVELOPMENT

There is no universally accepted definition of risk (Asselt, 2000, Chapman, 2006, Vlek, 1990, Atkinson et al., 2006, Aven and Kristensen, 2005). This paper acknowledges that ‘risk is a kind of attribute ascribed to the unknown future: the real dangers and hazards are only known afterwards’ (Asselt, 2000: 151). As the future is uncertain, some events can affect the expected outcome of a real estate development project. Events can both have a positive and a negative impact. According to managerial perspectives on risk, events with a positive impact are regarded as opportunities and events with a negative impact are regarded as risks (Akintoye and MacLeod, 1997, March and Shapira, 1987, MacCrimmon and Wehrung, 1986).

In a real estate development project many risks may occur varying over the uniqueness of projects. It is impossible to list all these possible risks. To give insight into the risks, and to structure the risk identification, several risk classifications are made. Various authors (Love et al., 2002, Miller and Lessard, 2000, Bing et al., 2005, Ng and Loosemore, 2007, Risman Instituut, 2005) use risk categories as technical, financial, legal, political, physical, social, and organisational. Risks can also be categorised as organisational, project-related and environmental (Have and Nauta, 2004) or macro level (exogenous), meso level (endogenous), and micro level (stakeholder relationships) (Bing et al., 2005, Baloi and Price, 2003, Mbachu and Vinasithamby, 2005). Others assign risk to the parties in the process (Rahman and Kumaraswamy, 2002, Kumaraswamy, 1997). In this paper the development aspects, as described in the previous section, are used to classify the risks:

- Land development risks: e.g. land cannot be purchased – land price/purchasing conditions is disproportionately high considering land conditions and current zoning plan;
- Design risks: e.g. program of requirements cannot be realised on the site – design is not kept within budget – delay of design process due to necessary changes on behalf of market fit or planning application;
- Entitlement risks: e.g. no approval of zoning plan or building permit – delay of planning procedure;
- Financing risks: e.g. financing cannot be arranged;
- Construction risks: e.g. at tender construction costs exceed budget – delay of construction process;
- Leasing risks: e.g. time to market lags behind schedule – design does not meet demand of space market (decrease in rental prices) due to economic fluctuations or innovativeness of product;
- Sale risks: e.g. wrong estimation of yield development on sale.

RISK PROFILES OF REAL ESTATE DEVELOPMENT STRATEGIES

This section gives insight into the relative sensitivity of the five development strategies for the main risks in real estate development. As each of the five development strategies has its own risk profile, the choice for a certain strategy can be seen as a strategic choice with regard to managing project risks and influencing the overall portfolio risk of the development organisation.

A. Supply driven strategy: site looking for a use

The main risk in this development strategy is the risk of delay due to the planning application procedure. The effects of delay are high: the financing costs of the land increase, adjustments to the design may be necessary resulting in extra architect fees, and it is not possible to control the time to market increasing the uncertainty about construction, rental and sales prices. Once construction is started, most risks are eliminated; even the leasing risk is nowadays reduced by applying a pre-rental percentage before starting construction. The remaining sales risk is dependent on the leasing speed, leasing prices and the demand on the asset market.

B. Demand driven strategy: user looking for a site and idea

The risk profile strongly differs from the previous strategy, because the leasing risk is eliminated at the start of the process by making it the starting point of the development process. Due to the conditions under the pre-rental agreement, the land development risk and the planning risk are shared with the tenant. When the development agreement is definite, the developer takes the design, financing, construction and sales risk, which become more stringent as the date of completion is fixed as well as the budget. Time and financial resources are constrained to obtain control, while the tenant will try to influence the design process which means flexibility is reduced as well. The sales risk is relatively low, because there is certainty about the rental of the project at an early stage in the development process.

C. Concept driven strategy: idea looking for a site and user

The risk profile largely depends on the development strategy that is combined with the conceptual development. Nevertheless, some risks are relatively lower. Because of the repetitive character of conceptual development, information and knowledge have been gained on the spatial and functional aspects in this kind of projects. This means that risks regarding the design and construction activities are reduced. Moreover, a conceptual strategy positively affects the leasing and sales speed and price, as when users and investors are familiar with a product, they are more willing to invest in this product.

D. Development competition: planning problem looking for an idea and use

In this development strategy, the division of risks between the municipality and the developer depends on the conditions in the development agreement. Logically, the risk of acquiring the land is transferred to the municipality, as land can be expropriated by the council, and the municipality commits oneself to be cooperative in the planning application procedure, which reduces the entitlement risks. As the land price is relatively high, because developers make a bid in competition, the effect of delay is high. This can be reduced by postponing (part of) the financial transfer to the start of the construction process and in case of a large area by purchasing the site parcel by parcel according to the phasing of the construction process. The developer usually bears the market risks (leasing and sales risks): these risks are relatively higher than in other development strategies, because the municipality imposes a program of requirements (on urban scale) and thus flexibility is low to adjust to the market need. Sometimes a municipality even demands a date of completion of the project. Preferably, the latter risk is avoided and market risks are reduced by making the start of construction conditional upon a fixed pre-rental percentage.

E. Investment driven strategy: capital looking for a site, idea and use

The risk profile of this development strategy is reduced relative to strategy A or B as the sales risk is eliminated or reduced depending on the condition in the sales contract. An investor can also be advantageous when he is willing to finance the land purchase or part of the construction costs. The risk profile is relatively higher regarding the design and leasing risks as result of additional requirements imposed on the product by the investor, which reduces flexibility in the design process and specific tenant demands may less easily be fulfilled.

DISCUSSION

This paper presents a real estate development framework that is different from other descriptive theories on real estate development as it introduces development *aspects* next to development *phases*. The introduction of development aspects provides insight in the interrelatedness of activities in the development phases and allows describing different development strategies. Moreover, the risks in a real estate development project can be categorised by these aspects.

In this paper the development strategies presented are described as ‘ideal types’ or most pure examples of different starting points and sequences of activities in real estate development processes. You will not find them as such in the real world, but they indicate the spectrum of strategic choices that can be made in a project. Further variations on these strategies can be made, for example by combining them with operational risk mitigation measures.

Development strategies are of vital importance for managing the total risk profile of a project and as such can be regarded as a form of strategic project risk management. Although the impact of the development strategies on the risk profile as described in this paper remains indicative, the importance of a conscious choice of a development strategy becomes quite clear. Further research attention is needed in the form of a quantitative analysis of the sensitivity of development strategies to risks to further substantiate the relevance of the development strategies as a strategic project risk management approach. In addition, the development strategies should also be seen as the way a real estate development company tries to make the most of the opportunities in a project. In order to increase the practical relevance more attention should be paid to opportunity management and to those activities that ensure an increase in value, such as the design, or the change of a zoning plan in order to get a clearer view on assessing the balance between risks and opportunities. For example, the application of real option theory provides new ways to value flexibility versus securing certain outcomes in the real estate development process, e.g. (Ford et al., 2002).

In practice, the development strategies can be used both at the start of a development project and during the development process at the investment decision moments. At the investment decision moments the development strategy is the basis for assessing a project. A development strategy can be translated into decision criteria for each investment decision moment in a development process. While in practice usually one set of criteria is used for each project, from this research can be concluded that each development strategy asks for its own set of decision criteria. These criteria are to be applied next to criteria regarding profit.

At the start of a project a company has to assess whether or not a project fits into a portfolio strategy. In large companies risks can be spread to apply multiple development strategies, just like a portfolio is composed of projects in different regions and market segments. Another portfolio strategy is to focus merely on one development strategy and develop specialist knowledge and competences in order to fully profit from the opportunities and manage the risks in that particular development strategy. This can lead to a new classification of real estate development companies based on their development strategies, and thus their risk profile and the competences to manage these risks and opportunities. In the end real estate development companies are professional entrepreneurs trying to profit from opportunities, meaning they have to take risks to keep in business.

The framework of real estate development and subsequent development strategies provide a series of challenges for academia and practice working towards an understanding of the real estate development business that is much more in touch with the entrepreneurial core of its profession – developing opportunities and in that process taking risks knowingly – than present literature rooted on disciplinary and sequential definitions.

REFERENCES

Akintoye, A. S. & Macleod, M. J. (1997) Risk analysis and management in construction. International Journal of Project Management, 15 (1)**,** 31-38.

APM (2004) Project Risk Analysis and Management Guide, Buckinghamshire: Association for Project Management Publishing Limited.

Asselt, M. B. A. V. (2000) Perspectives on uncertainty and risk; The PRIMA approach to decision support, Dordrecht: Kluwer.

Atkinson, R., et al. (2006) Fundamental uncertainties in projects and the scope of project management. International Journal of Project Management, 24 (8)**,** 687-698.

Aven, T. & Kristensen, V. (2005) Perspectives on risk: review and discussion of the basis for establishing a unified and holistic approach. Reliability Engineering & System Safety, 90 (1)**,** 1-14.

Baloi, D. & Price, A. D. F. (2003) Modelling global risk factors affecting construction cost performance. International Journal of Project Management, 21 (4)**,** 261-269.

Bing, L., et al. (2005) The allocation of risk in PPP/PFI construction projects in the UK. International Journal of Project Management, 23 (1)**,** 25-35.

Birrell, G. & Bin, G. S. (1997) The UK property development process: its phases and their degree of importance to profitability. *RICS Cutting Edge Conference.* Dublin, RICS Foundation.

Brealey, R. A. & Myers, S. C. (1988) Principles of Corporate Finance, Singapore: McGraw-Hill.

Cadman, D. & Austin-Crowe, L. (1983) Property development, London: Spon.

Chapman, C. (2006) Key points of contention in framing assumptions for risk and uncertainty management. International Journal of Project Management, 24 (4)**,** 303-313.

Ford, D. N., et al. (2002) A real options approach to valuing strategic flexibility in uncertain construction projects. Construction Management and Economics, 20(4), 343-351.

Gehner, E. (2008) Knowingly taking risk; investment decision making in real estate development, Delft: Eburon Academic Publisher.

Have, F. T. & Nauta, B. (2004) Handleiding risicomanagement bij PPS-gebiedsontwikkelingsprojecten. Den Haag, Kenniscentrum PPS.

ICE (2005) Risk analysis and management for projects, London: Institution of Civil Engineers and The Actuarial Profession, Thomas Telford.

Institute of Risk Management (2002) A risk management standard, www.theirm.org.
Kumaraswamy, M. M. (1997) Appropriate appraisal and apportionment of megaproject risks. Journal of Professional Issues in Engineering Education and Practice, 123 (2)**,** 51-56.

Love, P. E. D., et al. (2002) Using systems dynamics to better understand change and rework in construction project management systems. International Journal of Project Management, 20 (6)**,** 425-436.

Maccrimmon, K. R. & Wehrung, D. A. (1986) Taking risks: the management of uncertainty, New York: Free Press.

March, J. G. & Shapira, Z. (1987) Managerial perspectives on risk and risk taking. Management Science, 33 (11)**,** 1404-1418.

Mbachu, J. I. C. & Vinasithamby, K. (2005) Sources of risks in construction project development: an exploratory study. *Proceedings of the Queensland University of Technology Research Week.* Brisbane, Australia.

Miles, M. & Wurtzebach, C. H. (1977) Risk analysis in the real property development process: a conceptual framework and a computer simulation model. Journal of Business Research, 5 (4)**,** 325-357.

Miles, M. E., et al. (2000) Real Estate Development: Principles and Process, Washington D.C.: Urban Land Institute.

Miller, R. & Lessard, D. (2000) The strategic management of large engineering projects: shaping institutions, risks, and governance, Cambridge: MIT Press.

Ng, A. & Loosemore, M. (2007) Risk allocation in the private provision of public infrastructure. International Journal of Project Management, 25 (1)**,** 66-76.

Nozeman, E. (2008) Handboek Projectontwikkeling, Voorburg: Neprom.

Peiser, R. B. & Frej, A. B. (2003) Professional Real Estate Development; The ULI Guide to the Business, Washington: Urban Land Institute.

PMI (2000) A guide to the project management body of knowledge (PMBOK Guide), Newtown Square: Project Management Institute.

Rahman, M. M. & Kumaraswamy, M. M. (2002) Risk management trends in the construction industry: moving towards joint risk management. Engineering, Construction and Architectural Management, 9 (2)**,** 131-151.

Rics (2003) The management of risk - yours, mine and ours. London, Royal Institution of Chartered Surveyors.

Risman Instituut (2005) Risman-methode. www.risman.nl.

Schmidt, J. B. & Calantone, R. J. (2002) Escalation of commitment during new product development. Journal of the Academy of Marketing Science, 30 (2)**,** 103-118.

Vlek, C. A. J. (1990) Beslissen over risicoacceptatie, Den Haag: Gezondheidsraad.

Vos, A. (2005) De essentie van conceptontwikkeling: het uitvinden van wat van waarde en waardevol zal zijn. Real Estate Magazine, 43**,** 15-19.

IN SEARCH OF HIGH VALUE CONSTRUCTION: ADDING VALUE THROUGH SERVICE-LED PROJECTS

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The UK construction industry is increasingly exhorted to operate on the basis of adding value externally rather than focus on cost efficiency. Industry champions and policy setters advocate the need for construction companies to refocus firm orientation and add services to their traditional core product business. Major clients look to procure built facilities on the basis of added value, rather than capital cost. These trends towards 'high value construction' embrace design, production and facilities management and emphasise the need for the sector to shift its attention away from product delivery towards the satisfaction of clients' needs. In consequence growing emphasis is given to whole-life considerations and to the service dimension of projects. Of particular interest in this emerging commercial landscape is the concept of service-led projects. These projects are seen to provide a radically different context where the whole rationale for the project is driven by the client's business strategy and objectives for a new or enhanced service to its own customers. As such they are characterised by a localised 'vision' driven by downstream service delivery. Arguably this introduces a new realm of project complexity given the way in which the number of stakeholders increases. The paper examines the persuasive appeal of this vision and the difficulties that individual firms face in making such a transition. The case is made that the ideas of adding value and service-led construction projects have emerged in parallel with broader trends within manufacturing at large. Particular focus is given to how this new context challenges deeply-ingrained working practices in construction and why it presents a major challenge for the sector.

KEYWORDS**: service-led projects, high value construction, integrated solutions.**

INTRODUCTION

In the UK, major construction clients are increasingly looking to procure built facilities on the basis of added value, rather than capital cost. In the public sector domain growing emphasis is given to whole-life considerations and to the service dimensions of projects (HM Treasury, 2007) - a shift that is accelerated by the current environmental, financial and security challenges (HM Treasury, 2008). Industry champions and policy setters advocate the need for construction companies to refocus firm orientation and add services to their traditional core product business. Supporting arguments embrace design, production and facilities management and emphasise the need for the construction sector to shift its attention away from product delivery towards the satisfaction of clients' needs. Of particular interest in this emerging commercial landscape is that projects increasingly are becoming service-driven. These 'service-led' projects arguably provide a radically different context where the whole rationale for the project is driven by the client's business strategy and objectives for a new or enhanced service to its customers.

This paper contextualises and examines the concepts of high value construction and service-led projects through positioning them against broader trends in construction and manufacturing. It is argued that ideas of adding value through service-led projects in construction have emerged in parallel with long term developments within manufacturing at large. For quite some time now academics, industry champions and policy setters have been advocating the need for manufacturing companies to refocus firm orientation and add services to their traditional core product business (e.g. Vandermerwe and Rada, 1988; Gerstner, 2002; Livesey, 2006). The paper takes as its point of departure the unprecedented change that has taken place in the manufacturing sector over the last three decades. Initially the case is made that the term manufacturing no longer is clear cut and manufacturing firms come in many shapes and sizes. Particular attention is given to that manufacturing firms increasingly present themselves as through-life service providers; i.e. providing prolonged services around a manufactured product. The terms high value manufacturing and service-led producers are then introduced. Focus is given to how manufacturing and service no longer are considered to be separate endeavours and firms' revenue streams are increasingly dependant on both initial sales revenue and operations generated income. The argument is then turned to how these ideas are translated in the UK construction context and how construction firms have adapted to changes in their commercial environment. The discussion highlights the challenges that firms face when trying to compete on the basis of added-value and service delivery. The paper concludes with reflections on the types of empirical and theoretical inquiries necessary to further our understanding of firm behaviour in this emerging context.

THE CHANGING MANUFACTURING LANDSCAPE

That manufacturing firms add services to their traditional core product business is commonly explained on the grounds of commercial necessity. Some commentators suggest that globalisation has led to a more rapid customisation of products which in turn has forced down the prizes. Geographic boundaries no longer matter as clients can source their products from a larger area (Cova and Salle, 2007). The ability of manufacturing firms' to differentiate their products is therefore arguably declining and adding on services is a way of making the products more attractive. Hence, moving towards services is a means of escaping a profit squeeze in a firm's core 'production' business (Wise and Baumgartner, 1999).

Other commentators point towards how pressures from clients force a change in behaviour among suppliers (Oliva and Kallenberg, 2003). Customers, we are constantly led to believe, are becoming increasingly demanding due to changes in their own commercial environments thereby forcing a change in the business relationship. In particular, clients are portrayed as refocusing on their core activities and hence resorting to more and more integrated offers of products and services (cf. Cova and Salle, 2007). Deregulation of markets is also seen to have had an accelerating effect on the demand for integrated product and service offerings. Long-established trends of privatisation and outsourcing within client organisations is argued to have driven the appeal of a service-delivery focus provision and integrated product and service solutions (*ibid.*). Of further importance for this line of argument is that sector consolidation frequently acts to re-shape power differentials in ways that may be detrimental to the future profits of manufacturing organisations. Diversification into services is therefore recommended as providing a degree of recession proofing. There are also those who argue that companies will be forced into service provision on the basis of the sustainability agenda (e.g. Manzini and Vezzoli, 2002; Mont, 2002). Such arguments reflect more than short-term economic imperatives. It is believed that a change in emphasis towards services provides firms with means to stay competitive as patterns of production and consumption are transformed by public pressure on environmental issues (Tukker and van Halen, 2003).

In summary, manufacturing principles have changed radically. Some industries have completely or partially ceased to exist. Other more specialised 'high-value' processes or completely new industries have come to replace them. As a result, integrating products and services is almost universally considered essential for commercial survival.

HIGH-VALUE MANUFACTURING

In recognition of the wider changes in the competitive environment the UK government is encouraging the introduction of 'High Value Manufacturing' (EPSRC, 2008; TSB, 2008). This comes on the back of the recognition that historically the industry response to commercial pressures has mainly focused on improving production processes and enhancing efficiency. High value manufacturing is seen as a viable alternative for manufacturing firms to maintain a long-term and sustainable competitive advantage.

Current thinking on 'high-value manufacturing' seeks to classify firms according to two dimensions: (i) whether the majority of their revenues is derived from products or services, (ii) whether the majority of their costs are within production or outside production (see Figure 1). In short, product manufacturers are relatively traditional original equipment manufacturers with the majority of costs in production and the majority of revenues from selling products. Service-led producers are strongly based around production, but have begun to derive significant revenues from services. Service manufacturers have moved into providing services and have detached from their production base. System integrators sell products, but the majority of their costs are not associated with production. They control the channel to customers and manage an external production network.

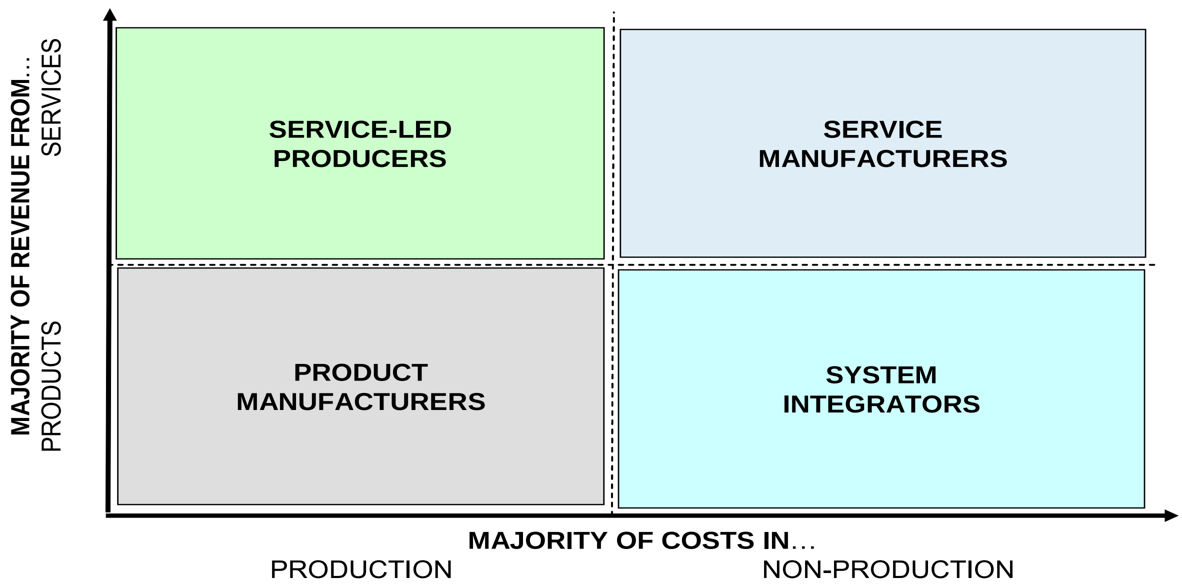

Figure 1: High Value Manufacturing (adapted from TSB (2008))

The classification provided is rather crude but serves to illustrate how services are becoming ever more significant in the offerings of manufacturing firms. ‘High value’ can of course be achieved in any of the four quadrants in Figure 1 and it is clear that products and production processes are still considered to be key. However, significant emphasis is given to services and how firms could and should add these to their traditional offerings.

THE CHANGING PROCUREMENT LANDSCAPE IN CONSTRUCTION

The insight that manufacturing has to cover the process from market assessment and product design through to manufacture, support and service delivery - High Value Manufacturing – is as described above high on the UK government’s agenda (BERR, 2008; EPSRC, 2008) and is identified as a priority theme for the Technology Strategy Board (TSB, 2008). These notions of ‘high value’ are also evident in the UK construction policy agenda. Policy makers and industry bodies are increasingly advocating that the sector should operate on the basis of adding value externally rather than focus on cost efficiency (e.g. Saxon, 2005). Such ideas are reflected in the vision and objectives of some of the large public sector clients, e.g. Highways Agency’s new knowledge programme portfolio ‘Improving Value for Money for the HA’. They also form the basis for the objectives of large private sector clients, e.g. the newly formed ‘Assets & Facilities Management Working Group’ under the auspices of the Construction Clients Group. Similar developments are also taking place elsewhere and are increasingly noticeable in visions for industry development and proposed research agendas; see for example the American Society of Civil Engineers’ vision for the development of the civil engineering sector in the USA (ASCE, 2007).

These developments are increasingly evident in a number of areas and changes in procurement strategies are clearly discernable amongst large construction clients; in particular in public sector procurement. The Private Finance Initiative (PFI) and associated Public-Private Partnership (PPP) projects is perhaps the most notable example. Comprising 10-15% of UK government's annual capital procurement budget PFI represents a significant part of the UK construction market (HM Treasury, 2006). Since its inception in 1992 whole-life considerations and extended contractual undertakings have been an integral part of the PFI. However, it is only recently that service-delivery and means of benchmarking and market testing the services provided has come to the forefront of PFI procurement (NAO, 2007). Service provision is now central to PFI projects across most sectors and the projects are increasingly becoming service driven. For example, the proportional division of costs between capital works and operations is significantly different in recent PFI infrastructure projects, such as the newly signed M25 motorway-widening scheme, compared to earlier DBFO roads. This reflects the Highways Agency's wish of linking payment to the delivery of a service (Highways Agency, 2009). Further, in the housing sector emphasis in the design of PFI schemes is shifting from improving and maintaining social housing stock towards the creation of sustainable communities and services to the local communities (cf. CLG, 2008). Likewise in the educational sector the 'Building Schools for the Future' programme was put in place not solely as a financing route for new school buildings, but as a vehicle that ensures that schools are provided that allow for educational transformation (4ps, 2007). Indeed, the programme approach is considered to create an opportunity to transform the way secondary schools function (CABE, 2006). In healthcare the insistence on the forming of limited companies under the 'Local Improvement Finance Trust' initiative is particularly notable. Shareholders include the local NHS Primary Care Trusts and Partnerships for Health together with private sector firms. Such developments represent a significant shift away from previously established PFI models and further blur the boundaries between construction and service.

Outside the PFI context the public sector has in the past been restricted in their ability to issue long-term contracts due to the centrally imposed need for frequent market testing. Nevertheless the trend towards a service-delivery focus in projects is easily discernable in several sectors. For example, the progressive privatisation of highway maintenance capabilities has affected the way in which both the Highways Agency and Local Authorities procure construction work. The Highways Agency has over the last decade introduced a succession of procurement initiatives such as Early Contractor Involvement (ECI), the Managing Agent Contractor (MAC) contract and Extended Managing Agent Contractor (EMAC) in order to facilitate a service-orientated engagement between public and private sectors (Highways Agency, 2005). Other regulated markets where the move towards long-term service oriented contracts is noticeable include the power and water sectors. In power generation and distribution the main bulk of the National Grid's major investment in upgrading and developing the electricity transmission network is procured through long-term collaborative contracts (National Grid, 2009).

MOVING TOWARDS SERVICE-LED CONSTRUCTION PROJECTS

The above described strategic changes in the procurement of projects go beyond merely adding additional services to construction asset procurement. Instead the projects are increasingly becoming service-led. They are driven by a localised vision of downstream service delivery based on the client's strategy and objectives for a new or enhanced service to its own customers. This increases the number of stakeholders and adds a new realm of project complexity (cf. Ivory *et al.*, 2006). Furthermore, the long-term nature of the service delivery requirements combined with the added risks associated with the extended timeframes and future business environments place new demands on clients and contractors alike. Clearly this move towards more service-orientated business models puts existing contractual arrangements to test. Equally clear is that most firms, regardless of size and specialisation, will have to acquire new capabilities or at the very least develop their present skill sets. However, these changes take place within the involved organisations larger portfolio of activities. The envisioned organisational and structural changes necessary for participation in service-led projects are likely to have an impact on other activities and at times challenge deeply-ingrained working practices. As service-led projects become more and more common they become ever more difficult for construction firms to ignore. Thus, from a commercial perspective competing for work on the growing service-led project market is becoming increasingly important. Yet, construction firms need to manage and protect the expertise and working relationships that support their excellence in specialised niches and secure their positions in more traditional markets, while realising their remit in service-led projects (cf. Leiringer *et al*., 2009). Furthermore, organisational and structural changes in the supply side have to be met by equivalent changes within client organisations – adding value through long-term collaborative working has in the past been curtailed by a lack of trust between public and private sectors (*ibid*.).

It follows from the above that it is necessary to root any exploration or explanation of how construction firms adapt to service-led projects and high value construction in the broader commercial environment in which they operate. Of course, in a sector as diverse and complex as construction there are few generalisations which will be true in all cases. What is clear is that the construction sector is characterised by continuous and complex processes of change which are highly nuanced and heavily contextualised. Explanations for organisational strategies and behaviour derived from the manufacturing sector cannot therefore be transferred unquestionably across contexts. Notions of high value and service provision may be rendered fashionable by debates in the manufacturing sector and extensive government and industry lobbying for virtues of PFI. But such discourses take on new meanings when assimilated with ongoing structural changes within the construction sector; as is briefly explored below.

Privatisation and outsourcing

In terms of understanding the broader context it is especially important to position the persuasive appeal of high value and service driven projects against long-established trends of privatisation and outsourcing. Over the last three decades newly privatised companies have frequently embarked upon extensive downsizing programmes in order to make themselves competitive in the marketplace (cf. Bishop *et al*., 1994). Many such downsizing programmes have often been accompanied by the outsourcing of clients' in-house asset-management capabilities. What should be remembered is that such developments by no means have been uniform, or even consistent. Not within the same sector and certainly not between sectors. A prime example of this trend is the water utility sector (Davidson, 1990; Ogden, 1995; Cooke, 2003). Here outsourcing strategies have consistently been driven by a range of factors, including regulatory pressures and the introduction of yardstick competition (Cowan, 1994; Ogden, 1995). In no small way, this has created the space for the private sector to offer integrated solutions in response to specified business needs. But the adopted strategies have by no means been uniform, or even consistent. While some water utility companies have outsourced asset management capabilities, others have retained them in-house. Some have chosen to outsource selected capabilities, but to retain others they consider to be strategically important. Such localised decisions have been influenced by the regulatory standards set by OFWAT (The Water Services Regulation Authority) at five-yearly intervals leading many water utility companies to oscillate between outsourcing and bringing capabilities back in-house again. Thus, the overall picture is one of vicissitude; the end result is that contractors endeavour to offer service-led solutions to some clients, whilst offering traditional 'build-and-run' to others.

The Property Services Agency and the importance of partnerships

Additional insights into the complexities of privatisation and how the notions of value and service have developed in construction emerges from the privatisation of the Property Services Agency (PSA). During the period 1992-1993 the PSA was progressively split up into separate operating companies which were then sold to private sector construction firms. Prior to privatisation, the PSA played a mediating role between government departments and private sector suppliers (Burnes and Coram, 1999). Its demise therefore represented a significant change in the established mode of engagement between public sector clients and the construction sector; this was especially so when considered in conjunction with the advent of the government's PFI initiative. The break-up and privatisation of the PSA potentially provided the opportunity for much closer, and more innovative, procurement relationships between government departments and the construction sector. But the downside was that the public sector lost much of its accumulated expertise in property procurement, including the PSA's much heralded database on construction and maintenance costs. The acquisition of the privatised regions of the PSA by private sector firms often comprised the means of developing a significant additional business stream based on facilities management (FM) services. It was in this context that the privatised operating companies began to emphasise the importance of 'partnerships' between themselves and public sector clients, with a particular emphasis on the benefits of long-term relationships. However, central government directives on competitive tendering and market testing acted against the possibility of long-term service contracts with the private sector (Erridge, 1998). While the rhetoric of 'partnership' prevailed on both sides, the reality was that any shift towards a long-term service ethos was heavily mediated by a continued insistence on short-term contracts.

The growth of subcontracting and systems integration

Unfolding processes of change and re-structuring within the construction industry's client base have been matched by extensive change within the sector. Recent decades have seen extensive restructuring with a significant increase in labour-only subcontracting supplemented by agency labour (Harvey, 2001). Many of the major contractors that characterised the 1970s have evolved into exemplars of the 'hollowed-out' firm. As such they have largely removed themselves from the physical work of construction, preferring to concentrate on management and coordination functions. Indeed, many contractors conceptualised themselves as 'service companies' long before service delivery became popular in the policy debate. Such trends have arguably been exacerbated by the promotion of various ‘management’ procurement routes which have legitimised an increased reliance on sub-contracting. This progressive shedding of responsibility for the physical work of construction has rendered the label of ‘systems integrator’ relevant, cf. Figure. 1. But the overall picture is, as always, by no means straightforward. There are many contradictions and paradoxes even within companies. The industry’s major firms have tended to adopt a decentralised structure to enable different divisions to compete in different market sectors. In consequence, divisions within the same company are frequently structured very differently to accord with the demands of their particular operating environment. Business units characterised by the dominant model of structural flexibility frequently co-exist with units that comprise a large direct labour force that has been transferred from the public sector.

Furthermore, the long-established expertise of the construction sector in the management and coordination of sub-contractors notwithstanding, it must be recognised that this is a very low-road version of systems integration. The dominant rationale behind the growth in sub-contracting has been the adoption of a competitive strategy based on structural flexibility, i.e. the ability to expand and contract in response to fluctuations in demand (Winch, 1998). There is also little doubt that sub-contracting is attractive because it serves to reduce a company’s fixed overheads, not least because it enables firms to abrogate their responsibilities for training and human resource development (Harvey, 2001). Simply put, sub-contracting has largely been driven by cost pressures rather than a need to provide high-value solutions.

DISCUSSION AND CONCLUDING REMARKS

It is clear that construction companies have become accustomed to changes in their commercial environment and have learnt to adapt to new policies and procurement routes. Most construction firms are very adept at adapting. In truth they have learnt to play multiple games at the same time and are consistently forced to deal with the apparent paradox between recursiveness and adaptation. This is no different in the context of the increased emphasis given to service in the procurement strategies of their major clients. As has been shown this is not a shift from a steady state to another, rather it is a continuation of a long-term trend. Nonetheless, service-led projects pose a considerable challenge to most firms and are likely to put deeply ingrained working practices to the test and at least partially re-shape business strategies. Construction firms might be extremely good at constantly adapting in order to remain competitive, but they still need stabilising routines in order to operate effectively. Therefore, the challenge for academics and practitioners alike lies in unravelling the myriad of practices contained in terms such as ‘adding value’ and ‘service delivery’, as realised in specific projects, situated in complex, yet specific environments. And to explore the tensions which participation in service-led projects pose for the involved parties and establish the different ways in which these can be managed at intra- and inter-organisational levels.

Within the manufacturing context researchers from different backgrounds and fields have researched this topic drawing on various theoretical fields. They have come up with a variety of concepts at various levels of abstraction such as: customer solutions (Foote *et al.*, 2001); product service systems (Mont, 2002); full service (Stremersch et al., 2001); servitization (Vandernerwe and Rada, 1988). In the studies of capital goods the concept of ‘integrated solutions’ has gained increased recognition and is commonly used to describe tailored combinations of products and services (Brady *et al.*, 2005). However, none of these models can be directly applied to explain or predict behaviour on construction projects. Simplistic models of centralised homogeneous firms, working in a single institutional environment, are not suited for the added complexity of service-led construction projects. As previously argued these projects will have a different place in the larger portfolio of activities of various internal stakeholders. A strong case can, thus, be made for a shift in emphasis from viewing firms as unitary entities and instead capture the dynamics of decentralised firms working in multiple markets on a variety of projects, some of which are service driven. This line of inquiry will lead to a more practical and nuanced understanding of intra-organisational dynamics throughout the project life-cycle. It could also, in turn, lead to a greater appreciation of the working relationships between different organisations at different stages of service-led projects.

REFERENCES

ASCE. (2007). *The Vision for Civil Engineering in 2025*. American Society of Civil Engineers. Reston, USA.

BERR. (2008). *Manufacturing: New Challenges, New Opportunities*. Department for Business Enterprise & Regulatory Reform. Crown Copyright, London.

Bishop, M., Kay, J. and Mayer, C. (1994). Introduction: Privatization in Performance. In: M. Bishop, J. Kay, and C. Mayer, (eds), *Privatisation and Economic Performance*. Oxford University Press, Oxford.

Brady, T., Davies, A. and Gann, D. M. (2005) Creating value by delivering integrated solutions, *International Journal of Project Management*, **23**, 360-365

Burnes, B. and Coram, R. (1999). Barriers to partnerships in the public sector: the case of the UK construction industry. *Supply Chain Management: An International Journal*, **4**(1), 43-50.

CABE. (2006). *Assessing Secondary School Design Quality. Research Report.* Commission for Architecture and the Built Environment, London.

CLG. (2008). *The Private Finance Initiative for Housing Revenue Account Housing: The pathfinder schemes baseline report*. Department for Communities and Local Government, London.

Cooke, F.L. (2003). Maintaining change: the maintenance function and the change process. *New Technology, Work and Employment*, **18**(1), 35–49.

Cova, B. and Salle, R. (2007) Introduction to the IMM special issue on ‘Project marketing and the marketing of solutions’ A comprehensive approach to project marketing and the marketing of solutions. *Industrial Marketing Management*, 36(2), 138-146.

Cowan, S. (1994). Privatization and regulation of the water industry in England and Wales. In Bishop, M., Kay, J. and Mayer, C. (eds) *Privatization and Economic Performance*, Oxford University Press, Oxford, pp. 112–36.

Davidson, J.O. (1990). The commercialization of employment relations: the case of the water industry. *Work, Employment and Society*, **4**(4), pp. 531–49.

EPSRC. (2008). *Delivery report 2007/2008*. Engineering and Physical Sciences Research Council, Swindon, UK.

Erridge, A. (1998). Competitive tendering and partnership in the public sector. In b.Burnes and B.G. Dale (eds) *Working in Partnership*, Gower, Aldershot, UK.

Foote, N.W., Galbraith, J., Hope, Q. and Miller, D. (2001). Making solutions the answer. *The McKinsey Quarterly*, 3, 84-93.

Gerstner, L.V. (2002). *Who Said Elephants Can't Dance? Inside IBM's Historic Turnaround*. HarperCollins Publishers, London.

Harvey, M. (2001). *Undermining Construction*. Institute of Employment Rights, London.

Highways Agency. (2005). *Delivering Best Value Solutions and Services to Customers - HA Procurement Strategy Review 2005.* Highways Agency Publications Group, Wetherby, UK.

Highways Agency. (2009). *About DBFOs*. Available online at: http://www.highways.gov.uk/roads/3009.aspx [accessed on: 2009-05-14]

HM Treasury. (2006). *PFI: strengthening long-term partnerships*. The Stationery Office, London.

HM Treasury. (2007). *Transforming government procurement*. The Stationery Office, London.

HM Treasury. (2008). *Infrastructure procurement: delivering long-term value*. The Stationery Office, London.

Ivory, C., Alderman, N., McLoughlin, I. and Vaughan, R. (2006). Sense-making as a process within complex projects. In Hodgson, D. and Cicmil, S. (eds) *Making Projects Critical*, Palgrave Macmillan, Basingstoke, pp. 316–34.

Leiringer, R., Green, S.D. and Raja, J.Z. (2009). Living up to the value agenda: the empirical realities of through-life value creation in construction. *Construction Management and Economics*. **27**(3), 271-285.

Livesey. (2006). *Defining High-Value Manufacturing*. Institute for Manufacturing, University of Cambridge, Cambridge.

Manzini, E. and Vezzoli, C. (2002). *Product-Service Systems and Sustainability: Opportunities for sustainable solutions*. United Nations Environment Programme, Paris.

Mont, O. (2002). Clarifying the Concept of Product-Service System. *Journal of Cleaner Production*, **10**(3), 237-245.

NAO. (2007). *Benchmarking and market testing the ongoing services component of PFI projects*. National Audit Office. London,

National Grid. (2009). Electricity Alliances and Infrastructure Projects. Available online at: http://www.nationalgrid.com/uk/Electricity/projects/ [accessed on 2009-05-11].

Ogden, S.G. (1995). Transforming frameworks of accountability: the case of water privatization. *Accounting, Organization and Society*, **20**(2), 193–218.

Oliva, R. and Kallenberg, R. (2003). Managing the transition from products to services. *International Journal of Service Industry Management*, 14(2), 160-172.

Saxon, R. (2005). *Be Valuable: A guide to creating value in the built environment*. Constructing Excellence, London.

Stremersch, S., Wuyts, S. and. Frambach, R.T. (2001). The Purchasing of Full-Service Contracts: An Exploratory Study within the Industrial Maintenance Market. Industrial Marketing Management, **30**(1), 1-12.

TSB. (2008). *High Value Manufacturing: Key technology area 2008-2011*. Technology Strategy Board. Swindon, UK.

Tukker, A. and van Halen, C (eds). (2003). Innovation Scan for Product Service Systems: Open your eyes to the power of your company to create value!. TNO-STB, Delft, the Netherlands.
Vandermerwe, S. and Rada, J. (1988). Servitization of business: adding value by adding services. *European Management Journal*, **6**(4), 314–24.

Winch, G. (1998). The growth of self-employment in British construction. *Construction Management and Economics*, **16**, 531-42.

Wise, R. and Baumgartner, P. (1999) Go Downstream: The New Profit Imperative in Manufacturing. *Harvard Business Review*, September-October, 133-141.

4ps. (2008). *An Introduction to Building Schools for the Future: 2008 edition*. Public Private Partnership Programme, London.

ZAGREB HOLDING WATER AND SEWER INVESTMENT PROJECT: OPERATING PROCEDURES

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The Zagrebacki Holding has received a loan (60 mill EUR) from the EBRD for large scale improvements of the water supply and wastewater facilities in the Croatian capital Zagreb, serving about 850,000 inhabitants. Zagreb Municipality will provide counterpart funding (40 mill EUR) for the investment component of this project.
The project comprises the following activities: 1) Project Management and Coordination - arranging overall project coordination including assistance to the Project Implementation Unit (PIU) in all aspects of project management and compliance with the EBRD Loan Agreement and other mandatas; 2) Design of part of the works; 3) Project Procurement Service; and 4) Supervision of Works in construction phase under Croatian Building Act and other related and applicable local laws and regulations and under FIDIC Contract Conditions for Construction (Red Book).
The Project Implementation Unit (PIU) is set up by Zagrebacki Holding for the day-to-day management of the project. In consultation with the PIU, the Consultant (IGH) has established the Project Implementation Plan (PIP) to cover all aspects of project implementation ensuring an effective Project Management and adequate expert input.
The project will be implemented in a four-year period (2008-2011).

KEYWORDS: project management, project implementation plan, operating procedures.

INTRODUCTION

Background

The Zagrebacki Holding has received a loan (60 mill EUR) from the European Bank for Reconstruction and Development (EBRD) for large scale improvements of the water supply and wastewater facilities in the Croatian capital Zagreb, serving about 850,000 inhabitants. Zagreb Municipality will provide counterpart funding (40 mill EUR) for the investment component of this project. Croatia (area 56,580 km2) is administratively divided into 20 counties and the capital, Zagreb, has a county status.

Water supply

An organized water supply system in the city of Zagreb dates from 1878. Back then, the water supply system was providing water to some 10 000 inhabitants, while today the municipal water supply system provides drinkable water to 850,000 inhabitants residing in Zagreb and Samobor, Dugo Selo, Vrbovec and Rugvica, Stupnik and Sveta Nedelja municipalities.
The municipality is mainly supplied with groundwater from the river Sava alluvium extracted from wells and pumped directly (untreated) into the water network. The water network - made of different kinds of pipe material - is approximately 2,600 kilometres long.
In Zagreb, affordability issues and lack of resources have limited the development within the sector and made long-term planning difficult. Consequently, maintenance of the existing water supply system has been low. Hence, the water supply system in Zagreb municipality is in need of major repair and new investments.

Sewer system

The construction of the sewer network in Zagreb began in 1892. Today the sewer system is approximately 1,800 kilometers. Construction of a main collector line ("GOK") and a central waste water treatment plant (CUPOV) is on-going and in its final stage.
The sewer system covers roughly 88% of the total city area, meaning that 120,000 citizens are not connected to the public sewer system. In the city area; mainly the upper part of Mala Mlaka pump site spill, i.e. in Novi Zagreb – west and Brezovica and at slopes of Medvednica, which is not served by public sewer, some 10,000 septic pits have been established causing a threat to the surrounding environment. It is estimated that additional 450 kilometres of sewers are required to cover the need of the Zagreb municipality.

Scope

The project includes both Consulting Services and Construction Works.

The Consulting Service Contract consists of following activities: 1) Project Management and Coordination - arranging overall project coordination including assistance to the Project Implementation Unit (PIU) set-up by Zagrebacki Holding for the implementation of the project in all aspects of project management and compliance with the EBRD Loan Agreement and other mandates; 2) Design of part of the works; 3) Project Procurement Service; and 4) Supervision of Works in construction phase under Croatian Building Act and other related and applicable local laws and regulations and "Engineer" under FIDIC Contract Conditions for Construction (Red Book).

The Construction Works consists of the following activities: 1) Water Supply Works - Zagreb East, Water Reservoir Cerje, Zagreb West, Water Leakage Management Phase I and Phase II, and 2) Sewage Works - New Zagreb, Trešnjevka and Zagreb East.

Zagrebacki Holding (the Client) has designs available for all the above mentioned works to be implemented except for the sewage works in Zagreb East.
The project also includes supply and installation of Supervisory Control And Data Acquisition (SCADA) equipment (Water Supply and Sewerage).

Project Management Structure

For the day-to-day management of the project, a Project Implementation Unit (PIU) is set up by Zagrebacki Holding and approved by EBRD. Project Implementation Unit is an organisational unit established within the Zagrebacki Holding in charge of the technical implementation of the Project within its competence. PIU is further an implementing body, responsible for the overall financial and administrative management of the implementation of the Project, including organisation of tendering, contracting, contract management, verification of invoices before payment for Service, Works and Supplies Contracts, monitoring at contract level and reporting to the Bank.
The Zagrebacki Holding appoints the members of the PIU. The PIU Leader is authorised to represent Zagrebacki Holding throughout the Project implementation.

Project Manager for the project is a person appointed by the Consultant (IGH as Lead Consultant in a consortium of Partners), approved and delegated by the Client for all obligations and responsibilities for technical implementation of the Project.
The Project Manager (PM) establishes, review and updates, in consultation with the Zagrebacki Holding/PIU, the Project Implementation Plan (PIP).

PROJECT IMPLEMENTATION PLAN (PIP)

The Project Implementation Plan (PIP) for the Zagreb Holding Water and Sewer Investment Project is divided into four parts as follows: Part 1: Project Procedures System; Part 2: Financial Management System including Project Budget; Part 3: Procurement Plan; and Part 4: Construction Supervision.
The Project Implementation Plan covers all aspects of project implementation, and includes, inter alia: Project Scope, Project Programme, Project Budget, Project procurement, Project risk matrix, Project organizational planning, Communication plan, Systems and Procedures for Filing and Documentation, Quality Management.
The Project Implementation Plan (PIP) (the manual) is a dynamic document, which can be revised if required in order to match changes in the project or its environment.

Part 1: Project Procedures System

This document - Part 1 of the Project Implementation Plan, describes the PIU operation procedures system in detail including:

The Project Scope - the background for the project, the scope, stakeholder analysis, planning including the strategy for project implementation and means of verification to ensuring that project objectives and expected outputs are met by the project;

Project Programme - describing in detail: Project Milestones defining the thresholds for the planned and required key deliveries and events; Milestones for Project Documents listing periodicity for key project documents prepared by the Consultant and submitted to the PIU and key project documents prepared by Zagrebacki Holding and submitted to the EBRD for info and/or "no objection"; Reporting based on unified reporting templates; and Project Monitoring with the purpose to identify problems during the project implementation and to ensure that timely action is taken to solve any problems.

A detailed Project Programme is prepared (presented in PRIMAVERA) for implementation of the Project - showing all activities and key events for design, approvals, procurement, construction, completion, etc.;

Project Risk Matrix - analysis of the critical risks and assumptions is carried out and presented in a table together with identified potential impacts and possible mitigations to negate such impacts.
Example from the Project Risk Matrix presented in the PIP, Part 1, see Table 1.

Table 1: Project Risk Matrix

Assumptions	Completion of the tasks, according to the time schedule and the budget.
Risk	Inadequate functionality and quality of the existing designs (prepared by Zagrebacki Holding) forming the background for the preparation of tender documents (Procurement Packages).
Main Impact	The level of information and data captured in the already prepared designs (by Zagrebacki Holding) will have a significant bearing on the level of risk of construction cost (extra claims from constructors) and time over-run later.
Mitigation Actions	Efficient communication with/transfer of site information during implemetation to the design teams (who prepared the designs) if any additional inforamtion / modifications to the designs required. A well organised construction supervision team should further surveys be required and extensive use of electronic integration of any survey data. Use of effective internal Quality Assurance System and control during construction phase.

Project Organizational Planning - describing the Project Organisation; Key Stakeholders Roles and Responsibilities; Project Implementation Unit including the staffing and the responsibilities of the PIU; the Project Team including presentation of organisation diagram; and Contact Details of all project stakeholders.
The Project Organisation structure is illustrated in the Figure 1 outlining the major project agreements among the key stakeholders.

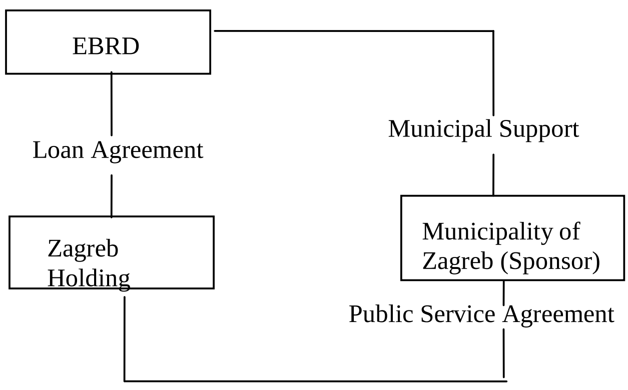

Figure 1: Project Structure

In Figure 2 is shown the organisational setup for the implementation of the Zagreb Holding Water and Sewer Investment Project.

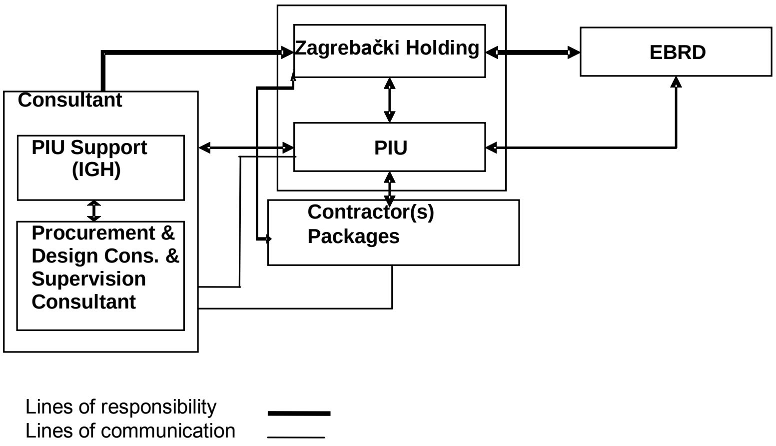

Figure 2: Project Organisation of the Implementation of the Project

Communication plan - describing in detail communication procedures including lines and targets, frequency, reporting and timely information distribution to ensure the streamlining of information flow between the PIU and project participants.

Systems and Procedures for Filing and Documentation - describing in detail: Document Types produced on the project; Identification of Documents; Registration and Distribution of Reports and Minutes; Handling of Communication Documents; Filing System; and Document Layout.

Quality Management - is carried out according to Zagreb Holding/PIU quality management system and the procedures described in the Project Implementation Plan Part 1, 2, 3 and Part 4. This section of the PIP describes the Preparation and Quality Verification of Project Documents including Internal and External Check and Approval procedures and approval of final versions of documents.

Quality verification is defined as "Activities to verify the fulfilment of quality requirements". Checks and approvals are used in order to verify the quality.

The check and approval covers both internal preparation of documents and all receiving documents from project stakeholder. The individuals responsible for the preparation of the *document* do the self-check and discipline check (technical and financial). The responsibility for the professional content of the document rests with the author of the document, who shall always personally check that the document is complete, correct, and sufficiently detailed, not with the person checking it.

The check of project documents is an independent activity to be planned and carried out like all other activities of the project. The check shall be performed and possible revisions made to the satisfaction of the PIU Director.

Part 2: Financial Management System including Project Budget

This document describes the PIU operation procedures system in relation to procurement of works and EBRD reporting and payment of Contractors including management of the Project Budget including:

Project Accounting and Budget Management System - describing in detail:

• *Project Accounting Systems*: All accounting related with the Project is maintained by the Accounting Department of Zagrebacki Holding. All the related expenses will be accounted separately in specially opened sub-accounts. However, in order to keep track on the project development, PIU maintains accounting for all project related activities, including loan disbursement, estimation/calculation of interest and principal payments values, loan servicing payments, invoices received from the Contractors, and accounts verification.
The project accounting should be maintained on day to a day basis, with further summarisation of actual data on monthly, quarterly and finally on annual basis. This information should be widely used for project budgeting and budget management.

• *Management of Project Budget:* Budgeting is a very important part of the PIU activity. Budget is the financing plan of the project implementation activity and achievement of planned results. The PIP stipulates that the budget should be prepared at an early stage of the project, even taking into account that it could be changed significantly during the actual implementation phase. Therefore it is proposed, in the PIP, that the Project Budget is revised on monthly basis, based on the estimates of payments provided by the Contractors and the analysis of the project activity and deviation from planned results is carried out.
The careful monitoring and updates of the Project Budget will allow Zagreb Holding/PIU to make necessary adjustments in the loan withdrawal schedule with respective notification of the EBRD on the changes and progress achieved

• *Zagreb Holding Economical Performance Indicators:* In parallel with collection and monitoring of project financing and expenses activities, PIU has to furnish EBRD (Quarterly and Annually) information on a number of financial coefficients / affirmative covenants specified in the Loan Agreement between Zagrebacki Holding and the EBRD.

Loan Servicing - describing in detail:

• *Loan Servicing:* The first step allowing withdrawing the funds from the Loan account is to obtain/satisfy the requirements applying to the Borrower necessary for Loan Effectiveness. A complete list of the requirements is presented in the Loan Agreement between the Zagrebacki Holding and the EBRD.

• *Debt Service Reserve Account Management:* According to the Loan Agreement the Debt Service Build-Up (DSR) Account is to be established prior to the first application for the Disbursement, into which Zagreb Holding shall deposit and at all times maintain a balance of equal to not less than the HRK equivalent of the sum of all payments of principal and interest on the Loan which will be due and payable during the next six months.

Procedures for payment to the Contractor - describing in detail: The Payment Procedures including Advance Payment procedures, Interim / Monthly Payments and Final Payment. Loan Disbursement Procedures where the approximate order of documents approvals processing necessary for the loan disbursement/payment to the Contractors is presented.

Part 3: Project Procurement

This document describes in detail the Procurement Arrangements during the implementation of the Project including:

Procurement packages - describing in detail the Packages including description of the background, no of procurement packages, type and content/specification and budget of each procurement package.

Procurement Arrangements - describing in detail:

• *Procurement strategy of the Project:* Procurement of all goods, works and services required for the Project and to be financed out of the proceeds of the EBRD Loan to Zagreb is carried out in compliance with the procurement rules for public sector operations under the "Procurement Policies and Rules for Projects Financed by the European Bank for Reconstruction and Development"**,** as specified in the Loan Agreement between the EBRD and Zagrebacki Holding. Goods, works and services (excluding consultant's services) are procured through open tendering. All contracts are subject to the review procedures set out in "the Procurement Policies and Rules" and are subject to prior "no objection" by EBRD.

The contracts for the Engineering works designed by the Employer (mainly water supply and sewer piping) are based on FIDIC Conditions of Contract MDB Harmonized Edition 2006, for Building and Engineering works designed by the Employer and based on unit prices. Supply and Installation of equipment (bulk flow meters, potable flow measuring equipment, pressure meters, radio communication equipment etc.) for the water supply system and supply and installation of equipment (flow meters, rain meters etc) for the sewer system is based on FIDIC (Yellow Book) Conditions of Contract for Plant & Design-Build or EBRD "Standard Tender Documents for the Supply and Installation of Plant and Equipment".

• *Procurement Process*: For the procurements with time constraints "Open Tendering" procurement procedure without pre-qualification is used. It means that all interested tenderers who have purchased the tender documents can submit a tender. However, post-qualification is carried out, of those tenderers who have provided any tender security required etc., to ensure that these meets the criteria as stipulated in the "Invitation to Tender Notice". Detailed data on the key milestones are presented in Table 2.

Table 2: Key Milestones of the Procurement Package

Activity / Document and timing	
Type of project	Works (EBRD - FIDIC Red Book)
Cost estimate	(price)
Procurement Method	Open International Tendering
Prequalification Documents	(date)
Prequalification	(date)
Tender documents completed	(date)
Invitation for tendering starts	(date)
Tender evaluation completed	(date)
Contract signed	(date)
Contract completion	(date)

A detailed description of the actions and documents which need to be prepared during the tender period is provided with reference to relevant forms /templates, which are attached as annexes.

Procurement and Implementation Plan - "Master Plan" showing the timing of the project implementation activities including procurement and construction supervision of the Contract Packages is presented.

Part 4: Construction Supervision

This document describes the Construction Supervision Arrangements during the implementation of the Project including:

• *Roles and Responsibilities under Construction Supervision* - Construction supervision is performed by the selected Supervision Consultant (SC) acting as the Engineer (as specified in the FIDIC Conditions of Contract for Construction, First Edition 1999, MDB harmonized edition May 2005, amended March 2006) during the construction of the project. The Engineer will be responsible for all construction supervision from the Commencement Date until the end of the Defects Liability Period. The organisation of the supervision for this project is illustrated in Figure 3 showing the contractual relations and communication between parties of the project implementation.

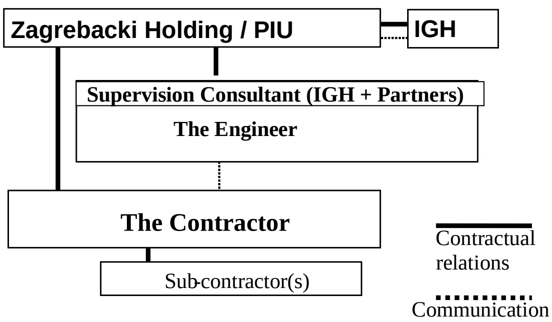

Figure 3: Relationship between the Parties of the Project

The tasks of the Contractor and the Engineer during the three main phases of the Project implementation, i.e. Pre-Construction, Construction and Defects Liability phase are described in detail.

The Supervision Consultant (SC) will prepare his own Supervision Manual on how the supervision will be performed. The SC will also prepare a Quality Assurance Manual describing the quality assurance of his supervision.

Phases of the Construction supervision - describing in detail the three main activities: Pre-construction activities such as organisation of quantity control, quality monitoring and checking and organisation of administration and monitoring system; Supervision activities comprising quality check before construction, quantity control, quality monitoring and checking, testing, monitoring and recording and contract administration; and Defects Notification Period activities comprising final control and completion activities.

Monitoring and Reporting of Project Implementation - describing in detail:

• *Project Monitoring and Reporting from Supervision Consultant*: In order for the Zagrebacki Holding/PIU to monitor and report progress to key project stakeholders the Supervision Consultant /the Engineer shall forward a number of reports to the PIU for comments and approval. To organise administration and monitoring the Supervision Consultant (SC) is establishing a system to handle all the supervision construction documents. A detailed list of documents to be prepared by the Supervision Consultant is presented.

• *Employer/PIU's Own Monitoring and Reporting*: Based upon the Supervision Consultant reporting, Zagrebacki Holding/PIU reports to the key stakeholders. The Contractor will submit a payment schedule at the commencement of the construction works, and update the payment schedule on quarterly basis. Each monthly invoice from the Contractor will show a summery of all payments, etc. Examples of such forms are shown in the PIP. Reporting to EBRD is dealt with in Part 2 of the PIP.

CONCLUSION

The most important aspect of a successful project management is a high standard organisation of work which implies that all project participants are fully aware of their responsibilities, task assignments and deadlines.

It is also important that the key project personnel recognizes the relation between various task assignments in order to act in due time.

In order to implement the aforementioned activities it is essential to make a project implementation plan with clearly and unambiguously defined roles and procedures on the project.

By establishing the project implementation plan we have created a solid basis for completion of the project within the anticipated time schedule and budget meeting the established quality requirements. However, it should be emphasized that the Project Implementation Plan is based on that the attitude among all individual staff on the project is:

- Having a Quality culture
- Working with the PIP as a tool
- Updating the PIP when necessary

It should be underlined that the project is in its early stage of implementation. Therefore, it is not possible to address the leasons learned at the moment. However, it can be concluded that during the preparation of the PIP we have been lead through a detailed analysis of the project scope, contractual basis for the projects including the established agreements, the EBRD procedures, etc., all of which has helped us to establish a solid basis for the project implementation including organization approach.

REFERENCES

European Bank for Reconstruction and Development (EBRD), (July 2004) Disbursement Handbook for public sector loans.

FIDIC Contract Conditions for Construction (Red Book), MDB harmonized edition (May 2005, amended March 2006) Conditions of contracts for construction for building and engineering works designed by the employer.

INSTITUT IGH, d.d. (January 2009) Project Implementation Plan (PIP). Approved by European Bank for Reconstruction and Development (EBRD).

Loan agreement between "Zagreb Holding" and European Bank for Reconstruction and Development (24th December 2007).

A PROTOTYPE RISK MANAGEMENT DECISION SUPPORT TOOL FOR CONSTRUCTION PROJECTS

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Although risk management (RM) is accepted as one of the critical success factors for construction projects, project participants generally do not have sufficient knowledge pertinent to RM concept and the number of support tools which facilitate the process is rather low. Decision support tools are necessary for the systematic identification of risks, scenario generation, and proactive management of risk and integration of RM activities with other project management functions. The aim of this study is to introduce a conceptual RM model and a prototype RM decision support system which is specifically developed for construction companies. The proposed decision support system, namely Integrated Risk Management System (IRMS), is designed to support the user at all phases of the RM process and to assist cost estimation in the bid preparation stage. The performance of the tool is tested on six international construction projects. Results demonstrate that IRMS can be used effectively for systematic management of risks and its prediction capability is high. Shortcomings of the tool and necessary refinements are also reported.

KEYWORDS: risk management, decision support systems.

INTRODUCTION

Significant changes in the global economy have resulted in increased business opportunities for engineering and construction companies throughout the world. Nowadays, more companies are positioning to expand their operations in the international construction market. Risk management (RM) is an important part of international project management as these projects are subject to more risks than domestic projects due to complexity of logistics, communication channels, cultural differences and vulnerability to host country conditions.

Risk management has taken its part in project management literature in early 1970’s and preserved its importance as a research topic since today. There are various process models proposed in the literature such as PRAM (Project Risk Analysis and Management) developed by Chapman (1997), RAMP (Risk Analysis and Management for Projects) proposed by Institution of Civil Engineers (ICE) (1998) and PMBoK (Project Management Body of Knowledge) by Project Management Institute (PMI) (2000). The construction management literature is also rich in terms of conceptual risk management frameworks. Researchers have proposed various conceptual risk management frameworks to overcome the informality of risk management efforts in the construction industry. However, as Dikmen et al. (2004) stated, risk management paradigms usually exist as methodologies rather than systems which can support RM process. There is only a limited number of risk management support systems (RMSS) developed for the construction industry. Another RMSS prototype is developed by Tah and Carr (2000) which is based on a formal methodology for construction project risk management, including a generic process model and underlying information model. Jaafari (2001) proposed a generic model, called IFE (Integrated Facility Engineering) that consists of various modules like information module, neural network and simulation engines and reporting functions.

The major problem of risk management support tools is lack of integration. Actually, the problem of integration covers integration of risk management with other project management tasks (scope, time, cost, quality, human resources, communication, claim and procurement management); integration of hard systems with soft or human based systems; integration of structured information with unstructured information; integration of project objectives (short-term) with strategic (long-term) objectives; integration of risk management processes with each other; and finally integration of RM activities in one company with those in other project participants.

PROPOSED RISK MANAGEMENT SUPPORT SYSTEM

The aim of this study is to propose a risk management decision support system which can be used in international construction projects at the bidding stage. The proposed model is designed to overcome some of the shortcomings pertinent to RMSS. Integrated Risk Management System (IRMS) is a decision support system which integrates all phases of RM and incorporates different risk perceptions of project participants by its multi-user option. With its built-in risk breakdown structure, risk identification process is systematized and a common risk language is formed. The system is designed to prepare various kinds of reports, charts and maps to increase the awareness of managers about the existence and magnitude of different risk factors. It enables monitoring of risk impacts throughout the project life cycle and updating of risk management plans. One of the vital features of IRMS system is incorporation of risk knowledge associated with previous projects, for the risk assessment of forthcoming projects. The system has a corporate memory which is formed by storing project data created by using IRMS.

IRMS system architecture

The Borland Delphi 7.0, MS Visio 2003, MS SQL and MS Access 2003 are used to develop and code IRMS model based on the object-oriented approach. The major aim of IRMS components is to ensure construction of the project cost performance model using built-in risk breakdown structure and setting the relations between risks, response and performance by referring to the past cases. IRMS project risk management process starts with acquiring and storing necessary project information. Major idea behind the detailed project information demand is that information entered for each project is stored in a project library, a SQL (Structured Query Language) type knowledge database. The information stored in the database such as country and project information, risk sources and consequences in terms of time and cost may be used during the risk identification and analysis phases of forthcoming projects. The volume of this corporate risk memory expands and accuracy of predictions tends to increase as a company utilizes IRMS more frequently.

IRMS supplies a multi-user platform to facilitate group decision making during risk identification and assessment. The administrator has the responsibility to get the work packages from the planning expert, enter them into the system, assign risk sources to the specified work packages and carry out the first rating process. If RM process is executed by using the multi-user option, other experts carry out the same process for all work packages defined by the risk administrator and rate the pre-defined risk sources for each work package. The experts do not have the opportunity to make any modifications pertinent to base information of the RM process. However, they can make comments through notes. IRMS is designed to supply a multi-user platform by forming a SQL based main server to import and export information by entering the passwords defined by the risk administrator. The system architecture and data flow of the proposed system is shown in Figure 1.

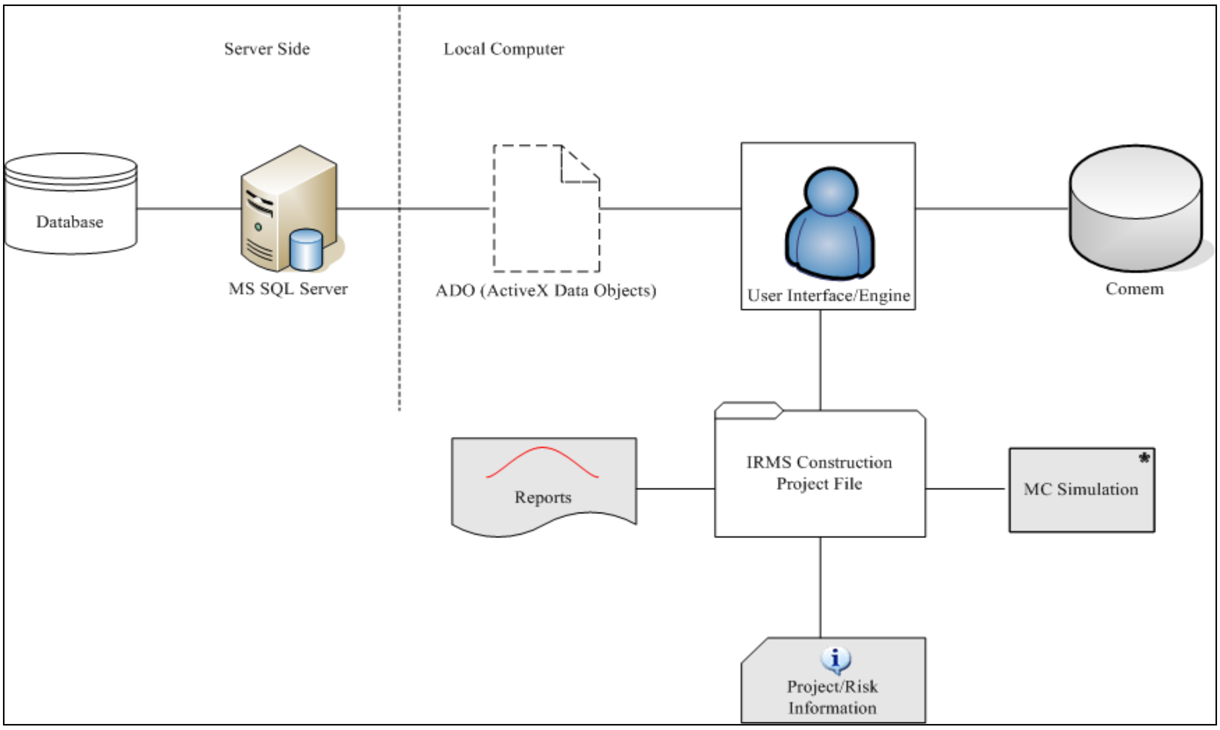

Figure 1: IRMS System Architecture Data Flow

IRMS risk management process model

IDEF0 modelling technique is used to develop the IRMS process model. The model consists of the following phases (Figure 2) such as setting project information, risk identification, risk rating and response development, risk analysis and risk revising and monitoring.

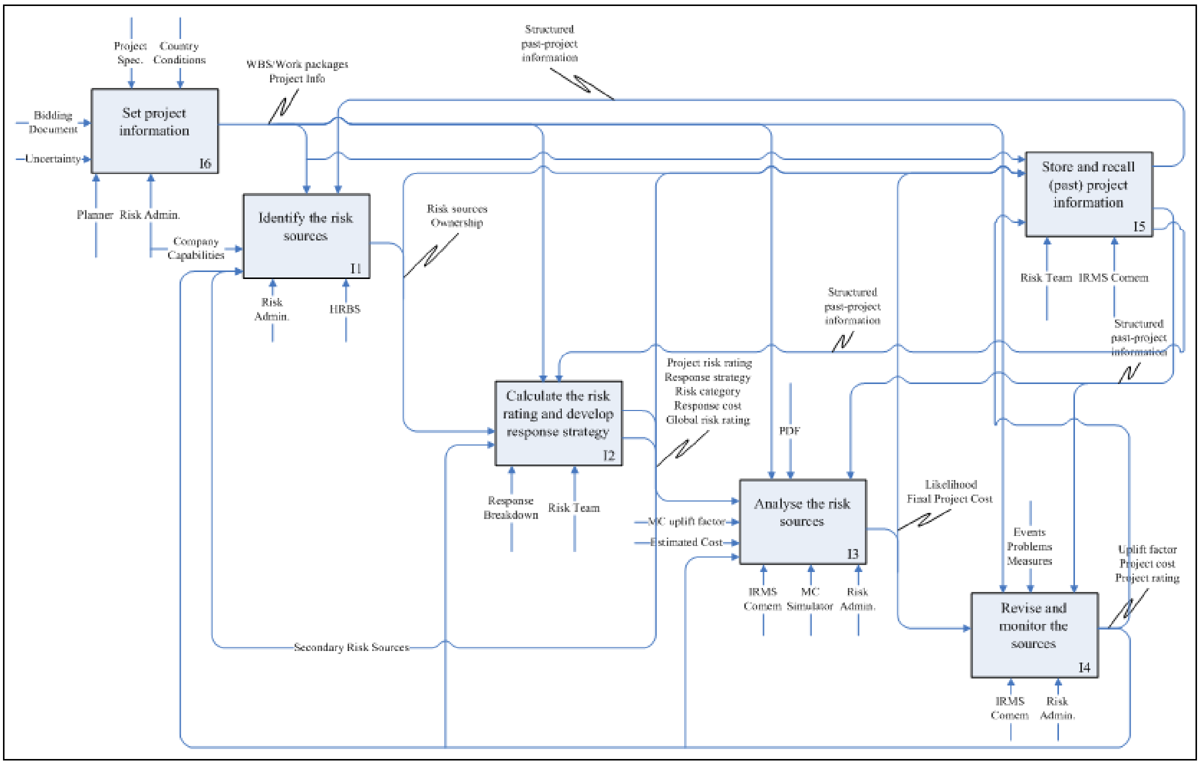

Figure 2: IRMS IDEF0 Process Model

IRMS risk identification phase

Risk identification is the process of defining "risk sources" which will have an impact on project success whereas the overall project success criterion is defined as "cost" in IRMS. Although risk identification seems to be a simple process when compared to other risk management tasks, it is one of the most important and complex task for a decision-maker, as poor definition of risk may result in wrong formulation of the risk model. IRMS handles risk as a "source" and prevents the possibility of inconsistent definition of risk by providing a consistent platform, called as HRBS (Hierarchical Risk Breakdown Structure). A HRBS template which incorporates a pre-defined coding system is embedded in the system to establish a common language for users.

In IRMS, the risk sources are handled as either project specific risks which can be assigned to project work packages or global risk sources those affect the whole project. The five-level HRBS template that includes 77 risk sources is formed by taking into account the contract clauses, project participants, project and country conditions as well as construction and design related issues which may affect project performance. The user is expected to identify potential risk events (risk factors) under each category and create a risk checklist for the project. The HRBS is flexible, thus the expert can make modifications, add new risk categories or delete irrelevant ones. Risk codes create a common understanding between project participants and improve the communication of risk information between different parties. IRMS provides a tutorial to the user which includes the codes, meanings and examples for the corresponding risk sources to prevent misunderstanding of risk items by different users under different conditions.

IRMS risk rating and response development phase

After the risks are identified for each package and the project, a risk rating process is carried out by the users for initial assessment of the risk level. Risk rating task covers assessment of probability of occurrence of identified risk sources and their impacts, if they occur. The risk rating of each risk source is calculated by simple multiplication of its probability of occurrence and its impact. For the probability and impact values, a Likert scale (1 to 5) is used. Based on his/her subjective judgments, a user assigns probability and impact values so that the risk rating can be calculated for each package and project. The aim of risk assessment is not to quantify risks but identify critical risk factors and compare relative magnitude of risks.

IRMS model integrates and systematizes all explained tasks of risk identification, risk rating and response development by using a process called as Risk Carding (RC). The logic of RC is to define a “card” for each risk that will be used as the basis of risk analysis. RC process starts with the identification of a risk source. The system calls automatically the risk code of the corresponding risk. After a risk is identified, the process continues with contract evaluation in order to determine the “ownership” of the identified risk source. After the initial rating process (pre-response rating) is completed, responses are determined and rating process is repeated (post-response rating). This is an iterative process as the feasibility of the identified strategy should be assessed by the decision-maker by monitoring its cost, residual and secondary risks.

IRMS global risk rating process

According to IRMS model, the same risk rating procedure used for risk assessment of work packages can be applied to global risk sources. The expert should assess the probability and impact values for country risk sources such as political, economical, social, legal and force majeure risks given in HRBS and compute a global risk score. Finally, total project cost is uplifted by a pre-defined percentage decided in the light of the global risk score. At this point, IRMS does not propose any percentage scale to the expert, since this percentage depends on many parameters like company strategy, company work load, company strengths and weaknesses etc. For this reason, IRMS leaves the responsibility of assessing the global risk percentage to the experts. However, if IRMS is used for many projects and therefore a more reliable corporate memory is achieved, then, the relationship between cost and risk rating may be learned from previous projects and a realistic contingency value may be selected using this information.

IRMS risk analysis phase

Risk rating approach and Monte Carlo (MC) simulation are used together to quantify the impact of risk sources on work packages. The risk rating score is an important input for the user while choosing the appropriate distribution parameters to be used during MC simulation. As the current study is pertinent to cost estimation, IRMS MC Simulator is used to calculate total project cost considering risk categories and additional response cost of each work package. After defining probability distribution functions among the most widely used probability distribution options such as uniform, normal, triangular, beta, trapezoidal and custom distributions, and assigning correlations between them, the simulation is run, total project cost for different scenarios are computed and corresponding probability values for different cost ranges are obtained.

The default distribution function of IRMS is triangular distribution and simplified rules are proposed to the users while choosing the most likely, minimum, maximum values of the triangular distribution according to the risk rating score as well as the subjective correlation values considering common risk factors affecting work packages. The details of MC simulation can be found in Arikan (2005). Finally, cost calculated by using MC simulation is uplifted by applying a percent value that reflects the impact of global risk sources on project cost. At this point, IRMS does not propose any percentage scale to the expert because this percentage depends on many parameters like company strategy, company work load, company strengths and weaknesses etc. For this reason, IRMS leaves the responsibility for assessment of global risk percentage to the experts or decision makers.

IRMS risk revising and monitoring phase

Risk revising and monitoring is the final stage within the risk management process. The risk sources must be monitored in order to follow how well the risk response strategies/measures are working and to take effective actions, when the risk occurs. As construction projects are dynamic in nature, status of risk sources may change. Therefore, the status of risk sources and their impacts on work packages should be monitored regularly by comparing the forecasted values with the actual ones and necessary modifications should be done as the project proceeds. In this respect, IRMS assists the user to monitor changes in risk levels and corresponding costs at different stages of project life cycle.

IRMS corporate memory (Comem)

IRMS Comem is a smart knowledge database which stores project, country, risk and cost related information for the retrospective use of data in the forthcoming projects. The main philosophy of the system is to classify and structure all kinds of risk information in order to enable learning from risks and decrease the subjectivity during the risk assessment process. Comem is a relational database that is composed of three types of domains such as project domain, risk domain and actor domain.

The risk expert shall use the search engine of the Comem to find out previous projects which meet the pre-defined criteria such as project type, country, global risk rating etc. Comem supplies structured past project information (both planned and actual) to facilitate the risk assessment and evaluation process of a forthcoming project. For example, a decision-maker may search previous projects that used a particular response strategy in order to estimate its cost in the current project. The actual costs and risk ratings of work packages may be recalled in order to decide on the lower and upper limits to be used in the probability distribution of a similar work package in the current project.

APPLICATION OF IRMS TO REAL PROJECTS

The developed IRMS prototype has been tested on six completed projects which were carried out in Saudi Arabia, Turkey, Turkmenistan, Iraq, Russian Federation and United Arab Emirates (Table 1). The aim of this study is to monitor possible difficulties faced by the users and test the accuracy of its outputs. Thus, the experts were requested to carry out a risk assessment exercise by using IRMS assuming that they are estimating the cost at the start of the project. The original values (estimated costs) are considered as base costs and contingencies are determined according to risk ratings calculated by using IRMS. All experts are members of the project management team of the case study projects and have sufficient knowledge about the risk events that actually happened throughout the project.

Case 1 is a petrochemical processing plant construction in Saudi Arabia. In this project, the project delivery system is design-bid-build in which the design works are under the responsibility of the client. The risk expert is the technical office manager of the related construction company. In this project, the risk expert considered “construction risk” source as the most critical one and identified 44 types of project risk factors. “Labour risk”, “material risk”, “quality risk” and “design risk” categories embraced a high number of significant risk factors. Similarly, the global risk rating indicated a high risk value. A screen shot of the IRMS tool for petrochemical processing plant construction project and one of the corresponding reports are shown in Figure 3 and Figure 4, respectively.

Case 2 is a hydro-electric power plant (HEPP) project which was realized in Turkey. The project delivery system is design-build and the associated parties are; members of a consortium that consists of a foreign construction company, a Turkish construction company and a Turkish design company. The risk expert is the manager of the foreign construction company. During the risk assessment phase, risk expert identified 33 types of risk sources and assigned a total of 141 risk factors to 8 work packages. Among the 33 types of risk sources, the ones under the category of “client”, “project management” and “contract” are identified as the ones having the highest impact on project cost. In addition, the global risk rating process carried out by the risk expert using HRBS resulted in a high rating (11.32, a value between 10 and 15, which indicates high risk as suggested by the Baccarini and Archer, 2001). The project and global ratings imply that project is a high risk project.

Case 3 is the refinement and storage units construction of a refinery in Turkmenistan. The project delivery system is design-build and the project is carried out by a joint venture formed by Turkish and German contractors. The risk expert is the construction manager of the joint venture. According to IRMS model, the major risk categories are identified as “labour risk”, “project management risk” and “sub-contractor risk”. The global risk rating corresponds to moderate risk category which foresees less global risk impact when compared to the first two cases.

Case 4 is a residential building project in Iraq. This project is a design-build project. In this project, the job is carried out by a single contractor and the risk expert is the technical office manager of this construction company. According to the information entered by this expert into the IRMS model, this project has less technical risk sources compared to other cases but the “scope risk” and “contract risk” may have significant impacts on cost. On the other hand, according to IRMS outputs, the global risk rating is found to be the highest among all case study projects.

Case 5 is a gas compressor station reactivation project in Russian Federation. This project is a design-bid-build project. In this project, there is a single contractor and the risk expert is the technical office manager of this construction company. According to the information entered by the expert into the IRMS model, this project has less technical risk sources compared to other cases but the “site conditions risk”, “external conditions risk”, and the resource based risks such as “material, equipment, labour and fund” may have significant impacts on cost. On the other hand, according to IRMS outputs, the global risk rating is similar to the Turkmenistan case and can be perceived as moderate category.

Last project is a drainage and sewage system construction project which is realized in Dubai, United Arab Emirates. The project delivery system is design-build. The risk expert is the project manager of the construction company and has great experience in infrastructure projects. The IRMS results indicate that the project has potential risk sources which arise from mainly “requirements” and “parties”. The expert defined 31 types of risk sources among which “quality”, “health and safety” and “project management” mostly govern the project cost. The global risk rating is found to be the lowest of all six cases, which influences the project cost less, when compared to other cases.

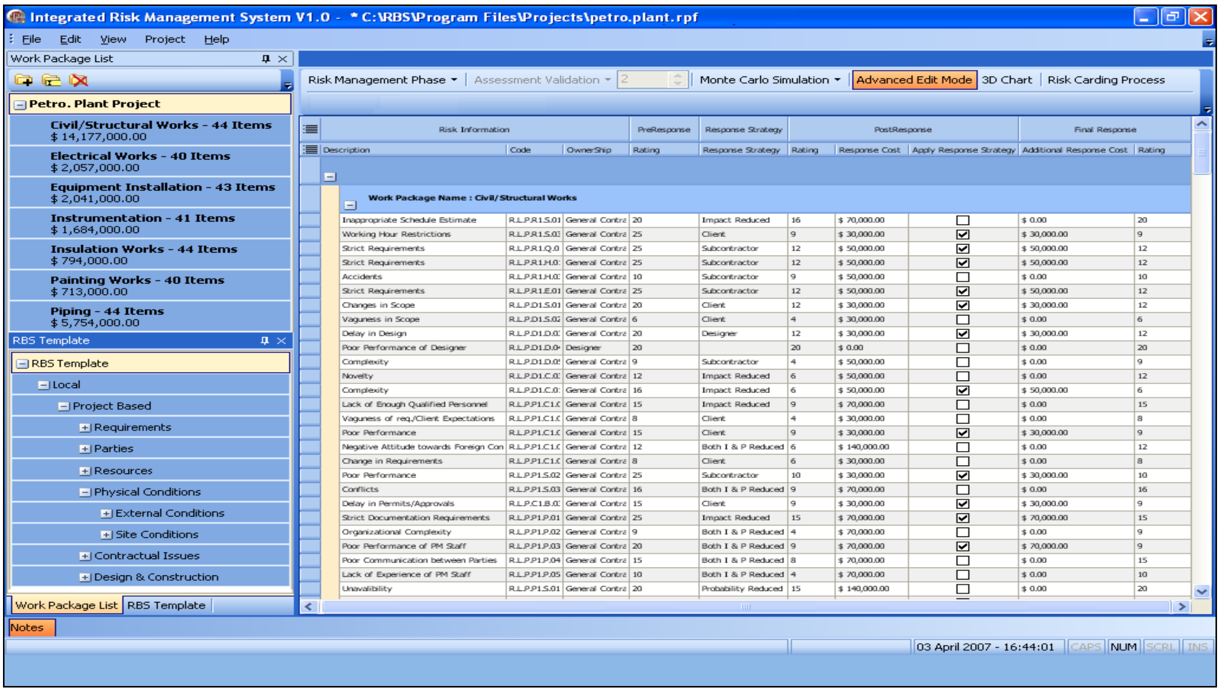

Figure 3: A Screen Shot of the IRMS

Table 1 shows the general information about the examined six cases. These cases cover a wide geographic region and they are within a reasonable cost range (small and large projects within the range of 6 million to 75 million US $). Moreover, the case study projects are carried out in countries that have different risk levels. Among the cases, the most risky country is Iraq and the least risky one is United Arab Emirates.

DISCUSSION OF CASE STUDY FINDINGS

As well as its capability to systemize the risk management process, the performance of IRMS can be measured by how well the risk impacts are reflected onto the price. Table 2 is a comparison table which shows the results of IRMS, mainly cost estimates (that have 50%, 75% and 100% probability of occurrence), project risk rating, global risk rating and actual cost figures. The results show that although outputs of IRMS are highly pessimistic compared to initial cost estimates, they are very close to actual costs, excluding the change order costs. The highest error, which is calculated by considering the difference between the mean value provided by IRMS and the actual cost figure is around 6%, which is an acceptable result.

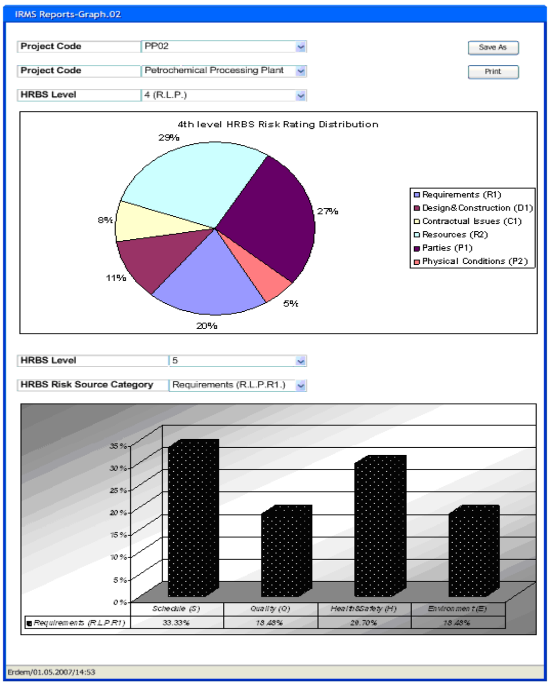

Figure 4: An Example of IRMS Report

Table 1: Information Summary of the Examined Cases

Project	Country	Estimated Cost (E) ($)	Realized Cost (R) ($)
Petrochemical Processing Plant Construction	Saudi Arabia	27.220.000	36.003.000
Hydro Electric Power Plant Cons.	Turkey	76.095.000	86.743.000
Refinement and Storage Units Construction	Turkmenistan	17.084.000	20.704.000
Residential Building Cons.	Iraq	15.500.000	20.462.000
Gas Compressor Station Cons.	Russian Federation	5.828.000	7.251.000
Drainage and Sewerage System Construction	United Arab Emirates	12.500.000	13.700.000

Although point accuracy is not the primary goal of IRMS, the results show that the cost estimation capability of the IRMS is highly satisfactory. All of the experts perceived IRMS as a practical tool that facilitates systematic management of risks. One of the major strengths of the system, as identified by experts is its HRBS that helps the systematic identification of risk sources and easy communication of risk information between project participants. Moreover, experts mentioned that the multi-user risk assessment feature can be very useful as it can increase awareness on risk issues (magnitude, ownership, possible response strategies etc.).

On the other hand, experts experienced difficulty in understanding the RC process and argued that the response costs cannot be estimated easily. Also, the experts criticized the time elapsed for the entry of basic information and proposed that the data entry speed may be enhanced by providing short-cuts. All of the experts used triangular and trapezoidal distributions and claimed that these two would be applicable for all the projects. The major difficulty faced by the experts was deciding on the upper and lower limit values in the distributions. One of the shortcomings of IRMS is denoted to be the subjectivity of the risk ratings and their impacts on project cost. It is believed that the multi-user option and corporate risk memory will decrease subjectivity and increase the trust of decision-makers on the IRMS outputs.

Table 2: IRMS Outputs

Project	Outputs of IRMS about costs($)			Outputs of IRMS about risk ratings		Error (%)	
	50% (EIRMS-Mean)	75%	100%	Final Project Risk Rating	Global Risk Rating	Without IRMS [(R-E)/E]*100	With IRMS [(R-EIRMS-Mean)/ EIRMS-Mean]*100
Petrochemical Process. Plant	35.626.000	36.411.000	38.260.000	12.45	10.42	32.27	1.06
Hydro Electric Power Plant	87.595.000	88.411.000	90.054.000	12.07	11.32	13.99	-0.97
Refinement & Storage	21.377.000	21.800.000	22.860.000	9.88	9.57	21.19	-3.15
Residential Building Cons.	20.554.000	21.051.000	21.930.000	10.24	19.71	32.01	-0.45
Gas Comp. Station	7.051.000	7.373.000	7.693.000	11.48	9.91	24.41	2.83
Drainage Sys.	14.561.000	14.900.000	15.500.000	12.55	8.84	9.6	-5.6

CONCLUSIONS

Within the context of this study, a prototype decision support tool, namely IRMS has been introduced. IRMS may overcome some pitfalls of the existing RM applications such as lack of a generic risk terminology and consistent risk breakdown structure (with its built-in HRBS), over simplistic tools to quantify risk (by using risk rating and MC simulation together) and a linear risk management process where feedback information is neglected (iterative risk carding, risk revising and monitoring processes). It also supports multi-user risk assessment process and storage of risk information in a memory based on a SQL server so that the relation between risk-response and cost can be learnt from previous projects. With its effective reporting system, it increases the awareness of managers on size, type and impact of risks and facilitates communication of risk information between the parties.

Applicability of IRMS prototype has been tested on six completed international construction projects. Its cost prediction capability is found to be very high. Although the outputs of the model are found very close to actually realized cost figures, the accuracy of IRMS must be tested on several other cases before it can be claimed to be a reliable tool. In this study, experts used IRMS on already completed projects. However, IRMS must be used at the start of a project and the actual costs must be compared with the initial estimates to test its performance more realistically. Next step of the research is to finalize the structure of the risk memory and test its performance by entering real project data.

REFERENCES

Arikan, A. E. (2005) Development of a risk management decision support system for international construction projects, MSc. Thesis, Graduate School of Natural and Applied Sciences, Middle East Technical University, Ankara, Turkey.

Baccarini, D., and Archer, R. (2001) The risk rating of projects: A methodology. International Journal of Project Management, 19 (3), 139-145.

Chapman, C. (1997) Project risk analysis and management: PRAM the generic process. International Journal of Project Management, 15 (5), 273-281.

Dikmen, I., Birgonul, M.T., and Arikan, A.E. (2004) A critical review of risk management support tools, in: Proc. 20th Annual Conference of Association of Researchers in Construction Management (ARCOM), Vol. 1, Heriot Watt University, Edinburgh, 1145-1154.

Institution of Civil Engineers (ICE) (1998) Faculty and Institute of Actuaries, RAMP: Risk Analysis and Management for Projects, Thomas Telford, London.

Jaafari, A. (2001) Management of risks, uncertainties and opportunities on projects: time for a fundamental shift. International Journal of Project Management, 19, 89-101.

Project Management Institute (PMI) (2000) A guide to the project management body of knowledge (PMBoK guide), Project Management Institute.

Tah, J.H.M., and Carr, V. (2000) Information modelling for construction project risk management system. Engineering, Construction and Architectural Management, 7(2), 107-119.

MANAGING BUSINESS CHANGES IN CONSTRUCTION COMPANIES

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The traditional nature of work organization in AEC companies in Slovenia, especially those that deal with construction, needs a better capturing of business changes they are faced with in the global economy. In order to manage those changes a trend of systematically introducing management methods for company re-organization, such as Business Process Re-engineering (BPR), ISO 9000, Total Quality Management (TQM), the 20 Keys Method, benchmarking, etc. has been applied recently. This paper focuses on the business process re-engineering concept from a different point of view; organizational and technical. The introduction of radical changes within the analysis of activities and the analysis of processes is described in the organizational part. The technical part discusses how to implement modern information and communication technologies as an appropriate tool for the purpose of introducing the concept of re-engineering in construction companies with the goal of ensuring faster and more efficient collaboration. Finally, the conclusion sums up some realization on the reengineering projects that was realized on the basis of our knowledge of the contemporary management methods and our practical experience.

KEYWORDS: construction management, business change, re-engineering, information technology.

INTRODUCTION

Construction industry is a very important sector of the national economy, one in which traditional management organization has been developed. The limits of traditionalism in the changeable global environment have led construction companies to realize that demands for the modernization of business processes and a more efficient work organization are needed. Hence, there has been a trend to systematically introduce one of the management methods for company re-engineering such as Business Process Re-engineering (BPR), ISO 9000, Total Quality Management (TQM), the 20 Keys Method, benchmarking, etc. Among the existing methods the business process re-engineering developed by Hammer and Champy (1993) as a general management concept was chosen in this paper because it offers the most opportunities for a radical re-engineering, and assures tangible positive results. Anyhow, the difference between the re-engineering of the construction process and the re-engineering of the process mass industrial production needs to be taken into consideration.

Over the years, there has been an initiative to formulate a concept for implementing a basic BPR concept in construction. The founders of construction process re-engineering were Ireland (1995), with his “T40 Report”, Betts and Harper (1994), with the publication of “Re-engineering construction”, Love et al. (1998), with the definition of the concept of “Construction process re-engineering CPR”. A few years later the Cheng and Tsai (2003) develop the “Construction management process re-engineering (CMPR)“ method and Courtney and Winch (2002) examined the strategic study on “re-engineering construction” and introduced the concept of re-valuing construction. All the concepts deal with the management of business systems from the process point of view in the case of managing change in a company within a modified type of work. Relatively low emphasis has been given to technology issues such as modern information and communication technologies in meeting these challenges.

Therefore, the introduction of modern information and communication technologies and automation seem as useful technical tools for systematically introducing the management concept of company re-engineering. Thus the introduction of a modified type of work and consequent efficiency of a re-engineering project significantly depend on the choice of adequate information and communication technology (ICT). ICT experts have developed a variety of solutions to support efficient co-ordination of information flow such as Electronic Data Interchange (EDI), the Electronic Document Management System (EDMS), the Workflow Reference Model, the Interactive Personal Communication Network (IPCN), the Dynamic Communication Environment (DyCE), and others.

The BPR concept as discussed in this paper is presented as a unified methodology for process monitoring during the implementation of a re-engineering project in a company, which is oriented towards the re-engineering of construction companies from the organizational and technical point of view.

CHARACTERISTICS OF THE SLOVENIAN CONSTRUCTION MARKET

The construction industry and construction company management in Slovenia, unfortunately still believe that there is no real need for the reorganization of business or work operations. But nowadays companies are faced with generally embraced principles of free trade and yet the global economy runs under certain principles. Therefore, several organization and business difficulties such as a distinctive hierarchy, rigidity in decision-making and inadequate financial and human resources are the reasons for a more than requisite reorganization.

In Slovenia, construction company management and its BPR method is still a relatively new field and has accordingly not been researched yet. They are new concepts, not only for most minor shareholders but also for the majority of newly established public and private institutions. These new shareholders have played a major role in the historical process of property transformation (Prasnikar, 1999). An analysis of the ownership structure in Slovenia has demonstrated that in 63% of the cases the internal owners, i.e. the employees of the companies with transformed ownership, are in majority. Together they hold over 50% of the stake of the company, which for instance is not common in the United States, where the BPR concept originates from. The company supervision via representatives in the supervisory boards operates as in the German system.

The basic reason for poor quality of Slovenian management is manifested mostly by disregarding the knowledge and understanding of managing business change in a company (Udovicic, 2004). Slovenian managers keep improving company operations by using standard methods of business operation, based considerably more on experience than on knowledge of contemporary management methods and techniques (Pivka and Mulej, 2004; Ursic, 2004). Furthermore, there is no general BPR model applicable yet in Slovenian business practice, especially in construction practice, burdened with social and economic transition.

IMPLEMENTATION OF RE-ENGINEERING PROJECT

Organizational part: Organization modification and company re-engineering

Business process re-engineering in construction companies is a unique project, which a company initiates with the focus of constructing new forms of organization. For initiating the reorganization, the company entrusts a project manager, who manages the project. As work in construction companies is mostly based on projects, we also have to accede on the new system of organization (reorganization) projectively. The advantage of such an approach is that the employees and others participating in the re-organization know the realization of different projects, which they can apply on the project of reorganization.

The introduction of the BPR concept in a company always means radical changes that could be achieved within two sequence implementation projects: analysis of activities and analysis of processes. Basically, the company will define its organization of work around basic processes. In this way the work could be done in different departments and beyond the traditional, narrow minded functional departments that will influence the company's reorganization.

Analysis of activities

The analysis of activities is the first implementation project that encloses the structuring of the activities inside of different departments and information analysis. An analysis of activities of all departments could be conducted on the basis of collected data. Structuring the activities actively involves department managers and construction project managers, which need to be organized in a process team. By critically evaluating an existent activity inside current processes, they could propose simplifying their work and optimizing the creation chain value (Reilly and Scwihs, 1998). The first project also includes the analysis of the existent information flow within collecting and categorizing business and project documentation of process activities.

Analysis of processes

After the implementation of the analysis of activities we normally found out that business processes in the company were too slow, too complicated and inflexible. Thus the analysis of processes implementation project followed that enclosed identification of key processes, process transformation and conformation of organizational structure. The purpose of processes analysis is to achieve process transparency throughout departments or working places, and increase communication among departments and participants.

The first step of process analysis is identifying the key processes in the company that will determine their optimal pursuance and appoint the process caretakers for defined process teams, which would translate the internal entrepreneurship logic into everyday work. The next step is process transformation, during which the basic processes must be structured. Therefore process transformation defines the basic operational process categories.

The identification and structuring of key processes is the basis for re-designing current hierarchical organizational structures. In an organization that puts processes in the foreground, the efficiency and effectiveness of the organizational units depend on the connections between individual processes that are carried out by different departments/units. It is therefore important that decentralized forms of organizational structure with fewer hierarchical levels be formed from current (and common) functional forms to flatter forms in which inter-departmental tasks can be adopted and solved within the framework of daily team work.

In a redesigned organizational structure the process caretakers play the key role. This will significantly modify the established relationships between the strategic, tactic and operative management. Consequently decision-making would be more efficient while flatter structure would speed up horizontal flow of communication and allow teams to perform process tasks at the operative level of the organizational pyramid.

Technical part: Implementation of the modern information and communication technologies

As the company initiates new management concepts of reorganization, as for example Business Process Re-engineering (BPR), ISO 9000, Total Quality Management (TQM), the 20 Keys Method, benchmarking, etc. it needs efficient ways of communication between employees in the company, for assuring successful new organization. Reorganization is an extensive project within a company, involving a large number of employees and other participants.

The reorganization is usually led by a project manager, who coordinates work with other participants. The precondition for successful leading of projects is accurate and correct information/data. Yet, the project manager is successful only if he has access to up-to-date and quality information. The companies should therefore establish an adequate vertical information system that should work for the duration of the project (Pšunder M. and Pšunder I., 2003).

Communication between the project manager and other participants of the vertical informational system can be managed in various ways. Apart from the classical ways of communicating and coordinating participants on the project, such as meetings, circulars, phone calls and communication via mobile phones, there are also other ways to initiate communication without disturbing the working process in construction companies, and at the same time allowing the reorganization project to be more qualitative and faster.

For the reorganization of the company it is wise to involve the advantages of the modern information and communication technology (ICT). These are important because they stimulate and enable re-engineering. With ICT we speed up the project of reorganization, but we also save up time for participants on the project, who would otherwise spend time with other, classical means of communication. It is a way how a project manager can keep an overview over the entire realization of the project. With the implementation of suitable ICT tools we establish fundamental accessories, which consecutively enable the below written advantages. Those accessories-demands of ICT are: virtual space for the disposal of documentation; software, which enables communication, not only via computer, but also audible and visual communication and video conferences and software, which enables hierarchical access to projects - and other documentation.

The above written demands enable a dynamical flow of information and data with the so-called systems Interactive Personal Communication Network (IPCN) (Magdic et al. 2004). Such IPCN systems are focused on the improvement of the personal communication network in the sense of encouraging ad-hoc communication, knowledge and information sharing. With their help a simultaneous coordination between participants during initiation and performing is possible. It has to be pointed out, that through the entire project a flow of information/data is being processed, which project participants have to share and coordinate. Among them are activities, which cannot be done consecutively, but only simultaneously or in cooperation. The communication and the transfer of information/data occur as shown below in Figure 1.

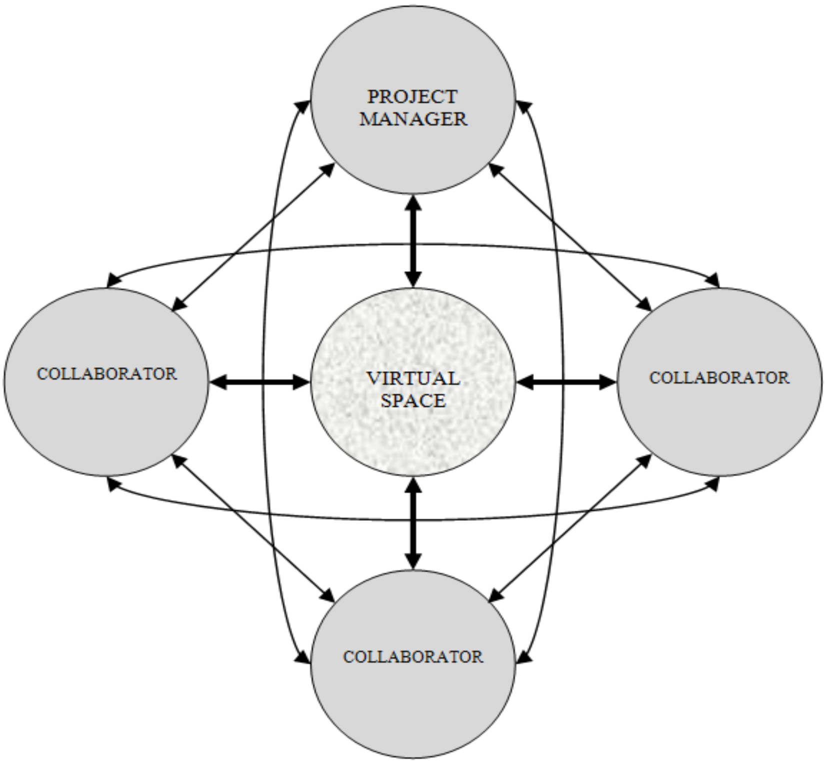

Figure 1: Communication by reorganization project in Constructions Company

In the project of reorganization we cannot avoid the classical means of communication and coordination. Therefore the ICT is a useful tool, which will be of great support for the project manager in initiating the project of reorganization. For the use of ICT it is necessary to inform the participants with the software, which supports the above written demands.

Some realizations on the reengineering projects

We could sum up that BPR method within its radical nature means decisive drastic modifications of the key company processes and influence on effectiveness of employing knowledge in a company. On the basis of our knowledge of the contemporary management methods and practical experience, we knew that new approaches can be efficiently realized, when understood and accepted by workers. Otherwise the announced changes in a company usually trigger off feelings of uncertainty, especially present in environments where the routine logic of thinking and working prevails. Hence, it can be concluded that the success of the re-engineering business process can be attributed to factors that have been emphasized: a devised strategy of the reengineering implementation, informing the employees with the emphasis on open communication between the management and the employees, investing in qualifying the employees to manage re-designed working operations, objective monitoring of the attained re-engineering results as well as introducing methods to motivate employees.

CONCLUSIONS

The paper presents a methodological concept of re-engineering, applied to construction companies in Slovenia. The proposed concept of re-engineering was justifiably selected with two methodological technologies: business process re-engineering (BPR) as an organizational point of view, and modern information and communication technology as technical background.

The first organizational part describes how to reach radical transformations of key business processes and changing the traditionally defined organizational structure. The implementation of the proposed re-engineering concept could be successfully implemented when realized through two implementation projects: (1) the analysis of activities and (2) the analysis of processes. With the second project the re-designing of the company's organizational structure must be achieved in way that will enable organizational support for decentralized cooperation and decision-making.

By implementing the technical background within the implementation of modern ICT, the suitable software, work productivity should be increased in most of the organizational units, with which the project of reorganization will be faster and of a higher quality. The project manager will have a better overview over the entire project, the participants (collaborator) will have access to actual and up-to-date data. After the project is finished, everyone who learned and got to know the new software (ICT) could use it with their future projects. Work in AEC companies, especially those that deal with construction, is based on various projects which occur simultaneously. Therefore, in a random project, virtual space, which seizes one project, restores the communication flow as in our example. The knowledge of ICT in the project of the reorganization of construction companies can only be an advantage when performing on other construction projects in the future.

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REFERENCES

Betts, M., and Harper, T. (1994) Re-engineering construction: a new management research agenda. Construction Management and Economics, 12 (6), 551-556.

Cheng, M. Y., and Tsai, M.H. (2003) Re-engineering of Construction Management Process. Journal of Construction Engineering and Management, 129 (1), 105-114.

Coleman, D., and Levine, S. (2008) Collaboration 2.0. California: Silicon Valley

Courtney, R., and Winch, M. (2003) Re-engineering construction: the role of research and implementation. Building Research & Information, 31(2), 172-179.

Hammer, M. and Champy, J. (1993) Reengineering the Corporation – A Manifesto for Business Revolution. New York: Harper Collins

Ireland, V. (1995) The T-40 project: Process re-engineering in construction. Australian Project Manager, 14, 31-72.

Love, P.E.D., and Li, H. (1998) From BPR to CPR – conceptualizing in re-engineering construction. Business Process management Journal, 4 (4), 291-305.

Magdic, A., Rebolj, D., and Suman, N. (2004) Effective control of unanticipated on-site events: A pragmatic, human-oriented problem solving approach. Journal of Information Technology in Construction, 9(Special Issue), 409-418.

Pivka, M., and Mulej, M. (2004) Requisitely holistic ISO 9000 Audit leads to continuous innovation/improvement. Cybernetics and Systems An International Journal, 35(4), 363-378.

Prasnikar, J. (1999) Poprivatizacijsko obnavljanje slovenskih podjetij (Post-Privatisation Conduct of Slovenian Companies). Ljubljana:Gospodarski vestnik

Pšunder, M. and Pšunder, I. (2003) Timely and quality information for assuring objective goals of civil and building projects. Informatologia (Zagreb), 36 (2), 90-93.

Reilly, F. R., and Scwihs, P. R. (1998) Valuing Intangible Assets. New York: McGraw-Hill

Udovicic, K. (2004) Metode nematerialne motivacije za inoviranje managerjev (Methods of Immaterial Managerial Motivation for Innovation), Ph.D. Thesis. University of Maribor: Faculty of Economics and Business

Ursic, D. (2004) Uceca se organizacija: sistemsko-organizacijski vidik (Learning organization: system-organizational sight). Maribor: Management Forum

INNOVATION IN CONSTRUCTION: A PROJECT LIFECYCLE APPROACH

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Innovation is a multidimensional, dynamic, global, and an open activity that increases competitiveness, generates economic benefits, and improves the quality of living standards through the creation and adoption of new ideas and technologies. The construction industry is widely perceived as being among the less innovative sectors, in part due to its project-based and fragmented nature. However, there is an increasing recognition that to understand and quantify the extent of innovative activity within a sector, metrics appropriate to the particular sector must be developed. The patterns of innovation in construction are different in many ways from those of others, and effective management of innovation is still essential to create value for construction customers and their clients. Therefore, more research is required to analyze the different types of innovative activities as well as the role of project stakeholders in stimulating and implementing construction innovation. The major objective of this study is to set out a methodology to investigate in detail the particular ways in which innovation occurs in a project setting and the dynamics between project and firm level innovation. In this respect, the innovation value chain can be investigated in terms of the parties involved in a construction project. The proposed lifecycle approach will help observe and measure the underlying drivers, enablers and the contextual variables related to the whole process and understand the role of different actors and improve their capability in facilitating innovation.

KEYWORDS: innovation measurement, construction industry, project lifecycle, project stakeholders.

INTRODUCTION

Innovation has become a central issue for all industries and countries due to its contribution to national economic growth, competitiveness, and higher living standards. It is a complex phenomenon with a wide range of inputs and outputs creating diverse impacts on performance at the company, sector and national level. There is not a single and complete definition of innovation; it can be technological as well as non-technological including organisational and marketing aspects. In broad terms, it may be defined as creation and adoption of new knowledge to improve the value of products, processes, and services.

Innovation can be a key source of competitive advantage for construction companies as well, offering the means through which a firm can achieve a client's objectives in a specific project or its own objectives over a range of projects (Slaughter, 2000). The construction industry provides an example of a sector within which traditional measures do not reflect the true extent of the innovative activity that is taking place (NESTA, 2006; Barrett et al., 2007). Construction is often categorised as being among the less innovative sectors. However, as the Hidden Innovation report (NESTA, 2007) has shown, this perception is perhaps undeserved. Much of the innovation remains hidden, as it is co-developed at the project level. Being a project-based and fragmented industry, the patterns of innovation in construction are different in many ways from those of others. There has been a considerable amount of research that focuses on investigating the characteristics, significance, and management of innovation in construction. More research is required to analyze different types of innovative activities that are carried out throughout the lifecycle of a construction project.

Management of innovation is complicated by the discontinuous nature of project-based production in which, often, there are broken learning and feedback loops. As Gann and Salter (2000) stated project-based firms need to manage both project and business processes since the resources of the firm are embedded at both the project and the firm level; it is the integration of these two sets of resources that enables the firm to be competitive. In addition, business processes are ongoing and repetitive, whereas project processes have a tendency to be temporary and unique (Gann, 1998; Brusoni et al., 1998), therefore firms should integrate the experiences of projects into their continuous business processes in order to ensure the coherence of the organisation. The same principle is also valid for the success of innovation both at the project and firm-level.

The major objective of this study is to obtain an insight as to how innovation occurs throughout the lifecycle of a construction project including the conceptual phase, planning and design, procurement, construction, and operation and maintenance. In addition, the role of project stakeholders including the clients, designers, contractors, suppliers, and external bodies in stimulating and implementing innovation should be investigated. In this respect, this study proposes a methodology to investigate the ways in which innovation occurs in a project setting and the dynamics between project and firm level innovation thereby enabling the analysis of the innovation value chain in terms of the parties involved in the process. The proposed methods include the production of case studies, interviews, workshops and a seminar. The proposed research will increase awareness on the hidden innovation at the project-level and in doing so aid project stakeholders to better understand and improve their innovation processes and activities, thereby increasing firm level competitiveness and value creation at the project level.

INNOVATION IN CONSTRUCTION

There are differing definitions of innovation, but there is an increasing trend to consider a wider view of innovation that reflects the many ways in which innovation occurs in practice. A suitably wide definition is that innovation is "*the adoption of an idea or behaviour, whether a system, policy, program, device, process, product or service, that is new to the adopting organisation*" (Damanpour, 1992). It is a complex and multidimensional process having a number of outcomes including the renewal and enlargement of products and services, and their associated market; new methods of production, supply and distribution; and new organisational and work forms and practices (Barrett and Sexton, 1998).

Phillips (1997) distinguishes between technological innovation and non-technological (including organisational and marketing) innovation. Technological innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. Organisational innovation in the firm includes significant changes in organisational structures; the implementation of advanced management techniques; and the implementation of new or substantially changed corporate strategic orientations. Marketing innovation, on the other hand, is the implementation of a new marketing method involving significant changes in product, price, and promotion strategy (OECD and Eurostat, 2005).

Slaughter (1998) presented five models of construction innovation categorised as incremental, modular, architectural, system and radical, which can provide a basis upon which companies can select and implement the innovations. These models range from incremental innovation, which is a small change, based upon current knowledge and experience, to radical innovation is a breakthrough in science or technology that often changes the character and nature of an industry.

Many studies on how innovation could be implemented in construction projects have been undertaken (Tatum, 1987; Slaughter, 1998, 2000; Winch, 2003). There have been a number of case studies of how successful firms have been able to make a range of different organisational, managerial or technological innovations to overcome the limits of their environment (Slaughter, 1993; 1998; Veshosky, 1998; Koskela and Vrijhoef, 2001; Sexton and Barrett, 2003). These studies usually focused on how innovation is managed within one firm and there is a lack of focus on specific project stages as well as a lack of specific focus on different construction sectors. Only a small minority of the research articles have considered innovation at a specific stage of the project lifecycle or from the point of view of the project lifecycle in general (Dickinson et al., 2005). Moreover, none of these studies discussed the accurate measurement and proper indicators for construction innovation.

As Blayse and Manley (2004) stated, building and construction is partly manufacturing (materials, components, equipment) and partly services (engineering, design, surveying, consulting, management) industry. The characteristics of innovation in the service industries are different from those in manufacturing industries (OECD and Eurostat, 2005). Therefore, as Barrett et al. (2001) have suggested, specific research into innovation in construction must be undertaken and all generic innovation research be “envisioned, embedded and evaluated in a construction context to form a robust body of construction innovation knowledge in its own right”. Since construction is also a project-based industry, while measuring construction innovation, project-level indicators as well as the firm and sector level ones should be considered.

ANALYSIS OF CONSTRUCTION INNOVATION

As a significant economic variable, the measurement of innovation has attracted a lot of attention. However, due to the complexities inherent in the whole process, measuring innovation is not an easy task. Historically, organisations and public bodies have tended to measure innovation in terms of inputs (e.g. R&D expenditure) and outputs (e.g. patent or trademark applications) (Archibugi and Pianta, 1996). Much construction innovation is project-based and unrelated to formal R&D expenditure and many innovations, particularly organisational or process innovations are neither patented nor trademarked (Slaughter, 1993). Construction is a very diverse sector and there is not one single way in which innovation occurs. According to Lansley (1996) the occurrence of innovation within the construction industry is often characterised by the widespread adoption of new practices as a result of advances in technological and business processes. Therefore, traditional indicators poorly reflect the true level of innovative activity in construction. This gulf between practice and measurement is the real innovation gap (NESTA, 2006).

Based on the review of construction innovation literature by Dickinson et al. (2005), studies on construction innovation so far lack a specific focus on the level of analysis, stage of lifecycle, and sector. According to Barrett et al. (2007) innovation can be observed at three different levels namely the sector, business and project level. Among these, sector-level is the most visible type of innovation and project level is the most hidden. The firm level has received most attention in the analysed literature; this might be because the principal drivers for innovation are often created at the firm level (Seaden and Manseau, 2001).

Innovation value chain at the project level

The innovation value chain view that is developed by Hansen and Birkinshaw (2007) presents innovation as a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts that includes six critical tasks namely, internal sourcing, cross-unit sourcing, external sourcing, selection, development, and companywide spread of the idea. Table 1 shows the links of value chain and key questions and key performance indicators to measure each link.

Table 1: The innovation value chain at firm-level (Hansen and Birkinshaw, 2007)

	IDEA GENERATION			**CONVERSION**		**DIFFUSION**
	In-house	**Cross-pollination**	**External**	**Selection**	**Development**	**Spread**
	Creation within a unit	Collaboration across units	Collaboration with parties outside the firm	Screening and initial funding	Movement from idea to first result	Dissemination across the organisation
Key questions	Do people in our unit create good ideas on their own?	Do we create good ideas by working across the company?	Do we source enough good ideas from outside the firm?	Are we good at screening and funding new ideas?	Are we good at turning ideas into viable products, businesses, and best practices?	Are we good at diffusing developed ideas across the company?
Key performance indicators	Number of high-quality ideas generated within a unit.	Number of high-quality ideas generated across units.	Number of high-quality ideas generated from outside the firm.	Percentage of all ideas generated that end up being selected and funded.	Percentage of funded ideas that lead to revenues; number of months to first sale.	Percentage of penetration in desired markets, customer groups; number of months to full diffusion.

The first phase is to generate ideas that can happen inside a unit, across units in a company, or outside the firm; the second phase is to convert or select ideas for funding and developing them into products or practices; and the third is to diffuse those products and practices. The innovation value chain offers a tailored and systematic approach to assessing firm-level innovation performance (Hansen and Birkinshaw, 2007).

Although the innovation value chain stages are sequential the actual process is a "recursive process through which firms source the knowledge they need to undertake innovation, transform this knowledge into new products and processes and then exploit their innovations to generate added value" (Roper et al., 2006). Adopting a similar view, this study proposes the investigation of innovation value chain of different actors in the construction process at the project-level.

Roles of different actors within the innovation process

The construction sector is viewed as a system involving clients, contractors, sub-contractors suppliers, consultants, and designers. Technological (product and process) innovation is driven mainly the suppliers (manufacturers), whereas contractors tend to introduce service and organisational innovations (Carassus, 2004).

In this view, clients can act as a catalyst to foster innovation by exerting pressure on the supply chain partners to improve overall performance and by helping them to devise strategies to cope with unforeseen changes (Gann and Salter, 2000), by demanding high standards of work (Barlow, 2000), and by identifying specific novel requirements for a project (Seaden and Manseau, 2001). Knowledge and financial provision, effective leadership, and dissemination of innovations are among the key roles which clients could play (Egbu, 2008).

Contractors on the other hand play a mediator role in the interface between the institutions that develop many of the new products and processes (materials and components suppliers, specialist consultants and trade contractors) and those which adopt these innovations (clients, regulators and professional institutions) (Winch, 1998). They introduce different types of innovations depending on their specialty areas. It is therefore suggested that companies operating in building, infrastructure, housing, industrial construction should be investigated as well as the subsectors of construction including architecture, urban planning, surveying, consultancy, asset/facilities management, and project management that could be better way of understanding and measuring innovation in different phases including the production, construction, and marketing.

Manufacturing firms are also key sources for construction innovation; they invest far more in R&D than contractors or consultants, and are subsequently more likely to develop product and process innovations (Gann, 1997) and thus they are recognized as key drivers of technical innovation in the construction industry.

Relationships and knowledge-flows are important for innovation at all levels of economic activity, including internationally, nationally, inter-sectorally, sectorally, inter-firm, intra-firm, inter-project and intra-project (Manley, 2008). In a complex systems industry such as construction, firms must rely on the capabilities of other firms to produce innovations and this is achieved by the cooperation between those concerned with the development of products, processes and designs (Blayse and Manley, 2004). More research is needed as the relationships between designers, contractors and suppliers need better explanation (Gann, 2000).

Project lifecycle approach for analysing construction innovation

Analysis of innovation at the project level is often ignored in the literature mostly due to the difficulties in monitoring different activities carried out by different parties in each stage of the project. Management of innovation is complicated by the discontinuous nature of project-based production in which, often, there are broken learning and feedback loops. Project-based firms need to manage technological innovation and uncertainty across organisational boundaries, within networks of interdependent suppliers, customers and regulatory bodies (Gann and Salter, 2000). However, project-based firms are always innovating; their work is always unique, always delivered to bespoke designs, always achieving something new (Keegan and Turner, 2002). Study by Gann and Salter (2000) points out the need for a better conceptual understanding and new management practices to link project and business processes. Although some strategies are proposed in these studies, they do not address how to track innovative activities during the lifecycle of a construction project.

It is increasingly accepted that construction innovation encompasses a wide range of participants within a 'product system' (e.g. Marceau et al., 1999). This broad view incorporates the participants including governments, building materials suppliers, designers, general contractors, specialist contractors, the labour workforce, owners, professional associations, private capital providers, end users of public infrastructure, vendors and distributors, testing services companies, educational institutions, certification bodies, and others (Blayse and Manley, 2004).

Figure 1 shows the innovation value chain in a construction project. The link between firm level processes and innovation at the project level should be explored to observe how different firms contribute to innovation process by developing/implementing strategies, assigning resources to create ideas and diffuse them.

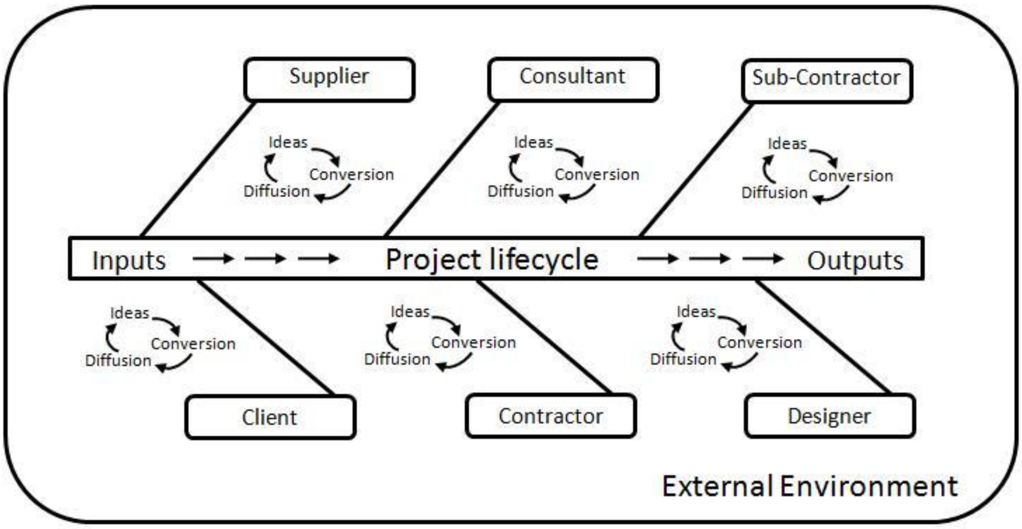

Figure 1: Innovation Value Chain in a Construction Project

Gann (2001) suggests that project-based construction firms often struggle to learn between projects, and often have weak internal business processes. Measurement of the dimensions and elements of construction innovation at the project level is key to improving the innovation performance of companies. Therefore, specific metrics should be developed to assess the inputs, implementation (processes/activities), contextual factors (related to the external environment), and outputs of innovation and different indicators should apply to different actors of construction industry for an accurate analysis. Possible indicators to measure the inputs include the necessary resources such as human, capital, IT, etc.; contextual factors relate to organisation, industry and country-level issues that enable/hinder innovation such as organisational culture, competitiveness, and economic conditions, respectively; implementation phase comprises of the tools, techniques, and strategies such as business process reengineering and building information modelling; and outputs include metrics such as improvement in the product/service and efficiency of the operations.

DISCUSSION AND FURTHER WORK

In construction, much of the innovation remains hidden, as it is co-developed at the project level. A deeper understanding and analysis of the different types of innovative activities that are carried out throughout the lifecycle of a construction project is therefore essential to enable its effective management and so create value for construction companies and clients. Besides construction firms, suppliers, designers, and service organisations play a large part in innovation. To carry out such a wider study of innovation, a comprehensive approach of the construction industry is necessary, specifying the different kinds of firms involved in the construction and the built environment processes.

Within the context of this study, it is suggested that innovation should be analysed throughout the project lifecycle and roles of different participants should be explored. Project-based analysis can be expanded to sector and national-levels as well. Analysis of distinct project stages and development of proper indicators will allow effectively measuring the different types of innovative activities. Innovation process in each stage will be identified considering the inputs, outputs and outcomes of those activities as well as the function of the parties involved in the project.

The innovation process and the roles of different actors throughout the lifecycle of a construction project can be analysed by adopting a set of research strategies. Through the use of a framework approach, the details of how, why and when innovation is developed and measured by individual stakeholders throughout the project lifecycle could be investigated by:

- The production of case studies documenting innovation within construction projects;
- Semi-structured interviews with key individuals within the above case studies;
- Individual reports on these cases and cross-case analysis;
- Project level workshops bringing together entire supply chains to consider how innovation occurred and was measured at the project and at the discipline level; and
- A final seminar event that brings together the wider industry and academics with project participants to summarise and publicise findings and good practice.

The study will investigate recently completed projects that have been commended for their innovation. Detailed case studies of the innovation process and the measurement of its results will be produced for each project. Participating firms will be given insights as to their processes for innovation at the firm level and the effectiveness with which this is translated to the project level. The project workshops will bring together project participants in a facilitated manner to consolidate lessons and formulate future good practice. An overall project report will be produced highlighting the contributions of the project participants.

CONCLUSIONS

Innovation is a dynamic, interactive, open, global, and a multidimensional activity that increases competitiveness, generates economic benefits, and improves the quality of living standards through the successful exploitation of new ideas and technologies. Due to its contribution to several performance indicators at firm and national level, management and accurate measurement of innovative activities in all industries are becoming more important. Since all sectors have their own unique characteristics, therefore those characteristics should be taken into account in innovation studies in order to stimulate, foster and control innovation effectively.

The patterns of innovation in the construction industry are different in many ways from those of others. The construction industry is largely project based and fragmented, so the majority of innovation occurs at a project level and it is difficult to capture this hidden innovation by using conventional measures. Understanding how innovation occurs at this project level is key to improvement yet most existing research is at the firm level.

This paper has set out a case study approach that employs a case study methodology using an innovation value chain approach to enable an improved understanding of how innovation actually occurs at the project level and how this relates to innovation at the firm level. In each case, the relevant supply-chain members will be fully involved so that the collaborative ways in which the successful innovations have been generated can be tracked and the consequent benefits of innovation at the project and company level investigated. Project partners are expected to participate in the interviews, followed by a workshop and a final seminar.

The proposed lifecycle approach will help observe and measure the underlying drivers, enablers and the contextual variables related to the whole process and understand the role of different actors and improve their capability in facilitating innovation. The proposed research will shed light on hidden innovation and in doing so aid project stakeholders to better understand and improve their innovation processes and activities, thereby increasing firm level competitiveness and value creation at the project level. Findings of the case studies and following activities can lead to a more detailed analysis of different disciplines within the construction industry and provide guidance to analyse innovations in other project-based industries as well.

REFERENCES

Archibugi, D. and Pianta, M. (1996) Measuring technological change through patents and innovation surveys. Technovation, 16(9), 451-468.

Barlow, J. (2000) Innovation and learning in complex offshore construction projects. Research Policy, 29(7-8), 973-989.

Barrett, P. and Sexton, M.G. (1998) Integrating to innovate: Report for the Construction Industry Council. London: DETR/CIC.

Barrett, P., Sexton, M.G., Miozzo, M., Wharton, A. and Leho, E. (2001) BaseReport: Innovation in small construction firms. Salford: University of Salford.

Barrett, P., Abbott, C., Ruddock, L. and Sexton, M. (2007) Hidden innovation in construction and property sectors. RICS Research Paper Series, 7(20), London: RICS.

Blayse, A.M. and Manley, K. (2004) Key influences on construction innovation. Construction Innovation, 4, 143-154.

Brusoni, S., Precipe, A., Salter, A. (1998) Mapping and measuring innovation in project-based firms. CoPS Working Paper, Brighton: CENTRIMrSPRU.

Carassus, J. (2004) Construction sector system, innovation and services. CIB Congress Proceedings, Toronto Canada, available at http://jc-desh.cstb.fr/file/rub49_doc46_1.pdf

Damanpour, F. (1992) Organisational size and innovation. Organisation Studies, 13(3), 375-402.

Dickinson, M., Cooper, R., McDermott, P. and Eaton, D. (2005) An analysis of construction innovation literature. 5th International Postgraduate Research Conference, April 14-15, University of Salford, Salford, UK.

Egbu, C. (2008) Clients' roles and contributions to innovations in the construction industry: when giants learn to dance, in Clients driving innovation, Brandon, P. and Lu, S.L (eds), UK: Blackwell Publishing.

Gann, D.M. (1997) Should governments fund construction research? Building Research and Information, 25(5), 257-267.

Gann, D.M. (1998) New manufacturing for the 21st century. AEGIS Conference Generating New Wealth for Australia, Sydney, 30 March, Keynote address.

Gann, D.M. (2000). Building innovation: Complex constructs in a changing world. London: Thomas Telford Publications.

Gann, D.M. (2001) Putting academic ideas into practice: technological progress and the absorptive capacity of construction organisations. Construction Management and Economics, 19(3), 321-330.

Gann, D.M. and Salter, A. (2000) Innovation in project-based, service-enhanced firms: the construction of complex products and systems. Research Policy, 29(7–8), 955-972.

Hansen, M.T. and Birkinshaw, J. (2007) The innovation value chain. Harvard Business Review, 85(6), 121-130.

Keegan, A. and Turner, J.R. (2002) The management of innovation in project based firms. Long Range Planning, 35, 367-388.

Koskela, L. and Vrijhoef, R. (2001) Is the current theory of construction a hindrance to innovation? Building Research and Information, 29(3), 197-207.

Lansley, P. (1996) Innovation: the role of research, education and practice, in Harlow, P. (Ed.), Construction Papers, No. 59, Ascot, UK: CIOB.

Manley, K. (2008) Implementation of innovation by manufacturers subcontracting to construction projects. Engineering, Construction and Architectural Management, 15(3), 230-245.

Marceau, J., Houghton, J., Toner, P., Manley, K, Gerasimou, E. and Cook, N. (1999) Mapping the building and construction product system in Australia. Sydney: Commonwealth Department of Industry, Science and Resources.

NESTA (National Endowment for Science, Technology and the Arts) (2006) The innovation gap – Why policy needs to reflect the reality of innovation in the UK, London: NESTA.

NESTA (National Endowment for Science, Technology and the Arts) (2007) Hidden Innovation, London: NESTA.

OECD (Organisation for Economic Co-operation and Development) and Eurostat (2005) Oslo Manual. 3rd edition, Paris/Luxembourg:OECD/Eurostat.

Phillips, R. (1997) Innovation and firm performance in Australian manufacturing. Industry Commission, Staff Research Paper, Canberra.

Roper, S., Du, J., Love, J.H. (2006) Knowledge sourcing and innovation. Aston Business School Research Paper 0605, Birmingham.

Seaden, G. and Manseau, A. (2001) Public policy and construction innovation. Building Research and Information, 29(3), 182-196.

Sexton, M.G. and Barrett, P.S. (2003) A literature synthesis of innovation in small construction firms: insights, ambiguities and questions. Construction Management and Economics, 21, 613-622.

Slaughter, S.E. (1993) Builders as sources of construction innovation, Journal of Construction Engineering and Management, 119(3), 532-549.

Slaughter, S.E. (1998) Models of construction innovation, Journal of Construction Engineering and Management, 124(3), 226-231.

Slaughter, S.E. (2000) Implementation of construction innovations. Building Research and Information, 28(1), 2-17.

Tatum, C.B. (1987) Process of innovation in construction firm. Journal of Construction Engineering and Management, 113(4), 648-663.

Veshosky, D. (1998) Managing innovation information in engineering and construction firms. Journal of Management in Engineering, 14(1), 58-66.

Winch, G. (1998) Zephyrs of creative destruction: understanding the management of innovation in construction. Building Research and Information, 26(5), 268-279.

Winch, G. (2003) How innovative is construction? Comparing aggregate data on construction innovation and other sectors - a case of apples and pears. Construction Management and Economics, 21(6), 651-654.

SOFTWARE PROPOSAL FOR SCHEDULING WITH BROWN-ŁOMNICKI ALGORYTHM

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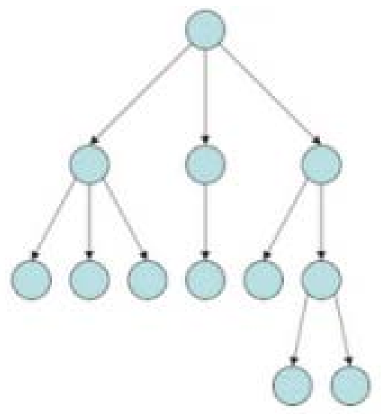
This paper considers a machines and equipment work scheduling problem of minimizing the unnecessary pauses in their work. This important scheduling problem need to be solved in modern construction systems, and is well known to be intractable (i.e., NP-hard). Branch-and-bound algorithms were developed by Łomnicki and Brown in the middle of twentieth century. In order to improve the use of branch-and-bound algorithms authors present a new and simply software by which the calculations could be reduced to the minimum. Brown-Łomnicki Algorithm is presented and its adjustment for computer platform. Authors present also some screen shots and chosen information about the software.

KEYWORDS: Brown, algorithm, schedule, software.

INTRODUCTION

Scheduling of machines, working on the same job in different sections of the constructed building is important element of construction management. Managers should schedule such a work properly, to avoid un-necessary breaks in their works. Branch and Bound algorithm is a "tree" used technique for solving optimization problem using search technique. Optimization problem is trying to find a schedule, which minimise breaks of the machines work. This solution can be represented as a state-space tree. Each branch represents all the possible next steps. The goal is to find a path which returns the maximum profit (in our case – minimal breaks and the shorter schedule). The basic idea is to have a fast way to compute the upper bound and lower bound of the profit of a sub-tree. If a sub-tree is know to have its upper bound lower than the lower bound of another sub-tree, then this sub-tree can be rejected because its best result is worse than the worst result of that another sub-tree (see figure 1).



START

possible states (variants) of the schedule

NODES - ALTERNATIVES (each got associated "profit")

next possible states (variants) of the schedule

OPTIMAL solution chosen

Figure 1: "Tree" applied for branch and bound algorithm, finding the optimal solution [own source].

SCHEDULING WITH BRANCH AND BOUND ALGORITHM

Solving NP-hard discrete optimization problems to optimality is often an immense job requiring very efficient algorithms, and the Branch and Bound algorithm is one of the main tools in construction of these. A Branch and Bound algorithm searches the complete space of solutions for a given problem for the best solution. Explicit enumeration is normally impossible due to the exponentially increasing number of potential solutions. The use of bounds for the function to be optimized combined with the value of the current best solution enables the algorithm to search parts of the solution space only implicitly.

Mathematical model of Branch and Bound algorithm based on the process of choosing the next “node” to expand – which means which schedule is optimal at the relevant stage. This model should also include a function for deciding when to stop a search path before reaching the end of the path. Abandoning searches early attempts to minimize computational efforts to find the minimal solution. The software presented in the following chapters works efficiently, minimizing number of steps while finding the optimal solution.

The basis of Branch and Bound algorithms is a ranking function (Horowitz, Sahni,Sanguthevar, 2008). The ranking function assigns a value to each node in the graph. At each step, a branch and bound algorithm uses the ranking function to decide which node to expand next. The usual DFS (Depth First Search) and BFS (Breadth First Search) (Horowitz, Sahni,Sanguthevar, 2008) exploration algorithms perform a blind search of the graph.

The ranking function, here called $c(x)$, ranks nodes based on the cost (in case of the scheduling – could be based on the time time) of a minimal solution reachable from node x. The problem with this ranking function is that the minimal solution must be known ahead of time. Instead, the ranking function uses an estimate, $g(x)$, of the cost (or time) of a minimal solution reachable from node x. Using $g(x)$ to rank nodes may require exploring unnecessary nodes in the graph (schedule) especially when $g(x)$ is estimated not correctly. The final element of the ranking function measures the cost (time) of reaching a node from the root. As the searches gets further from the root node, the node falls in the ranking.

The function $h(x)$ measures the “cost” (time) of reaching node x from the root node. After including a function of $h(x)$, the ranking function $c(x)$ is (Companys, 2007):

$$\mathrm{c}(x) = f(h(x)) + g(x) \qquad (1)$$

In formula 1 f determines how much significant to give the cost (or time) of reaching node x. If $f(h(x))= 0$ then the algorithm makes long, deep searches of the graph. If $f(h(x))> 0$ then the algorithm considers nodes close to the root before making long potentially fruitless forays into the graph. A node is *live* if its subgraph might contain a minimal solution. Live nodes are potential candidates for exploration (Horowitz, Sahni,Sanguthevar, 2008). A node is *dead* if its subgraph can not contain a minimal solution (Horowitz, Sahni,Sanguthevar, 2008). If the estimated cost of a minimal solution reachable from x is less than the actual minimal solution reachable from x then a node can be killed when the estimated cost is greater than the least upper bound on a solution. In symbols, if $c(x)>= upper$ then an optimal solution is not reachable from x (assuming *upper* is the least upper bound on a solution). Solution of the problem requires multi-calculations. Software presented in the next chapter minimizes the calculations to the absolute minimum.

BROWN-ŁOMNICKI ALGORITHM

The Brown-Łomnicki algorithm is designed to put *n* jobs done by *m* machines in the optimal order. The nodes in this algorithm represent the permutations of already chosen *r* jobs and the estimated time of finishing the work in this order. Assumptions for using this algorithm are:

- the machines works on every job in the same order (1,2,...,m),

- every machine can work on one job at the time and every job can use one machine only at one time (Jaworski, 1999).

The Brown-Łomnicki algorithm uses the ranking function in the following form:

$$\xi(G(w_r)) = \max\{\xi_1, \xi_2, ..., \xi_m\}, \tag{2}$$

$$\xi_i = T_{ir}^k + A + Bmin, \tag{3}$$

Where:

(T_{ir}^k) is the *h(x)* function and ($A + Bmin$) is the estimation function - *g(x)*, and where

$$A = \sum_{j \notin w_r} t_{ij}, \tag{4}$$

$$Bmin = \min_{j \notin w_r} \sum_{l=i+1}^{m} t_{lj}, \tag{5}$$

i – machine number (i = 1,2, ..., m)

j – job number (j = 1,2, ..., n)

w_r – permutation of r elements of j = {1,2, ...,n}

SOFTWARE PROPOSAL FOR SCHEDULES OPTIMISATION

The software is based on a simple block diagram presented on Figure 2. It receives the data from the user: number of machines, jobs and times of work for each machine on each job (Figure 3). It initially creates n one element permutations of jobs (W_1={1}, W_2={2},..., W_n={n}) and calculates ξ_{max} for each of them. In the next step it searches for permutation with the lowest ξ_{max} and checks if it could be branched, which basically means – if it has less then (n-1) elements. This step is repeated every time new branches are added. The application ends calculations and presents the solution when all permutations with the lowest ξ_{max} are the leaves – have (n-1) elements. Screenshots on the Figures 4 and 5 show the running program: calculations details and efficiency of the software.

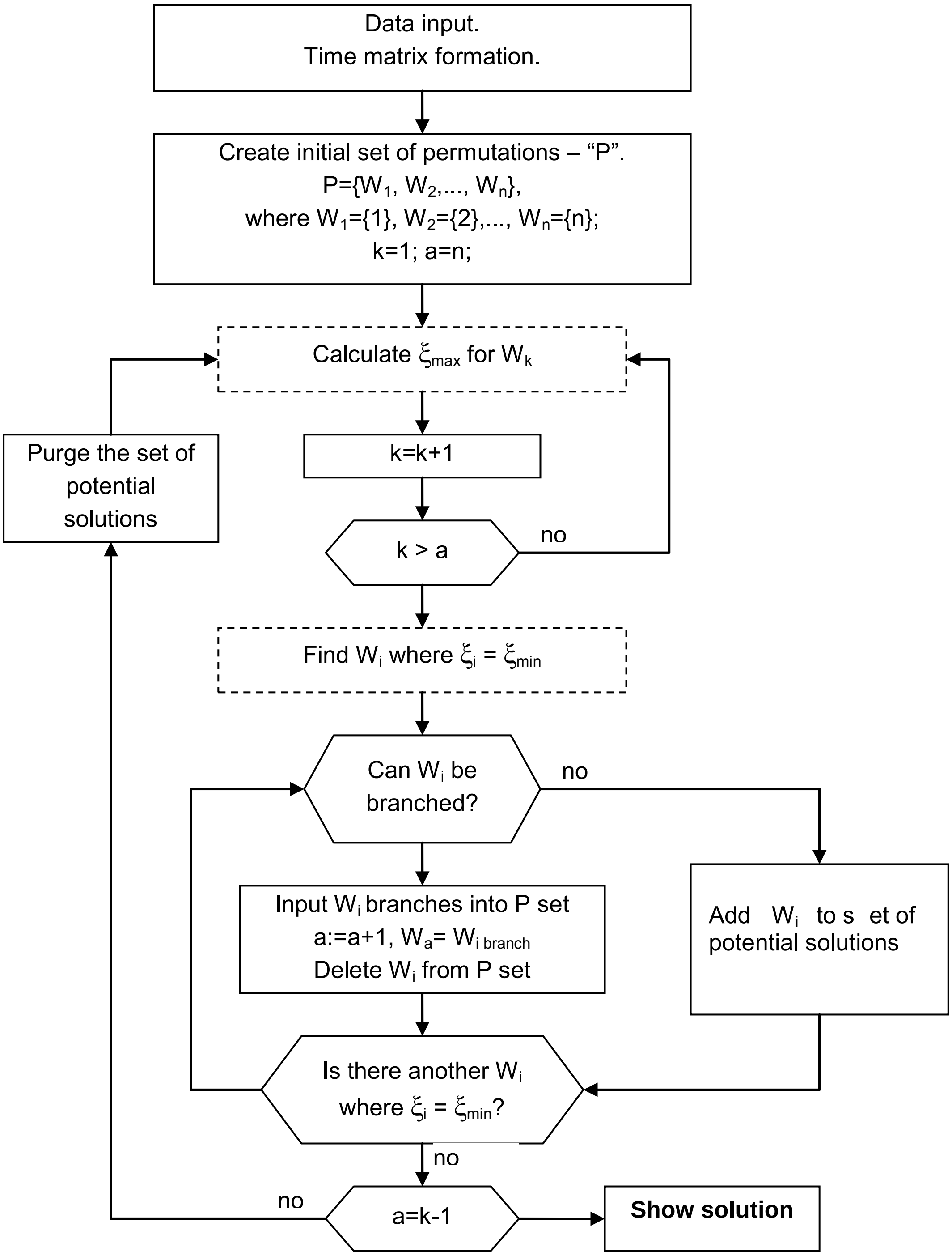


Figure 2: Block diagram for the software proposal [own source].

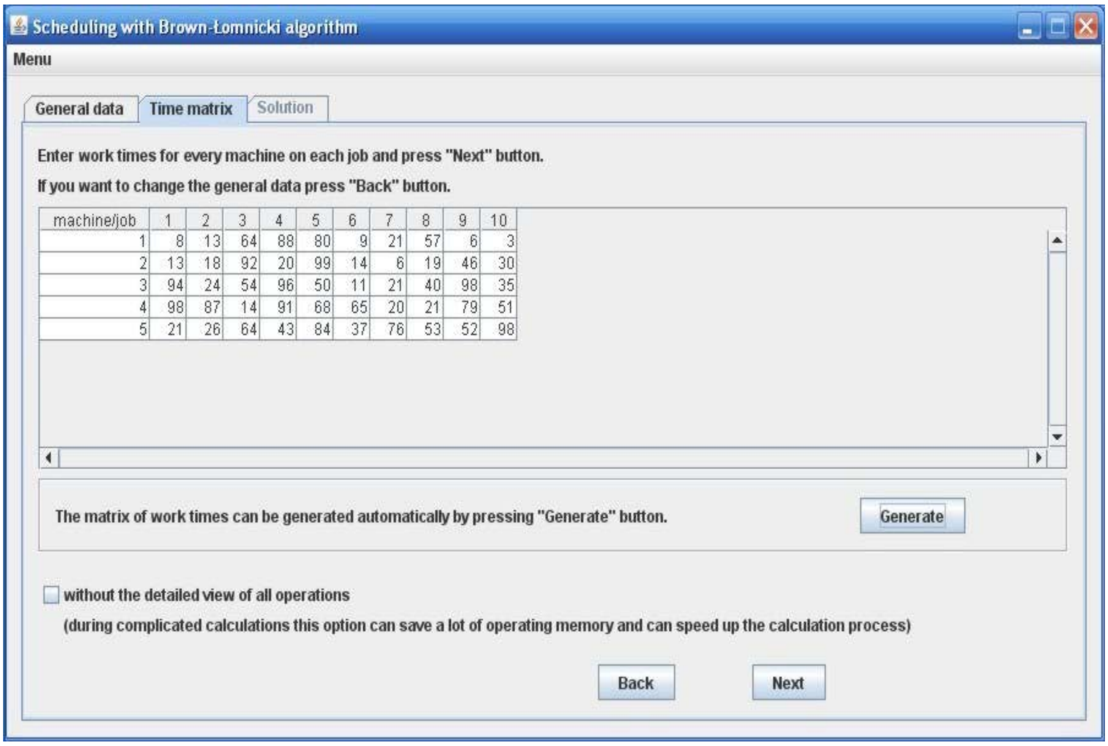


Figure 3: Branch and bound algorithm, data entering [own source].

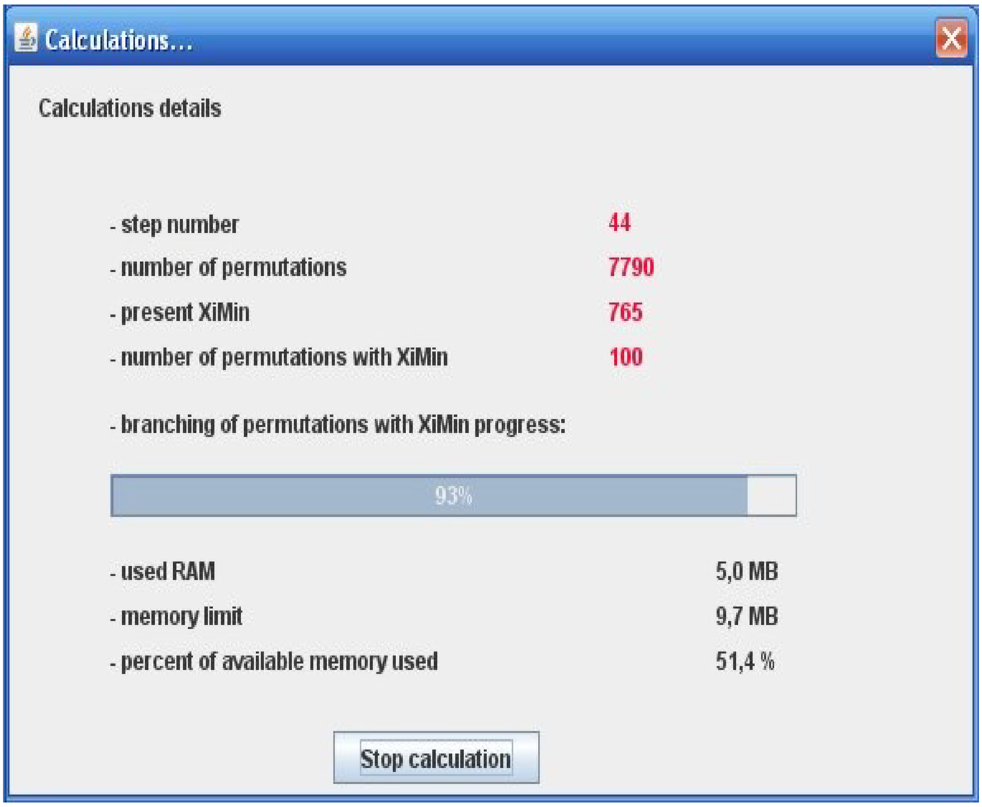


Figure 4: Branch and bound algorithm, calculations [own source].

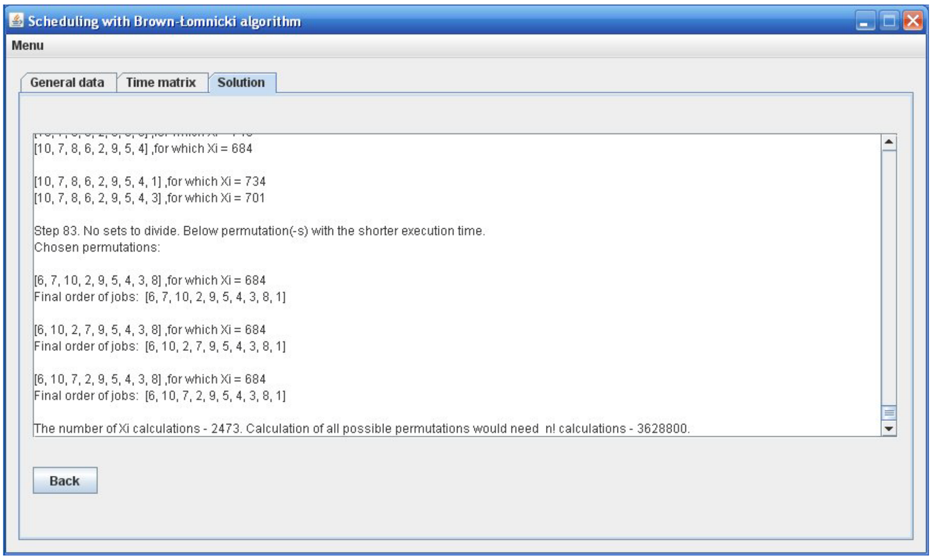


Figure 5: Branch and bound algorithm, last step - results [own source].

CONCLUSIONS

A large number of real-world planning problems called combinatorial optimization problems share the following properties: they are optimization problems, are easy to state, and have a finite but usually very large number of feasible solutions. The Branch and Bound algorithm presented takes advantage of this possibility for obtaining an optimal solution as early as possible in the branch-and-bound search. The presented iteration has three main components: selection of the node to process, bound calculation, and branching. At any point during the solution process, the status of the solution with respect to the search of the solution space is described by a pool of yet unexplored subset of this and the best solution found so far. The presented software limits number of calculations to the minimum. Moreover the obtained solution is truly optimal, which means it is equal to a strict mathematical solution of this optimization case, while the volume of calculations is in most cases significantly limited.

REFERENCES

Horowitz E., S. Sahni, R. Sanguthevar (2008) Fundamentals Of Computer Algorithms, Delhi: Universities Press (India) Limited

R. Companys (2007) Note on an improved branch-and-bound algorithm to solve n/m/P/Fmax problems, Berlin / Heidelberg: Springer, Business and Economics Issue Volume 7, Number 1, pages 25-31

S. Sahni (2005) Data Structures, Algorithms, and Applications in Java (second Edition), Delhi: Universities Press

K. M. Jaworski (1999) Methodology of building planning and realisation, Wydawnictwo Naukowe PWN, Warsaw, Poland

J. Clausen, J. L. Troa (1994) Do Inherently Sequential Branch-and-Bound Algorithms Exist?, Parallel Processing Letters 4, 1-2, p. 3 -13.

FEASIBILITY STUDY OF CONSTRUCTION INVESTMENT PROJECTS ASSESSMENT WITH REGARD TO RISK AND PROBABILITY OF NPV REACHING

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The paper presents an analysis of NPV and investment risk at the stage of assessment of the strategy and the feasibility study. This analysis, for a specific project value profile, allows for specification of probability of occurrence of a given value of cash flows and NPV and for presentation of their fuzziness.

KEYWORDS: NPV, fuzzy logic, risk.

INTRODUCTION

Decision-making with regard to investment is associated with analysis of risk related to achievement of the basic technical and economic parameters, including the updated value of NPV (Net Present Value). Prior to the decision-making stage, experienced investors analyse the revenues and expenditures for the investment project planned; usually, they have the knowledge sufficient to determine the value of deviations of these planned parameters from the really achieved ones. Such analysis may also be subject to opinion of construction experts, who may assess the value of such deviation in verbal form. The paper presented discusses the procedure of determination of probability of reaching the planned NPV value on the basis of linguistic assessments using fuzzy sets.

ASSESSMENT OF THE INVESTMENT PROJECT - ASSUMPTIONS

Any investment project, analysed in accordance with the NPV method, consists of the appropriate cash flows – revenues or expenditures. These flows finally result in the expected NPV value. If we fail to take into account the risks, individual flows may be presented as illustrated by fig. 1. In this case, we disregard the impact of the discount coefficient and we assume that these flows have already been discounted.

The precise flow values are provided in the second column of table 1. Expenditures (K_0) are represented by negative values, and revenues (Z_0) are represented by positive values. In general, expenditures and revenues will be marked as S_0 – cash flows.

Although the flows calculated within a given investment project have been presented as the most probable ones, their probability will not be equal to 1. In other words – we are not 100% sure that a given flow will assume the value of S_0, and not a greater or smaller one. This will be influenced by the differences between the expected (most probable) values of cash flows and the real values of these flows that emerge during the project implementation.

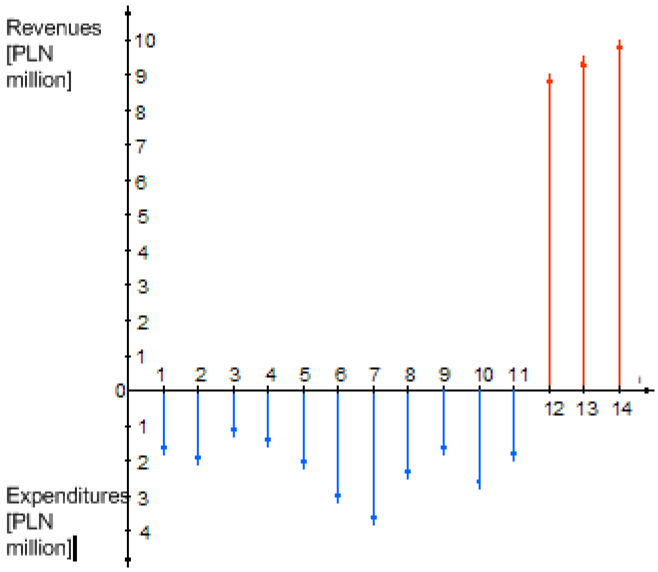

Figure 1. Individual cash flows, without taking into account the risk.

Table 1: The assumed cash flows for the project.

	i	Activity	S_0
Expenditures	1	Contractual proceedings	-1,8
	2	Project	-2,1
	3	Measurement works	-1,3
	4	Earthworks	-1,6
	5	Boarding	-2,2
	6	Concrete works	-3,2
	7	Steel structures	-3,8
	8	Water supply system	-2,5
	9	Ventilation	-1,8
	10	Power supply works	-2,8
	11	Sewage system	-2
Revenues	12	Revenues year 1	9
	13	Revenues year 2	9,5
	14	Revenues year 3	10

NPV = 3,4

Therefore, the flow can be reasonably presented as a random variable through its probability distribution, specifying the maximum probability, corresponding to flow S_0 and cash flow values, which are characterised by lower probability. We assume that the probability of emergence of value S_0 is the highest. The vertical axis of this chart is probability, while the horizontal axis consists of flow values.

Application of this type of distribution can be explained by the fact that at the stage of the feasibility study, we use approximate data, and application of more accurate distributions at this stage is not reasonable. The extreme values in the triangular distribution presented are, in fact, characterised by such a low probability hat at the stage of feasibility study, their probability has been assumed to be equal to zero.

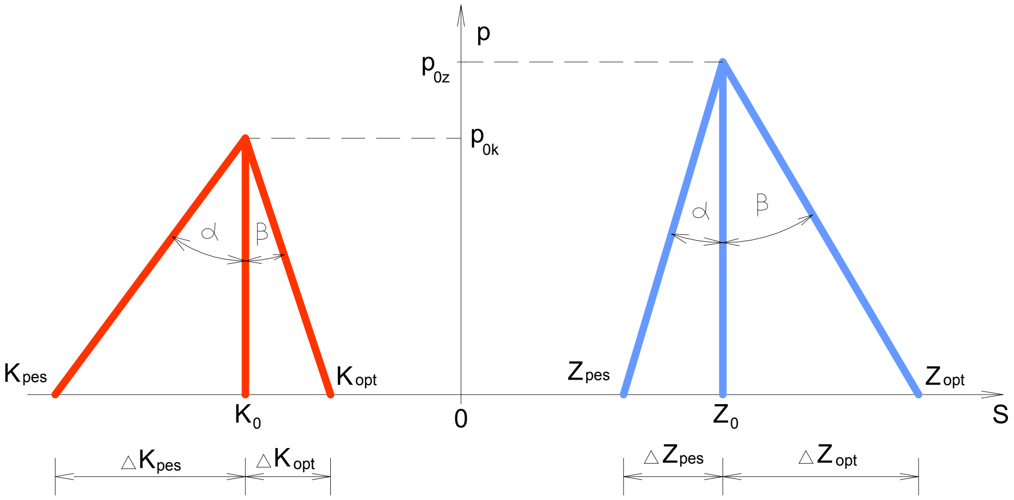

Figure 2. Presentation of the flow distribution in triangular form.

In fig. 2, variables have the following meanings:

Z_{pes} – extreme pessimistic value of revenues, assuming probability = 0,

Z_{opt} – extreme optimistic value of revenues, assuming probability = 0,

ΔZ_{pes} – difference between the most probable value and the extreme pessimistic value of revenues,

ΔZ_{opt} – difference between the extreme optimistic value and the most probable value of revenues,

K_{pes} – extreme pessimistic value of expenditures, assuming probability = 0,

K_{opt} – extreme optimistic value of revenues, assuming probability = 0,

ΔK_{pes} – difference between the most probable value and the extreme pessimistic value of expenditures,

ΔK_{opt} – difference between the extreme optimistic value and the most probable value of expenditures,

p_{0z} – the probability of revenue being equal to Z_0,

p_{0k} – the probability of expenditure being equal to K_0.

The arms of the triangular distribution show how rapidly a revenue or an expenditure may change. The character of this change will be determined by providing tangents of inclination angles α and β. Angle α will determine the "risk of increase of expenditure" or the "risk of decrease of revenue", while angle β will stand for the "risk of decrease of expenditure" or the "risk of increase of revenue". In other words, α – a negative risk (associated with a decrease of NPV value), β – a positive risk (associated with an increase of the NPV value). We define risk as the ability, or susceptibility, to changes for individual cash flows. A high risk of an expenditure change means that the most probable value may undergo significant changes upon slight changes of external conditions. On the other hand, a low risk of changes will be typical for more certain activities, less susceptible to changes. Moreover, a high risk of changes determines the lower probability of emergence of expenditure K_0, which means we have to take into account substantial changes during the investment project implementation in case of a flow characterised by a high α or β. Value S_0 will be obtained from the preliminary assessment of the investment. The probability p_0 of the flow assuming value S_0 is to be obtained from experts. To determine α or β, we also need the following ratio:

$$\frac{\Delta S_+}{\Delta S_-} = x \qquad (1)$$

$\Delta S+$ and $\Delta S-$ are deviations from values obtained on the basis of preliminary assessments.

Information concerning p_0 can be provided by experts in linguistic form as one of the five expressions: minimum, low, medium, high, maximum. When we obtain such answer, it needs to be transformed into numerical values. For this purpose, we apply a presentation of linguistic space. In our case, it consists of fuzzy sets {minimum; low; medium; high; maximum}. The numerical values of linguistic variable in the case of p_0 have been presented in fig. 3.

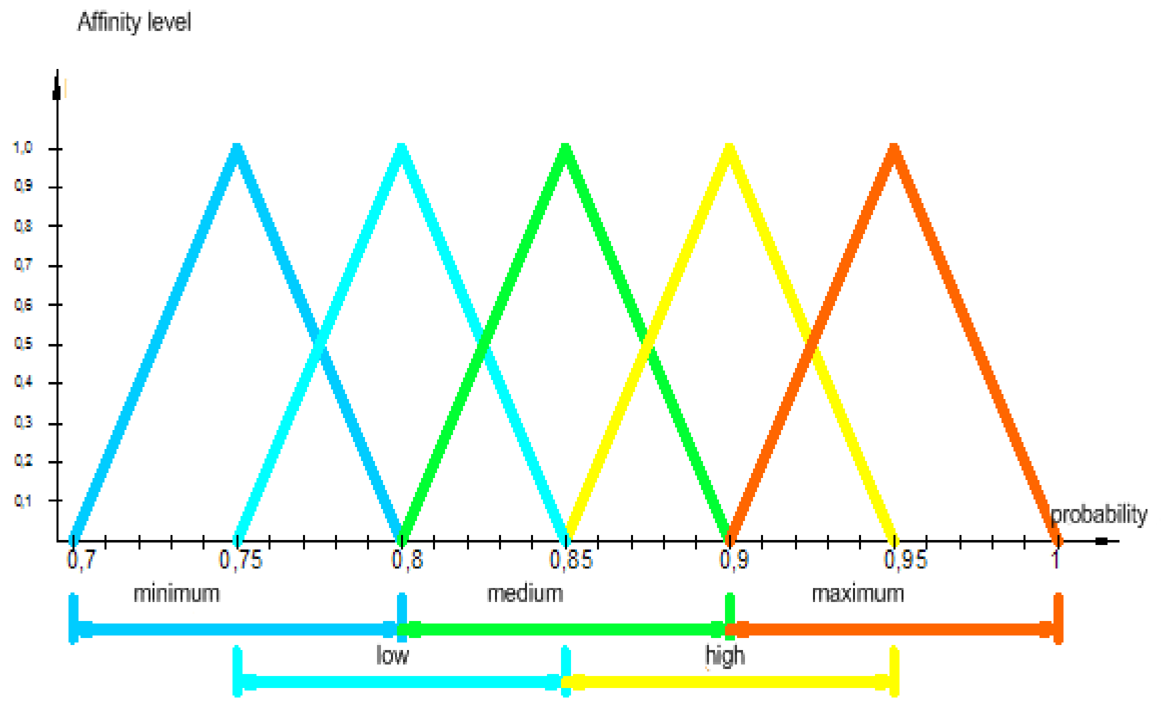

Figure 3. Presentation of probability as a linguistic variable.

Presented below is information in linguistic form, concerning probability p_0, obtained from three experts, as an example is presented in table 2.

Table 2: A breakdown of expert opinions on p_0 in linguistic form

	I	Activity	S_0	p_0(Eksp1)	p_0(Eksp2)	p_0(Eksp3)
Expenditures	1	Contractual proceedings	-1,8	medium	medium	low
	2	Project	-2,1	medium	low	minimum
	3	Measurement works	-1,3	maximum	high	high
	4	Earthworks	-1,6	medium	high	medium
	5	Boarding	-2,2	medium	medium	low
	6	Concrete works	-3,2	low	low	low
	7	Steel structures	-3,8	medium	medium	low
	8	Water supply system	-2,5	medium	high	high
	9	Ventilation	-1,8	high	medium	medium
	10	Power supply works	-2,8	medium	high	high
	11	Sewage system	-2	high	high	medium
Revenues	12	Revenues year 1	9	medium	high	medium
	13	Revenues year 2	9,5	medium	medium	low
	14	Revenues year 3	10	medium	low	medium

On the basis of the linguistic space assumed, numeric values have been determined for probability p_0 as established by experts.

Table 3: Characteristic values for each distribution

	i	Activity	S_0	x	p_0	ΔS_{pes}	ΔS_{opt}	S_{pes}	S_{opt}	$\Delta S_{pes}/\lvert S_0\rvert$	$\Delta S_{opt}/\lvert S_0\rvert$	$S_{pes}/\lvert S_0\rvert$	$S_{opt}/\lvert S_0\rvert$
Expenditures	1	Contractual proceedings	-1,8	0,4	0,83	1,71	0,69	-3,51	-1,11	0,95	0,38	-1,95	-0,62
	2	Project	-2,1	0,6	0,80	1,56	0,94	-3,66	-1,16	0,74	0,45	-1,74	-0,55
	3	Measurement works	-1,3	0,5	0,92	1,45	0,73	-2,75	-0,57	1,12	0,56	-2,12	-0,44
	4	Earthworks	-1,6	0,5	0,87	1,54	0,77	-3,14	-0,83	0,96	0,48	-1,96	-0,52
	5	Boarding	-2,2	0,8	0,83	1,33	1,07	-3,53	-1,13	0,61	0,48	-1,61	-0,52
	6	Concrete works	-3,2	0,5	0,80	1,67	0,83	-4,87	-2,37	0,52	0,26	-1,52	-0,74
	7	Steel structures	-3,8	0,7	0,83	1,41	0,99	-5,21	-2,81	0,37	0,26	-1,37	-0,74
	8	Water supply system	-2,5	0,8	0,88	1,26	1,01	-3,76	-1,49	0,50	0,40	-1,50	-0,60
	9	Ventilation	-1,8	1	0,87	1,15	1,15	-2,95	-0,65	0,64	0,64	-1,64	-0,36
	10	Power supply works	-2,8	0,7	0,88	1,33	0,93	-4,13	-1,87	0,48	0,33	-1,48	-0,67
	11	Sewage system	-2	0,6	0,88	1,42	0,85	-3,42	-1,15	0,71	0,42	-1,71	-0,58
Revenues	12	Revenues year 1	9	0,7	0,87	1,36	0,95	7,64	9,95	0,15	0,11	0,85	1,11
	13	Revenues year 2	9,5	0,8	0,83	1,33	1,07	8,17	10,57	0,14	0,11	0,86	1,11
	14	Revenues year 3	10	0,9	0,83	1,26	1,14	8,74	11,14	0,13	0,11	0,87	1,11

In this manner, each of the cash flows has been presented in form of two distributions – absolute and relative.

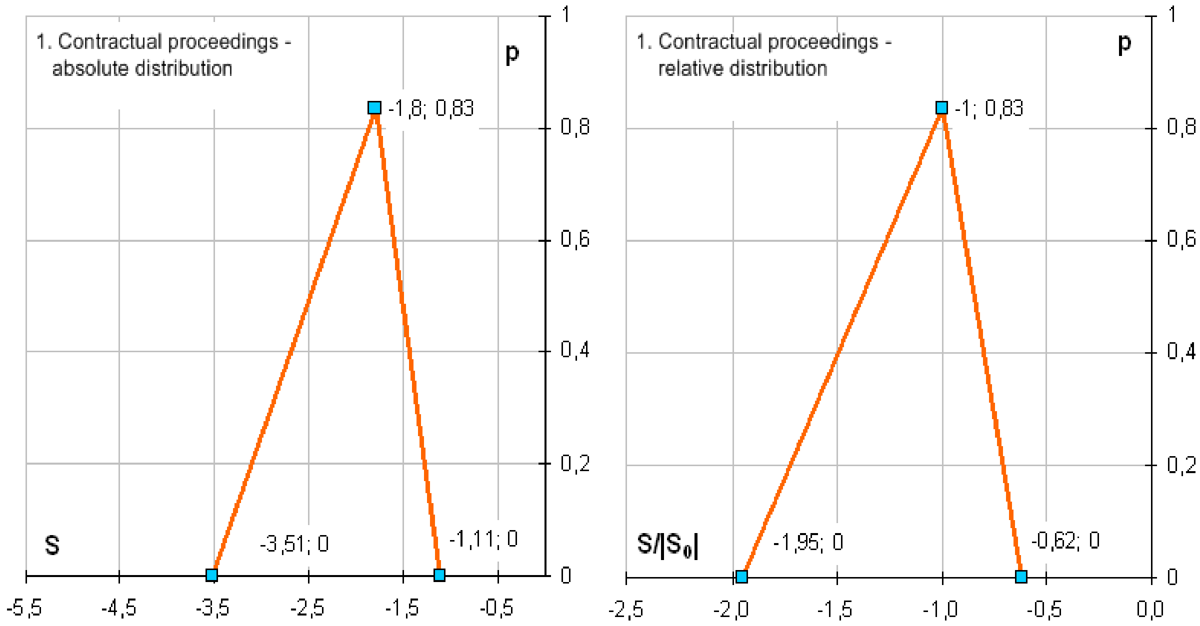

Figure 4. Exemplary flows in form of a triangular probability distribution.

On the basis of cash flows, presented as a random variable, NPV has been determined:

$$NPV_{pes} = \sum_{i=1}^{n} S_{pes} \tag{2}$$

$$NPV_0 = \sum_{i=1}^{n} S_0 \tag{3}$$

$$NPV_{opt} = \sum_{i=1}^{n} S_{opt} \tag{4}$$

Due to the fact that the value of NPV has been presented as a random value, it is possible to calculate the value of p_0 of its emergence, as well as the values of α, β.

$$P_{\Delta} = \frac{1}{2} \cdot (NPV_{opt} - NPV_{pes}) \cdot p_0 = 1 \Rightarrow p_0 = \frac{2}{NPV_{opt} - NPV_{pes}} \tag{5}$$

$$tg(\alpha) = \frac{\Delta S_{pes}}{p_0}, \tag{6}$$

$$\alpha = arctg\left(\frac{\Delta S_{pes}}{p_0}\right), \tag{7}$$

$$tg(\beta) = \frac{\Delta S_{opt}}{p_0}, \tag{8}$$

$$\beta = arctg\left(\frac{\Delta S_{opt}}{p_0}\right). \tag{9}$$

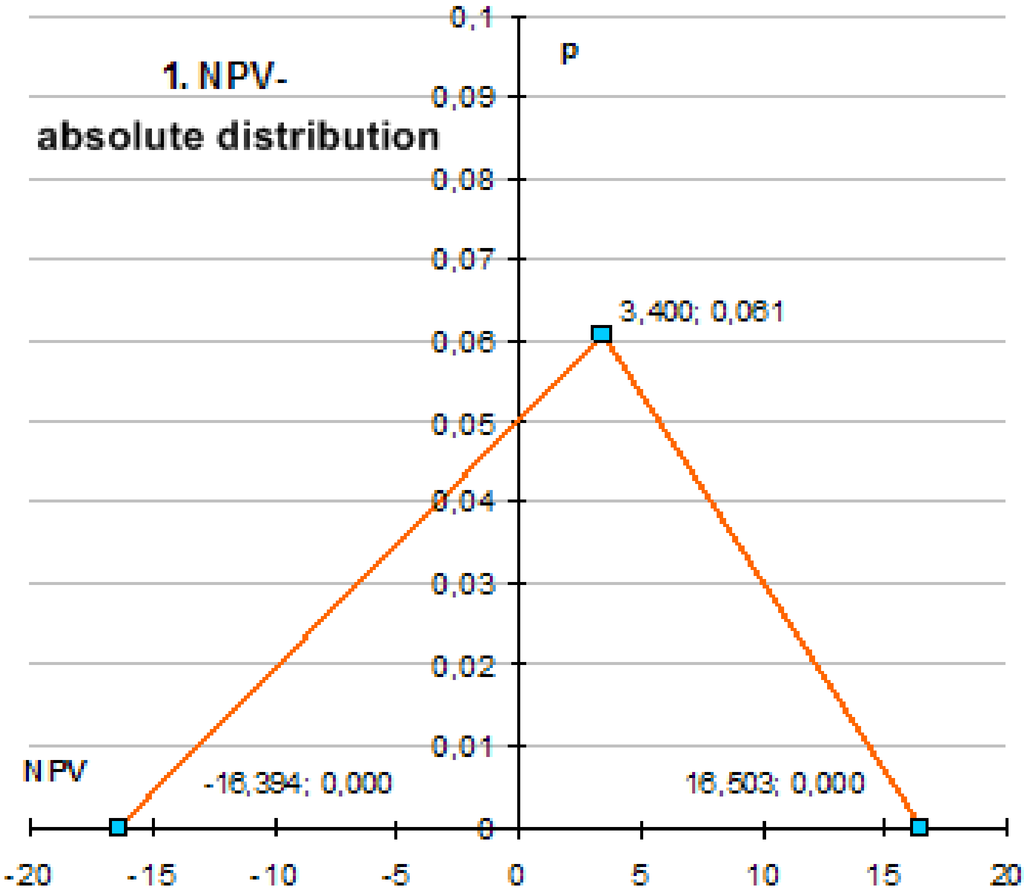

Figure 5. Presentation of NPV value in form of a random variable distribution.

The values of all distributions were determined not on the basis of the entire set of assessment of linguistic variables p_0, but only the values of affinity equal to 1, that is: minimum = 0.75; low = 0.80; medium = 0.85; high = 0.9; maximum = 0.95.

Therefore, the distribution values constitute acute distributions. In order to grasp the fully subjective and imprecise nature of expression of value p_0, it is necessary to take into account all values of the linguistic variable. Thanks to the fact we have assumed a triangular function of affinity, it is now sufficient to conduct calculations for 3 values: L – extreme left of affinity level = 0; C – central of affinity level = 1; P – extreme right of affinity level = 0.

In our case, the linguistic value (L ; C ; P) will be as follows: minimum = (0,7 ; 0,75 ; 0,8); low = (0,75 ; 0,80 ; 0,85); medium = (0,85 ; 0,90 ; 095); high = (0,85 ; 0,9 ; 0,95); maximum = (0,9 ; 0,95 ; 1).

In this manner, instead of a single probability value p_0, we have obtained three values of p_0, and thus – three probability distributions for a single cash flow (extreme left – L, central – C, extreme right – P). On the basis of flow distributions, presented in this manner, the fuzzy distribution of NPV has been determined.

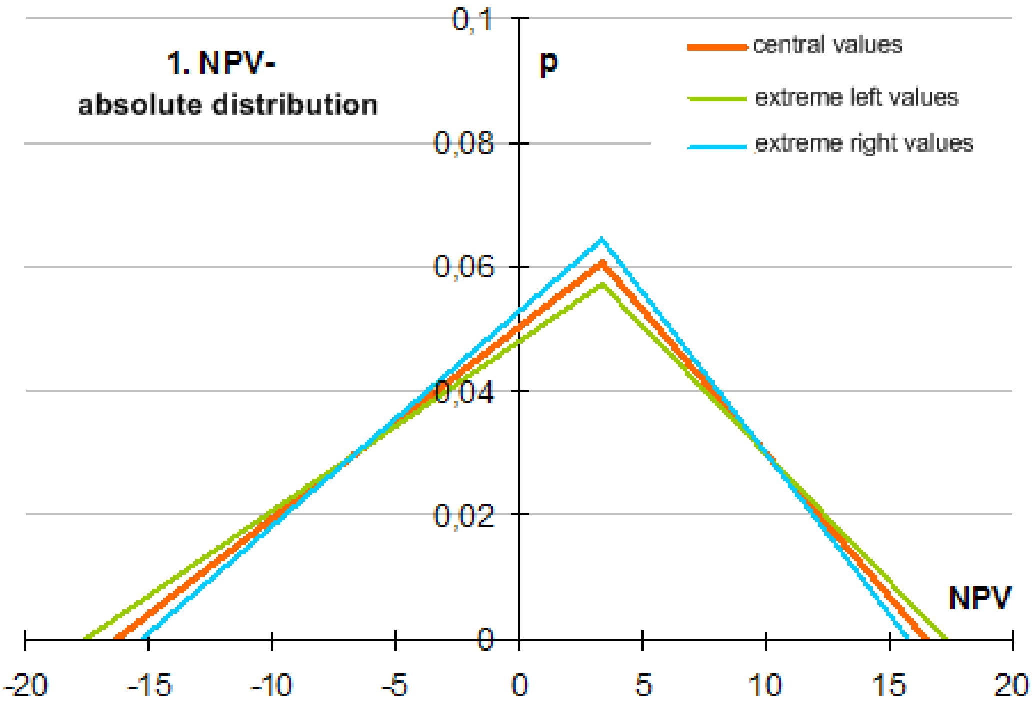

Figure 6. Absolute distribution of NPV values.

CONCLUSIONS

Such presentation of the distribution allows for an objective assessment of distribution of cash flows and the resulting NPV distribution. The levels of fuzziness of the parameters discussed allow for determination of subjectivity and imprecision of assumption of the basic values, which characterise the individual cash flow distributions and NPV values in linguistic form. The procedure discussed may be applied in practice at the stage of strategy assessment and the feasibility study. It allows for determination of probability of emergence of a given value of cash flows and NPV values and for presentation of their fuzziness.

REFERENCES

Morgan N.G., Henrion M. (1990) Uncertainty. A Guide to dealing with uncertainty in quantitative risk and policy analysis. Cambridge University Press, New York.

Piegat, A. (1999) Modelowanie i sterowanie rozmyte. Akademicka Oficyna Wydawnicza EXIT, Warsaw.

Minasowicz A. (2008) Analiza ryzyka w projektowaniu przedsięwzięcia budowanego, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa.

TRIANGLES, TRADEOFFS AND SUCCESS: A CRITICAL EXAMINATION OF SOME TRADITIONAL PROJECT MANAGEMENT PARADIGMS

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The concept of the 'project triangle', together with the related issues of project tradeoffs and project success factors are frequently discussed together in project management (PM) literature. However, these discussions rarely examine their interconnection critically. As a consequence, the models that are developed from and for these concepts are not properly connected; essentially, the *tradeoff* and *triangle* models can only deal with a limited range of *project success* elements. This paper is a conceptual study to highlight the significance of this 'triple connection' through a comprehensive review of PM literature. It then compares the traditional approach with suggested alternative ways of dealing with the concepts separately and jointly. Finally, the features of an improved framework for making tradeoff decisions are identified and discussed.

KEYWORDS: project triangle, project tradeoffs, project success, tradeoff framework.

INTRODUCTION

In 1969, Dr Martin Barnes, illustrated the construction projects' time, cost and quality relations by drawing a triangle to emphasize the importance of managing 'quality' besides time and cost (Barnes, 2006). Barnes's purpose was to envisage, for the first time, the necessity and significance of integrating the three elements to improve project control. This simple illustration set the foundation of the well-known classic *triangle* in PM history.

Three issues of *project triangle*, *project tradeoffs* and *project success/failure*, referred to as *'Triple Issues'* in this paper, are closely interwoven in project management thinking. The pairwise relations between these issues are frequently addresses in PM literature; however, the relation between the three and its implications is not clearly established. On the one hand, the lack of common consent on the concepts and elements involved in each issue, and, on the other, their discussion in different contexts, cause difficulties of their rational integration.

This paper is a conceptual study aimed at examining the project success, project tradeoffs and project triangle coherence as three crucial and closely interrelated concepts in PM. To achieve this purpose, the history and status quo of factors and trends associated with each concept are discussed and compared to each other. It is supposed that a meaningful relation between the Triple Issues supported by a consistent set of elements for each will facilitate making critical decisions and increase the chance of project success.

For the purpose of this study, to reveal the growing trend in recognition of new elements for the Triple Issues plays an important role. Hence, examples of the resources, which are evidences of this trend, whether by adding new criteria or suggesting a new classification of the criteria, will be addressed to highlight the trend. Deciding whether a specific element or a set of elements should be included in each issue or not, is of significance in PM but it is not in the scope of the current paper. This paper is a snapshot of an ongoing research on project critical decisions.

THEORETICAL FRAMEWORK

Project Triangle Concept

Since its early utilization by Barnes, the *project triangle* has been discussed in different areas in the PM and construction project management literature but the concept had not been subject to a major change, to the extent that Gardiner and Stewart (2000) address it as a well-worn cliché. The author of the only book dedicated to 'the triple constraints', refers to the subject as "fundamental and yet surprisingly unexplored" and one of "the most-overlooked" concepts in PM (Dobson, 2004, p. xi, xiii).

Project Triangle Developments

In his early version, Barnes named the corners of the triangle 'time, cost, quality' but in a later version developed soon after, changed 'quality' to 'performance' (Lock, 2007). 20 years later, the concept was called 'the triangle of objectives' by the initiator (Barnes, 1988).

Since then, the most significant trials to develop the 'triangle concept' have led to a number of different illustrations through adding one or more sides to the shape and/or changing the dimensions from two to three. The illustration has taken the forms of a *tetrad* (Wideman, 2004), *tetrahedron* (Atkinson, 1999; Davis, cited in Wideman, 2004; Burke, 2006), *pyramid* (Marasco, 2004), and *cube* (Hamilton, 2001) so far.

The above mentioned combinations of the elements are referred to as *triangle of objectives* and *trade-offs* (Barnes 1988; Lock, 2007); *project triangle* (Devaux, 1999; Nokes et al., 2003); *triple constraints* (e.g. Turner and Simister, 2000; Hamilton, 2001; Frame, 2002; Bennett, 2003; Dobson, 2004); *criteria's of success* (Williams, 2002); *the iron triangle* (Atkinson, 1999); *Project's Building Blocks* (Orr, 2007); *the Square Route* (Atkinson, 1999); *the project pyramid* (Marasco, 2004); and so forth.

Various names have also been given to the vertices and/or sides of the shapes; nevertheless, 'time' and 'cost' are almost invariably the fixed ones, though they may be referred to as 'schedule' or 'budget'. Despite all of the different versions, the original, developed by Barnes remains the most popular in PM literature (see, for example, Turner and Simister, 2000; Hamilton, 2001; Williams, 2002; Dobson, 2004; Burke, 2006; Kerzner, 2006; Pollack-Johnson and Liberatore, 2006) and specifically that related to construction (see Clough et al., 2000; Woodward, 2003; Bennett, 2003; Lock, 2004).

Besides 'time' and 'cost' other suggested elements have been *quality* (Klein, 1993; Turner and Simister, 2000; Davis, cited in Wideman, 2004; Wideman, 2004; Marasco, 2004; Barnes, 2006; Burke, 2006; Pollack-Johnson and Liberatore, 2006; Orr, 2007); *performance* (Barnes, 1988; Hamilton, 2001; Williams, 2002; Dobson, 2004; Kerzner, 2006; Nicholas and Steyn, 2008); *scope* (Devaux, 1999; Nokes et al., 2003; Davis, cited in Wideman, 2004; Wideman, 2004; Gradiner, 2005; Orr, 2007); *specifications* (Frame, 2002; Lock, 2007); *resources* (Davis, cited in Wideman, 2004; Wideman, 2004); *Net Present Value (NPV)* (Gardiner and Stewart, 2000); *frugality, speed, risk* (Marasco, 2004); *people* (Lock, 2007; Kliem and Ludin, cited in Lock, 2007); and the three factors: *information system*, *benefits to organization*, and *benefits to stakeholder community* besides the *iron triangle* (Atkinson, 1999).

Project Tradeoff Decisions

Originally, the concept of *trade-off* in PM appears to refer specifically to problems which demand finding a balance between the project's '*time* and *cost'* and it is said to be the origin of the critical path method (CPM) developed in 1950s (Pollack-Johnson and Liberatore, 2006). According to Leu et al. (2001), one of the most important aspects of planning and control in construction is trade-off analysis between time and cost. Thus, when time and cost are considered as *'resources'*, tradeoffs might be necessary due to their scarcity (Dobson, 2004) and when they are considered as *'objectives,'* tradeoffs serve as a balancing act when these objectives conflict (Williams, 2002; Lock, 2007). In fact, if a project went well according to the plan or had the benefit of unlimited resources, there would not be a need to make a tradeoff (Williams, 2002; Kerzner, 2006). In general, a tradeoff comprises 'making a decision'; hence, it can be perceived as a type of decision making problem and not simply a controlling or scheduling tool like CPM.

Elements of Project Tradeoffs

A considerable amount of research has aimed at resolving the *time-cost* tradeoffs on projects, either by developing new methods or technically improving the current ones (see, for example, Deĭneko and Woeginger, 2001; Yang, 2007; Wuliang and Chengen, article in press). However, the main focus of this study is another line of research, which claims project tradeoff and/or its resolution method should consider *other factors* besides time and cost (Barnes, 1988; Babu and Suresh, 1996; Shenhar et al., 1996; Leu et al., 2001; Pollack-Johnson and Liberatore, 2006). As one of the pioneers in this line, Dr Barnes (Barnes, 1988) highlighted the significance of considering *performance* as a factor alongside *time* and *cost* in construction projects' decisions.

Over a decade ago, Babu and Suresh (1996) claimed that they could not find a model in the literature to simultaneously consider the three objectives of *time, cost, quality* in tradeoffs. Hence, they developed a mathematical method based on three linear programming models to overcome the problem. Ten years later, Pollack-Johnson and Liberatore (2006) were still criticising the traditional time-cost tradeoffs for ignoring the *quality* factor. They suggest a framework to combine different definitions of quality with their related time, cost, and priorities. They used mixed integer linear programming, goal programming, mixed integer linear program for problem modelling and the Analytic Hierarchy Process (AHP) for choosing among the alternatives.

Shenhar et al. (1996) link project tradeoffs with the recognition of top management and the project team's expectation at the project start up.

Leu et al. (2001) associate the construction project's uncertainties with the various external environment's factors and developed a method to find the best balance between time and cost, considering the risk levels. Their model is based on Fuzzy Set Theory and searches for an optimal solution by Genetic Algorithms (GAs). The consideration of other parameters in the model, such as *total cost* rather than only *direct costs* is left for future research.

Marasco (2004) suggests four elements i.e. *scope, time, quality* and *resources* that should be included in the project tradeoffs. Illustrating these elements as a pyramid, he resolves the tradeoff by calculating the pyramid's volume.

Tareghian and Taheri (2006a) developed a method to resolve the time-cost tradeoff in 2006, but soon after, in two subsequent papers (Tareghian and Taheri, 2006b, 2007) they included '*quality*' in their mathematical methods. These papers used (respectively) 'the fast algorithm of randomized minimum cut'; three 'inter-related integer programming models'; and 'electromagnetic scatter search' as tradeoff methods.

Kerzner (2006, p.684) gives a schematic view of some of the factors affecting, or 'forcing' the tradeoffs. The illustration is not explained in detail; however, it seems that some of these factors like *reputation*, *market position* and *profit* are perceived as internal and some external such as *reliability, service, response* and *controls*.

Project Success/ Failure

The project management community's obsession with project success/ failure is not a recent issue. Bryde and Robinson (2005) date back the studies to the 1960s or earlier. In fact, project success is such closely interwoven with the field that the most globally accepted success criteria ('*time, cost* and *quality/performance'* or the *'Iron Triangle'*) invariably play their part in the various definitions of PM (see Atkinson, 1999). Referring to the way PM was defined in the 1950's and reviewing a few recent definitions; Atkinson (1999) shows that PM fundamentals and concepts of project success were unchanged in half a century. Belassi and Tukel (1996) portray the era as 'highly focused on project scheduling based on the triple elements, in the hope of having more successful projects through better schedules'.

Shenhar and Levy (1997, p.337) acknowledged that project success might be "the most frequently discussed" topic in PM; while, just one year before them Belassi and Tukel (1996) stated that there was a small number of studies in this field. Nevertheless, both sources agree on the wide range of disagreement and lack of common consent on the topic. A decade later, after conducting comprehensive research on project success, Prabhakar (2006) continues to highlight the lack of agreement on success criteria.

The deficiency of the project triangle elements in reflecting the reality of 'what it takes to have a successful project' was raised by Belassi and Tukel (1996); Shenhar et al. (1996); Winch et al. (1998); Atkinson (1999); Gardiner and Stewart (2000); Morris et al. (2000); Bryde and Robinson (2005); Prabhakar (2006); and Kerzner (2006), to name but a few.

The importance of considering the 'client satisfaction' as central to PM and its necessary involvement in project definition is put forward by Winch et al. (1998).

The fact that the project parties might perceive and evaluate success criteria in different ways has been recognised for a long time (Barnes, 1988; Belassi and Tukel, 1996; Shenhar and Levy, 1997; Atkinson, 1999; Morris, 2005; Cleland and Ireland, 2006; Lock, 2007). It is this difference (between the client and contractor's views on success criteria) that is the basis of a study by Bryde and Robinson (2005). Woodward (2003) specifically refers to the difference between viewpoints of construction project's parties on project *cost*, despite sharing the same intention to complete the project *on time*.

Many of the attempts to classify success criteria have been discussed by Belassi and Tukel (1996). They categorize the related literature into two major categories, i.e. theoretical and empirical, and further compare the critical success factors suggested by seven authors. To overcome the shortcomings of these categories, they propose another framework for categorizing the success factors (Belassi and Tukel, 1996, p.143) including the factors related to the project; project manager and team members; organization; and external environment.

Gardiner and Stewart (2000) replace the phrases 'on time and to budget' with 'best achievable NPV (Net Present Value)' to ensure the shareholders' benefits in the long run. They also highlight the significance of the non-financial factors in project success.

Cooke-Davies (2002) distinguishes '*success criteria* from *success factors'* and '*project management success* from *project success'*. Based on these distinctions he puts forward three questions and ultimately extracts 12 success factors. Besides, he emphasises the importance of human resources in project success, though it is not included in the suggested factors.

INTERRELATION BETWEEN THE 'TRIPLE ISSUES'

Previous sections provided a general view of elements present within a project's *triple issues* and the changing views regarding each topic. This section portraits the pairwise relations between the topics and the trio in order to clarify the need for coherence between their elements. One common area for discussing these topics is 'decision making' in projects. Generally speaking, in this context, a successful project needs to establish a proper balance between its success criteria, which can be analysed and decided through tradeoffs.

Triangle-Success
The *project triangle* has been discussed in project 'success/failure' context as the projects' success criteria or at least a main part of it. A few instances of this are Atkinson (1999), Turner and Simister (2000), Williams (2002), Marasco (2004), Gardiner (2005), Cleland and Ireland (2007), and Lock (2007).

Triangle-Tradeoffs
A number of other academics emphasize the role of the triangle as the basis of project decisions in general and/or tradeoffs in specific. Barnes (1988), Klein (1993), Devaux (1999), Williams (2002), Nokes et al. (2003), Dobson (2004), Wideman (2004), Gardiner (2005), Kerzner (2006), Pollack-Johnson and Liberatore (2006) and Nicholas and Steyn (2008) are a few examples.

Tradeoff-Success
The relation between project decisions (or more specifically tradeoffs) and project success is the least discussed theme. Belassi and Tukel (1996, p.150) include the project manager's "ability to do tradeoffs" as one of the project success factors. Shenhar et al. (1996) emphasizes *success criteria* as the foundation of project tradeoffs both in the launch of and during the project. The methodology for project tradeoffs is called 'facilitation for project success' by Babu and Suresh (1996).

Triangle-Tradeoff-Success
A limited number of the references reviewed explicitly associate all the triple issues with each other. Williams (2002) refers to *the triangle* simultaneously as a set of success criteria and the foundation of 'project tradeoffs'. Lock (2007) stresses the significance of the decisions or tradeoffs between the conflicting objectives, i.e. *Time, cost, specification* and *people* in centre, and their impact on project success. Babu and Suresh (1996) have much the same discussion; however, they use *quality* instead of *specifications* and exclude *people*. Marasco (2004) links the probability of project success in an extended model of triangle and discusses this model as the basis for tradeoffs required for achieving project success.

Upon reviewing a wide range of PM literature, it has thus been demonstrated that neither pairwise relations between project tradeoffs and project success nor an integrated relationship between the Triple Issues are sufficiently focused or clear, especially when compared to success-triangle and triangle-tradeoff relations.

DISCUSSION

The theoretical framework reveals a growing trend in criticising the traditional views on the Triple Issues. There is a common consent between a large number of PM researchers that each one of these issues needs to consider further elements than they traditionally did. Nevertheless, there is no agreement on the *new* or *alternative elements* themselves. A schematic view of the traditional and most emphasised alternative elements is summarized in Table 1. It should further be mentioned that there still exist many PM sources that are not affected by such discussions and continue to recycle the same old theories.

It can be seen in Table 1 that the non-traditional views range from very specific, tangible, measurable factors (like NPV) to hard to measure, intangible and very general ones such as external environment. The largest number and variety of alternative elements were found in relation to *project success*, though only a few could be discussed in this paper.

Table 1: Traditional and Some Alternative Elements of Triple Issues

	Project Triangle	**Project Tradeoffs**	**Project Success-Failure**
Traditional Elements	Time, Cost, Quality/ Performance	Time, Cost	Time, Cost, Quality, Performance
Examples of Other Suggested Elements	Scope, Specifications, Risk, People, Resources, NPV, Frugality, Speed, External Environment, Information System, Benefits to organization, Benefits to Stakeholder Community	Quality, External Environment, Scope, Top management & project team's expectations, Resources, Reliability, Control, Service, Response, Reputation, Market Position, Profit	Scope, Stakeholder's Different success criteria, Client satisfaction, NPV, External Environment, Organizational factors, Project managers and team members' factors, Many other factors and classifications

Reviewing the various views reveals that in terms of the triangle concept, PM academics have not, so far, been able to think ‘out of the box’. In fact, it seems that all that is being done is to try to make the ‘box’ at first, by adding more and more sides’ before inventing a totally new way of illustrating it. The question is whether the basis of the tradeoffs and project success criteria should be necessarily drawn as a triangle; or indeed in a geometrical format at all? Is it more important to retain the form or reflect the real content? Frame (2002, p.6) criticizes the traditional PM approach because it puts too much emphasis on: “satisfying the famous triple constraints of time, budget, and specifications” (though his real point is merely that the role of *customer satisfaction* is being ignored).

Additionally, different methods developed to resolve tradeoffs reveal that despite the identification of other factors, researchers’ efforts are mainly focused on time-cost tradeoffs, and, at most, adding *quality* to their predominantly mathematical methods. It is worth noting that the necessity for alternative/additional elements is mainly discussed in papers that are not concerned with actually solving the tradeoff. In other words, when it comes to developing a resolution model, the elements considered are normally limited to the original ‘triangle’.

The above considerations raise a major question: namely, whether the *tradeoff methods* are chosen based on their capability to deal with the real factors, or the *tradeoff factors* are chosen based on the capabilities of the available methods?’ The case seems more closely to support the latter. Frame’s (2002, p.6) statement, referring to a “[traditional PM approach] … single-minded focus on a fixed set of tools for dealing with scheduling, budgeting, and resource allocation” appears to be appropriate. Clough et al. (2000, pp.140-141) pinpoint the limitations and failures of the time-cost based computerized methods to solve the construction tradeoffs. They associate the failures with “oversimplification” of the *tradeoffs’ reality* which ultimately leads to a continued dependence on “human judgment and insight” as the most important role in such decisions.

CONCLUSIONS

The status quo of the studies on project triangles, project tradeoffs and project success/failure reveals a real need to change the traditional viewpoints on their constituent elements. However, the significance of the interrelation between these issues is overlooked in the related literature, and this leads to lack of cohesion and connectivity between the studies carried out on them. Hence, tradeoff and triangle models can deal with just a few limited factors and the success-failure models suggest so many factors with different natures that the most accepted methods are incapable of dealing with them, either as success criteria in reviews or decision criteria in tradeoff assessments.

To overcome these problems, such studies should look for creative viewpoints, methods and models capable of dealing with the real influencing factors. The continuing identification of missing elements, while trying to preserve the traditional PM paradigms, will not improve the situation. It is time for a radical overhaul of the models and methods in use.

Project tradeoff decisions should be taken within an integrated framework linking project objectives, constraints and success criteria. Such a framework should also provide proper methods of dealing with as many as possible of the recognised influencing factors. Projects are often considered as unique entities with different objectives, constraints and success criteria from one to the other; furthermore, within each project, stakeholders also might have different perspectives on each of these. Yet traditionally, PM models are perceived to be applicable for every project, and the limits of their applicability are rarely mentioned. The future paradigms called for here should also be general and flexible enough to deal with this wide range of variations. Obviously, a set of predefined criteria and methods might not be applicable for any type of project.

This paper is a snapshot of an ongoing research project aimed at developing a proper decision making framework, based on decision science theories, to model and solve project tradeoffs. Whilst the deficiencies of existing models have been exposed, further work is now required to put better, alternative approaches in place.

REFERENCES

Atkinson, R. (1999) Project management: cost, time and quality, two best guesses and a phenomenon; it’s time to accept other success criteria. International Journal of Project Management, 17 (6), 337-342.

Babu, A. J. G. and Suresh, N. (1996) Project management with time, cost, and quality considerations. European Journal Operations Research, (88), 320-327.

Barnes, M. (1988) Construction project management. Project Management, 6 (2), 69-79.

Barnes, M. (2006) “Some origins of modern project management-A personal history”, available at: http://www.pmforum.org/viewpoints/2006/08_4.htm

Belassi, W. and Tukel, O. I. (1996) 'A new framework for determining critical success/failure factors in projects', International Journal of Project Management, 14 (3), 141-151.

Bennett, L. (2003) The Management of Construction- a project life cycle approach. Burlington: Gower Publishing Limited.

Bryde, D.J. and Robinson, L. (2005) Client versus contractor perspectives on project success criteria. International Journal of Project Management, 23, 622-629.

Burk, R. (2006) Project management- planning and control techniques. 5 edn. Burke Publishing.

Cleland, D. I. and Ireland, L. R. (2006) Project management – strategic design and implementation. 5 edn. McGraw-Hill.

Clough, R. H., Sears, G. A. and Sears, S. K. (2000) Construction Project Management. 4 edn. Canada: John Wiley & Sons, Inc.

Cooke-Davies, T. (2002) The ‘‘real’’ success factors on projects. International Journal of Project Management, 20, 185-190.

Deĭneko, V. G. and Woeginger, G. J. (2001) Hardness of approximation of the discrete time-cost tradeoff" problem. Operations Research Letters, (29), 207-210.

Devaux, S. A. (1999) Total project control-A manager's guide to integrated project planning, measuring, and tracking. New York: John Wiley & Sons, Inc.

Dobson, M. S. (2004) The triple constraints in project management. United States of America: Management Concepts Inc.

Frame, J. D. (2002) The New Project Management: Tools for an Age of Rapid Change, Complexity, and Other Business Realities. 2 edn. Jossey-Bass.

Gardiner, P. (2005) Project Management: A Strategic Planning Approach. New York or Hampshire: Palgrave Macmillan.

Gardiner, P.D. and Stewart, K. (2000) Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure. International Journal of Project Management, 18, 251-256.

Hamilton, A. (2001) Managing Projects for Success- A Trilogy. London: Thomas Telford Publishing.

Kerzner, H. (2006) Project Management: A System Approach to Planning, Scheduling and Controlling. 9 edn. New Jersey: John Wiley & Sons.

Klein, J. H. (1993) Modelling Risk Trade-Off. The Journal of the Operational Research Society, 44 (5), 445-460.

Leu, S. S., Chen, A. T. and Yang, C. H. (2001) A GA-based fuzzy optimal model for construction time-cost trade-off. International Journal of Project Management, 19, 47-58.

Lock, D. (2004) Project Management in Construction. Burlington: Gower Publishing Limited.

Lock, D. (2007) Project Management. 9 edn. Hampshire, UK: Gower Publishing Limited.

Marasco, J. (2004) The Project Pyramid, available at: http://www.ibm.com/developerworks/rational/library

Morris, P. W. G. (2005) "Managing the Front-End: how project managers shape business strategy and manage project definition", available at: http://www.indeco.co.uk/filestore/Morris-ManagingtheFront-End2005.pdf

Morris, P. W. G., Patel, M. B. and Wearne, S.H. (2000) Research into revising the APM project management body of Knowledge. International Journal of Project Management, 18, 155-164.

Nicholas, J. M. and Steyn, H. (2008) Project Management for Business, Engineering, and Technology- Principles and Practice. 3 edn. Oxford: Elsevier Ltd.

Nokes, S., Major, I., Greenwood, A., Allen, D. and Goodman, M. (2003) The definitive guide to project management. Great Britain: Pearson Education Limited.

Orr, A. D. (2007) Advanced project management –A complete guide to key processes, models and techniques. 2 edn. London: Kogan Page Limited.

Pollack-Johnson, B. and Liberatore, M. J. (2006) Incorporating quality considerations into project time/cost tradeoff analysis and decision making. IEEE Transactions on Engineering Management, 53 (4), 534-542.

Prabhakar, G. P. (2006) A switch in time saves nine: Discovering a new methodology to succeed in projects using transformational leadership in cross-cultural settings. ESC Lille.

Shenhar, A. J., Renier, J. J. and Wideman, R. M. (1996) “Improving PM: linking success criteria to project type”, available at: http://www.pmforum.org/library/papers/2002/improvingpm_wideman.pdf

Shenhar, A. J. and Levy, O. (1997) Mapping the dimensions of project success. Project Management Journal, 28 (2), pp. 337-342.

Tareghian, H. R. and Taheri, H. (2006a) 'An application of randomized minimum cut to the project time/cost tradeoff problem', Applied Mathematics and Computation, (173), 1200-1207.

Tareghian, H. R. and Taheri, S. H. (2006b) On the discrete time, cost and quality trade-off problem. Applied Mathematics and Computation, (181), 1305-1312.

Tareghian, H. R. and Taheri, S. H. (2007) A solution procedure for the discrete time, cost and quality tradeoff problem using electromagnetic scatter search. Applied Mathematics and Computation, (190), 1136-1145.

Turner, R. and Simister, S. (eds.) (2000) Handbook of Project Management. 3 edn. Gower.

Wideman, M. (2004) “An Exciting New Model of Project Management”, available at: http://www.maxwideman.com/musings/newpmmodel.htm

Williams, T. (2002) Modelling Complex Projects. West Sussex: John Wiley & Sons.

Winch, G., Usmani, A. and Edkins, A. (1998) Towards total project quality: a gap analysis approach. Construction Management and Economics, 16, 193-207.

Woodward, L. (2003) Construction Project Management. London: Thomas Telford Publishing.

Wuliang, P. and Chengen, W. ‘A multi-mode resource-constrained discrete time–cost tradeoff problem and its genetic algorithm based solution’. International Journal of Project Management (2008), doi:10.1016/j.ijproman.2008.10.009

Yang, I. T. (2007) Performing complex project crashing analysis with aid of particle swarm optimization algorithm. International Journal of Project Management, (25), 637-646.

AN APPROACH TO THE BUSINESS PROCESS IMPROVEMENT PROJECT IN CONSTRUCTION COMPANY

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Croatian construction companies, during the last two decades passed very hard and dramatic transition. The construction companies faced simultaneously: economic transition of country, privatization of companies, internal restructuring (business process improvement), and in the recent time economic crisis - recession.

Despite of severe difficulties majority of construction companies survived on the internationally opened and very competitive construction market, even trying to modernize their business processes to improve construction company's management.

During the scientific research project „Information technology in Croatian construction“, in the Years 2001 – 2007, authors concluded that in the construction companies is not enough recognized necessity for the systematic approach to the company's business process improvement, as the base for increase of:

- Productivity,
- Competitiveness,
- Profits

Authors are presenting conceptual approach to the development Project of business process improvement in the construction company.

Construction processes, project goals, project scope, construction process rationalization tools, methodology, possible benefits are described.

KEYWORDS: construction company, business process, information technology, IT application.

INTRODUCTION

Increasing complexity of modern buildings and the growing competition in the construction market increased the pressure for performance improvement of the construction business processes. Many construction projects are not delivered within the planed budget, time and quality and often are poorly focused on client needs.

Construction business processes usually require thousands of interdependent, often conflicting, decisions. A large number of various participants should properly cooperate in all phases of construction business processes.

In order to improve construction business processes management, construction company can undertake systematic approach to design and develop appropriate company's business process model, which would allow consistent and integrated construction business process management.

Business process

Business process has been defined as a collection of activities, connected by flows of goods and information that transforms various inputs into more valuable outputs: products and services.(Izetbegović, Žerjav 2009.)

Business process improvement goals

The typical goals of the corporation business process improvement are:

- reducing the work parts
- simplifying the control and checkpoints
- reducing the internal and external communication costs
- rationalization of the decision processes
- transition from sequential processes to simultaneous (parallel) processes through implementation of flexible information systems

Potential benefits after realization of the business processes improvement project are:

For the organization:
- increasing competitiveness
- consistency through process replication
- better predictability of planning processes
- easier partnering and contracting with other construction project participants
- IT systems support

For the business process:
- reducing time and costs
- better planning
- better and timely information exchanges
- better communications
- reduce errors and rework
- benchmark for improvement

For the client:
- better product quality
- fitness for the purpose
- delivered on time
- delivered to planned costs

The agent that enabled companies to break their old rules and create new process models is modern information technology (IT). IT acts as an enabler that allows organizations to work in radically different ways (Hammer, Champy 1993.).

During the scientific research project „Information technology in Croatian construction“, in the Years 2001 – 2007, authors concluded that in the construction companies is not enough recognized necessity for the systematic approach to the company's business process improvement, as the base for increase of:

- Productivity,
- Competitiveness,
- Profits (Izetbegović, Orešković, Bandić 2004.)

Business process map

Construction company’s generic Business process map is presented on the next page schema.

The Business process map (BPM) is a base for the development Business process improvement project (BPIP) of the construction company.

The concept of the BP improvement project, divided into phases and main activities, is presented in the following Table 1. (Hammer, Champy, 1993, Tzortzopoulos, 2004),

Table 1: Phases and activities of the BP improvement project concept

Phase	Main activities
Implementation Strategy	Strategic goals, objectives and scope of the project Identify the problems Gain management support Promoting the powerful leader Defining the process owners Team building
Planning for the BP model	Appoint a team, and a project manager Analyze existing processes, performance gaps, quantity measure Understanding client’s / customer’s needs Identify core processes Communicate – win acceptance from company employees, disseminate results Provide training
BP Development	BP Redesign Review people and technological requirements Validate new process and realize performance measures Review organizational structure, competence and motivation Develop action plan Pilot implementation
BPM Implementation	Phased implementation roll out throughout the company

and handover	Monitor performance Asses/evaluate performance Identify new uses Standardize process use and implementation method Continuous improvement

A BPM contains milestones corresponding to the completion of each phase. The timing of these milestones is defining the schedule – master plan for the overall development project. The model is the base for the exchange of informations between Project stakeholders and enables the better communication and coordination between specialists acting in the Project.

In this way, process model in the Business processes improvement project is a tool for the increase of the end project result.

Roles during the BP improvement project execution

The following roles emerge during the BPM execution:

- Leader - a senior executive who authorizes and motivates the overall engineering effort
- Process owner - a manager with responsibility for a specific process and design effort focused on it
- Project team - a group of individuals dedicated to the particular process(es), who diagnose the existing process and oversee its (re)design and implementation
- Steering committee - a policy making body of senior managers who develop the organization's overall BPI strategy and monitor its progress
- BPI czar - an individual responsible for developing techniques and tools within the company and for achieving synergy across the company's separate Business process improvement projects (Hammer, Champy 1993.).

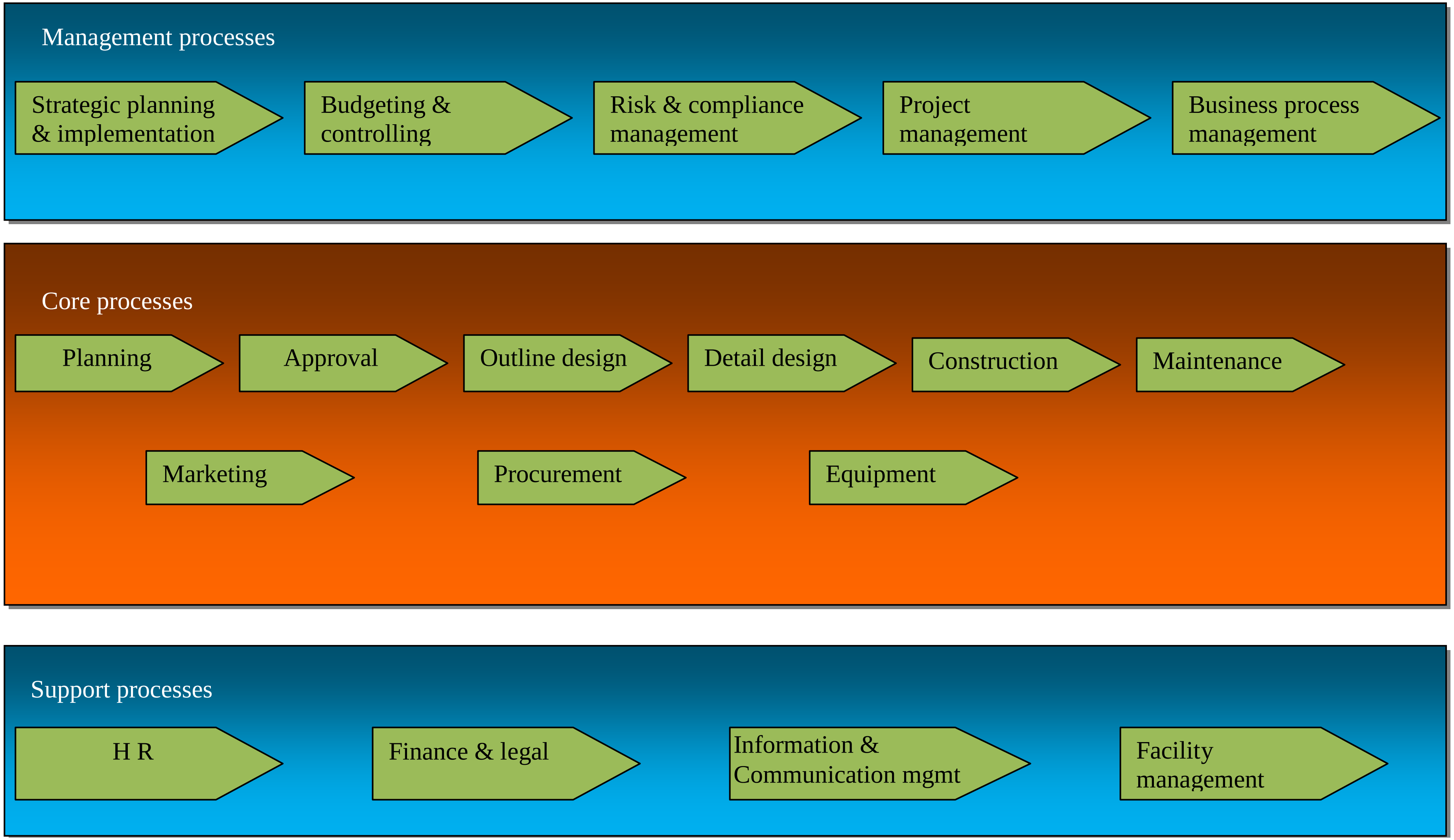
The relationship among these roles is normally the following: The leader appoints the process owner, who convenes a project team to reengineer the process, with the assistance from the czar and under the auspices of the steering committee (Hammer, Champy 1993.).

BPM development project

During systems development phase project team starts by modeling of the corporation's core business processes. This could be done as a part of a systems definition study or a strategic business study. It is appropriate to start information analysis in this phase.

The next phase is analysis of the business requirements in detail, database and application systems. The realization of the above noted phases enables automatically software production for final system implementation.

Construction Company Business process map



System development can be carried out iterative by developing smaller sub-sets of prototype applications by intensive end user participation.

During the business process analysis it is important to identify core business processes. These are the processes that corporation requires in order to survive; the processes that distinguish some organization form its competitors.

Process models use multimedia, animation and critical path techniques to visualize business processes. This is especially useful in communicating a vision of how processes could operate in a reengineered environment.

A key part of processes improvement is measuring how some organization carries them out. The measures are in terms of time, costs, and quality of the processes.

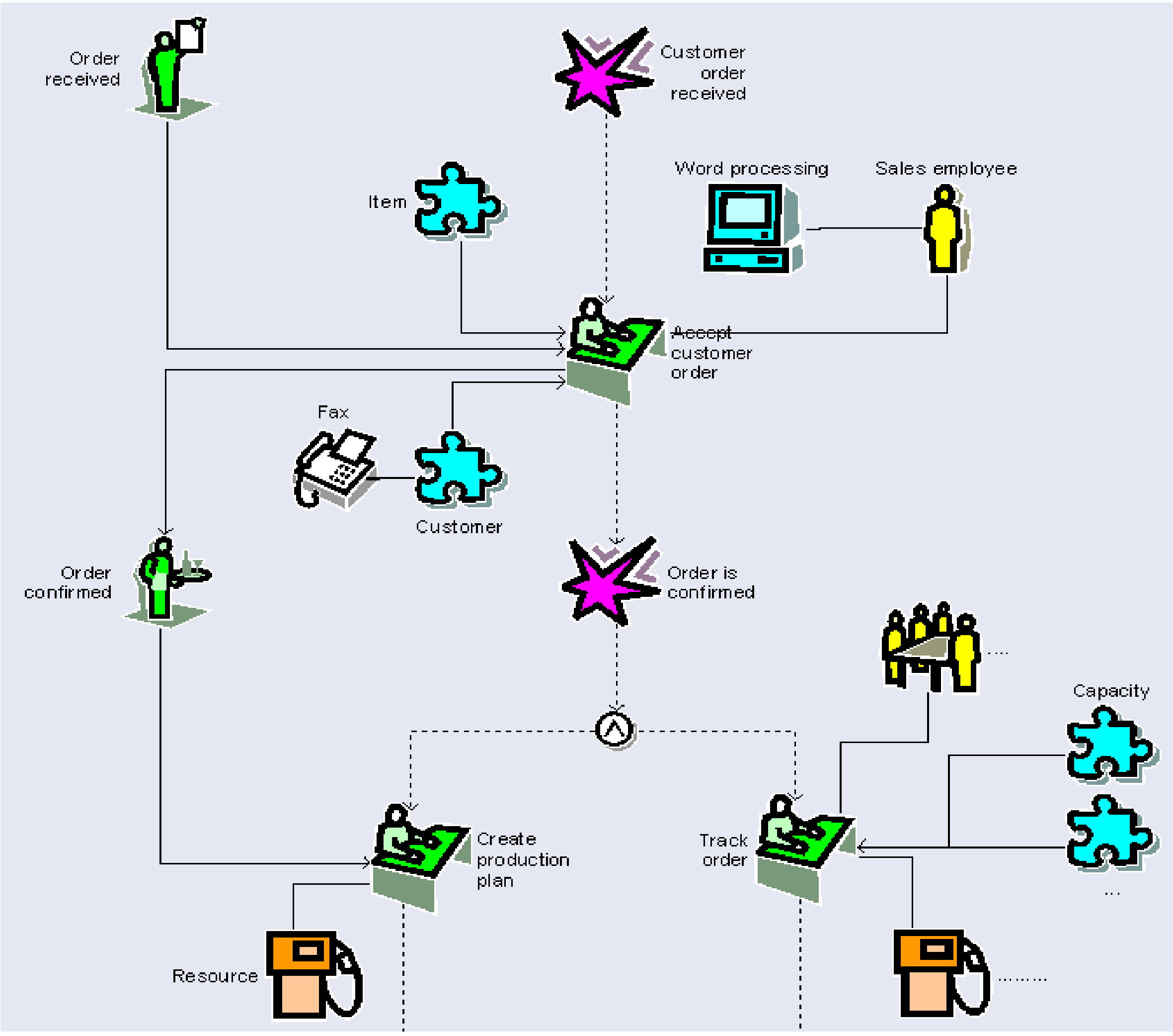


Figure 1. Model of a business process Ordering

Through IT application in the BP improvement process it is easier to:

- Identify critical informations needed for the business process
- Rethink organizational issues by bringing to light low value organizational boundary interfaces

- Facilitate process improvement steps by organizing all organizational information in one common data source (data repository)
- Enable new creative thinking, which could lead to dramatic improvements.

Through the introducing of the modern information technologies, the business processes should be improved, in the way that process should have possibly less work parts.

There are numerous BPM software tools (ARIS, Designer 2000, Workflow etc.). The precedent Figure 1 is extracted from ARIS Method manual. (IDS Scheer: ARIS Method manual, Saarbruecken, 2006)

Common errors by BP improvement

Michael Hammer and James Champy are reporting that many companies that begin reengineering don’t succeed at it. They could not make significant changes; they did not achieve their performance improvement. Hammer and Champy’s estimated that 50% - 70 % of organizations that undertake reengineering effort, did not achieved dramatic results they intended. Therefore they analyzed the most common errors in reengineering process. These errors should be avoided, than success is very certain.
These common errors are:

- Try to fix a process instead of changing it
- Don’t focus on business processes
- Ignore everything except process redesign
- Neglect people’s values and beliefs
- Be willing got settle for minor results
- Quit to early, etc.

Authors argue that payoffs of successful reengineering are spectacular - for the company, its employees and the economy as a whole.

According to some authors there is enough room for skepsis regarding Corporation Reengineering concept application (Nippa, 1995., or Osterloh, Frost, 1994.)

CONCLUSIONS

The potential benefits from the implementation of Business process model in construction company for the organizations as the whole, for the business processes, and for the company’s clients are listed above on the page 2.

In construction it is very difficult to quantify BPI project implementation results as well to compare results between the projects because of their variability. Probably the most benefits are qualitative and hard to evaluate through specific measures.

Application of the BP reengineering (Hammer, Champy 1993), according to their research data, brought improvements of service and benefits higher in order of magnitude to some of 30%-40% companies that took this undertaking. This will be carried out through fundamental rethinking of the actual business processes and building them newly “from the ground”.

Despite some doubts on the Corporate reengineering process results (Osterloh, Frost, Nippa), there is a lot of positive results in the reengineering process.

Further research in Croatia is needed on the results of BP development and implementation project results in specific organizational context of different construction companies.

REFERENCES:

Books:

Izetbegović J. Žerjav V.: “Construction Industry Organization” (Croatian) University Manual, Zagreb, 2009.

Michael Hammer & James Champy: “Reengineering the Corporation”, A manifesto for business revolution, Harper Collins Publishers, New York, 1993.

IBM Business Systems Planning: Information Systems Planning Guide, IBM Corp. 1981.

Currid, Cheryl & Company: “Computing Strategies for Reengineering Your Organization”, Prima Publishing, Rocklin, California USA, 1994.

Articles:

Izetbegović J., Orešković M., Bandić M.: “IT Application Development in Croatian Construction”, Research Project, Građevinar, Zagreb, 2004.

Osterloh Dr. Margit, Frost Jetta: ”Business Reengineering: Modeerscheinung oder ‘Business Revolution’ Zeitschrift Fuehrung + Organisation, 6/1994.

“Reengineering - Top oder Flop?” Interview with Dr. Michael Nippa, Muenchen, Zeitschrift Fuehrung + Organisation, 3/1995.

ORACLE Corp. Oracle Designer /2000, 1995.

ARIS Platform Method ARIS 7.0 IDS Scheer, Saarbruecken 2006

Tzortzopoulos P.: “The Design and Implementation of Product Development Process Models in Construction Companies” University of Salford, Salford UK, P.h. Thesis, 2004

Scheer at al.: “AGILITY by ARIS Business Process Management” Yearbook 2006/2007

Bandić M., Orešković M.,: “Corporation Reengineering in Construction-Information Technology Role“, CIB W55, Zagreb 1996.

PERFORMANCE INDICATORS OF CO-LOCATED FURTHER AND HIGHER EDUCATION PROJECTS

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The purpose of this paper is to present a performance measurement framework, currently under development, to evaluate co-location projects in the further and higher education (FE/HE) sectors. A focus group and questionnaire survey were used to identify factors characterising the performance of a co-located campus. The questionnaire was based on a two-dimensional classification of performance measures; comprising leading and lagging measures. Factor analysis and canonical correlations were employed to identify key factor constructs and then to evaluate the relationship between the identified constructs. The importance of this research lies in the growing competition among education institutions to provide improved facilities that cater for a variety of learning provisions.

KEYWORDS: co-location, performance measurement, leading indicators, lagging indicators.

INTRODUCTION

Education institutions attempt to increase efficiency to counter escalating running costs and to meet the growing demands of end users for quality and value for money (Varcoe, 1995, cited by Amaratunga and Baldry, 2000). A study published by CABE (2005) provided evidence of the link between the functions and facilities of education buildings and the recruitment, retention and performance of both the staff and students of higher education institutions. Douglas (1996) has characterised change as inevitable, especially when considering the future of higher education estates that are not completely foreseeable. The speed of ‘buildings’ change, influenced mainly by technological and financial factors, is likely to rise, and that in turn will increase the need to adapt more economic use of the space of higher education buildings (ibid).

The adoption of shared education facilities is an emerging response to these influences. It maybe suggested that such a response is typified by the co-location of core and support educational services at one particular site. Oxford Dictionary defines the term co-location as “the act of placing multiple (sometimes related) entities within a single location”. This means placing two or more groups (or organisations) together to share one place. In the education sector, co-locating further and higher institutions is referring to placing two or more institutions in one campus. This could take the form of only sharing the place, or sharing of facilities and services though collaboration between institutions. An example is the co-location of Heriot-Watt University's Scottish Borders Campus and Borders College in Galashiels. The two institutions will share the same campus creating a hub for educational excellence in the Scottish Borders. They will have the advantage of using more efficient services and facilities in addition to providing better learning environment for students and staff. This approach can be an effective, efficient and strategic solution for enhancing education infrastructure.

Effective techniques of measuring building performance will assist in adapting to those changes and implement new initiatives (ibid). It can be argued that education institutions adopt more commercial methods to allocate resources than they used to do in the past (Clarke, 1997). Hence, models of performance measurement can be more useful to inform better resource allocation in education initiations, and to guide the improvement of new resource-based methods for commercial competitive advantage (Preiser, 1995). In fact, governments worldwide consider evaluating the performance of further and higher education as an issue of special interest in the attempt to enhance educational provision effectiveness and maximise value for money (Belcher, 1997).

Aim and objectives

This paper is a part of a research project funded by the Scottish Funding Council (SFC) to develop a performance measurement framework for further and higher institutions (FE/HE) co-location projects. The purpose of the paper is to present the current stage of the development of the framework and it will also

- evaluates key issues surrounding performance measurement models;
- identifies the criteria that determine long-term success of educational provision, institutions' estates, services and facilities; and
- provides a list of critical success factors for co-location projects.

Advances in performance measurement

Traditionally the techniques used to measure business performance relied mainly on monetary figures and accounting numbers. In the 1920s, the DuPont Company established the return on investment 'ROI' measure, and the General Motors Corporation introduced original financial management ways in that era. Since then, several management accounting practices have become widespread, including discounted cash flow (DCF); residual income (RI); earned value analysis (EVA); and cash flow return on investment (CFROI) (Bassioni *et al.,* 2004; Neely *et al.,* 2000; Kaplan 1984; Chandler 1977).

Despite their continuing prominence, dissatisfaction with performance measurement models based solely on financial approaches such as those above began to emerge in the 1950s. Since the 1970s, this dissatisfaction has escalated into over criticism (Bassioni *et al.,* 2004). The inability of financial measures to meet professionals' expectations has been explored in the work of many researchers. Skinner (1974) argued that traditional financial systems ignore the strategic perspective, while Hayes *et al.* (1982) reported that they promote short termism.

Advocates of financially based practices remain, however. While it is accepted that financial measures do not improve performance, they maximise shareholders' gains (Johnson and Kaplan, 1987; Lynch and Cross, 1991) and they lack the focus on other aspects of the business like internal business processes, customer satisfaction and potential learning and improvement (Kaplan and Norton, 1992). Acknowledging that financial measurements do provide useful insight, but do not provide a complete picture when used alone, Neely *et al.* (2000) noted that dissatisfaction with financial performance measures triggered the emergence of more "balanced" or "multi-dimensional" performance measurement systems. To obtain a comprehensive perspective about how a business is performing, a broader evaluation, which involves considering the potential perspectives and aspirations of the company's corporate strategy, business processes, and customers' requirements (Zairi, 1996 and Olve *et al.,* 1999) is required. Such evaluation must go beyond the "traditional" backward looking and limited financial measures.

More recent performance evaluation systems have expanded to include non-financial measures that cover wider perspectives (Bourne *et al.*, 2000). Bourne has characterised recent developments with examples from studies such as that of Keegan *et al.* (1989) who developed a balanced measurement matrix that combined internal and external business criteria with financial and non-financial metrics; and others, like Lynch and Cross (1991), who introduced a pyramid of performance measures that paralleled the management structures of hierarchical organisations. Neely *et al.* (2000) pointed out that in the last decade of the last century approaches to measuring business performance moved towards developing frameworks that involve “integrated measurement systems,” typified by the balanced scorecard introduced by Kaplan and Norton in 1992. It can be argued that other performance frameworks have been developed since the 1950s, although they were quality-based performance frameworks, such as the Deming Prize initiated in Japan in 1950, the Malcolm Baldrige National Quality Award that was established in 1987 and the European Foundation for Quality Management launched in 1989. However, the last three models include a set of criteria that encourages total quality management by focusing on personnel, processes, strategic planning, leadership, customer satisfaction as well as the end product.

Performance Measurement of Education Institutions

Owlia Aspinwall (1996) proposed a conceptual framework as a foundation for the measurement and improvement of quality in higher education. Cheng and Tam (1997) suggested that the quality of education can be measured according to seven models. These models are: the goals and specification model; the resources input model; the process model; the satisfaction model; the legitimacy model; the absence of problems model; and the organisational learning model. Used together, these models provide a comprehensive measurement framework for improving quality in education. Pounder (1999) examined valid and reliable organisational effectiveness self rating quality based scales for higher educational institutions. He found “quality of education” to be an inadrquate metric for analysing the institutional performance in higher education. Amaratunga and Baldry (2000) presented the development of a measurement framework using the balanced scorecard (BSC) to assess the performance of higher education institutions. The study was based on the four perspectives of the BSC and the internal cause and effect relationships between these perspectives. It concluded that the BSC has a major input in three main categories in facilities and property management: communication and teamwork, commitment and feedback and learning. In a study presented by Hedley *et al.* (2001), indicators which represent key “estate management statistics” for the UK higher education sector were identified. Their study revealed 16 key measures grouped under five headings, namely: condition and suitability; non-residential property costs; component property costs; non-residential space ratios; and residential ratios. Other researchers tried to apply different quality dimensions adopted in non-academic fields into the education sector. Osseo-Asare *et al.* (2002) used an assessment tool developed by the European Foundation for Quality Management (EFQM) to examine the quality of a UK higher education institution. They recognised that “people satisfaction” and “leadership” are critical issues among other critical areas that need improvement. Chen *et al.* (2006) explored the application of the balanced scorecard (BSC) as a strategic management tool to evaluate the performance of education institutions. Their study found that higher education has the potential to learn from business. They claimed that education institutions can achieve their strategic themes that are based on the four perspectives of the BSC by setting specific and effective strategic targets and continuously measuring them by establishing suitable performance indicators.

Leading and lagging indicators

An indicator can be defined as a combination of one or more measures or metrics of a process or a result of a process (Smith and Hawkins, 2004). This definition distinguishes between two sets of measures corresponding to two sets of indicators: process-based measures and result-based measures, referred to in the literature as "leading and lagging indicators" respectively (Beatham *et al.*, 2005).

The differentiation between leading and lagging indicators has been addressed in the work of many researchers. Charter and Tischner (2001, p 171) asserted that while leading indicators "measure internal product development practices that are expected to improve future product performance", lagging indicators "are measures of the results or outcomes that are attributable to product improvements". Beatham *et al.* (2004) described leading indicators as "performance indicators (PIs)," emphasising that such indicators describe performance or associated performance. They pointed out that performance indicators, as leading indicators, can inform revisions in the current practice of an ongoing process. In contrast, they used the term "performance outcomes (POs)" to represent measures of finished processes. Performance outcomes cannot, therefore, inform the alteration of practice because the practice will have been concluded by the time of the measurement. Such indicators are characterised as "lagging" measures.

Methodology

The research methodology consisted of a comprehensive literature review, a focus group workshop and a questionnaire survey. The literature review examined different performance measurement frameworks, explored the efficiency of the current frameworks and identified what a performance measurement system embraces in terms of measures developed, types of data needed and methods of implementation. The findings of the literature review were analysed by professionals in the fields of education, architecture, estate management in a facilitated focus group workshop to determine which of the identified criteria could be used to indicate how the performance of a co-location project could be measured. The study followed this empirical technique because it allows the participants to discuss one issue at a time from different perspectives in a structured way.

The workshop informed the design of a questionnaire survey which sought a confirmative view of those measures suitable for use as performance indicators and performance outcomes in a measurement framework to characterise FE/HE co-location performance. The list of respondents was formed on the basis of the professional roles they hold within further and higher institutions and on the understanding that most will not have experience of co-location.

Once data is available from the questionnaire, factor analysis will be used to determine the underlying relationships among leading and lagging indicators and minimise those indicators into a fewer number of variables.

Framework development

The literature review identified 82 indicators including leading and lagging indicators and covering the pre-delivery stage and post-delivery stage of the co-location project. Indicators were derived from reviewing the literature about what co-location projects in the education sector are trying to achieve in terms of cost, time, quality, safety, sustainability and education services. This list was reduced by a focus group workshop which sought to validate, and reduce the indicators into a manageable number.

Focus group workshops

Greenbaum (1988) explained that a focus group session typically incorporates 8-10 people drawn together in one place to deal with questions that are of great concern to the researcher(s). Hence, the focus group was undertaken with representatives of a cross section of professionals to reveal success factors to be tested at the second stage of the research project. Easterby-Smith *et al.* (1991) suggest, in such situations, the researcher must provide a rationale for the workshop to the participants, and create and promote a suitable environment for discussions.

The focus group workshop used in this study was facilitated by the research team. Frey and Fontana (1993) described how the focus group usually takes the form of a structured interview, directed by the facilitator. The focus group consisted of eight individuals who were chosen to represent different project disciplines. Actually, the main idea behind implementing the focus group approach was to consider, examine and discuss criteria that are critical to the co-located type project success. Another reason was to provide different opinions from various backgrounds and from diverse personal experiences. The facilitated workshop created an environment for open arguments and steered discussions.

During the workshop two questions were under focus: identification of the “top five” indicators considered by the participants to be the most critical for a co-located project from their own perspective. The justification for this question was to focus on how the participants perceive success from different angles. This would provide the means to appreciate the group’s rational perception and understanding regarding different issues. However, a focus group would also permit a diversity of ideas to be considered.

Potential success criteria were reviewed by the group with regard to two stages of co-location project implementation. The first stage was the delivery stage which includes project phases from inception through to project handover. The second was the post-delivery stage which starts thereafter and continues till the end of the proposed age of the facility. The 82 indicators developed from the literature were divided and set up within the two main stages.

The participants were split into two groups; each addressing one project stage. The reason for dividing the participants into two groups was to have their understanding and realisation of the project objectives, which were expressed in the first half of the workshop, converted into ranking inputs according to their expertise and the participant’s positions of responsibility. Thus, the second question was to rank the set of performance indicators on a high, medium and low scale. New indicators were added to accommodate the suggestions made by the participants during the workshop.

The list of performance indicators

The focus group outcome directed the research study towards performance indicators that evaluate operational and organisational issues. However, the list of success factors generated in the workshop is a long one and therefore there was a need to reduce the number of indicators. The list that was produced as a result of the workshop is presented below:

- Increasing student retention
- Increasing student achievements
- Increasing student recruitment
- Increasing research opportunities
- Increasing space efficiency
- Increasing cost effectiveness
- Increasing space productivity (profitability)
- Increasing efficiency of using water
- Increasing energy efficiency
- End user satisfaction with the shared facilities (i.e. library, computer labs, sport, etc)
- End user satisfaction with the shared services (i.e. administrative service, financial services, purchasing, catering, etc)
- End user satisfaction with shared space
- End user satisfaction with the construction services
- Completing the construction/renovating project on time
- Completing the construction/renovating project in budget
- Completing the construction/renovating project to specification

- Sharing non-academic services (i.e. administration, finance, purchasing, catering, etc)
- Sharing facilities and resources (i.e. library, computer labs, sports, etc)
- Developing communication between the FE/HE co-located institutions
- Providing FE/HE students with easy access to the co-location facilities (i.e. library, computer labs, sports, etc)
- Building trust between the co-located institutions
- Meeting the needs of potential applicants for education and professional development
- Using sustainable construction materials
- Providing high quality building
- Providing well articulated academic links between the FE/HE co-located institutions
- Engaging students/staff in understanding the importance of FE/HE co-location
- Enhancing the quality of the academic staff
- Minimising disruption to ongoing educational processes during the construction phase
- Transferring knowledge between FE/HE co-located institutions
- Promoting the strengths of the FE/HE co-located institutions
- Providing fit-for-purpose design
- Providing effective construction management service

Validating Questionnaire

Following the focus group exercise, a questionnaire was drawn up and distributed via-email to senior management staff of further and higher education institutions in Scotland. The sample represented people who were chosen on the basis of their professional roles within their organisations. They held positions that are equivalent to those who were involved in managing the FE/HE co-location project in Galashiels at the Scottish Borders. However, the fact that the majority of the respondents might not have experience on co-location projects has been considered. The questionnaire attempts to collect views and different perspectives of the respondents based on their professional experiences will inform what factors might define the overall success of FE/HE co-location projects. The questionnaire covered success indicators generated through the literature review and focus group. Those indicators were divided into leading and lagging indicators but they were mixed in the questionnaire so that the respondent will not be confused by the two concepts of indicators. The questionnaire was piloted in two institutions representing further and higher education institutions in Scotland. These two institutions are currently sharing one campus as part of a co-location project for the purpose of effective and efficient provision of high quality further and higher education in the Scottish Borders region. The sample to whom the questionnaire was piloted included key people who directed the co-location project process between the two institutions. The questionnaire was designed using the Survey Monkey survey tool and the main purpose was to assess the extent to which each success factor can be used to characterise the success of an educational co-location campus. Responses were sought on ten-point Likert scale where items statements were measured from 1 to 10 (1= Strongly disagree, 10= Strongly agree). Data collected was intended to be analysed using SPSS.

Questionnaire Data Analysis

The data generated by the questionnaire was analysed using interdependence techniques, which are multivariate statistical methods. These techniques investigate common attributes a group of variables has and therefore decrease the number of variables to few constructs or factors. However, they do not examine influence or explanation. They are concerned with the relationships between a numbers of variables in one group (Blaikie, 2003). The aim of using these techniques was to reduce the number of success factors, identify underlying constructs among leading and lagging indicators, and examine the relationship between each group of indicators. Examples of interdependence techniques are factor analysis, cluster analysis and multidimensional scaling.

Factor analysis

Blaikie (2003) described factor analysis as an interdependence method that looks at relationships between variables in a group at the same time. Brace, (2004) stated that this method enables researchers to identify sets of "attitudinal constructs" on the basis of similarity of response samples that could consequently illustrate "underlying attitudinal dimensions". Kim and Mueller (1997) explained that factor analysis first attempts to explore the interrelationships between variables in a group and then tries to examine if the identified interrelationships can be interpreted by a small number of hypothetical variables.

Cluster analysis

Cluster analysis is a common term describing a variety of mathematical methods used to investigate which objects in a group have similar features so that they can be clustered into related sets (Romesburg, 2004). Aldenderfer and Blashfield (1984, p. 7) describe cluster analysis as "a multivariate statistical procedure that starts with a data set containing information about a sample of entities and attempts to recognise these entities into relatively homogeneous groups The difference between cluster analysis and factor analysis was clarified by Blaikie (2003); he stated that cluster analysis groups individuals or objects based on a number of criteria which in turn must be quantitative. By doing this cluster analysis seeks to maximise the similarity within clusters and, at the same time, maximising diversity between clusters. On the other hand, factor analysis groups variables on the basis of underlying patterns or liner combination in one set of variables. In other words, it tries to group variables as underlying factors (ibid). This means larger number of clusters and smaller numbers of underlying factors. The research at this stage is trying to reduce the number of performance indicators and performance outcomes. This fact makes factor analysis more suitable to adopt than cluster analysis.

Canonical correlation

Canonical analysis is a technique that explores correlation patterns among variables that belong to two or more groups. Leech et al. (2004) pointed out that canonical correlation investigates how differences in one set of variables relate to differences in other set of variables. This research is interested in the relationship between the “leading indicators” and the “lagging indicators”. Factor analysis will be used to identify underlying constructs within each set of indicators and then the canonical correlation will be employed to examine any significant correlation between the identified constructs. This technique will explore the casual relationship in the proposed framework between leading and lagging indicators.

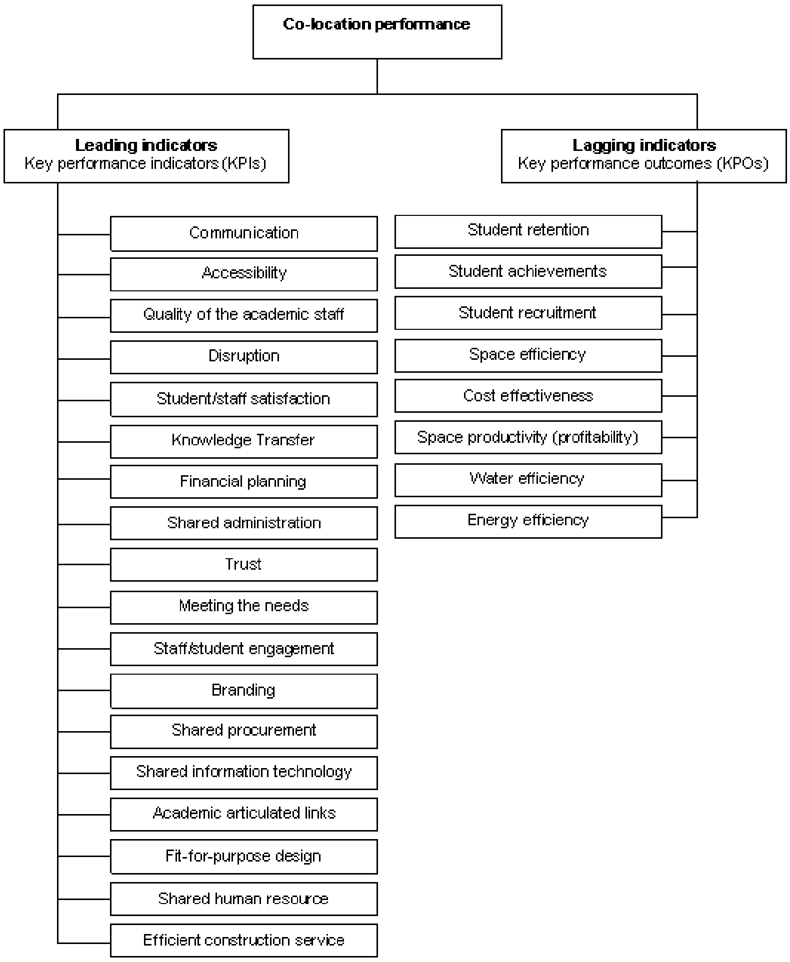

Figure 1: The leading and lagging indicators (Framework adapted from Beatham *et al.*, 2004)

The performance measurement framework of co-location projects will comprise lagging and leading indicators. The proposed framework will offer a comprehensive and integrated view of performance through finding the relationships between the identified constructs in the leading indicators group and those identified in the lagging indicators group. This will explain the causality between the two groups and consequently identify factors that should get much of attention in order to maximise the results and the overall performance

CONCLUSION

This paper presented thinking behind the development of a performance measurement framework for further and higher education co-location projects. Such an approach, if adopted, will assist in the delivery of high quality, student focused and innovative education services. On the one hand, co-location can be considered as an effective, efficient and strategic solution for enhancing education infrastructure in a particular location. It also brings significant curricular, financial, and structural advantages not achievable through occupation of separate estates.

To promote the successfulness of co-location projects, effective techniques of measuring performance of this type of project are required. The proposed framework, although currently under development, has identified and validated a set of relevant performance indicators, divided into leading and lagging measures on the basis of what they are explaining: practices, activities and processes; or results and outcomes. Further, this study has also established that it is important to examine the relationship between these two sets of indicators.

The proposed performance measurement framework can be used to enlighten resource allocation in education institutions and to form a guide to improvement in teaching and learning, and in new approaches to co-located estate development and management.

REFERENCES

Amaratunga, D. and Baldry, D. (2000), “Assessment of facilities management performance in higher education properties”, Facilities, Vol. 18, No. 7/8, pp. 293-301.

Aldenderfer, M. and Blashfield, R. (1984), “Cluster analysis”, SAGE Publications Ltd, London, UK, pp. 7-60

Bassioni, H.A., Price, A.D.F. and Hassan, T.M. (2004a), “Performance measurement in construction firms”, Journal of Management in Engineering, 20(2), 42–50.

Beatham, B, Anumba, C., Thorpe, T. and Hedges, I. (2004), “KPIs: a critical appraisal of their use in construction”, Benchmarking: An International Journal, Vol. 11, No. 1, 93-117.

Beatham, B, Anumba, C., Thorpe, T. and Hedges, I. (2005), “Insights from practice: An integrated business improvement system (IBIS) for construction”, Measuring Business Excellence, Vol. 9, No. 2, pp. 42-55

Blaikie, N. (2003), “Analysing quantitative data”, SAGE Publication Ltd, London, UK.

Belcher, R.G. (1997), “Corporate objectives, facilities, measurement and use: a university model”, Proceedings of the RICS Cobra Conference, Portsmouth.

Brace, I. (2004), “Questionnaire design: How to plan, structure and write survey material for effective market research”, Kogan Page Ltd, UK

CABE (2005), “Design with Distinction: The Value of Good Building Design in Higher Education”, (www.cabe.org.uk)

Charter, M. and Tischner, U. (2001), “Sustainable solutions: developing products and services for the future”, Greenleaf Publishing, Sheffield, UK, pp. 165-187

Chandler, A. D. (1977), “The Visible Hand: The Managerial Revolution in American Business”. Harvard University Press, Cambridge, Mass.

Chen, S. H., Yang, C. C. and Shiau, J. Y., (2006), “The application of balanced scorecard in the performance evaluation of higher education”, The TQM Magazine, Vol. 18 No. 2, pp. 190-205

Cheng, Y. C. and Tam, M. (1997), “Multi-models of quality in Education”, Quality Assurance in Education, Vol. 5, No. 1, pp. 22-31

Clarke, G. (1997), “Reassessing resource allocation strategies in higher education: methods for analysis”, International Journal of Educational, Vol. 11 No.6, pp.286-92.

Douglas, J. (1996), “Building performance and its relevance to facilities management”, Facilities, Vol. 14, No. 3/4, March/April, pp. 23-32.

Easter-Smith, M., Thorpe, R. and Lowe, A. (1991) “Management Research: An Introduction”, London, Sage.

Frey, J. H. and Fontana, A. (1993), “The Group Interview in Social Research”, in Morgan, D. L. (Ed) “Successful Focus Groups”, Sage Publications, California, USA.

Hayes, R.H. and Abernathy, W.J. (1980). “Managing Our Way to Decline”. Harvard Business Review, July-August, pp. 67-77.

Hedley, C., Smith, A. and Whelan, J. (2001), “Defining, collecting and using property performance indicators: The UK higher education sector experience”, Journal of Facilities Management, Vol.1, No.2, pp. 177-187.

Johnson, H.T. and Kaplan, R.S. (1987). “Relevance Lost. The rise and fall of management accounting”. Harvard Business School Press, Boston, MA.

Kaplan, R. S. (1984). “The evolution of management accounting”. Account. Rev., 59(3), pp. 390–418.

Kaplan, R. S. and Norton, D. P. (1992), “The balanced scorecard – measures that drive performance”, Harvard Business Review, January–February, 71–79.

Kim, J. and Mueller, C. (1997), “Introduction to Factor Analysis: What it is and how to Do it”, Edition 25, SAGE Publication Ltd, London, UK

Leech, N., Barrett, K., and Morgan, G. (2004), “SPSS for intermediate statistics: use and interpretation”, 2nd Edition, Lawrence Erlbaum Associates Inc, New Jersey, USA

Lynch, R.L., Cross, K.F. (1991), “Measure Up! Yardsticks for Continuous Improvement”, Blackwell, Cambridge, MA.

Neely, A., et al. (2000), “Performance measurement system design: Developing and testing a process-based approach”. International Journal of Operations and Production Management, 20(10), pp. 1119–1145.

Olve, N., Roy, J. and Wetter, M. (1999), “Performance Drivers: A Practical Guide to Using the Balanced Scorecard”, Wiley, Chichester.

Osseo-Asare, A. E., and Longbottom, D. (2002), “The need for education and training in the use of the EFQM model for quality management in UK higher education institutions”, Quality Assurance in Education, Vol. 10, No. 1, pp. 26-36

Owlia, M. S. and Aspinwall, E. M. (1996), “A framework for the dimensions of quality in higher education, Quality Assurance in Education, Volume 4, Number 2, pp. 12–20

Pounder, J. (1999), “Institutional performance in higher education is quality a relevant concept”, Quality Assurance in Education, Volume 7, Number 3, pp. 156-163

Preiser, W.F.E. (1995), “Post-occupancy evaluation: how to make buildings work better”, *Facilities*, Vol. 11 pp.19-28

Romesburg, C. (2004), “Cluster Analysis for Researchers”, Lulu Press, North Carolina, USA, 2-25

Skinner, W. (1974). “The focussed theory”. Harvard Business Review, May-June, pp. 113-21.

Smith, R. and Hawkins, B. (2004), “Lean Maintenance”, Butterworth-Heinemann, Oxford, UK, pp. 38-53

Zairi, M. (1996), “Benchmarking for Best Practice”, Butterworth-Heinemann, Oxford

FACTORS AFFECTING OUTPUT SPECIFICATION IN PPP PROJECTS

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In traditional form of procurement of construction projects specification of building requirements are defined by the Client who mainly lack expert knowledge to express his needs, and usually covers separated project functions – design, construction, operation and even sometimes demolition. With lack of this synergy, project outcomes often do not reach expected performance. New types of procurement, such as PPP have led to new practice in defining output specification for Facilities that are focused on user requirements and enables great flexibility for all participants involved, but also enables Clients to penalize under-performance of the Contractors. One of the most critical parts of PPP Contracts are technical specifications of building requirements known as the Output specification requirements which presents Client needs. Output specification are building specific requirements defined by the Client that have to be satisfied by the Contractor during operational period of constructed Facilities. Output specifications should define what have to be achieved, not how it has to be achieved. Output Specifications should not be too ambitious but should take proper account of what the Clients are prepared to fund. In this paper the factors affecting Output specification will be defined and discussed, as well as some practical tips in order to avoid overestimation of these specifications.

KEYWORDS: output specification, operation, PPP type of procurement.

INTRODUCTION

In traditional form of procurement of construction projects specification of building requirements are defined by the Client who mainly lack expert knowledge to express his needs, and usually covers separated project functions – design, construction, operation and even sometimes demolition. With lack of this synergy, project outcomes often do not reach expected performance. Public Private Partnership (PPP) and Private Finance Initiative (PFI) have led to new practice in defining output specification for Facilities that are focused on user requirements and enables great flexibility for all participants involved.

The procurement of PFI projects is a complex process. The primary objective is service delivery over an agreed time span, which is designed to meet a policy objective. This requires a shift in the mindset of construction contractors, as their own financial success and hence future is locked up in the long-term future of the constructed facilities they create (Construction Industry Council, 1998). This cultural change will transform the structure of project teams, redefine roles and responsibilities, and the risk management strategies adopted (Button, 2008). The fundamental differences that distinguish the PFI regime from the traditional procurement of public sector construction projects are: a) The opportunity for construction companies to take an equity share in the facility as part of the a concessionaire agreement with other stake holders; b) the transfer of risk to the private sector; and c) different criteria for evaluating project risk defined by the consortium providing the capital (The HM Treasury, 2000). PFI projects must also demonstrate value for money when compared with the Public Sector Comparator (PSC) as well as being affordable to the client (Construction Industry Council, 2000). Constructed facilities must be fit for purpose, and robust, to programmes and lifecycle costs identified including construction, asset renewal, Facility Management (FM), contingencies and margin (El-Haram et al., 2002). Uncertainty can deter success so there must be risk mitigation and payment procedures. The performance of the service provider needs to be measured against agreed criteria with a risk of penalties.

One of the most critical parts of PPP and PFI Contracts are technical specifications of building requirements known as the Output Specification (OS) requirements which presents Client needs.

OUTPUT SPECIFICATION

In order for the Client or a Purchaser (local authority and its stakeholders) to achieve its Project goals or to satisfy the needs he would need to clearly state what those goals are and what needs are to be satisfied. When looking at PPP models of procuring Public infrastructure or Public services, the needs would cover a wide range of works or services to be procured in order to satisfy the end Project goals or Client needs (Marenjak et al., 2008).

These works and services in PPP project in most cases cover Design, Construction, Maintenance, Cleaning, Security, Catering etc., as services to be provided in relation to facilities that are being used by Public sector in order to provide the Public services. In some cases even the Public services it self would be contracted out of house for provision of the same by Private sector.

Since one of the founding ideas and one of the main characteristics of the PPP models is how to find more effective and efficient provision of services in combination with more flexibility of Private sector, introducing innovative technologies and techniques in carrying out provision of those services, the need for different kind of defining requirements immerged. PPP types of procurement could be seen as a type of procurement where Public sector procures the end product, whether it is a facility or services to be conducted, and is paying for that product in accordance with the product performance.

To define the requirements for Private sector partner in such PPP projects it is clear that, having in mind everything stated, there is a need for requirements to be performance based. In order for the requirements to be performance based they would need to be described in “output” terms in a way that they describe the end goals of Project and specify the level of performance to be achieved in provision of services or works.

The Output Specification is the base on which the local authority and its stakeholders state in output terms what they need to achieve from the facilities and services to be provided (Sanders and Lipson, 2001). Generally in PPP Projects the Output Specification would need to define outcomes, without defining means for attaining that end. This is the main characteristic of OS because it leaves room for Private sector to introduce novelties in techniques or technologies and optimization of processes and organization in provision of the procured services. The Output Specification should detail what needs to be achieved, not how it is to be achieved (Sanders and Lipson, 2001).

Table 1: What is Output Specification – School example (Sanders and Lipson, 2001)

Output specification	**Not Output Specification**
Classrooms must have an adequate power supply to meet operational requirements.	Ensure that classrooms have at least two pairs of 240V power supply socket outlets available on each wall.
Ensure that there are adequate arrangements in place to maintain the safety of the school and its users.	The school should have a 24-hour security patrol.
Ensure that the school is clean enough when in use to provide a safe, hygienic environment.	Internal cleaning of a school every morning and evening.

All project requirements stated in the Output Specifications need to be intelligible for all relevant project participants as they will form the basis for monitoring of the Contractor‘s performance.

Valid Output specifications should contain following characteristics:

- clearly state Client’s objectives and be concise and unambiguous,
- only contain affordable and deliverable requirements,
- highlight constraints which are essential to project,
- allow compliance with statutory requirements,
- ensure lifecycle coordination between design, construction and operation,
- give bidders sufficient information to prepare their offers including identification of service areas which are most critical and will be given most importance in the payment structure and performance monitoring,
- in the procurement process allow that bidders proposals be evaluated against defined criteria (Scottish Executive, 2004).

The Output Specifications need to be in correlation with other tendering and contract documents as to avoid the discrepancy between them, such as:

- tendering documentation (instructions and guidance to bidders),
- risk allocation matrix,
- the payment mechanism and the performance monitoring system.

Output Specification can be developed using workshops or brainstorming sessions which involve all key stakeholders, where they can achieve consensus on realistic and affordable outputs, also it is possible to start with an input specification that can then be converted into outputs or refer to Output Specifications used elsewhere. It is important to involve the end users of the product that is to be procured (public services, facilities, and services in relation to usage of facilities) in order for them to state their expectations which then have to be formulated in the concise and understandable OS. The PPP Project will have greater chance of becoming successful and being perceived as such from the public if the end users are satisfied with outcomes and if they feel that they added value for the money in terms of quality performance for the provision of procured services.

FACTORS AFFECTING OUTPUT SPECIFICATIONS

By analyzing literature and case studies of 11 different PPP/PFI contracts in Croatia for three different types of public buildings (sport halls, administrative buildings, primary and high schools) this paper suggests relevant influence factors which affect Output specification and possible way of their classification.

In relation to PPP/PFI Projects the Output Specifications usually cover a range of services that will be related to the functionality and availability of the public sector infrastructure or facilities used by Public sector to provide some public service. Output Specification in PPP/PFI Projects are mostly related to Design, Construction, Maintenance and other facility management services such as Catering, Security, Cleaning etc. As such they can be grouped in different categories depending on the phase of Project lifecycle and the nature of works and services. Table 2 represents one of possible categorizations of the Output specifications. Every proposed category in Table 2 has been broken down in to domains specific for that category. Proposed domains are related to specific works and services that have to be procured through PPP/PFI project. Table 2 demonstrates a short description of characteristics for every stated OS domain as well as highlighting some of the most important factors affecting those OS domains.

Table 2: Factors affecting Output Specifications in PPP/PFI projects

Output Specifications (OS)			**Factors affecting OS *(Influence factors)***
Categories	**Domains for defining OS**	**Characteristics of OS domain**	
Building design	Layout of a facility	Architect's solutions of a facility should be functional for operation, maintenance and services to be provided	Planning regulations, Site characteristics, Capital investment budget etc.
	Building services and infrastructure (utility, water etc.)	Building installations, utility, specialist services installations etc.	Infrastructure at surrounding site location, infrastructure at location, services to be provided etc.
	Design and planning of traffic regulation at site	Connection to surrounding roads and traffic infrastructure, car parks, pathways, garage, traffic regulations on site etc.	Already extant traffic infrastructure network surrounding site, laws and regulations, number of car parking spaces, expected traffic frequency etc.
	Designing firefighting and evacuation corridors	Architect's vision of evacuation corridors etc.	Characteristics, type and purpose of building, site specific conditions regarding risks from unforeseen circumstances, disastrous events etc.
	Horticulture and external design	Green and other external horticulture areas, external playgrounds, parks, public spaces etc.	Micro-climate and other agronomy conditions on project location (site specific conditions) , purpose of the building, planning regulations etc.
	Protection of culture goods at project location	For example, monuments, protected architecture, etc.	Buildings under heritage protection, special requirements of the Ministry of Culture etc.
	Protection of sea and other goods at project location, ecological	Incorporating sustainable development ideas, ecological guidelines etc.	Position of protected coastline areas of project location, site specific conditions, changes in laws and regulations, existing guidelines etc.
Maintenance	Building maintenance	Maintenance of all building elements (roof, walls, ceiling, building construction etc.)	Building design, site location, needed service response times in relation to level of importance of affected functional area, labor and material availability in relation to location of the facility etc.
	Maintenance of installation, infrastructure and plants or equipment	Maintenance of services, aqueduct, sewerage, heating, IT etc., plants and equipment, regular testing etc.	Surrounding infrastructure, needed service response times in relation to level of importance of affected functional area, labor and material availability in relation to location of the facility and the services being provided etc.
	Maintenance of external areas	Green and other external areas, horticulture, playground etc.	Level of maintenance, service response times etc.
	Maintenance of roads, pathways and parking areas	Traffic regulations, state of roads, pathways and parking areas according to existing regulation throughout the Contract period etc.	Traffic regulations, occupancy, types of vehicles etc.
	Lifecycle replacements of building elements and equipment	Lifecycle replacements of building elements, equipment etc.	State of the facility at the end of contract period, building demolition etc.

Table 2: Factors affecting Output Specifications in PPP/PFI projects, *Continued:*

Output Specifications (OS)			**Factors affecting OS** *(Influence factors)*
Categories	**Domains for defining OS**	**Characteristics of OS domain**	
Operation	Cleaning services and waste management	Internal cleaning, external cleaning, specialist cleaning, specialist waste management, recycling etc.	Characteristics, type and purpose of facility etc.
	Security services	Type of security services, what areas, specialist security services, building security, site security etc.	Characteristics, type and purpose of facility, services required, e.g. level of required security, security risks (for example vandalism) etc.
	IT systems	Modularly drafted to enable installation of new systems,	Changes in technology, Service specific needs etc.
	Energy and Utility services	Utility consumption control based on volume or all risks concerning volume and energy price transferred to contractor, types of energy and utility etc.	Configuration and capacity of public supply network, utility supplier market, services specific requirements (example hospital always might have an alternative power and energy systems in place) etc.
		Own energy sources	Solutions of Echo homes etc. which are motivated and enabled by legislation etc.
	Building administration	Helpdesks, Reception, Facility related documentation etc.	Characteristics, type and purpose of Facility, needs for logistic support to the end users of the Facility, organization of service provision to be carried out at the Facility etc.
Commercial activities	Space lease	Lease of non required or unneeded space/areas/ or giving the potential for other spaces at location or inside facility to be used commercially etc.	Laws and regulations, purpose of facility, commercial attractiveness of facility or location, (e.g. are there any benefits for end users or project) etc.
	Catering services	Food and beverages, Restaurants Cafe bar etc.	Sanitary law regulations etc.
		Outsourcing catering services	End user profile/needs, occupancy etc.
	Marketing	Marketing needs and possibilities etc.	Laws and regulations, etc.

As presented in the Table 2, every category of Output Specification common for PPP/PFI project is in close correlation with all other categories. This comes from a fact that Project is perceived during whole life and most OS have an impact one at another. This is especially important when talking about OS for Building design category. Since Building design can and will have an enormous impact at all later phases of project it is clear that OS at Building design can and in most cases will influence drafting Output specifications for Maintenance or Operation. This close correlation of categories should always be in mind of team that is responsible for drafting Output specifications. Table 2 indicates some of the factors affecting particular category of OS. The other influence factor that will be present in drafting most OS will be current and future legislation and guidelines. This influence factor should also be looked at carefully because it will be in close relation to risk allocation of the PPP/PFI contract regarding the legislative changes throughout the contract period. One more categorization of OS could be added to Table 2. In relation to PPP/PFI projects and categorization could be Construction. Output specifications for construction works and services can be drafted but they can be optional. Reason for this comes from the fact that construction works will be highly influenced by Building design and also with OS for maintenance and operation phase. OS for Building design and for Maintenance and Operation will cover most of the quality requirements for construction works if drafted carefully and with logical sequence. OS regarding construction can cover construction works, organization, risks, communication of project participants etc.

At the project “start up” and during development of PPP/PFI project, Output Specifications represent important tool for the Client/ Purchaser to express his project needs and Private partner’s (Contractor) obligations in project. All of these are embraced in tendering documentation which contains Contract proposal with variety of important Contract appendixes. When Bidders take over tendering documentation, OS form basic input at which bidders develop theirs offers and represent the foundation for negotiation. During the negotiation it is critical to analyze influence of any change to the correlation of Contract elements and especially to the OS. Submission of the offer and successful negotiation leads to Contract signature which contains final version of OS. These become base Contract element for monitoring period during Project operational stage and enables Client/ Purchaser to monitor performance of the Contractor’s realization of Contract obligations. According to defined Contract standards, Client applies contract mechanisms to reduce payments to Contractor if he fails to meet required standards that are defined with OS. At the end of Contract period, Contractor returns building to the Client and during take-over the constructed facility has defined Contract standard levels. Importance, position and characteristics of OS during Project development stages, along with related influence factors are demonstrated in the Table 3.

Table 3: Factors affecting Output Specifications during project development

Project stages		**Liability domain**	**Activities with OS**	**OS properties**	**Influence possibilities at OS**	**Factors affecting OS *(Influence factors)***
Project preparation and definition	Feasibility	Client/ Purchaser	Brainstorming of OS logic *(Client/ Purchaser needs to understand OS logic, Project idea need to be developed in a way that embrace OS logic)*	Contains proposals that are possible to apply in project	large	Understanding of OS logic by the Client/ Purchaser
	Preparation of a Project Brief (project description, legislation issues, project goals ets.)	Client/ Purchaser	Basically defining OS (defining Client’s/ Purchaser's requirements and OS scope)	Contains scope of services Contains basic characteristic of included services	large	Understanding of OS logic by the Client/ Purchaser Ratio of wishes/possibilities of the Client/ Purchaser

Table 3: Factors affecting Output Specifications during project development, *Continued:*

Project stages		**Liability domain**	**Activities with OS**	**OS properties**	**Influence possibilities at OS**	**Factors affecting OS *(Influence factors)***
Tendering and Contracting	Expression of interest	Initiated by the Client/ Purchaser, response from companies on the market	*Beginning of OS development (services scope revision and alignment with project goals)*	Contains principals of best practice and in line with existing legislation	large	Ratio of wishes/possibilities of the Client/ Purchaser
	Preparation of tendering documentation	Client/ Purchaser	Development and defining OS	Contains principals of best practice and in line with existing legislation Enables measuring realization performance of required services levels by the Client/ Purchaser	large	Client's/ Purchaser's experience in realization of similar projects Quality of performance measuring mechanism in Contract documentation
	Tendering documentation	Client/ Purchaser	Contains defined OS	Clearly defined Client's/ Purchaser's requests	medium	-----
	Taking-over Tendering documentation	Bidders that pass Expression of interest	Contains defined OS	Issued OS (in public procurement process) becomes project milestone and Client/ Purchaser does not have full liberty for OS changes	small	Characteristics of Public procurement law legislation
	Planning	Bidders	Possible suggestions of OS changes by the Bidders	Represent foundation on which Bidders develop and submit theirs offers	small	Experience of the Bidders in realization of similar projects
	Bid preparations	Bidders	Possible suggestions of OS changes by the Bidders	Represent foundation on which Bidders develop and submit theirs offers	small	Experience of the Bidders in realization of similar projects
	Bid submissions	Bidders	-----	Bidders contains suggestions of possible changes and completions of OS		Possibility that offer viability is based on suggested changes and completions of OS
	Bid analyses and negotiations	Client/ Purchaser and Bidders	Negotiation for possible changes and completions of OS	Contains adoptive changes and completions of OS	small to medium	Quality of suggested changes and completion of OS
	CONTRACT SIGNATURE	Client/ Purchaser and selected Bidder	All OS should be clearly defined and final version of OS should be adoptive by the Contract signature	Contains final OS version that is harmonized and accepted by the Client/ Purchaser and Bidder	none	Possibilities of accidentally errors (grammar etc.) in final Contract version which may influence OS interpretation and meaning in later project stages
Construction	Realization according to construction time plan that is adoptive in Contract	Contractor	Monitoring construction so that the building is able to meet OS demands in signed Contract	Contains final OS version that is harmonized and accepted by the Client/ Purchaser and Bidder	none	Contractors experience in realization of PPP Projects
Maintenance and Operation	Realization according Contract terms	Contractor	Monitoring realization of OS in accordance with Contract	Contains final OS version that is harmonized and accepted by the Client/ Purchaser and Bidder	none	Clients/ Purchasers competence to monitor performance of services realization regarding agreed services standards in Contract
Contract end	CONTRACT EXPIRATION	Client/ Purchaser	Control of Contract defined OS during building take-over by the Client/ Purchaser	-----	none	-----

As it is presented in Table 3, in all project development stages OS are affected in different ways by variety of factors. Factors in early project development stages (preparation, definition, competition and contracting) mostly affect definition, development and quality of OS and directly affects Contract documentation. Factors during Construction, Maintenance and Operational project stages mostly affect usage of OS standards and interpretation of Contract by Contractual parties.

Proposed factors classification structure affecting output specification and list of influence factors provide checklist for PPP practitioners and researchers to enhance realization framework of important elements when considering PPP projects.

CONCLUSION

During the development of PPP/PFI Projects it is essential to find the tool that will effectively express Client's project goals and expectations, and later during realization and usage of project Client has to be able to monitor realization of Contract obligations by the Contractor. Output specification represents a choice for these purposes allowing Client and Contractor to avoid misunderstanding about contract expectations and obligations. Describing term and concept of OS it demonstrates new way of thinking in realization of PPP projects. Systematically positioning factors that are affecting development of Output specifications and analyzing/defining theirs characteristics/restrictions regardless their position at different Project categories or Project Stages, it is possible to improve PPP Project realization process. With clearly defined concept of Output Specification and limitations in liberty to describe OS through factors that are affecting process of defining OS, the Contract moderator has tool to minimize vagueness of Contractors project obligations and potential project conflict nodes. Applying this knowledge it is possible to moderate the Project in course that allows Bidders to prepare qualitative Bids and to avoid misunderstanding of project obligations during the validity of the PPP contract for all participants in the project.

REFERENCES

Construction Industry Council (1998) Constructors' Key Guide to PFI, London, UK, Thomas Telford Services Ltd.

Button M. Ed. (2008) A practical guide to PPP in Europe, Second Edition, Surrey, UK, City and Financial Publishing.

The HM Treasury (2000) Public Private Partnership – The Government's Approach, London, UK, The HM Treasury publication.

Construction Industry Council (2000) The role of cost saving and innovation in PFI projects, London,UK, Construction Industry Council.

El-Haram M. A, Marenjak S., Horner R.M.W. (2002) Development of a Generic Framework for Collecting Whole Life Cost Data for the Building Industry. Journal of Quality in Maintenance Engineering, MCB University Press, Vol.8, no. 2., pp 144-152.

Marenjak S., Kružić D., Čengija J. (2008) PFI/PPP Case study - multifunctional Sport Hall “LORA” in Split, Croatia, Proceedings of the PM-04 - 4th SCPM & 1st IPMA/MedNet Conference “Project Management Advances, Training & Certification in the Mediterranean”, Chios Island, Greece.

Sanders S., Lipson M. (2001) Output Specification for PFI Projects, A 4Ps guide for Schools, London, UK, Public Private Partnerships Programme.

Scottish Executive (2004) Output Specification: Building our future: Scotland’s school estate, Edinburgh, UK, Scottish Executive Press.

MILITARY PRINCIPLES OF CHINESE ORIGIN TO IMPROVE COMPETITIVENESS

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An old but still significant topic is that managers need to understand how to improve competitiveness. This paper describes the contributions of the Chinese military principles to enhance firm's competitiveness. The research method used in this paper is literature review. The contributions obtained through four steps. First is to identify traditional Chinese military principles. Secondly, Sun Tzu's Art of War was identified by making a comparison among seven Chinese military principles. Thirdly, Sun Tzu's Art of War was reviewed and its relevance to business competitiveness was identified. Finally, a brief comparison between Sun Tzu's principle and Porter's strategy for competitiveness is made. At last, this paper suggests that swiftness, adaptability and intelligence are useful principles for operating in China.

KEYWORDS: Chinese military strategy, the Art of War, competitiveness.

INTRODUCTION

The growth of China's economy and paralleling that, its construction market, and the improved performance of Chinese construction firms in international market make the study of Chinese firms' competitiveness a worthwhile endeavor. The aim of this paper is to review the relevance of Chinese military strategies in general, and Sun Tzu's Art of War in particular to improve business competitiveness. To achieve this objective, four steps were adopted. Firstly, traditional Chinese military principles were identified. Secondly, a comparison among seven Chinese military principles was made and one strategy, Sun Tzu's Art of War was identified as representative of Chinese military principles. Thirdly, Sun Tzu's Art of War was reviewed in detail and its relevance to business competition was investigated. Finally, a brief comparison between Sun Tzu's military principle and Porter's (1980) general strategy for competitiveness was made. The purpose of this paper is to identify useful military principles that can be used in business competition in China.

CHINESE MILITARY PRINCIPLES

In the western context, several researchers have suggested that military strategies may be applied to marketing in a highly competitive situation. Ries and Trout (1986) attempted to simplify and apply the basic propositions of military works to modern organizational theory and strategy in their famous publication, marketing warfare. Based on the belief that classical military strategy offers guidelines for marketing strategies, researchers (Parks et.al., 1994) identified the contribution of Clausewitz, a famous military strategist in western, to win market share. Though marketing-as warfare is a metaphor, it has dominated the way researchers in marketing and business strategy think about and discuss industry competition (Rindfleisch, 1996).

In China, “military strategist” is one of nine components (rectangles in single dash line in figure 1) of the traditional Chinese Culture based on which Chinese management forms (Li, 2008). Li (2008) and Yuan (2008) classified these nine areas of knowledge into two categories, i.e. “subjects” and “schools” (rounded rectangles in Figure 1). Knowledge of “Military strategist” was compatible with those ‘schools’ since it is usually used as evidences to prove their respective points.

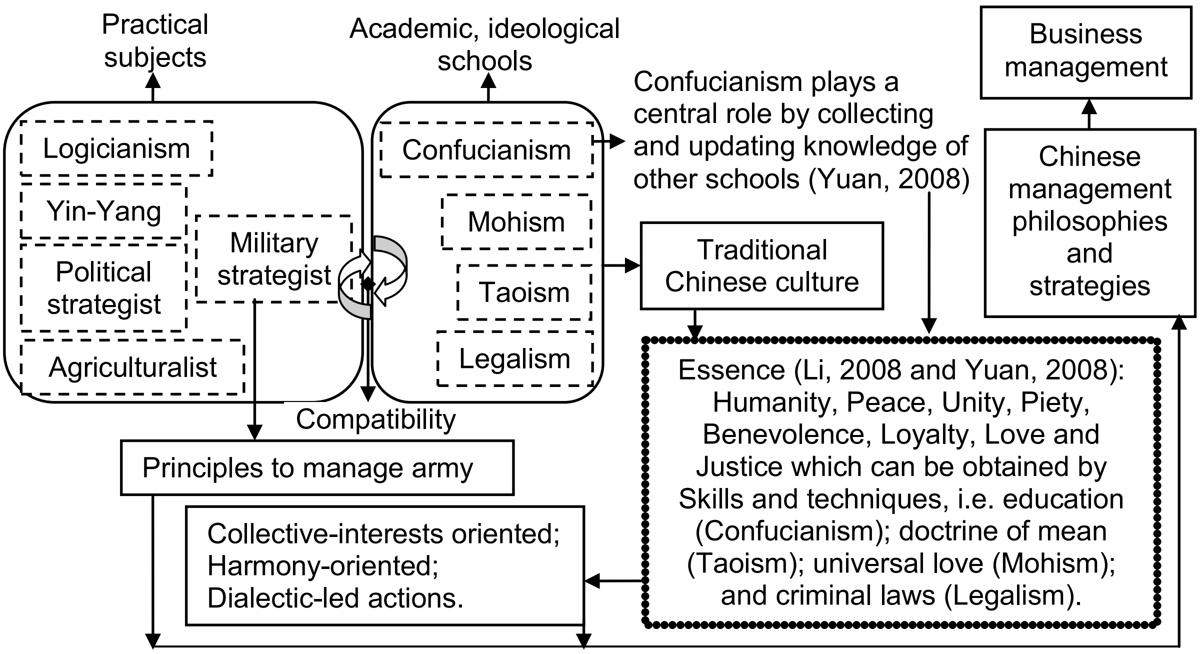

Figure 1: Traditional Chinese Military Principles (source: authors)

These “schools”, focusing on main ideas and philosophies, are more academic and ideological. The knowledge from Confucianism, which plays a significant role among these “schools”, is summarized as essence of the traditional Chinese culture by many researchers (rectangle in dotted line in the right part of Figure 1). Principle of “Military strategist”, which is classified into “subjects” linking to practices, may be utilized as a tool to analyze management thinking and actions influenced by culture of “unity, harmony, peace, dialectic and systemic thinking logic” (Li, 2006 and Yuan, 2008). The contribution of “Military strategist” could consist of principles and actions influenced by collective-interests oriented, harmony-oriented dialectic-led ideas.

SUN TZU'S ART OF WAR

"Wu Jing Qi Shu" is an authoritative collection of ancient military literatures (Pian *et al*., 2007). It includes seven military classics, viz. "Six Secret Strategic Teachings", "The Methods of the Ssu-ma", "the Art of War", "Wei Liao Tzu", "Wu-tzu", "Three Strategies of Huang Shih-kung", and "Questions and Replies between T'ang T'ai-tsung and Li Wei-Kung". These seven classics may be regarded as the essence of Chinese military knowledge.

The contents of seven military classics are briefly summarized based on the knowledge from "Wu Jing Qi Shu" (Pian *et al.*, 2007). "Six Secrete Strategic Teachings" is the original source of the Chinese traditional military texts, contributing much to later frameworks and systems of military strategies. "Art of War" deals with strategies to win a war. "The methods of Ssu-ma" is mainly about institutions and regulations to manage the soldiers. "Wu Qi's Wu-tzu" covers attitude to war, attitude to national defence, approaches to manage army and principles of warfare. From the contents of the texts, Wu Tzu's work might be established upon some part of Sun Tzu's Art of War (Li, 2006; Li, 2008). "Wei Liao-tzu" focuses on the forms and arrangements of the army. "Three Strategies of Huang Shih-Kung"'s goal is to identify the source of prosperity and downfall of the state. "Questions and Replies between T'ang T'ai-tsung and Li Wei-Kung" involves military knowledge of military institution, regulation, training, frontier defence, and command in war. According to the standards of classifications proposed by Li (2006), Sun Tzu's Art of War is of better maturity, more focused and contains more complete knowledge on strategy of war compared to other works.

Sun Tzu's Art of War was set up around 400 BC when conflicts between different parts in China were furious and frequent. The Art of War consists of thirteen chapters, in general, the first three chapters, which are laying plans, waging war and offensive strategy deal with war (Li, 2008). While chapters 4 to 13 contain principles to win. The information in these thirteen chapters do overlap. The Art of War has been translated by many writers, and one of the earliest ones is Griffith (1963).

One of the first questions asked about a war is "Can a war be won by other means than engaging in battle?" Sun Tzu advocated "subdue the enemy without even fighting", since "war is a matter of vital importance to the state" and "it concerns the lives and deaths of the people; and affects the survival or demise of the state". Sun Tzu outlind specific strategies to overcome conflicts while viewing the world as a complete and interdependent system which must be preserved (Low and Tan, 1995) Sun Tzu also believed that there are indirect approaches to winning without direct confrontation to win. To obtain this, Sun Tzu proposes "the highest form of generalship is to attack the enemy's strategy", the next best policy is to disrupt his alliances; the next best is to attack his army", all of which can only be accomplished through deliberated planning (Wee et al., 1991).

The second question about war is "what is used to assess whether victory has been achieved on the battlefield?" The paramount purpose in war, according to Sun Tzu, is a complete victory which means "capture the enemy's cities without fierce assaults; and destroy the enemy's nation without protracted operations". Sun Tzu emphasized "winning a battle and becoming stronger" and "conquering those enemies that are easily conquered". Since war consumes resources, protracted war means more losses, thus "it is advantageous to go for swift victory". Because war is vital to the nation, "engaging only when it is in the interest of the state; cease when it is to its detriment". It is suggested that winning, from Sun Tzu's war strategy, is assessed by "cost", "time" and "interest".

The third related question is "What is the resource of win?" Sun Tzu proposed that: "With much calculations, one can win"; "what is essential in war is victory rather than prolonged operations"; "Knowing the enemy and know yourself, a hundred battles you will never be in peril", "a victorious army wins its victories before seeking battle"; and "the elements of the art of war are measurement, estimation, calculations, comparisons and chances of victory".

However, according to Sun Tzu, it is possible that "one may know how to win, but is not necessary to do so" because "in the tumult and uproar the battle seems chaotic", and "army may be liken to water which, has no constant form, and there are in war no constant conditions". Therefore, Sun Tzu stated that "one able to gain the victory by modifying his tactics in accordance with the enemy situation", "control of the factor of changing circumstances", "speedy is the essence of war", "change methods and make alterations so that people have no knowledge of what you are doing", "alters his camp-sites and marches by devious routes, and thus make it impossible for others to anticipate his purpose, "it is by proper use of the ground that both shock and flexible forces are used to the best advantage".

From the brief review of various Chinese military strategies, it suggests that Sun Tzu's Art of War is by far the most comprehensive, and used as the foundation for the development by other military strategists. Based on Sun Tzu's Art of War, victory may be achieved in three ways: strengthening oneself, borrowing strengths from alliance, and utilizing errors done by the opponent. The principles to ensure a victory should cover both preparation for the war and execution during the war.

APPLICATIONS OF SUN TZU'S ART OF WAR

There are a number of studies, in Chinese, English and other languages, which applied Sun Tzu's Art of War strategies to business and management environments. Sun Tzu's principles have been used to explain current phenomena by attempting to "translate" military principles into business approaches. The intention is to study how the prescriptions of Sun Tzu may be applied to management as well as to draw parallels between the principles advocated by Sun Tzu and the situation of top management. For example, Lee et al. (1998) devised business management strategies using Sun Tzu's Art of War. The 13 chapters of Sun Tzu's Art of War were analyzed to identify the equivalent business management strategies by using questionnaire survey. Hawkins and Rajagopal (2005) constructed a framework integrating Sun Tzu's strategies with project life cycle context to show the correlation between the various aspects of military strategies and the fundamental building blocks of project management. Though Sun Tzu's principles were linked with the methods of executing projects, the authors opined that waging war may be simpler than some of the challenges faced in real projects.

Foo and Grinyer (1995) compared Sun Tzu's Art of War and strategic planning process. They investigated the extent, nature and success of strategic planning in large ASEAN companies and found widespread adoption of regular, formal and analytical strategic planning which substantially reflected the basic precepts of Sun Tzu. McNeilly (1996) set up the framework for managers to design strategies and achieve lasting success by adopting six principles from Sun Tzu's Art of War. These are: capturing the market without destroying it; avoiding competitor's strength, and attacking their weakness; using foreknowledge and deception to maximize the power of business intelligence; using speed and preparation to swiftly overcome the competition; using alliances and strategic control points in the industry to "shape" one's opponents and making opponents conform to one's will; and developing one's character as a leader to maximize the potential of employees.

Krause (1996) suggested using Sun Tzu's principles to achieve business success. The major business principles are: learn to fight; show the way; do it right; know the facts; expect the worst; seize the day; burn the bridge; do it better; pull together; and keep competitors guessing. According to Krause (1996), these ten principles are foundation for firms to be competitive. Based on Sun Tzu's Art of War, Tan et al. (1998) proposed that the various types of battlegrounds identified in the Art of War may be classified into three strategic dimensions: the ease of entry; reversibility; and fit. Seven types of markets with specific characteristics for small and medium enterprises (SMEs) are identified based on these dimensions. Macdonald and Neupert (2005) applied Sun Tzu's six terrains and nine ground principles to the study of marketing strategy. Each terrain and ground is discussed in the context of its relationship to customer markets, and prescriptions for dealing with each situation are provided. Results show that Sun Tzu's typology is useful for marketing and relevant for today's business manager as it provides a heuristic system that is parsimonious but still broad enough to describe a diverse set of existing phenomenon.

While both ancient Chinese military strategy and general business strategy may have a similar aim of beating the competitor, there are some differences. Foo (2007) stated that knowledge of Chinese cultures, psychology and sociology is needed to obtain a deeper understanding of Sun Tzu's ideas, which are sometimes presented in metaphors. Therefore, it is easy to believe that many conflicts of using Sun Tzu's work may result from the complex implications of Chinese words which can lead to opposite viewpoints. Besides, the difference between ancient and modern time is also considerable. It is wise in using Sun Tzu's knowledge carefully, appropriately and moderately in studying business strategies.

The brief literature review above shows that many researchers have applied the military principles proposed by Sun Tzu to business management. It shows that Sun Tzu's military principles may be used for strategic management and strategy formulation in business.

COMPARISON BETWEEN SUN TZU AND PORTER'S STRATEGIES

In the western academic area of studying competitiveness, Porter's (1980) generic strategy for competitiveness is looked as one of those that are widely adopted and a 'general rule' for studying a firm's strategy (Ormandidhi and Stringa, 2008). When a firm faces stiff competition and is in a stable market structure, Porter (1980) proposed that the 'winning' firm is one that occupies a superior market position compared to its competitors. Porter (1980) proposed that these generic strategies, i.e. cost leadership, differentiation, and focus can provide companies with abilities to achieve competitive advantages and outperform other companies in their industry.

The fist generic strategy is cost leadership. Porter (1980) stated that charging the lowest prices, occupying higher market share, or receiving higher profits than the competitor can be obtained by the companies that provide services at the lowest cost in the industry. Differentiation, the second generic strategy, is to strive for uniqueness in the industry. Finally, the focus strategy is focusing on a particular market segment or a geographic segment where it is about to services customers better than full-line producer. In employing focus strategy, companies have two options, cost focus and differentiation focus. Porter (1980) also claimed that companies should develop one of the three generic strategies rather than combing them to avoid being stuck-in-the-middle resulting in below average performance.

Several researchers have questioned the use of generic strategies. Johnson and Scholes (1993) stated that the pursuit of more than one generic strategy simultaneously is viable, and Miller and Dess (1992) showed that firms adopting the hybrid theory do not face the situation Porter has described. In real competition, most companies will not admit that their product is essentially the same as that of others (Macmillan and Tampoe, 2000). Besides, Lynch (2003) argued generic strategies may not provide relevant strategic routes in the case of fast growing markets.

In this section, a comparison is made between Sun Tzu's Art of War and Porter's (1980) strategy, since they are both dealing with competition. As ideas of strategy, they have their own inadequacies. The intention of comparison is to identify the chances to make a combination of them.

Long Term vs One-off Endeavor

Strategizing to help firms achieve competitiveness based on Porter's (1980) framework is viewed as a long term endeavor. However, Sun Tzu's military strategy is for a one-time transaction, to win a war. The strategies set up to obtain the long term goal will be focused, precise but might be general and impractical one because it is distant. One-time transaction emphasizes the effective of the strategies. However, concentration of all forces and resource in confrontation, suggested by Sun Tzu, may not sustain the survival and development of firms in current business context. Leading by the one-time transaction strategy, people will be motivated all the time, but might be lost without long term goal.

Environmental Context

Porter's (1980) frameworks appear to be based on the assumption that the environment is predictable (Downes, 1998), while the Art of War was drafted in an era of chaos and almost continuous warring among different groups of people. The environment Sun Tzu was addressing was both predictable and variable. These different attitudes to environment lead to different strategies. When the environment is believed can be predicted, strategist can anticipate the behaviors of the firm and the results of the behaviors based on their previous experiences. Therefore, it is reasonable that strategy to win can be obtained by comprehensively collecting elements in establishing goals and arranging actions. Strategists who believe environment is dynamic and unpredictable but still can be counted will also consider elements in real execution in strategy making by updating, rearranging and redesigning both known and new information. Therefore, the strategies from Porter may focus on well-structured analysis framework describing and proactive moves, while moves to respond and react to real conditions can be extracted from Sun Tzu's strategies.

Context of Winning

With the goal to achieve a decisive win, Sun Tzu advocated avoidance of full-scale confrontation to obtain peace and harmony by detour, while Porter proposed front confrontation which results in either win or loss. The Art of War contains many alternative actions to be taken after analyzing the situation in detail and responding to difficulties that had not been anticipated. Leading by Sun Tzu's understanding of wining, which is a complete and unimpaired one, win-win is the outcome that people are pursuing. Therefore, Sun Tzu advocated being alert to find other chances, being adaptable to accept the new chances, and being smart to utilize chances.

Planning Process

Both Porter (1980) and Sun Tzu emphasized the importance of planning, however they are different in equate panning to the approach to win. Porter (1980) suggested that “proper planning process” works as the link between thinking and implementing. This has been criticized because thinking and action are separated (Wit, 1997). In Sun Tzu’s Art of War however, the strategies appear to cater to unstable and unexpected factors in operations concurrently, and deviation of planned strategies is part of execution.

The brief comparison suggests that Porter’s (1980) competitive strategies may not be comprehensive enough. It appears that certain aspects of Sun Tzu’s military strategies could be incorporated to help firms achieve greater competitiveness. It is expected that the combination of them may serve firms that operate in a complex situation better, and help them to analyze the issues they face.

ART OF WAR’S UNIQUE CONTRIBUTIONS

In this section, some unique features from the Art of War which are applicable to business competition are discussed.

Swiftness

Sun Tzu stated that: *“Speed is the essence of war; capitalize on the unpreparedness of the enemy; travel by the unexpected routes; and attack those places where he does not take precautions”*.

The above suggests the importance of swiftness in execution. Once the plan is formulated and agreed upon, it has to be executed swiftly so that it will not be leaked to the rivals. Sun Tzu’s swiftness strategy involves three aspects (Wee, et.al., 1991): timing; synergy; and speedy. First, Sun Tzu stated that “when the strike of the falcon breaks the body of its prey, it is because of correct timing”. Choosing a right time to enter the market to attack the rivals is prerequisite for swiftness. It is quite similar as Kotler’s (1997) viewpoint that the implementation of firm’s strategy should be swifter than its competitor, shortening the whole time by speedy execution (Arditi et al. 1985). Second, Sun Tzu’s statement that “when torrential water pushes boulders, it is because of its momentum” suggests synergy of diverse actions to overwhelm the competitor leaves no time for rivals to think, respond and develop effective defense. Construction firm obtaining innovative products and processes through active collaboration (Hastak et al., 1993) is an example of this. Third, Sun Tzu asserted that: “when victory is long delayed, the ardor and morale of the army will be depressed. When the siege of a city is prolonged, the army will be exhausted. When the army engages in protracted campaigns, the resources of the state will be impoverished.” This third situation of “swiftness” related to being “speedy” in execution. In the construction context, it related to completing a project within the shortest time.

Adaptability

While Sun Tzu advocated swiftness in execution, he forbad blind assault and instead advocated adaptability. Sun Tzu’s adaptation strategy is shown in his principle: *“Just as water shapes itself according to the ground, an army should manage its victory in accordance with the situation of the enemy. Just as water has no constant shape so in warfare there are no fixed rules and regulations; therefore, do not repeat the tactics that won you a victory, but vary them according to the circumstances; effective strategies must constantly change according to the situation of the enemy.”*

Being adaptable is necessary to bring the planning to reality, because even with detailed planning things may still go wrong. The field commander must be sharp to recognize that the field situation is inconsistent with the information or assumptions made at the planning stage. He should thus change the war strategy accordingly. In the construction industry, calls have been made for firms to create flatter and broader adaptive structures. Establishment of an adaptive culture helps to reduce employees' resistance to changes (Sun and Alas, 2007). In addition, during the change process, strong supports from top management, communication and commitments among employees, as well as compensation and incentive system to facilitate changes are necessary to bring about change (Price and Chahal, 2006).

Market Intelligence

According to Sun Tzu, fore-knowledge, which can be obtained by systematic intelligence, is important to achieve victory. Sun Tzu's emphasis on intelligence can be shown in these statements: *"one must not enter into any alliance with the rulers of neighboring states without knowing their military motives and designs. On must not move troops without being familiar with the conditions of mountains, forests, passes, swamps, marshes, and so on. This foreknowledge can be elicited from obtained from men who have knowledge on enemy's situation."*

The dynamic and complexity of the operating environment call for skills in selecting, collecting, interpreting and distributing information. For example, construction firms could set up channels with agent, clients and suppliers to smoothen project development and execution in China (Ling et al., 2005). To set up system of dealing with market information, firms need to have the ability to process and manage information. Information technology infrastructures, human resources and IT-enabled intangibles (such as—customer orientation, knowledge assets and synergy) (Bharadwaj, 2000) are also important aspects to acquire market intelligence.

CONCLUSION

In the western context, it is not a new concept to apply military strategy into business area. The literature review suggests that among the different Chinese military strategies, Sun Tzu's Art of War is the one that has much relevance to business competition. Porter's (1980) generic strategies on competitiveness appear to be one of those are widely adopted in the western. Comparisons were made between these two strategies. One of Sun Tzu's most important war strategies is to obtain victory by avoiding direct conflict, while, strategy for competitiveness, as posited by Porter suggests a full and frontal attack of the rival. The Art of War has other useful elements can may help western firms to achieve competitiveness when operating in China's construction market. These are: swiftness, adaptability and intelligence. In future studies, research will be conducted to ascertain the extent to which western firms adopt some Art of War principles in their construction business in China.

REFERENCE

Arditi, D., Akan, G. T., and Gurdamar, S. (1985) Reasons for delays in public projects in Turkey. Construction Management and Economics, 9(4), 311-325.

Bharadwaj, A. S. (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIC Quarterly, 24 (1), 169-196.

Bowman, E. H. (1990) ‘Strategy changes: possible worlds and actual minds’, in Frederickson J.W (ed.), Perspectives on Strategic Management. New York: Harper and Row, 9-37.

Downes, L. (1998) ‘Beyond Porter’, available at: http://www.coontextmag.com/setFrameRedirect.asp?src=/archives/199712/technosynthesis.asp.

Foo, C. T. (2007) Epistemology of strategy: some insights from empirical analyses. Chinese Management Studies, 1 (3), 154-166.

Foo, C. T. and Grinyer, P. H. (1994) Organization Strategy: Sun Tzu Business Warcraft. Singapore: Utopia Press.

Griffith, S. B. (1963) Sun Tzu: The Art of War. NY: Oxford University Press.

Hastak, M., Vanegas, J. A. and Puyana-Camargo, M. (1993) Time-based competition: competitive advantage tool for A/E/C firms. Journal of Construction Engineering and Management, 119(4), 785-800.

Hawkins, D., & Rajagopal, S. (2005). Sun Tzu and the Project Battleground: Creating Project Strategy from the Art of War. New York: Palgrave MacMillian.

Huang, R. J. (2008) A study of Chinese-style management in the twenty-first century. The Chinese Economy, 41 (3), 7-16.

Johnson, G. and Scholes, K. (1993) Exploring Corporate Strategy: Text and Cases, 3rd edn. London: Prentice Hall.

Kotler, P. (1997) Marketing Management: Analysis, Planning, Implementation, and control. NJ: Prentice Hall, Englewood Cliffs.

Lee, S. F., Roberts, P., Lau, W. S. and Bhattacharyya, S. K. (1998) Sun Tzu’s the Art of War as business and management strategies for world class business excellence evaluation under QFD methodology. Business Process Management, 4 (2), 96-113.

Li, L. (2006) The integrative analysis of thirteen chapters of <Sun Tzu>. Beijing: ZhongHua Book Corporation.

Li, X. T. (2008) Ideology of China’s Traditional Civilization and Modern Management. Zhe Jiang: Zhejiang University press.

Ling, Y.Y., Ibbs, C. W., and Cuervo, J. C. (2005a) Entry and business strategies used by international AEC firms in China. Construction Management and Economics, 23(5), 509-520.

Low, S. P. and Tan, M. C. S. (1995) A convergence of western marketing mix concepts and oriential strategic thinking. Marketing Intelligence &Planning, 13(2), 36-46.

Lynch, R. (2003) Corporate Strategy, 3rd ed., Prentice Hall Financial Times.

Macdonald, J and Neupert, K. (2005) Applying Sun Tzu’s terrain and ground to the study of marketing strategy. Journal of Strategic Marketing, 13, 293-304

Macmillan, H. & Tampoe, M. (2000), Strategic Management, Oxford University Press.

McNeilly, M. (1996) Sun Tzu and the Art of Business : Six Strategic Principles for Managers. New York: Oxford University Press.

Miller, A, and Dess, G. G (1993) Assessing Porter's (1980) model in terms of its generalizability, accuracy and simplicity. Journal of Management Studies, 553-85.

Ormanidhi, O. and Stringa, O. (2008) Porter's model of generic competitive strategies: an insightful and convenient approach to firms' analysis. Business Economics, 43 (3), 55-64.

Parks, B, Pharr, S.W. and Lockeman, B.D. (1994) A marketer's guide to Clausewitz: lessons for winning market share. Business Horizons, July/August, 68-73.

Pian, Y. Q., Li, J. M. and Sheng, D. L. (2007) Wu Jing Qi Shu. Bei Jing: Zhong Hua Book Corporation.

Porter, M. E. (1980) Competitive Strategy: Techniques for Analyzing Industries and Competitors. NY: Free Press.

Price, A. D. F. and Chahal, K. (2006) A strategic framework for change management. Construction Management and Economics, 24, 237-251.

Ries, A. and Trout, J. (1986), Marketing Warfare. NY: McGraw-Hill.

Rindfleisch, A. (1996) Marketing as warfare: reassessing a dominant metaphor. Business horizons, September/October, 3-10.

Sun, W. and Alas, R. (2007) Process Model for Organizational Change: a Study of Chinese organizations. EBS Review, 22: 29-41.

Thomas, H. (2002) Strategic management: its development and future direction, in Pettigrew, A., Thomas, H. and Whittington, R. (Eds) Handbook of Strategy and Management. London: Sage Pub.

Wee, C-H., Lee, K-S. and Hidajat, B. W. (1991) Sun Tzu War & Management. UK: Addison-Wesley, Reading.

Wit, B. D. (1997) 'Porter on Business Strategy, in Van den Bosch, F.A.J and de Man, A. P. (eds.) Perspectives on Strategy: Contributions of Micheal E. Porter. London: Kluwer Academic, 7-18.

Yuan, G (2008) Relation between 'GuoXue' and management. The study, 9. 35-38.

COST OPTIMIZATION OF CONSTRUCTION PROJECT SCHEDULES

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The paper presents the cost optimization of construction project schedules. The optimization was performed by the nonlinear programming approach, NLP. Accordingly, a NLP optimization model for the cost optimization of project schedules was developed and applied. The nonlinear objective function of the total project costs was subjected to a rigorous system of generalized precedence relationship constraints between project activities, the activity duration constraints and the project duration constraints. The results of the optimization include the minimum total project cost and the project schedule with the optimal start times and the optimal durations of activities. A numerical example presented at the end of the paper demonstrates the advantages of the proposed approach.

KEYWORDS: cost optimization, project scheduling, construction management, nonlinear programming, NLP.

INTRODUCTION

The cost effective scheduling is one of the most important aspects of the construction project management. Traditionally used methods for the cost effective project scheduling in construction management include either the Critical path method (CPM) or the program evaluation and review technique (PERT) combined with trial-and-error procedure. In this way, the cost effective project schedules are achieved in a time-consuming cost-duration analysis of various alternatives for start times and durations of construction project activities. However, doubt always exists as to whether or not the obtained project schedule is optimal.

To surmount the mentioned disadvantages, various different optimization methods have been proposed for the cost optimization of project schedules. Considering the exact mathematical programming methods, the cost optimization of project schedules has been handled mainly by different linear programming (LP) methods, see e.g. Demeulemeester et al., (1998); Achuthan and Hardjawidjaja (2001); Möhring et al. (2001); Vanhoucke et al. (2002). Since the LP methods can handle only linear relations between the variables, the nonlinear terms of the optimization models have been formulated as the discrete relationships between the variables or they were approximated with (piece-wise) linear functions.

However, even the earliest studies in this field have recognized the nonlinear nature of the project cost-duration relationships. Therefore, the nonlinear programming (NLP) techniques have been proposed to solve project scheduling optimization problems with nonlinear cost functions, see e.g. Kapur (1973); Deckro et al. (1995) and Turnquist and Nozick (2004). Nevertheless, in most of the published works the cost optimization of project schedules was performed considering only the Finish-to-Start precedence relationships between activities.

This paper presents the cost optimization of construction project schedules performed by the NLP approach. Accordingly, a NLP optimization model for the cost optimization of project schedules was developed and applied. The nonlinear objective function of the total project costs was subjected to a rigorous system of generalized precedence relationship constraints between project activities, the activity duration constraints and the project duration constraints. The results of the optimization include the minimum total project cost and the project schedule with the optimal start times and the optimal durations of activities. A numerical example presented at the end of the paper demonstrates the advantages of the proposed approach.

NLP PROBLEM FORMULATION

The general NLP optimization problem may be formulated in the following form:

$$\text{Minimize } z = f(\boldsymbol{x})$$

$$\text{subjected to:}$$

$$\boldsymbol{h}(\boldsymbol{x}) = \boldsymbol{0} \qquad \text{(NLP)}$$

$$\boldsymbol{g}(\boldsymbol{x}) \le \boldsymbol{0}$$

$$\boldsymbol{x} \in \boldsymbol{X} = \{\boldsymbol{x} \mid \boldsymbol{x} \in \boldsymbol{R}^n, \boldsymbol{x}^{LO} \le \boldsymbol{x} \le \boldsymbol{x}^{UP}\}$$

where $\boldsymbol{x}$ is a vector of the continuous variables, defined within the compact set $\boldsymbol{X}$. Functions $f(\boldsymbol{x})$, $\boldsymbol{h}(\boldsymbol{x})$ and $\boldsymbol{g}(\boldsymbol{x})$ are the (non)linear functions involved in the objective function z, the equality and inequality constraints, respectively. All the functions $f(\boldsymbol{x})$, $\boldsymbol{h}(\boldsymbol{x})$ and $\boldsymbol{g}(\boldsymbol{x})$ must be continuous and differentiable.

In the context of the project scheduling optimization problem, the continuous variables define schedule parameters such as activity durations, start times, direct costs, etc. The objective function determines the total project cost. Equality and inequality constraints and the bounds of the continuous variables represent a rigorous system of generalized precedence relationship constraints, the activity duration constraints and the project duration constraints of the project scheduling optimization problem.

NLP MODEL FORMULATION

The cost optimization of the project schedules was performed by the NLP approach. In this way, the NLP model formulation consists of the total cost objective function, the generalized precedence relationship constraints, the activity duration constraints and the project duration constraints. The following total project cost objective function is defined for the cost optimization of project schedules:

$$C_T = \sum_{i \in I} C_i(D_i) + C_I(D_P) + P(D_L) - B(D_E) \qquad (1)$$

where objective variable C_T represents the total project cost, set I comprises the project activities i, $i \in I$, $C_i(D_i)$ denotes the direct cost-duration functions of the project activities i, $i \in I$, $C_I(D_P)$ is the project indirect cost-duration function, $P(D_L)$ is the penalty-duration function and $B(D_E)$ is the bonus-duration function. The variables D_i, D_P, D_L and D_E denote the durations of the project activities i, $i \in I$, the actual project duration, the amount of time the project is late, and the amount of the time the project is early, respectively. The total project cost objective function is subjected to the rigorous system of the generalized precedence relationship constraints, the activity duration constraints and the project duration constraints.

Each project activity i, $i \in I$, is connected with its succeeding activities j, $j \in J$ by fulfilling at least one of the following generalized precedence relationship constraints:

Finish-to-Start: $$S_i + D_i + L_{i,j} \leq S_j \tag{2}$$

Start-to-Start: $$S_i + L_{i,j} \leq S_j \tag{3}$$

Start-to-Finish: $$S_i + L_{i,j} \leq S_j + D_j \tag{4}$$

Finish-to-Finish: $$S_i + D_i + L_{i,j} \leq S_j + D_j \tag{5}$$

where S_i is the start time of activity i, $i \in I$, D_i is the activity duration, $L_{i,j}$ is the lag/lead time between activity i, $i \in I$, and the succeeding activity j, $j \in J$, and S_j is the start time of the succeeding activity j, $j \in J$.

The actual project duration D_P is determined as follows:

$$D_P = S_{i\omega} + D_{i\omega} - S_{i\alpha} \tag{6}$$

where $S_{i\omega}$ and $D_{i\omega}$ represent the start time and the duration of the last project activity $i\omega$, $i\omega \in I$, and $S_{i\alpha}$ denotes the start time of the first project activity $i\alpha$, $i\alpha \in I$.

Since the project activities must be executed between the project start and finishing time, the following constraint is set to bound the completion times of the project activities:

$$S_i + D_i - S_{i\alpha} \leq D_P \tag{7}$$

The relationship between the actual project duration D_P, the amount of time the project is late D_L, the amount of time the project is early D_E and the target project duration D_T is formulated as follows:

$$D_P - D_L + D_E = D_T \tag{8}$$

Only one of the variables D_L and D_E can, at the most, take a nonzero value in any project scheduling solution. In this way, these two variables are additionally constrained by the following equation:

$$D_L \cdot D_E = 0 \tag{9}$$

NUMERICAL EXAMPLE

In order to present the applicability of the proposed NLP approach, the paper presents an example of the cost optimization of the construction project schedule. The considered construction project scheduling optimization problem is a variant of the time-cost trade-off problem for a small building project presented by Yang (2005).

The construction project consists of 7 activities. The precedence relationships and the lag times between succeeding project activities are presented in Table 1. The crash/normal points and the direct cost-duration functions of the construction project activities are presented in Table 2.

Table 1: Precedence Relationships and Lag Times between the Project Activities

Activity	Succeeding activity	Precedence relationship	Lag time [day]
ID Description	ID		
1. Underground service	2.	Start-to-Start	2
2. Concrete works	3.	Finish-to-Start	3
3. Exterior walls	4.	Finish-to-Start	0
4. Roof construction	5.	Finish-to-Start	0
	6.	Finish-to-Start	0
5. Floor finish	7.	Finish-to-Start	0
6. Ceiling	7.	Finish-to-Finish	6
7. Finish work	–	–	–

Table 2: Crash/Normal Points and Direct Cost-Duration Functions of the Project Activities

Activity	Duration [days]		Direct cost [$]		
ID Description	Crash	Normal	Crash	Normal	Direct cost-duration function
1. Underground service	3	6	4,500	1,500	$250\ D_1^2 - 3{,}250\ D_1 + 12{,}000$
2. Concrete works	10	12	7,000	5,000	$-10{,}969.6299\ \ln(D_2) + 32{,}258.5063$
3. Exterior walls	8	12	3,600	2,000	$11{,}664\ \exp(-0.1469\ D_3)$
4. Roof construction	6	8	3,100	2,000	$-550\ D_4 + 6{,}400$
5. Floor finish	3	4	3,000	2,000	$-1{,}000\ D_5 + 6{,}000$
6. Ceiling	4	6	4,000	2,500	$-750\ D_6 + 7{,}000$
7. Finish work	10	14	2,800	1,000	$75\ D_7^2 - 2{,}250\ D_7 + 17{,}800$
Project	42	55	28,000	16,000	

The daily indirect cost is $200.00. While the per-period penalty for late project completion is set to be $400/day, the per-period bonus for early project completion is determined to be $300/day. The targeted project duration is 47 days

The objective of the optimization is to find a construction project schedule with the optimal activity start times and durations so as to minimize total project cost, subjected to the generalized precedence relationship constraints, the activity duration constraints and the project duration constraints.

The proposed NLP optimization model formulation was applied. A high-level language GAMS (General Algebraic Modelling System) (Brooke et al., 1988) was used for modelling and for data inputs/outputs. CONOPT (generalized reduced-gradient method) (Drud, 1994) was used for the optimization.

Since the NLP denotes the continuous optimization technique, the optimization of the project schedule was performed in two successive steps. In the first step, the ordinary NLP optimization was performed to calculate the optimal continuous variables (e.g. start times, durations, etc.) inside their upper and lower bounds, see Table 3.

Table 3: Optimum Continuous Solution

Activity	Start time [day]	Duration [days]	Direct cost [$]
1. Underground service	1.000	6.000	1,500.00
2. Concrete works	3.000	12.000	5,000.00
3. Exterior walls	18.000	8.000	3,600.00
4. Roof construction	26.000	6.667	2,733.33
5. Floor finish	32.667	4.000	2,000.00
6. Ceiling	32.667	6.000	2,500.00
7. Finish work	36.667	11.333	1,933.33
		Indirect cost [$]	9,400.00
		Penalty [$]	0.00
		Bonus [$]	0.00
		Total project cost [$]	28,666.66

In the second step, the calculation was repeated/checked for the fixed and rounded variables (from in the first stage obtained continuous values to their nearest upper discrete values). Table 4 summarizes the optimum rounded solution for the small building project schedule.

Table 4: Optimum Rounded Solution

Activity	Start time [day]	Duration [days]	Direct cost [$]
1. Underground service	1.000	6.000	1,500.00
2. Concrete works	3.000	12.000	5,000.00
3. Exterior walls	18.000	8.000	3,600.00
4. Roof construction	26.000	7.000	2,550.00
5. Floor finish	33.000	4.000	2,000.00
6. Ceiling	33.000	6.000	2,500.00
7. Finish work	37.000	12.000	1,600.00
		Indirect cost [$]	9,600.00
		Penalty [$]	400.00
		Bonus [$]	0.00
		Total project cost [$]	28,750.00

The minimum total project cost obtained by the NLP optimization of the project schedule was found to be $28,750.00. The gained optimal results include the minimum total project cost and the project schedule with the optimal start times and the optimal durations of activities. The example also shows that the total cost optimization of the project schedule performed by the NLP approach is carried out in a calculating process, where the start times and durations of project activities are considered simultaneously in order to obtain the minimum total project cost. The obtained maximum values for durations of the project activities 1, 2, 5, and 6 demonstrate that the cost optimization of the project schedule not necessarily minimize the project duration. Moreover, the example shows that the optimum duration of the project may also exceed the target project duration. In this way, the additional feature of the total project cost optimization represents the advantage of the proposed NLP approach to construction project scheduling over the traditionally used CPM and PERT methods.

CONCLUSIONS

This paper presents the cost optimization of construction project schedules performed by the NLP approach. The NLP optimization model formulation for the cost optimization of construction project schedules was developed and applied. The input data within the NLP optimization model include: the project network with determined preceding and succeeding activities, the precedence relationships and the lag/lead times between activities, the normal/crash points and the direct cost-duration functions of the activities, the project indirect cost-duration function, the penalty-duration function and the bonus-duration function. The nonlinear continuous total project cost objective function was subjected to the rigorous system of the generalized precedence relationship constraints, the activity duration constraints and the project duration constraints. For specified input data, the NLP optimization yields the minimum total project cost and the construction project schedule with the optimal start times and the optimal durations of activities.

The existing exact NLP methods have focused on the cost optimal solution of the project scheduling problems which include simplifying assumptions regarding the precedence relationships among project activities. On the other hand, the present work aims to incorporate generalized precedence relationships between project activities and to propose the NLP model for making optimal project time-cost decisions applicable to actual construction projects. In addition, solving the construction project scheduling optimization problem using the proposed NLP model avoids the need for (piece-wise) linear approximation of the nonlinear expressions, which has been the traditional approach proposed for solving this optimization problem using the LP models. Since the proposed optimization approach enables an insight into the interdependence between the project duration and the total project cost, the decision-maker can more effectively estimate the effect of the project deadline on a total project cost before the submission of a tender.

REFERENCES

Achuthan, N.R., and Hardjawidjaja, A. (2001) Project scheduling under time dependent costs – a branch and bound algorithm. Annals of Operations Research, 108, 55–74.

Brooke, A., Kendrick, D., and Meeraus, A. (1988) GAMS - A User's Guide. Redwood City: Scientific Press.

Deckro, R.F., Herbert, J.E., Verdini, W.A., Grimsrud, P.E., and Venkateshwar, S. (1995) Nonlinear time/cost trade-off models in project management. Computers and Industrial Engineering, 28(2), 219–229.

Demeulemeester, E., De Reyck, B., Foubert, B., Herroelen, W., and Vanhoucke, M., (1998) New computational results on the discrete time/cost trade-off problem in project networks. Journal of the Operational Research Society, 49(11), 1153–1163.

Drud, A.S. (1994) CONOPT – A Large-Scale GRG Code. ORSA Journal on Computing, 6(2), 207–216.

Kapur, K.C. (1973) An algorithm for project cost-duration analysis problems with quadratic and convex cost functions. AIIE Transactions, 5(4), 314–322.

Möhring, R.H., Schulz, A.S., Stork, F., and Uetz, M. (2001) On project scheduling with irregular starting time costs. Operations Research Letters, 28(4), 149–154.

Turnquist, M.A., Nozick, L.K. (2004) A nonlinear optimization model of time and resource allocation decisions in projects with uncertainty. Engineering Management Journal, 16(1), 40–49.

Vanhoucke, M., Demeulemeester, E., and Herroelen, W. (2002) Discrete time/cost trade-offs in project scheduling with time-switch constraints. Journal of the Operational Research Society, 53(7), 741–751.

Yang, IT. (2005) Chance-constrained time-cost trade-off analysis considering funding variability. Journal of Construction Engineering and Management, 131(9), 1002–1012.

"FAULTY" STEPS IN CONSTRUCTION – "FAULTY" LEARNING FROM EXPERIENCE

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Normally we consider history to be a process of progression and adaptation. As we learn from experience we are able to solve problems and will, over time, improve the quality and efficiency of task performance. However, in construction problems seem to persist. Problems with quality, efficiency, and defects seem immune to all our efforts. Based on an empirical study, this paper explores the possibility that such immunity is caused by a systematic misreading of experience, leading us repeatedly to learn a wrong lesson from history.
The paper's contribution is to show how imagination and more complex conceptions of reality may help construction to improve the validity of the lessons drawn from experience and, as a consequence, to enable adaptation towards a lower frequency of construction defects.

KEYWORDS: construction defects, chance events, false learning.

INTRODUCTION

Accidents, mistakes, failures, collapses, defects, and a host of other production and management problems seem to haunt construction work. In spite of continuous and concerted efforts at the level of projects, companies and the sector as a whole these quality and efficiency problems linger on. Failures have almost become icons of the building process, reflecting negatively on the reputation of everybody involved.

In this paper we offer a minor, but slightly significant change in perspective on these very old and persistent problems. We suggest that the problems continue to haunt construction not because the sector has failed to learn from experience, but because it has systematically learned a too narrow, a too limited, and sometimes a wrong lesson from these experiences. Specifically, we suggest a different interpretive framework for understanding accidents, collapses, defects etc. Thus, our effort can be characterized as an attempt to substitute the prevailing single-loop learning with double-loop learning (Argyris and Schön 1996).

We challenge the prevailing interpretive framework which presumes that when things go wrong a cause can be found in the processes prior to the accident or defect. Experiential learning implies a reconstruction of a causal chain and the identification of the individual act or actor accountable for the failure. The failure-bound action is discouraged in the future through prescription, supervision, and/or incentive schemes.

However, it is easy to deconstruct the logic behind such interpretations. For example, it builds on the mistaken assumption that the action that is determined to be defective is action that is *not* performed when things go well. We suggest that it may well have been. It is our conjecture that learning in construction is very difficult because causes and effects are loosely coupled. Often people do the same things when they succeed and when they fail. In this sense, work may succeed even when the action is deviant from the plan, and it may fail even when action is conducted dutifully in accordance with the plan and prescription.

In addressing this difficulty, Gilbert Ryle's distinction between tasks and achievements may prove helpful (Ryle 1949/2000). Defects are (negative) achievements and therefore a characterization of a situation that exists after the action. Such situations can never be reduced to the individual acts preceding them. Many more aspects than the specific action is necessary to understand the outcome. In Ryle's own words, when appreciating an achievement "… we are asserting that some state of affairs obtains over and above that which consists in the performance, if any, of the subservient task activity. For a runner to win, not only must he run but also his rivals must be at the tape later than he; for a doctor to effect a cure, his patient must both be treated and be well again …" (p. 143-44). In short, if winning is not a quality of the running, but of the reality that exists after the running, perhaps defects and mistakes are not qualities of task performance on construction sites, but qualities of the state of affairs that obtains after some task performance. We cannot in real time observe 'defects in the making', because that would mistake the task for the achievement, or the process for the outcome. We can observe the running as a progression, but not the winning. Likewise, we can observe task performance in real time, but not the defective performance. Only in retrospect can we construct the (by then completed) running as a winning run and the (by then completed) task performance as defective.

Surely, the achievement, i.e. the future state of affairs, is possibly present in the mind of the runner and construction worker as a motivator and sense-giving idea or fantasy. Some kind of achievement is already present as a mental object, as a course-of-action or a program (Ryle 2000). It is the imagination of winning, or the imagination of a completed task that guides and informs the running and the task performance, respectively. Human action is based on future-perfect-thinking (Schutz 1973; Kreiner and Winch 2008; Kreiner and Winch 2009).

We can safely claim that construction work is a more complicated case than running a race, and we want to point out that in the former case it is difficult to take guidance from the mental object when acting in the present. 'Run faster' were the appropriate advice if lacking behind in a race we intend to win, even if we lack the strength to do it. In construction, however, the appropriate advice is not always similarly clear. Such advice follows, as we will illustrate below, from processes of sense-making and judgment. Construction work takes place in a much more ambiguous reality than running a race, and as a consequence neither the problem nor the effective solution presents itself in clear and obvious terms. We conjecture that this fundamental ambiguity is the reason why learning from failure in construction is a risky and fault-ridden business - and the reason why the history is so ineffective in moving us towards some optimum of performance.

Aim of the paper

The aim of the paper is to understand how supposedly informed judgment about reality may contribute to the persistence of the problems with defects in construction. We define a defect as some physical outcome that needs repair. In practice, however, it may not always be self-evident whether something needs repair or not, and it is always determined as an outcome of mental and social processes. There are processes of discovery or detection of problems; there are processes of judging the character of the problem; and there are social processes of negotiation and power as repairs are designed and responsibility placed. In all of these processes, there is an element of subjectivity and chance involved.

To show the intricacies of drawing valid implications from experience we analyse a single case of a foreman assessing a specific situation. We reconstruct the mental framework within which he reasons with himself before deciding what to do. While his action seems rational within this mental framework, the framework itself may be questioned. If we assume that construction projects are characterized by very complex processes, single events will be seen as *chance* events. As we all know, nothing can be learned from chance events, but we may exploit them in imagining a population of *possible events* from which the observed events are drawn. In practice, this population of possible events might deserve more attention than the individual chance events.

In a world of chance events the risk is not only to learn too little from actual experiences, but also to learn too much. Learning too much from randomly encountered experiences may be a contributing cause of the persisting problems with defects in construction.

Plan of the paper

First, we discuss the methodology of our study. Admittedly, we need to justify that we base the whole argument in this paper on an observation of a short sequence of events. We also need to explain why we enrich this limited amount of data with imagining counterfactual events instead of amassing more observations and background data.

Next, we describe the sequence of events on a construction site which we happened to observe. This leads to an analysis of the complex manner in which this task performance may relate to outcomes, and in this context to defects. Following this section, we venture to illustrate the types of strategic learning that might propose itself in the specific case. And we conclude by reviewing the type of implications that might be drawn rationally from a more imaginative form of learning.

Methodology

This paper is part of a larger study of things that go wrong in construction, including serious accidents and collapses. In the present study we focus on the less spectacular and more ordinary types of mistakes. We focus on construction defects, i.e. physical outcomes in need of repair. To learn how defects happen we did an observational study of the “crime” scene, i.e. the construction site.

However, in line with the above reasoning we cannot observe mistakes and defects in the making, because mistakes and defects are not qualities of the task performance but of some subsequent situation. On the other hand, while we observe task performance in general we also observe work processes leading, with some likelihood, to defects. The perspective is one of risk and probabilities. All work processes are relevant to observe in such a perspective because they all have some potentiality of leading to defective outcomes. In this sense, the nature of the processes preceding failures and successes is the same. Even their likelihood of leading to failure may not be different, since variation in outcomes will have a random component.

We came to observe work processes that were quite successful, meaning that they did not lead to outcomes in need of repair. However, this fact does not matter because we analysed the observations from a perspective of defects being a chance event. If in fact it did not lead to a defect, it might have done. We need to understand how it might have led to defects – and to illustrate such an understanding. The issue to be understood is how risks and probabilities in relation to subsequent outcomes, like defects, are managed or could be managed, directly or indirectly.

Theory and Data

We are *studying* construction defects, i.e. situations that require repair in one way or the other. But as mentioned above, we are not collecting data on defects. We are observing task performance processes on construction sites - performances that may or may not be failure-bound, and performances that with varying degrees of likelihood will lead to defects.

In between what we are studying and what we are observing lies theory. Most theories build on simple causal notions – and can do so because they observe things that did in fact happened on the presumption that they had to happen given the preceding action. Since we are studying action with as yet undetermined outcomes we cannot assume simple causal relationships but must rely on notions of probability. Some theories, e.g. in relation to the issue of buildability (Nielsen, Hansen et al. 2009), do recognize that defects are chance events, but are aimed at assessing the inherent risk of specific methods of construction. Our point is that risks are mostly socially constructed and are outcomes of, rather than merely parameters for, human action. We aim to make a modest contribution to a foundation for such theories, in the form of offering some basic modelling of the ways risks of defects are managed and ignored in practice.

Our approach deviates from common practice. Most studies start with situations in which repair work is needed and from there move backwards in time to reconstruct the preceding processes. And most studies try to amass many cases to validate the lessons learned. However, such reconstructions and learning are already informed by an implicit model of causality. In contrast to our perspective, such studies assume that what happened, had to happen, given the circumstances excavated in the research process. It is further implicitly assumed that it would not have happened, had some action at some place in the causal chain been different.

However, it is our position that what happened did not have to happen, but had a certain likelihood of happening. Moving backwards from an already occurred defect gives a picture of what happened, but not what might have happened - and might from a theoretical point of view as well have happened. There is not only one route to success of failure. There are multiple, and the critical path may be construed and constructed in many different manners. Since our intention is to challenge the interpretive framework of causality – the perspective from which numerous construction defects have already been analysed and made sense of – and to replace it with a framework that focuses more on defects as a probabilistic phenomenon, reconstruction of things already turned into defects will produce a highly biased sample to learn from.

To circumvent such problems, we have chosen to insist on observing actual action on construction sites. We make no pretention of observing failure-bound action; it is more likely that we are studying success-bound action. After all, most task performances are successful, even in a failure-ridden construction project.

But we claim that we are observing action with the potential of leading to outcomes seen as defective, wrong, irresponsible, etc. In view of the complexity we ascribe to construction work, any action and any judgment has the potentiality to prove misguided retrospectively. There may be more or less risk involved, but the likelihood of misconstruing the situation is never nil. Thus, we are observing action that might turn into defective action, and we are analysing the multiple ways in which this may happen, whether or not it actually happens subsequently.

OBSERVATION: THE UNSTEADY INSULATION MAT

We encounter the foreman on the construction site on a normal workday. The foundation has already been completed and the terrain has been prepared and insulated with foam mats for concreting soon. The foreman is commuting from his office to another part of the site and to save time he cuts across the building footprint. He suddenly stops and returns to one of the insulation mats which he stepped on. Presumably, the mat moved when he stepped on it. The gravel on which the mat rests is supposed to be level and the wobbling indicates that it is not. He returns to investigate how much it can move and to learn how uneven the surface is. After having tilted the mat back and forth for at while he continues his walk without further ado.

He discovered a potential defect, investigated the matter and weighted the evidence pro et con, before deciding that this was not a defect (not something in need of repair) but only a tolerable imperfection.

We cannot know if we happened to observe a critical moment in this particular construction project. Chances are that we did not, but the possibility exists that we did. The reason that we cannot know is the simple fact that such things can only be known retrospectively. Subsequent events may turn the unsteady insulation mat into a cause of serious problem in the future – or into a trivial imperfection.

Nor can we know for sure what went on in the foreman’s mind when tilting the mat back and forth. All we know is that something went on – and that he would have told us that the wobbling didn’t matter, had we asked him afterwards. Instead of interviewing him about his retrospective rationalizations we theorize how he came to the assessment that nothing needed to be repaired.

Analysis

What follows is an analysis of this short observation, a guided interpretation of the event and action. The analytical driver is the quest for imagining what might exist and what may come to happen.

Chance events - Accidental learning

The first thing to note is the fact that the foreman was stumbling over a learning opportunity. He was pursuing a different course of action and clearly not intend on controlling the quality of the work. He simply happened to step on the unsteady insulation mat when he made a shortcut in commuting from one place to another. His discovery is a chance event. The unsteady mat is turned into a learning opportunity because the foreman's mind was prepared. He was trained and competent enough to imagine what significance the unsteadiness might have. He was heedful enough to register that it moved and diligent enough to pause with his ongoing task while returning to the insulation mat to investigate the matter.

If we learn from experience, but the experiences we learn from are chance events, lessons learned from experience must somehow also be influenced by chance – thus to a certain extent random.

Ambiguity: imperfection or defect

The need to investigate the matter is a sign of the fact that the information he receives is ambiguous. If we believe that more information makes reality better understood, here is a case to show that more information occasionally makes reality more complicated (Dörner 1996). It requires the foreman to draw implications that are apparently not self-evident, and rather a matter of judgment. While we cannot know how the foreman construed the issues, we may suggest that he is spending time on determining whether the unsteady insulation mat is an imperfection or a defect. The implications he will draw depends on this judgment: will he require the work to be redone or will he consider the mat to be 'as good as' steady and do nothing? Apparently, he decides that it is 'as good as' steady, even if it is unsteady why he may resume his other businesses.

What kind of judgment is the foreman making? How can we imagine justifying such judgments? If we assume that the foreman's judgment is informed, what kind of knowledge and experience informs it? These questions are important, yet not so easy to answer. Especially, the common claim that making informed judgments represents a trained capacity will be challenged below.

Complexity: the multiple roads to defects

Trained capacity is likely acquired in processes of learning-by-doing. We learn by observing the effects of acting and by adjusting the action until the actual effects correspond to the intentions. In our case, the foreman could be imagined to have assessed the unsteadiness of insulation mats many times before and slowly gained the appreciation of future consequences of different degrees of unsteadiness. But the complexity of construction work is not conducive to such learning-by-doing. As we shall suggest now, consequences are highly contingent and highly displaced in time and space.

Clearly, there is no straight causal link between a loose mat and some future defect or damage. There are numerous other intervening and concomitant factors that help co-produce whatever effects the unsteadiness will have. The insulation mat may become steady when covered with 20 centimetres of concrete. But the imperfection may also turn into a defect if the mat moves during the concreting. If it can move under the feet of the foreman it can also move under the impact of the concreting work. Thus, if the gang works carelessly the mat may move and the concrete will run in between the insulation mats and possibly produce a thermal bridge. Cold and damp cellars may be experienced in the future use of the building. However, not even the thermal bridge will necessarily lead to cold and damp cellars. With feedback so distant and delayed, and with so many steps in the causal chain, learning-by-doing must become highly unreliable.

Might learning-by-failing be an alternative? Often it is assumed that failure forces people to question their assumptions (double-loop learning), but in complex realities it may as well reinforce existing assumptions. Investigations into the cause and responsibility of poor quality might retrace the coldness and dampness of buildings to the thermal bridge and further to the displacement of the insulation mat. But the problem might also be blamed on heedlessness of the gang, on the subsoil water, etc. Few cases and the highly ambiguous causal chain would make it little likely that the judgment of the foreman was calibrated by such processes of learning-by-failing.

The fact that his judgment will soon be buried under 20 centimetres of concrete may serve as a symbol of the inaccessibility of the reality as a source of feedback and adaptation.

The foreman's judgment may also have been informed by strategic considerations, e.g. by the risk of subsequently being held accountable for eventual defects revealed in the future. It will appear that this probability is slim – not to say nil. Was this the way his judgment were informed, we would not be able to explain why he paused and investigated the unsteadiness in the first place. So probably, it is not a rational calculation of one sort or the other that guides his behaviour. More likely, we might find an explanation if we assumed that he followed the logic of appropriateness. He probably investigates such situation, because that is what a foreman does (March 1994). He pauses because his identity and role requires him to do so. But when he pauses and makes his assessment, he may easily fall victim to a natural confirmation bias. He may look for reasons to consider it an imperfection if he wants to minimize the amount of repair. And the point is, he will find ample of reasons to believe that the unsteadiness will cause no future defects.

Probabilistic nature of defects

However, a slightly different picture emerges if we accept that future defects, while unlikely, are still possible. This might lead us to consider defects in construction as a probabilistic phenomenon. The unsteady insulation mat is unlikely to cause problems because many other things will have to "go wrong" before a defect materializes. For example, there is a certain (probably small) likelihood that the concrete gang will work carelessly, and a certain (probably small) likelihood that the insulation mat will move during the concreting. And if it does, there is a certain (probably small) likelihood that heat and moisture will end up travelling between cellar and ground. Each of the factors will probably have some probability, but the combined probability will easily be seen as low. And even if the gang works carefully there is still a small likelihood that the mat will move – and even if it does not move there is still a small likelihood that concrete will flow between mats, etc.

So far, this will still inform the foreman to do exactly what he did: to consider the unsteadiness an imperfection. This is the irony of defects: their likelihood is always above zero, but still quite low, suggesting that the expected costs of defects will not legitimize much investment in their prevention. All these contingent factors seem to constitute a source of justification for doing nothing. And it is merely because the number of judgments is so immensely large that defects, each with a very low probability, nonetheless turn into a recurrent empirical phenomenon.

We will suggest that this probabilistic view on defects may inspire us to draw alternative implications than the foreman did when he just walked away.

IMPLICATIONS

We have found plenty of reasons why the foreman's response to the experience of an unsteady insulation mat is sensible. However, in view of the complexity of even the simple causal chain that we have analyzed; and not least in view of the persistence of the problems in construction mentioned in the beginning of the paper, we might actively seek to formulate a framework that would *suggest* a different response pattern.

The implications of complexity: a different learning strategy

We will give two illustrations of how to approach reality if we assume that construction is a complex process and that history is accessible only through chance events.

First, the presumption of a complex and uncertain reality implies that we are encouraged to explore what the reality may hold. We cannot easily extrapolate the experienced reality to cover everything. Thus, in this case the fact that the foreman ascertains that the insulation mat, while obviously unsteady, is not a problem, leads him presumably to infer that he has literally stepped on an exception. But he might have come to a different conclusion, namely that he had happened to step on *an exemplar* – a signifier of a larger population of unsteady mats. With such an understanding, rather than just walking away he might have decided to increase the sample by walking around to get a better basis for estimating the population.

From the probabilistic perspective on defects we may challenge the strategy behind the foreman's action and judgment. He is making too much of the unsteady insulation mat as a problem, and too little of it as an exemplar. He is returning to learn more about that particular mat – about which there is probably little more to learn, and in particular little else to do than what he does. The probability that the unsteadiness of one single insulation mat will prove disastrous is very small. However, if it is considered a random draw from a larger population of unsteady mats, then it may inspire us to adopt a different strategy. Rather than returning to the insulation mat already established as being unsteady, the foreman should have "returned" to all the other mats, because these might actually add to his current knowledge. One being unsteady suggests the possibility that more may be unsteady. If 100 mats are unsteady, each with a small chance of causing problems, the likelihood that one of them will lead to defects is suddenly substantial.

Thus, the foreman is probably correct in assessing the insignificance of the unsteady insulation mat. But he is possibly wrong in directing his judgment towards the risk of the individual mat. He might have made judgments about the possible existence of a population of unsteady mats. Such a judgment would have initiated a search for additional information to allow him to assess the size of the population and then to estimate more reliably the combined risk of defects. In this sense, this judgment would initiate a process of learning rather than concluding it!

Imagining that all our experiences are random draws from a larger population of things we might have, but did not experience, would likely inspire a more exploratory attitude to work and life. What we know is nothing more than hypotheses looking for tests, not presumptions looking for confirmation.

Secondly, if reality is understood to be complex it is hard to act as if it could be controlled and predicted. But it is not hard to appreciate also that many more opportunities for intervention are conceivable. For example, we cannot know if the foreman's judgment was correct or incorrect. Whether in retrospect it will prove correct will, in part, depend on the subsequent action of the gang when concreting the floor on top of the mats. Thus, by consciously guiding the action of the gang he may also actively influence the likelihood that his prior judgment will become vindicated. He could mark the mat or he could verbally instruct the gang about his discovery. If they pay heed to the unsteady mat while pouring and vibrating the concrete there is a fair chance that the mat will not move and then the unsteadiness is made irrelevant and the judgment of the foreman is made correct. If the correctness of a judgment is determined by action and processes after the judgment is made these actions and processes become opportunities for turning judgments into self-fulfilling prophecy. It is a strategy of meddling with the odds of subsequently being proven correct.

We are all forced to make judgments under conditions of uncertainty and ambiguity. There may be no way in which we can better manage the project or the organization by improving the quality and rationality of judgments and choices. What good management may be all about is intervening into processes and guiding action subsequent to the judgment and the choice in such a way that, in retrospect, the judgment will appear sound and the choice rational.

Learning and imagination

The imagination that goes into learning under conditions of ambiguity and complexity is illustrated here in two ways. First, learning requires us to imagine the existence of a population of potential events from which the small samples of actual experience are drawn, more or less randomly. This imagination constrains us in over-learning from single events. *Learning should be fuelled by the experience of problems and failure, but tamed by the awareness of the randomness of experience*. It is not that what we actually experience is irrelevant, since that would make all experiential learning impossible. It is the fact that what we actually experience needs not be more relevant than what we might have experienced, but happened, in this particular case, not to experience. If the probabilistic nature of defects – and of all other achievements, positive and negative – were to be accepted, we would need to make sense of experience within an interpretive framework based on the consciously formulated imagination of the population of possible experiences from which the actual experiences are randomly drawn. Learning sediments an understanding of the population of potential effects – including things that did not happened, but which might as well have happened, in addition to what actually occurred.

Secondly, we need to develop an imagination of the complex tree of causalities, not because it enables us to control effects and achievements narrowly, but because it gives us inspiration to a larger array of potential points of intervention. Interventions are, as illustrated above, ways of making it more likely that prior judgments turn out to be correct subsequently. Not only may it give inspiration to new ways of intervening, but an understanding of subsequent intervention opportunities may also allow us to imagine new types of judgments to be made.

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REFERENCES

Argyris, C. and D. A. Schön (1996). Organizational Learning II. Theory, Methods, and Practice. Reading, MA, Addison-Wesley.

Dörner, D. (1996). The Logic of Failure. Recognizing and Avoiding Error in Complex Situations. New York, Metropolitan Books.

Haugbølle, K. and M. Forman (2009). Shaping Concepts, Practices and Strategies: Arbitration and Expert Appraisals on Defects in Construction. CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges. Dubrovnik, Croatia.

Jørgensen, K. (2009). Failures and Defects in the Building Process - Applying the Bowtie Approach. CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges. Dubrovnik, Croatia.

Kreiner, K. and G. Winch (2008). Future Perfect Strategy: The Role of Imagination and the Risk of Empty Horizons. EGOS Colloquium. Amsterdam

Kreiner, K. and G. Winch (2009). Future Perfect Strategizing on Major Projects. EURAM 2009. Liverpool, UK.

March, J. G. (1994). A Primer on Decision Making. How Decisions Happen. New York, Free Press.

Nielsen, J., E. J. d. P. Hansen, et al. (2009). Buildability as Tool for Optimisation of Building Defects. CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges. Dubrovnik, Croatia.

Ryle, G. (1949/2000). The Concept of Mind. London, Penguin Books.

Ryle, G. (2000). "Courses of Action or the Uncatchableness of Mental Acts." Philosophy **75**: 331 - 344.

Schutz, A. (1973). Collected Papers I: The Problem of Social Reality. The Hague, Martinus Nijhoff.

CURRENT AND POTENTIAL FUTURE TRENDS IN CONSTRUCTION PROJECT MANAGEMENT (CPM) AND THEIR BENEFITS FOR CENTRAL AND SOUTH EASTERN EUROPEAN (CEE/SEE) COUNTRIES

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INTRODUCTION

The aim of the paper is to inform the global construction research community of current and potential future trends in international construction project management and its potential benefits to CEE/SEE countries. In doing this, the paper outlines the tradition of Construction Project Management (CPM) thinking in relation to project structure and identifies the key questions to be addressed in applying this thinking to current and future trends in the construction industry. It is argued that a new tradition for CPM thinking is emerging and that project managers must move to a new way of thinking about projects in order to meet the project aims of the future.

RESEARCH METHODOLOGY

In addressing the aim of this paper, the views of academics and practitioners in the world of CPM were gathered through the global network for CPM that exists within ICPMA, from university research work and from personal experience in Western Europe and CEE/SEE countries. The information that is presented is a result from practical experience as a professional construction project manager and of numerous verbal and e-mail conversations through which professionals were asked to provide their views on the following:

- *The structure through which projects are perceived*
- *The questions that arise from this perception*
- *The perception of the need for change*
- *The activities of CPM professionals today*
- *The drivers of change*
- *The developing role of the Construction Project Manager*
- *The benefits to be achieved*

The paper concludes with a summary of the findings and the benefits for all from a new role for CPM professionals.

THE TRADITION OF THINKING IN PHASES

The structure through which projects are perceived

The tradition of CPM is a tradition of thinking in phases. From the beginning of a project we are used to organize and optimize it phase by phase. The project cycle seen from a PM expert's viewpoint is structured in the three main phases of the life of a building or an infrastructure project.

Phase A Pre-Construction, Project Development
The early phase of investigating and defining the demand, the frame conditions and the project (master planning, programming, studies, concept design, etc.)

Phase B Design&Construction, Project Management
CPM with its two main phases of design management and construction management including the crucial decisions of structuring the project, forming and organizing the project team, tendering and contract award.

Phase C Operation&Maintenance, Facility Management
Management during the complete period of operation and maintenance of the project until the end of its life cycle, its demolishing or complete refurbishment for renewed use.

These phases, showing the involvement of the different built environment professionals are shown in Figure 1. The third "Phase C – Facility Management" is by far the longest of the three. Whether a project may be called successful can only be decided after this phase, when we can judge all factors of success, doubt or failure across all three phases.

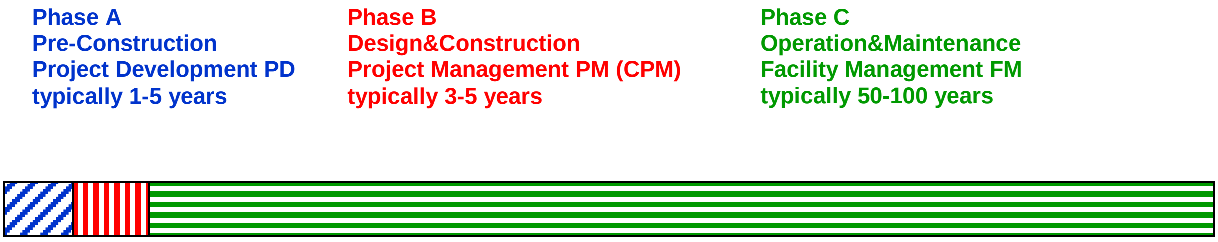

Figure 1: Phases in a Construction Project

NEW WAYS OF THINKING IN CPM?

The questions that arise from this perception

The questions to be discussed in the preparation of this paper were as follows:

Can present tradition, tools and techniques in CPM ensure that a project will be successful when viewed at the end of its life cycle?

Do we investigate and formulate demand and frame conditions in such a comprehensive way and with such a long horizon to cover the needs of operation and maintenance?
Do we design projects for an optimum life cycle with respect to costs and sustainability?

Do we have adequate organization, tender and contract models for life cycle optimized projects?

Are we clear enough about the goals a sustainable project shall fulfil and the criteria to assess it?

In many instances, the answer to these questions will be "no" and, though many of the questions raised here have been the subject of discussion for several years, the radically changing circumstances in which the world now exists mean that this might be the best time to explore them.

SUSTAINABLE PROJECTS

The perception of the need for change

So the time is right to discuss about change. In CPM, this discussion must explore how to match the necessary levels of authority and responsibility to ensure that we, the world community of CPM experts, can substantially contribute to a positive change, designed and managed by us with the goal to make our projects - and hence our world - more sustainable. Not only the time is right to discuss these matters, also the place is right. Here in Central and South Eastern Europe where so much is to be done in the next decades, where the skills and experience of European and international experts can show what they have learnt and consider essential, here is an ideal occasion to demonstrate to the world what construction project managers can contribute. And it is one of our tasks as architects, engineers and project managers to prove that sustainable projects seen from a global, comprehensive angle deliver greater value than "traditional" ones.

Two things are indispensable for this demonstration: political will and financial means.

- Whether our politicians will in fact and every day practice support the development towards more sustainable projects by giving them political support and adequate political and legal framework, we will have to see.
- The financial means should not be the problem on the long run. Although more expensive in preparation and investment, times and thinking should change and the market will develop, if supported by our political leaders.

One important aspect is a new balance we need to make our projects more sustainable on the long run. Whenever one group of stakeholders dominates others, imbalances are the consequence making sustainable success impossible. We have seen this very clearly as a result of the growing dominance of financial and legal aspects in real estate development during the past decades. As a result, we must approach CPM from a wider number of perspectives including political, social, cultural, environmental and many other aspects.

The CPM process is changing. The responsibility and capability of engineers, architects and project managers to develop, design and implement sustainable projects using the latest technologies (or develop new ones, if not appropriate), incorporating social and environmental aspects and lead the way to a changed built environment responding to future needs, is growing. This must be done by approaching CPM from these wider perspectives.

THE ACTIVITIES OF CPM PROFESSIONALS TODAY

To start successfully always means to analyse the present position, to discuss and define the goal and the possible ways to achieve it. Analysing the present situation in CPM we can see highly sophisticated tools and techniques in PM and CPM world wide. At this occasion we may emphasize that CPM has different requirements than PM in other fields such as manufacturing industry, IT, etc. The reason is that a construction project is always a single, non-repeatable process with its specific location, scope, organisation, team etc. CPM has to cope with the double challenge to develop tools and techniques comprehensive enough to be widely applied and flexible enough to be adapted to each individual project. CPM has a low repetition factor, with the exception of the lessons learnt from each project, which are often very similar and lead the way to improvement, if discussed openly.

The fundamental processes and principal tools of the construction project manager are

- the documents defining the structure, organisation and procedures (approvals, reporting etc.) of the project
- the total of all contracts in force
- the time schedule
- the project cost planning and monitoring system

The backbone of the CPM's successful performance are the regular project meetings which need to be well prepared, strictly chaired and minuted, where decisions are met and enforced.

The role of the CPM during design and construction (phase B) is to support the client in fulfilling these tasks (preparing, proposing, discussing) and to organise and control the "rest", i.e. to care of the completion of the project within the agreed budget, time and quality. In order to fulfil these tasks CPM is traditionally split into the following stages

- project preparation
- design
- preparation of implementation including tendering and contract award
- implementation, construction
- completion including take over and defects liability

Whether a professional CPM expert is assigned or not depends on the tradition and experience of the project country and the specific client. In the Anglo-Saxon world there is a long tradition of employing independent engineers and project managers. In Central Europe, on the "continent" the traditional way to organise projects is rather the "bilateral" model. The employer assigns designers and consultants on his side and later, the employer himself is the active contract party towards the contractor(s). More and more we now see professional CPM in our countries.

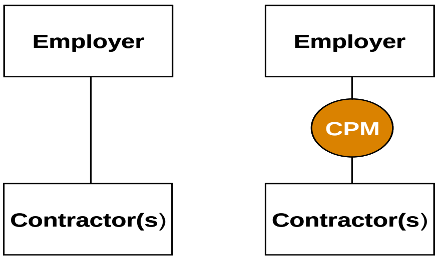

Figure 2: Project Organisation Systems (simplified)

As a conclusion of our short analysis of the present situation we may state that professional CPM has become the state of the art and will be the standard practice in CEE/SEE. But:

- Where are our goals for the future?
- Will they be the same as today?
- Will our projects really change?
- Will CPM change, if the projects change?
- Which is the way to go, if projects and CPM change?
- Is there one way to go?
- Are there alternative ways?

FUTURE TRENDS

The drivers of change

In order to find answers to these questions we have to discuss where the profession goes or ought to go? Which requirements do we recognize for the process of developing, designing and implementing sustainable projects? The most significant change in requirements will be to stop thinking in phases. Creating a project which shall be called successful after phase C, at the end of its life cycle, we have to involve all important aspects for the optimisation of all project phases in a CPM-process at the beginning of the project cycle.

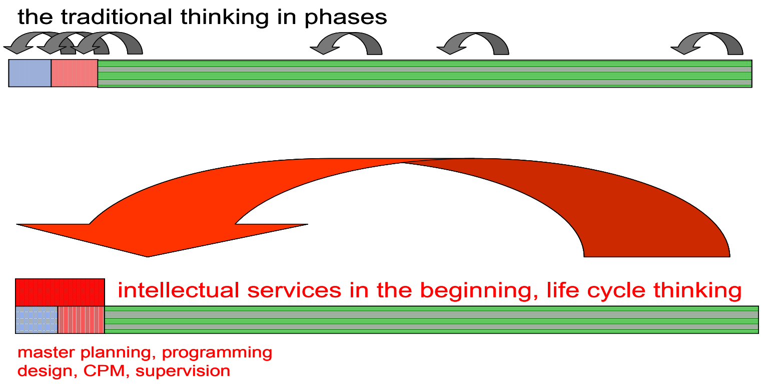

Figure 3: Creating a sustainable project

What has to be different creating a sustainable project?
Two levels of consideration are needed to find answers focussing on

- the quality of the projects, of the built environment, in future
- the process of CPM to achieve this desired quality

Sustainable projects, green building implies much more than saving energy or using renewable sources of energy. To discuss and define the quality we call “sustainability” in building is a task hardly started yet, far from being complete or in consensus. It will occupy us for years. The pursuit and need of sustainability will create new technologies and it will have to, since we will not be able to fulfil reasonable goals with the technologies available today.

Life cycle costing will replace traditional costing in phases with important consequences on the contractual setting of projects. How can the responsibility for optimum life cycle costs be imposed on those who bear the responsibility for the early projects phases with all their critical decisions? The actual costs that occur on a project might occur at a specific point – such as the intellectual services illustrated in Figures 3 and 4 – but how can this long-term responsibility be passed on through the tendering procedures, into the construction and operation? How can the results be assessed after years of operation and how can the results of this assessment be used as an incentive for those who have worked on it years before?

New types of processes in teambuilding, organisation and management, new forms of contract will have to be developed. Sustainability may count for a lot more than optimized life cycle costs. Other aspects of sustainability (social or environmental impact, induced costs beyond the project limits) may prevail making the process even more complex and aggravate assessment and decision making.

Knowledge management will become extremely important as a success factor in CPM. Each company, university and the expert community worldwide will more and more have to become learning societies frankly sharing knowledge and experiences made. Tools have been developed and will be constantly improved. Our mind-set will have to keep pace with future requirements. It is not longer the case that we will survive, when we do not share our knowledge, when we keep it for ourselves. It is rather the case that we will survive when we share it. Competition no longer means to have more knowledge than the other but to make better use of the knowledge available to everybody. To acknowledge this will be an important step towards better projects and processes; and it is a clear sign of human intelligence if we are able to accept this paradigmatic change.

Handling complex situations and using the existing know-how efficiently will depend on appropriate IT applications. We have witnessed an ongoing process of reciprocal effect between IT and development for years: IT has solved complex situations, and as a consequence we could afford to organize our life in a more complex way. Challenged by this new situation again, our IT experts managed to solve it again and provide again solutions for a more comfortable life in complex environment. So we may be optimistic and rely on our IT experts that they will be able to support the processes we need to plan, manage and control the processes we need. *Building Integrated Modelling (BIM)*, for example, will be one of the future trends changing the development and design of projects and helping to enhance sustainability.

The last and by far not least requirement to discuss in anticipating the future of CPM are the *construction project managers* themselves. In the end it is always the person in charge, the team assigned who will enable success. Construction project managers will need specific skills to create sustainable projects. The complexity of integrated thinking simultaneously focussed on all phases and aspects of the project, directing large teams of very different experts, each one (legitimately) concentrated on his view and problem, requires much more than professional knowledge. It will be our task at the universities, in the expert companies to train and encourage personalities to whom we attribute the qualification of a good construction project manager with three elements to the qualification, namely:

- sound technical knowledge and experience to understand the project or process he is managing
- soft skills of all kinds to lead the team, understand the culture, communicate and negotiate with many different project stakeholders and

- the character combining strength in principle and ability to compromise where necessary, power of judgement based on critical listening and a good deal of humour and common sense.

The following sections will deal in a very practical way with different aspects of potential future trends in CPM as we see them. We will focus on the second level of consideration, the potential impact on the process of CPM. Dealing with the future we can only provide theses, anticipate and extrapolate what we witness in our business practice today.

SUSTAINABLE PROJECTS

The drivers of change

Suddenly projects have to be “sustainable”. What has been “unrealistic” some years ago is now part of specifications. Still, we do not know yet how sustainable buildings and cities will look like. The process of developing and designing sustainable projects will have to be completely different from what we are used to today. Presently we optimise projects phase by phase with a few “excursions” to future needs. Mostly we optimise investment costs, but often we do not know or include the final user into our processes early enough.

Master planning, programming will be the processes needed dealing simultaneously with all aspects and phases of a project and - far beyond - with the integration of the project with society, environment, neighbourhood, infrastructure etc.

Taking sustainability seriously we have to organize a reverse process. We have to start project development and definition by designing the operation and maintenance. Our project specifications will be based on the needs of sustainable use. Our cost estimate will cover the complete life cycle. All experts needed will work together and check all sorts of interdependencies between different influence factors before any decision is taken. The focus of our work as architects, engineers and project managers will shift to the beginning of the project cycle, and so will have to shift our fees. Saving money by saving fees for intellectual services will hopefully belong to the past.

LIFE CYCLE COSTING

The drivers of change

Figure 4 is demonstrating the change of paradigm we are discussing as a necessity for sustainable projects. The relation of costs during the project life cycle will have to change. Its focus will have to be in the first project phases when the decisions have the strongest effect on costs and quality. Any decision not met or not met wisely then can hardly be corrected later.

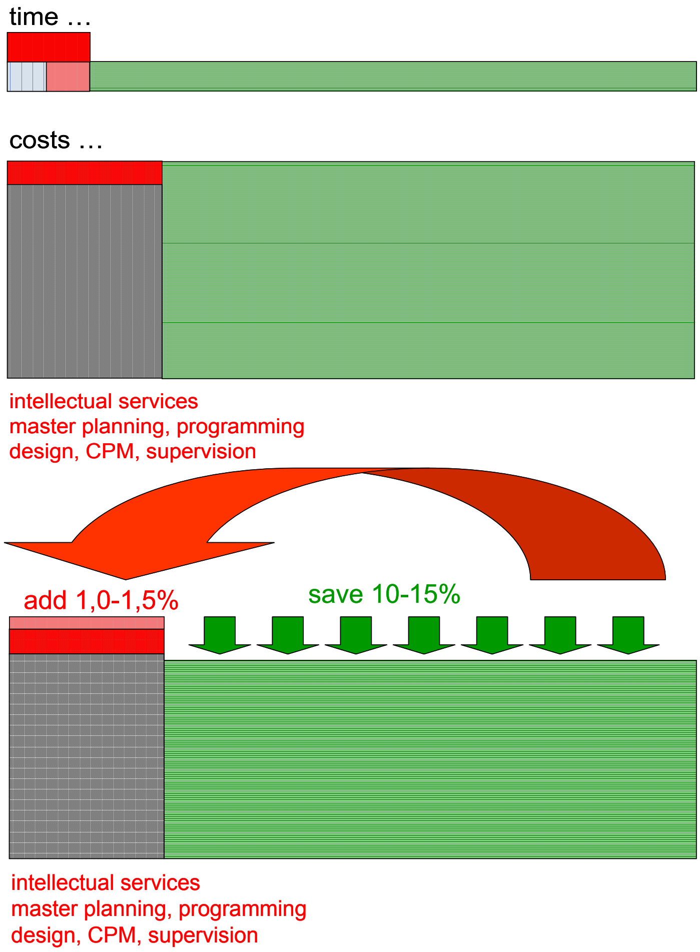

Figure 4: Relation of Costs during Project Life Cycle

BOT projects have demonstrated what can be achieved in this respect. As soon as they have been made responsible for the complete project life cycle, contractors concentrated on better design, more efficient work and optimized operation and maintenance. The downside of BOT projects is their potential for extremely high process costs on the legal and financial side due to the risk shift from client to contractor. The key will be to develop fair and reasonable processes for finding (tendering) and paying (contracting) those experts who have the responsibility to optimise the LCC in the beginning of a project. Years after their main assignment is completed the costs of operation and maintenance can be measured. Many factors of sustainability cannot be measured at all.

Will there be contract models where incentives will be paid out to the architect, engineer, project manager after 5 years of operation of the project? Will there be contract models where they benefit year by year from low energy costs of a building they have designed many years ago (like the famous historical Chinese doctor who is paid only when the patient is in good health)?

Here again political support and responsibility will be required. To build up market conditions and control their observance will always be a public responsibility. Not to interfere then into operational details is the other one.

KNOWLEDGE MANAGEMENT

The drivers of change

Knowledge is becoming the most important production factor in our “knowledge society” and the project manager is in a central position and responsibility to care for the generation of organized knowledge and enhance the cultivation of knowledge to make it available to the people and organisations involved in the project and for the next projects. State of the art techniques are available to collect the knowledge gathered in the heads of the individuals, process it to make it useful for others and offer it in a format easily to be accessed. Whether the knowledge and experience gained in a project will be made available for others depends largely on the CPM´s commitment. The creation of sustainable projects will depend on knowledge management. If we will not be able to inject the knowledge gathered from the whole life cycle, from operation and maintenance into to process of programming, master planning, into the very first phase of project development, then we will not have the expected results.

BUILDING INTEGRATED MODELLING

The drivers of change

BIM is an example for some of the theses we have introduced. It is a process where everything happens in the beginning, where all thinking goes into the virtual construction of the project and where all processes have to be integrated, otherwise you cannot complete the model. It further is a good example where IT is challenged to its limits and where the solutions enabled by IT will create new demand. As soon as the problems of adaptation of BIM to specific situations, standards, products will be solved, designers worldwide will broadly use it and revolutionise the building process. Nobody is designing on drawing tables any more but we all say, we do not need BIM, it’s too complicated and not apt for our case.

Will design by BIM enable projects we would not be able to design today? Would Frank Gehry’s projects look different without BIM?

THE CONSTRUCTION PROJECT MANAGER

The developing role of the Construction Project Manager

No contemplation on the future of CPM shall end without appraisal of the construction project managers, the people behind every sustainable development, every perfect tool, every successful process and completed project. Two factors will never be mastered by anybody except human brains: nature and other humans. And construction is fully depending on both. Foundations, dams, slopes, ditches, construction pits, tunnels, channels, pipelines, the weather during construction, the storm attacking a slim structure, the waves in the harbour, the sun on the façade … every project depends on nature and we will always need our full knowledge and experience to cope with it.
And to cope with humans in the project teams, in client organisations, workers on our sites, different nations, citizens as neighbours, affected by our projects … this is a core duty of a construction project manager.

This leads us to the final recommendations and answers to the question what benefits CPM and its future development will bring for CEE/SEE countries.

BENEFITS …

.. not only for CEE/SEE countries

First of all, professional CPM brings benefit to all projects where it is applied. It grants to the client the successful completion of the project. If CPM is not widespread till now in some CEE/SEE countries, if it does not correspond to the contractual system used so far, it will soon prove its benefits once applied. In countries where technical education has always been on the highest level as it is in all the CEE/SEE countries, CPM with all its organisational, contractual and financial implications will form a perfect complement to the teams of engineers and architects committed in the design, construction and supervision of projects.

To educate and train qualified CPMs requires effort. A professional CPM must understand the language of the country, the customs of its people and all the local conventions. Consequence is that the CPM should be well acquainted will the project region and it is of great importance that CPM is trained at the universities of each country. The benefit will be that an initiative to apply CPM will bring a wave of intercultural exchange and professional quality to the region. Although we said earlier that CPM is hard to teach, we recommend offering to the students a series of lectures where theory, tools and practical case studies are presented. International university partnerships will lead the way.

To develop sustainable projects will be beneficial per se, as it will be for all countries. No separate argument is needed to convince the audience. If sustainable projects require more brainwork than traditional ones knowledge management will be crucial. Building up adequate KM systems as we are starting in ICPMA and as we are teaching at our universities will bring benefit to the CPM community of our host countries – academic and practical benefits.

And if sustainable projects require more brainwork than traditional ones the appropriate selection of experts will be the key to success. We are aware that many (legal) obstacles exist limiting the choice of the preferred project partner. Still we may recommend FIDIC´s guideline "Quality Based Selection" knowing by experience that only the best partner, providing the most intelligent services will pay off in the end. Benefit comes from intensive thinking of trained, experienced brains and from the positive exchange of the results. This is where we have to invest, especially in times of crisis.

Finally we may recommend to benefit from networking with the international CPM expert community. ICPMA has started an international network active in the exchange of practical experience as well as the latest innovative development in the industry and at the universities. CPM is a classical network profession - today and tomorrow. A construction project manager alone cannot solve any problem.

And solving problems is our life, transforming problems into solutions is our profession.

BUILDABILITY AS TOOL
FOR OPTIMISATION OF BUILDING DEFECTS

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Defects in buildings harm the reputation of the construction industry and the amount of defects is believed to represent a loss in economy. The purpose is to study whether the buildability concept could serve as an efficient tool for reduction of defects. The project includes a literature study and the development of a technical-probabilistic perspective on the building process in which an optimal amount of defects exists. Three levels of risk are defined as a basis for proposing strategies for forming rules for optimisation of defects. It is concluded that a dynamic and flexible approach is needed, because different rules apply to different situations during the building period and because the economic potentials in better planning and in savings by a reduction of defects are different for different types of buildings.

KEYWORDS: buildability, buildings, defects, risk.

INTRODUCTION

The study of defects in buildings is important in Danish building research, partly based on interests from the construction industry and the authorities. One reason is that defects are often exposed in public media harming the reputation of the construction industry. Another reason is that the costs caused by defects are believed to represent a considerable loss in the economy, about 10 pct of the turnover in the construction sector (Nielsen et al, 2004).

A simple attitude to the reduction of defects is to map the number of building defects for different alternative technical solutions and then, in future designs, avoid those with a high score as non-buildable. However, this strategy may not lead to an improved economy, because an alternative technical solution may be considerably more expensive or have a poor building performance. Taking further into account that innovative solutions normally contain more defects than traditional ones, this simple attitude may block for innovation and long term improved performance in building construction. The purpose of the project is therefore to study whether the buildability concept, based on a technical-probabilistic perspective on the building process, offers a more adequate approach.

The term *defect* is used as a common term for a *physical defect* and for a *process defect*. It is considered *a physical defect* when *project documentation, a building material, a structure or a part of a structure lacks abilities which can be expected according to the construction contract, public requirements or good building practice*. It is considered *a process defect* when *the construction process takes place in a way that represents a significant loss in resources or time in comparison to an optimal process*. This means that a defect is seen as a technical problem independently of the cause for the defect and independently of when the defect is observed, which may be before, during or after the construction period. The economical consequence of a defect is either a direct cost to make up for the physical defect or for doing the work in a less efficient way, or an indirect cost, mainly as consequence of a delay in the construction process or as a reduced service life.

THEORETICAL FRAMEWORK

The theoretical framework consists of a perception of the building process being a probabilistic process, risk assessment, the engineering method, buildability, and quality management. These elements are presented, in some cases developed, and discussed.

A probabilistic perception of the building process

The building process is perceived as a process with many possible paths leading to a finished work, see Figure 1. The full lines represent successful processes which end up in an acceptable solution. The doted lines represent processes which either end up being corrected or continue until finished work as a solution with defects. It may or may not be known to the building contractors that a defect is present in the solution. The solid dots indicate decision points, which are points where the further process may follow different paths, including going back. Decisions are taken by people involved in the building process at all levels. People may or may not be aware of the presence of a decision point.

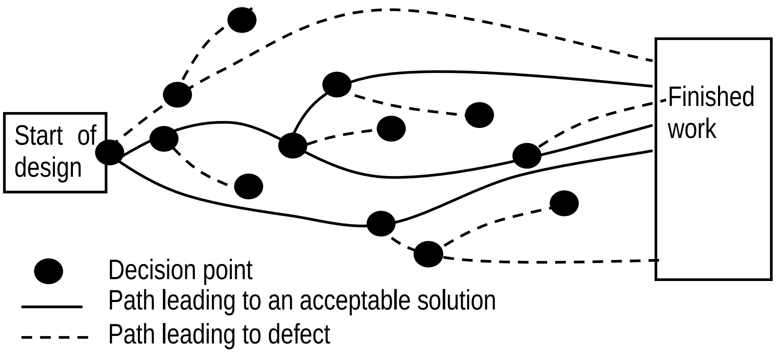

Figure 1: Perceived building process. Possible paths between start of design and finished work.

A building can be seen as a collection of a number of solutions (roof, walls, floors, bathroom, etc.). The number of decision points and of potential possible processes is huge. A deterministic view implies that, in considering all those potential processes, an optimal design may be developed, described and communicated to people involved in the building project so that no mistake is done. If not impossible in practice, such a deterministic approach will obviously be extremely expensive.

A probabilistic approach offers a more realistic view. It considers that design and planning must stop at a certain stage and that some decisions concerning details are to be taken in the construction phase. In this approach the expertise at the construction site is used. Seen up front it is then accidental exactly which process and which solution will be realised. This perception fits well with a probabilistic view on the construction process as illustrated in Figure 2.

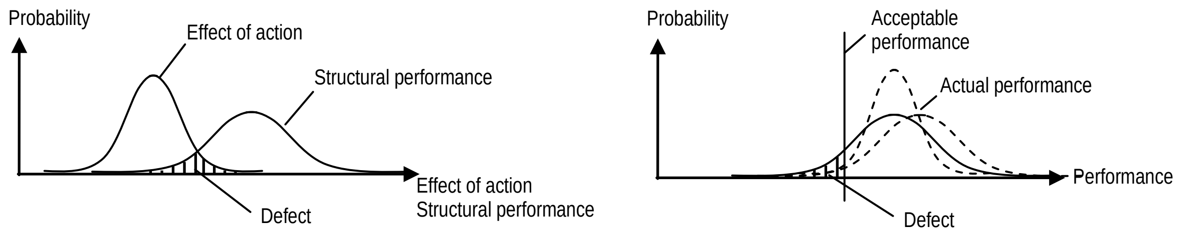

Figure 2. The probability of a defect is illustrated as the area below two curves showing probability distributions (left), one showing the effect of action (e.g. from an earthquake) and the other showing the performance of the realised structure (e.g. the strength of a wall). A defect materialises when a relatively weak structure is subject to a relatively large effect of action. The figure to the right shows the situation when an acceptable performance is just a matter of a simple measure. The probability of no defect may be improved by prescribing a better performance or by more emphasis on quality management leading to a smaller statistical variation in the outcome.

The probabilistic perspective has the following implications for evaluating risk of defects: 1) Defects are associated with decisions, and decisions are made at all levels and through the whole building process. Decisions taken at the construction site are often associated with a time pressure because the costs related to a halt may be large (Haugbølle and Forman, 2009), and decisions may be based on a high or low level of information concerning the decided solution as well as the possible consequences for the further construction process. Decisions may correct faulty design solutions and thus prevent defects. They may also lead to defects, typically if the decisions are taken due to lack of materials or lack of equipment and the consequences for the further process are not foreseen (Jørgensen, 2009), (Kreiner and Damkjær, 2009). 2) Efforts to prevent defects are oriented towards a process which is only partly known. Therefore, tools for a reduction of some types of defects have to contain rules that in general reduce the likelihood for defects rather than aiming at preventing a specific one. The rules must relate not only to technical solutions but also to the circumstances for construction (weather, organisation, worker skills, etc.). 3) Experience (learning) is gained only on processes which has been realised. Knowledge about alternatives which are seldom realised is therefore limited and sometimes unreliable. Furthermore an observed defect may be just one out of a large number of successful similar processes with no answer to why the defect is found in that particular case and not in other cases. Therefore learning from experience must involve statistics or calls for a very cautious and careful interpretation.

Risk assessment

Defects are here categorised by their consequences. Three risk levels are considered: Risk for lives and health, Risk for large economic losses, and Risk for small economic losses.

The acceptable *risk for life and health* is prescribed in building regulations which normally refers to standards. The formal acceptable probability of a defect is of the order of magnitude of 10^{-7}. An example is the safety of load bearing structures in which a defect may lead to a catastrophic collapse during construction or after. Defects of this category are seldom, they call for specialist knowledge to be prevented, and they are normally impossible to detect just by inspection. Preventing measures like project revision must therefore be part of a formal procedure to be carried out before start of construction.

The acceptable *risk for large economic losses* is not regulated by law, and although insurance companies are typically involved, the numbers of defects and the economic consequence of these are not well known. It is assumed that an acceptable probability of a defect is of the order of magnitude of 10^{-4} to 10^{-5} if the economic consequences are between 0.1 and 1 Million €. Defects of this type originate often from the design. BRE has estimated that 90 % of building design errors arises because of failure to apply existing knowledge (CSIRO 1986). Most of these defects will not be detected in time if they are not identified before start of construction. In some cases the insurance companies may require formal quality management, including a review of the design.

Risk for small economic losses covers many types of defects from small damages, which may be considered only an aesthetic problem, to defects which change the technical performance and must be corrected. The associated costs do not normally lead to an involvement of insurance companies. An acceptable probability of such defects may be decided by the contractor on a purely economic basis. The optimal amount of defects may in some cases correspond to a probability of existence of the order of magnitude 10^{-2}. Most of the defects are identified by the companies involved in the building process and corrected during the process (Nielsen et al., 2004). Because each defect has a small economic consequence it may look as if it is not important to try to avoid it. However, the total economic consequence of defects is almost exclusively caused by defects of this category because they are so numerous. They are found in every project and therefore they may be studied more systematically, using statistics, and in more details than defects in the two other categories.

This differentiation in risk levels calls for a flexible approach to risk assessment with rules that focus on different phases of the building process. Defects of the first two categories - the serious ones – call for formal tools and regulation, while the third category more or less may be considered an internal matter subject to economic optimisation based on rules of thumb.

Bayesian Networks is a rigorous decision tool used in relation to large engineering problems (Jensen, 1996). Practical use of the model involves a considerable investment for developing a probabilistic model of the decision process for an actual construction, including alternative solutions, and for collecting statistics concerning the probability of defects including cost consequences for the different alternatives. FMECA, Failure Modes, Effects and Criticality Analysis, is a similar method, which in relation to buildings has been used for service life prediction of building materials and components (Talon et al. (Eds.), 2006). It is not considered realistic to use these tools in connection with design and construction of a specific building, but the systematic approaches and the basic understanding are considered a good starting point for an engineering judgement of a complicated problem. In their report on risk, uncertainty and decision-making Willows and Connel (2003) focus on decisions related to climate change adaptation on a wide scope of complex problems. Decisions in relation to these problems have different nature, and one universal tool, adequate for all types of problems, has not been found. Instead reference is given to about 50 tools and techniques, from simple expert judgement to Bayesian methods. These tools are taken from risk assessment literature in general and are equally relevant for the construction sector.

The challenge therefore is to match a risk assessment problem with an adequate and economic method.

The engineering method

Koen (2003) defines the engineering method as *the use of heuristics* (common sense rules) *to cause the best change in a poorly understood situation within the available resources.* In this perspective the effort in planning shall be seen together with the likelihood for a successful process in a way that the total costs for planning, construction and correcting defects are minimized, see Figure 3. Rigorous risk analyses will be more relevant for large off-shore structures than for ordinary buildings, where rules of thumbs in many cases will have to do.

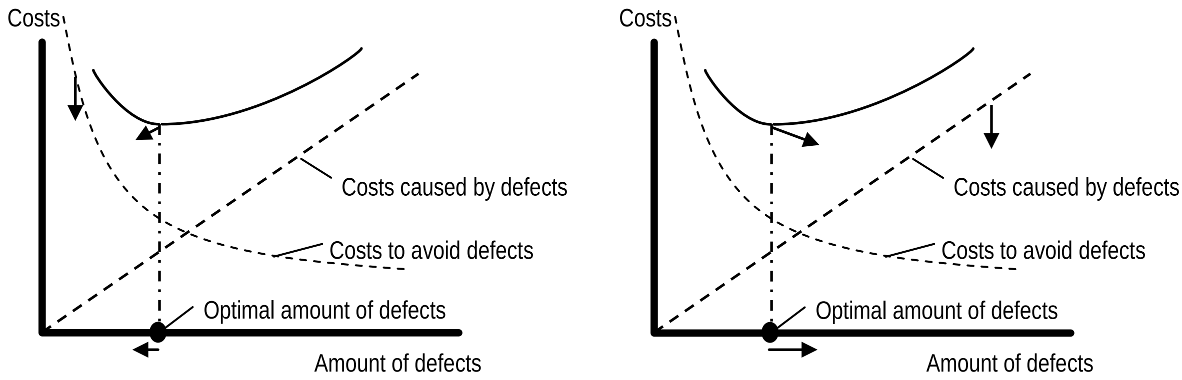

Figure 3. Optimal amount of defects. More efficient rules for a reduction of costs to avoid defects lead to an optimum at a lower amount of defects (arrows in the left figure). A reduction of costs caused by defects leads to an optimum at a higher amount of defects (right).

Buildability

Building projects have become very complex, and in most cases design and construction are more or less separated from each other and performed by different companies. This has lead to many examples of defective designs, i.e. designs that were not possible to perform or that needed redesign before it became buildable, resulting in delays and/or overrun budgets, e.g. (Glavinich, 1995), (Glavan and Tucker, 1991) and (Lutz et al., 1989).

In the late 1970s *buildability* emerged as an area of research, based on the assumption that buildability problems exist because of the comparative isolation of many designers from the practical construction process (Chen and McGeorge, 1994). A widely accepted definition of buildability is: *the extent to which the design of the building facilitates the ease of construction, subject to the overall requirements for the completed building* (CIRIA, 1983), focusing on how to improve the productivity in spite of the complexity of a building project. This definition was criticised for its narrowness in scope, in that it essentially confined buildability to the design process (Wong et al., 2007). Nevertheless, the achievement of good buildability depends upon both designers and builders being able to see the whole construction process through each other's eyes (Adams, 1989).

Chen and McGeorge (1994) conclude that a workable concept of buildability needs to recognise the many factors in a project environment which has an impact on the design process, the construction process, and the link between design and construction. They suggest that buildability might be redefined as: *The extent to which decisions, made during the whole building procurement process, ultimately facilitate the ease of construction and the quality of the completed project.* In accordance with this Glavinich (1995) states that the efficiency of a set of construction documents can best be measured by how easily a building contractor can meet project milestones set by the owner. This requires the architect/engineer to consider local conditions and construction practices as well as the availability of labor, materials, and equipment in the design.

Guidelines for buildability or constructability aiming at improving the productivity can be found in several references, e.g. (Adams, 1989), (Chen and McGeorge, 1994), (Nima et al., 1999), (Fox et al., 2002), (Lam et al., 2007). In Singapore, buildability has become part of the legislation or code of practice (BCA, 2005). A minimum Buildability Score is required for the building plan approval. The Buildability Score is a simplification of the buildability concept, acknowledging that the buildability of a design is a qualitative concept that is difficult, if not impossible, to measure objectively (Glavinich, 1995).

As a corresponding term, *constructability,* was introduced, widely cited as *the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives* (CII, 1986). Based on a comprehensive literature study, Wong et al. (2007) concluded that constructability is concerned with the whole process of project development to facilitate construction efficiency and achieve project goals. By contrast, buildability deals mainly with construction efficiency seen at the design stage.

It is generally acknowledged that buildability can give rise to better construction quality and productivity, but no concrete evidence has so far been presented to suggest that this is indeed the case. One of the main reasons for this lacuna is the lack of quantifiable measures for buildability, quality and productivity which make it possible to analyze their correlation meaningfully (Low, 2001).

Buildability – a definition related to defects

Buildability and constructability are both connected with 'ease of construction' which is highly relevant for an evaluation of risk of defects. However, buildability further is connected with 'design' and 'efficient and economical construction', while constructability is connected with 'integration of construction knowledge and experience' and 'optimisation'. Furthermore, by focusing on the quality of the completed project and on meeting project milestones set by the owners, the definition of buildability (CIRIA, 1983) to some extend limits the scope to evaluation of contractors for design-build projects and to defects in the *final* product, while the by far largest amount of defects, identified and corrected *during* the building process is not considered. Procurement types, such as design-build, public-private partnership (PPP), and private finance initiative (PFI), are expected to have an effect on the amount of defects, but an analysis of such an influence has not been part of this study.

In order to focus on defects the definition of buildability is therefore modified to: *The extent to which the management of the building process, the design, the skills of the workers involved and the circumstances at the construction site decreases the probability of a defect, either during construction or in the completed building*. This definition combines aspects of the CIRIA-definition of buildability (review at an early stage) with the wider perspective of the term constructability, e.g. (Glavinich, 1995), (Adams, 1989) and (Chen and McGeorge, 1994) as well as the definition of a constructability program as found in (ASCE, 1991).

Quality management

(ISO, 2008) introduces quality management in general terms: *At suitable stages, systematic reviews of design and development shall be performed in accordance with planned arrangements, a) to evaluate the ability of the results of design and development to meet requirements, and b) to identify any problems and propose necessary actions*. Low and Abeyegoonasekera (2001) conclude that the ISO 9000 quality management system can function as an effective and appropriate working platform for buildability. However, guidance is given only at a very general level, which is not directly applicable to practice.

IMPLICATIONS OF A TECHNICAL-PROBABILISTIC PERSPECTIVE

In line with the probabilistic approach, it is acknowledged that it is impossible to make a complete list of all elements with an impact on the amount of defects. Furthermore, one universal tool for a reduction of the amount of defects does not exist, and it is not economical feasible to arrive at zero defects in a building process. Therefore, different strategies and approaches should be adopted, dependent on the type of risk and which part in the building process they address.

An overall observation is that quality management according to (ISO, 2008) may serve as an adequate framework, but it must be detailed for use in practice. It shall not be implemented as a rigid system increasing the general formal planning and documentation at all levels, but as a flexible tool which reflects different types of risk elements.

Another observation is that buildability with a strong focus on evaluation of risk of defects seems adequate as a platform for formulating rules leading to an optimum of defects. In agreement with the engineering method, such rules may be as simple as just rules of thumbs, while in other cases guidelines or even law requirements are needed. The rules must concentrate on the most important matters, in order to efficiently direct the effort to elements with a high risk and suggest correcting actions with a high probability of leading to a reduced amount of defects. Many of the elements in existing guidelines for buildability or constructability are relevant in this context, e.g. 'consider access', 'use suitable materials', 'design for skills available', and 'simplify construction' (Adams, 1989).

Furthermore, the tool must represent a balance between the resources used on preventing defects and the consequences of defects, see Figure 3, and the rules must be flexible, dynamic (change with time) and multi-focused (a wide search for origins of risks):

Flexible, because 1) defects are associated with decisions, and decisions are made at all levels (different professions) and through the whole building process, 2) the risk profile and available resources are different from case to case (large buildings – small buildings, design/build – separate trade – PPP – PFI contracts, etc.) with a need for formal rules for categories of high risk and rules of thumb for risks with small economic losses, and 3) the rules shall address different actors. The authorities have a primary interest when it comes to risk for life and health, while risk for large economic losses involves insurance companies as a primary part. Risk for small economic losses is mainly a matter of interest for the parties directly involved in the building process: client, designer and contractor, including construction workers.

Dynamic, because specific risk elements change with time due to new experience (learning, partly based on statistics) and developments in new types of structures, industrialisation, IT, management systems, and education.

Multi-focused, because the risk related to a specific technical solution may depend on management, the design/complexity of the solution, worker skills, and conditions at the construction site. They shall be seen in the perspective of the whole building process as well as in the perspective of a specific technical solution.

The rules shall act as aid in decisions concerning correcting actions, including the use of an alternative – maybe more expensive – solution, se examples of rules in Table 1. It is a management responsibility to ensure that the person, who uses the rules, has sufficient insight and knowledge. However, the introduction of unspecific experience includes an extra risk element (Kreiner and Damkjær, 2009).

Table 1: Examples of elements associated with the management of risk of defects.

	Risk element	Corrective actions
Management	The skills of the people at all levels of decision making does not match the complexity of the chosen technical solutions, and the conditions at the construction site	Another solution, other people or instruction Ensure good access to technical guidelines and law requirements at all levels
Design or technical solution	New types of technical solutions	Critical review of the solution. If necessary get an expert evaluation e.g. a criticality analysis or a risk assessment
Worker skills	Decisions at the construction site under time pressure and based on limited information about consequences of changes	Use experienced staff
Construction site	Difficult weather conditions	Use weather protection systems

Can evaluation of buildability, in practice, significantly improve the likelihood of few building defects? Can the costs for evaluation and for defect preventing measures, including the possible choice of an alternative design, be kept small enough to ensure an increased productivity? Due to the nature of the problem no final answers can be given, but the analysis suggests that it is possible to move to a more optimal amount of defects according to Figure 3 by obeying to the approaches as presented. This may include development of specific tools and guidelines, especially for project reviews at the design stage in order to reduce the risk for large economic losses. However, the challenge is to develop a set of different rules of thumbs to be used at different stages during the building process in order to reduce the many risks for small economic losses.

CONCLUSION

A technical-probabilistic perspective on the construction process is developed. It implies that there is an optimal amount of defects.

A redefinition of the buildability concept with a stronger focus on defects is suggested as a necessity for buildability to become an efficient tool in the optimisation of defects.

Three levels of risk are defined as a basis for proposing strategies and rules for evaluation of risk of defects.

It is found that the approach for forming rules for optimisation of defects shall be flexible, dynamic and multi-focused for the following reasons: 1) decisions associated with defects are made at all levels and through the whole building process, 2) the economic potentials in better planning and in savings by a reduction of defects are different for different types of buildings, 3) the challenges in construction changes with time, and 4) risks may originate from the type of contract, management, the design/complexity of the solution, worker skills and conditions at the construction site.

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REFERENCES

Adams, S. (1989) Practical buildability. London: Construction Industry Research and Information Association (CIRIA), London, UK.

ASCE (1991) Constructability and constructability programs: white paper. Journal of Construction Engineering and Management, 117(1), 67-89.

BCA (2005) Code of practice on Buildable Design. Singapore: Building and Construction Authority (BCA).

Chen, S.E., and McGeorge, W.D. (1994) A systems approach to managing buildability. Australian Institute of Building Papers, 5, 75-86.

CII (1986) Constructability: A Primer. Publication 3-1, Austin: University of Texas: Construction Industry Institute (CII).

CIRIA (1983) Buildability: an assessment. London: Construction Industry Research and Information Association (CIRIA).

CSIRO (1986) Dealing with the Information Explosion. Rebuild, (11)5, 1986.

Fox, S., Marsh, L., and Cockerham, G. (2002) Constructability rules: guidelines for successful application to bespoke buildings. Construction Management and Economics, 20(8), 689-696.

Glavan, J.R., and Tucker, R.L. (1991) Forecasting design-related problems – case study. Journal of Construction Engineering and Management, 117(1), 47-65.

Glavinich, T.E. (1995) Improving constructability during design phase. Journal of Architectural Engineering, 1(2), 73-76.

Haugbølle, K. and Forman, M. (2009) Shaping concepts, practices and strategies: Arbitration and expert appraisals on defects in construction. CIB Joint Int. Symp. 2009: Construction Facing Worldwide Challenges, 27 September – 1 October 2009, Dubrovnik, Croatia.

ISO (2008) Quality management system – Requirements (EN ISO 9001:2008).

Jensen, F.V. (1996) Introduction to Bayesian networks. New York: Springer-Verlag.

Jørgensen, K. (2009) Failures and Defects in the Building Process – Applying the Bowtie Approach. CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges, 27 September – 1 October 2009, Dubrovnik, Croatia.

Koen, B.V. (2003) Discussion of the method – conducting the engineering approach to problem solving. Oxford University Press. New York.

Kreiner, K. and Damkjær, L. (2009) "Faulty" Steps in Construction – “Faulty” Learning from Experience. CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges, 27 September – 1 October 2009, Dubrovnik, Croatia.

Lam, P.T.I., Wong, F.W.I., Chan, A.P.C., and Chan, D.W.M. (2007) Benchmarking buildability using the Buildability Assessment Model in Hong Kong. The Hong Kong Institution of Engineers Transactions, 15(1), 7-17.

Low, S.P. (2001) Quantifying the relationships between buildability, structural quality and productivity in construction. Structural Survey, 19(2), 106-112.

Low, S.P., and Abeyegoonasekera, B. (2001) Integrating buildability in ISO 9000 quality management systems: case study of a condominium project. Building and Environment, 36(3), 299-312.

Lutz, J.D., Hancher, D.E., and East, E.W. (1989) Framework for design-quality-review data-base system. Journal of Management in Engineering, 6(3), 296-312.

Nielsen, J., Pedersen, C., and Hansen, M.H. (2004) Svigt i byggeriet. Økonomiske konsekvenser og muligheder for en reduktion (In Danish). København: Erhvervs- og Byggestyrelsen.

Nima, M.A., Abdul-Kadir, M.R., and Jaafar, M.S. (1999) Evaluation of the engineer's personnel's role in enhancing the project constructability. Facilities, 17(11), 423-430.

Talon, A., Chevalier, J-L., and Hans, J. (Eds.) (2006) Failure Modes Effects and Criticality Analysis – Research for and Application to the Building Domain. CIB Report, Publication 310.

Willows, R. and Connel, R. (Eds.). (2003) Climate adaptation - Risk, uncertainty and decision-making UKCIP Technical Report.

Wong, F.W.H., Lam, P.T.I., Chan, E.H.W., and Shen, L.Y. (2007) A study of measure to improve constructability. Int. Journal of Quality & Reliability Management, 24(6), 586-901.

MANAGING AND ANALYSING SYSTEMS SUPPLIES FOR BUILDING CONSTRUCTION

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Management of increasingly complicated supplies is getting essentially important for modern construction. Several problems and risks occur in a typical delivery of industrialised building components. Particularly the monitoring of supplies, the local optimisation by various partners and lacking communication system were seen as major problems of the current practice. This paper is addressing the field of systems supplies that refers to integrated construction products and their managerial challenges. Process modelling and models are widely used means to design and analyse such processes. The structuring of the internal logic of such models in new manner is seen as a way towards more valuable process modelling.

KEYWORDS: system deliveries, logistics, simulation, construction.

INTRODUCTION

Industrialized supply, integrated supply or service oriented operations are examples of terms that all trying to express the overall development of construction business towards new stage of more complicated products and their deliveries. In this stage the new products are increasingly customised to meet variety of needs, they are delivered on demand of project specific needs and milestones, and finalisation of those products require integration of work of different partners. In this paper the rather compact term "systems supply" is used to cover such products, their characteristics and managerial challenges.

Development of service oriented professionals, their capabilities and relating products is an improvement area of key significance for the modern building construction sector (Barrett, 2005; ManuBuild, 2005). It looks obvious that the most desirable service products are the ones having characteristics such as approachability (scope easy to understand, easy contacting), transparency (content, accessing progress data) and reliability (minimal variances in time, cost and quality). Profound understanding of customer needs is always behind of the overall set-up of any service product. Standardisation is considered as a key avenue for the development of service products. The resultant service can be characterised as a system the development of which can have different needs (or their combinations) as listed on the following:

1. *Packaging* of processes and results according to the identified main needs,
2. *Segmentation* of service products towards different customer groups using key parameters,
3. *Constant performance creation* where processes are standardised for having highest possible reliability,
4. *Integration* of processes of several companies in the form of service products, and
5. *Homogenisation* of operations and enabling solutions (for example information systems) regarding service suppliers. On the other hand the homogenisation can mean also a

standardised information source for accessing building data by any selected service provider.

This paper addresses the development of standardised delivery services of integrated building products, that is systems supply. Business process modelling (BPM) is often used as an approach when standardised service products need to be developed. BPM enjoys also wide usage in relation to general business process re-engineering and development of company wide ICT systems which as examples demonstrates the overall importance of business process modelling. As a consequence of this position there are several hundreds of BPM tools available. Behind of them one can find many process modelling techniques. The purpose of most BPM modelling techniques is qualitative modelling that is particularly suitable for understanding and communicating operational details to those involved.

The less understood BPM modelling approach is quantitative modelling of processes in question and what are the main achievable benefits from it. Whereas qualitative modelling is successfully meeting many of the service system modelling needs listed earlier the quantitative modelling is particularly meeting the need for creating processes with constant performance. With a probabilistic dimension (stochastic models) the quantitative modelling can provide a source for understanding the statistical performance of established services on the long run. This model can be used for setting up the reachable but realistic targets for the performance of services. Additionally quantitative performance indicators can be extracted from the model to be used as tools for monitoring the performance and providing feedback to the process itself. Quantitative model can reach a level of an active model that acts by it-self or react when the user interacts with it. In simple terms an active model is like a spreadsheet for exploiting costs and risks with what if factor (Schrage, 2000).

The main objective of this paper is to present quantitative process modelling as an approach in the development of standardised systems supply services.

RESEARCH PROJECT

The work presented in this paper commenced as a part of ManuBuild - "Open Building Manufacturing" EU NMP project 515825-2. ManuBuild was an industry-led collaborative research project on Industrialised Construction, part-funded by the European Commission. This project was started in April 2005 and completed in March 2009, thus it was a 4-year project and involved 22 partners from 8 countries across Europe.

The ManuBuild vision is of a future where customers will be able to purchase high quality, manufactured buildings having a high degree of design flexibility and at low cost compared to today. The aim of ManuBuild was to combine inspirational unconstrained building design with highly efficient industrialised production. Since completion of ManBuild the study described in this paper has been continued as a part of Erabuild Supply research project partly financed by the Finnish Funding Agency for Technology and Innovation (Tekes).

LOGISTICS MANAGEMENT

Logistics management and relating supplies were one of the key topics in the ManuBuild project. As a starting point it was valued that several problems and risks occur in a typical delivery of industrialised building components. Particularly the monitoring of supplies, the local optimisation by various partners and lacking communication system were seen as major problems of the current practice. It was considered that most of the problems described above are related to producing, maintaining and sharing of project information.

Integration of production planning and construction component delivery scheduling with visual 3D assembly planning was anticipated to provide an overall solution to the logistics problems described above. As a result a prototype system was developed that encapsulated 3D component based product modeller with a scheduling oriented construction project planning system. The resultant prototype is a web-enabled system for distributed logistics management, assembly planning and provides a monitoring environment with on-line, multi-user access via Internet to a shared building information model (Ristimäki & Stephens, 2009).

The described prototype was tested within several industrial case studies. One of those was provided by a Finnish contractor YIT Corporation. This case study focused on the management of logistics of the LuxCool product. LuxCool is a multifunctional ceiling element that includes lightning, ventilation, heating, cooling, electricity and control automation. Design, manufacturing, transportation and installation of complete LuxCool elements requires combination of performance of several disciplines and thus it is also a good example of a modern systems supply (Figure 1).

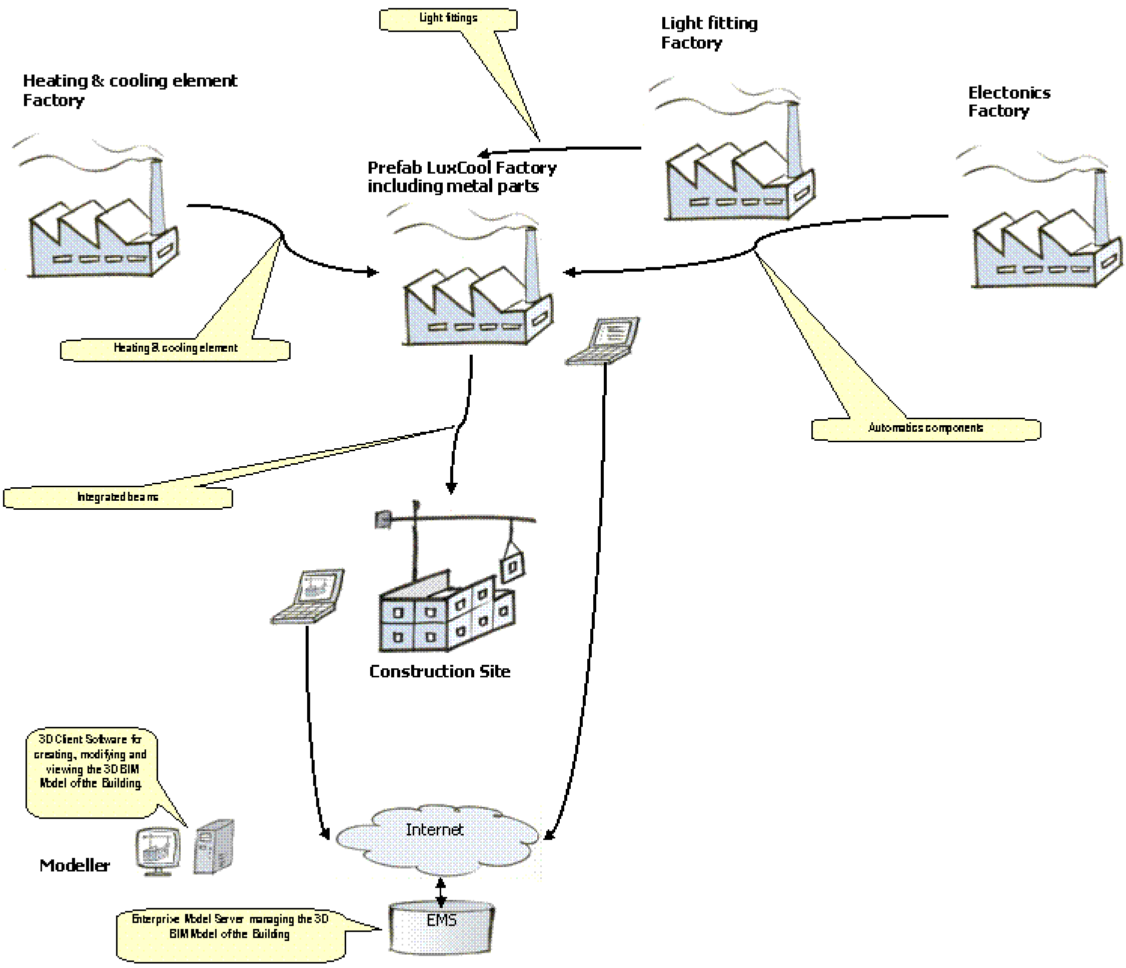

Figure 1. Delivery network of LuxCool products (Ristimäki & Stephens, 2009).

ANALYSIS OF SYSTEMS SUPPLIES

Most traditional process modelling methods are deterministic meaning that input data represent fixed and historic singular values. In addition to this it is usually assumed that all different tasks or processes included in the model shall take place unconditionally. This means that e.g. all four tasks included in the process model in Figure 2 shall take place in all conditions.

Quantitative stochastic models intend to capture the uncertain nature of the actual conditions. Input data for these models can be randomised based on probabilistic distributions. Furthermore the realisation of certain parts of the total process is conditional or uncertain. This situation is illustrated in Figure 2 which includes a set of fallback activities that are only carried out under certain conditions. Examples of this kind of conditional activities are also rework, waiting and claiming.

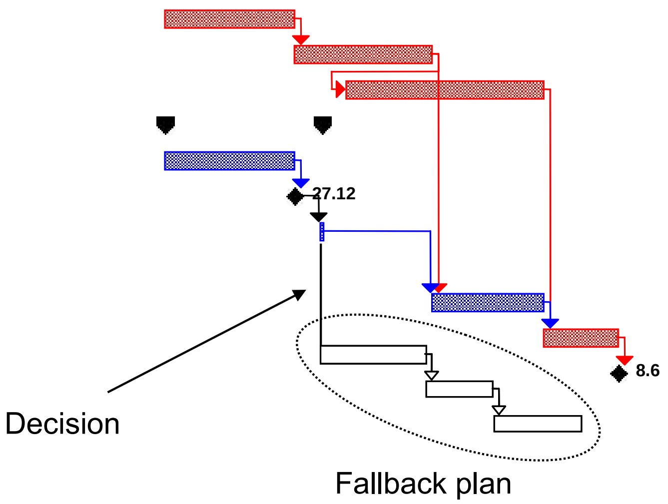

Figure 2: Conditional tasks inside stochastic process model.

The main modelling approaches for the inclusion of conditional parts in the process models are:

Conditional branching = the next successor activity is selected in terms of making decision on the basis of progress - or lack of it - elsewhere in the model. This is fully providing chances to have conditional clauses in the model, likewise in live contracts, that shall enables realisation of certain actions.

Probabilistic branching = the next successor activity is selected in terms of the estimated probability. Usually this is applicable in situations where some historic data is available concerning the statistical performance that can be then used as a basis for probabilistic variables.

The described stochastic model provides starting point for process simulations that shall show the performance of the process in different conditions. The resulting data present statistically the overall spectrum of process performance in different situations; best case, worst case, most probable performance etc. This data can be used also as reference material for defining target values for different performance indicators.

Figure 2 shows a process performance control system based on thinking arising from stochastic modelling. The core of the system is i) coherent objectives set annually by company management and ii) daily site reporting. The performance objectives consist of absolute values for performance attributes, their typical deviations and the expected rates of improvement. Analysis and definition of industry's best practice forms the perspective and final goal for the performance objectives (benchmarking). Daily site reporting aims to consistent and continuous understanding of project performance and its improvement. Daily site reporting obviously requires appropriate education and attitude toward recording daily site data.

One should notice the examples of performance attributes provided in figure 3. Amount of waiting, amount of design changes, ratio value-added time / total elapsed and timeliness (how the times of project and its parts match that which was planned) are examples of common measures to evaluate the output of project. These measures can easily reveal the potential problems relating to the performance rather than showing only technical performance which seems to be case with many conventional measures.

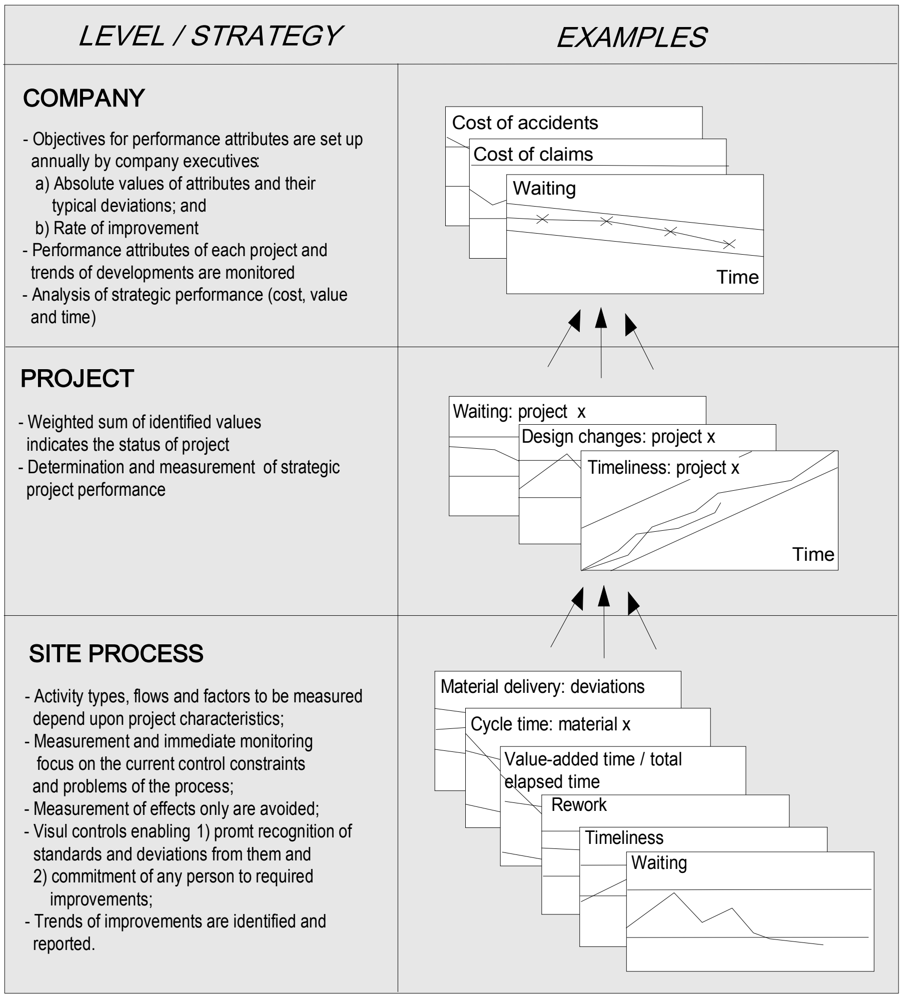

Figure 3.: Measurement of project performance based on the new model

Stochastic process models are usually considered as a more comprehensive models where deterministic elements are present with the new stochastic elements. This is the rationale how the classical GERT (Graphical Evaluation and Review Technique) and causal loop diagramming of System Dynamics were originally developed (Phillips & Garcia-Diatz, 1981; and Sterman, 2000). Developers of these famous methods considered that the deterministic modelling techniques have limitations that do not meet to requirements for modelling dynamics of complex business operations. The resultant modelling techniques include probabilistic functions that determines the realisation of activities linked to them. These techniques have provided original sources for numerous modifications of the original technique, case studies and large number of simulation tools. For recent examples look at (Kenzo & Nobuyuki, 2002; www.palisade.com; www.systemdynamics.org. Having all this history behind and all the emerging new results we should be able to identify the most viable elements of stochastic business modelling and name their potential usage.

Usually researchers have put their attention on the limits of earlier development that has resulted in increasingly powerful but also more complex modelling methods and tools. Many rather comprehensive modelling methods together with modelling examples exist. These have been used as reference material for studying the requirements and content of stochastic process modelling that preferable would be widely applicable in company environment. Figure 4 presents the key elements of the stochastic process modelling that resulted from this study. On the following the main elements of it are presented together with the related requirements.

1. *Structural logic* is composed of i) process objects including deterministic part and stochastic part, and ii) process objects (e.g. activities, tasks) on timeline. It is important to understand stochastic modelling as an extension of deterministic models. Whenever uncertainly plays an important role regarding the realisation of key task then one should turn attention towards stochastic branching of this part of the process. The importance of the presentation of process on timeline should not be ignored. Schedules, and particularly bar charts/gant charts, are perhaps the most important way to communicate and understand effectively the structure of processes or complete projects. <u>Requirement</u>: Exotic solution that is far away from other frequently used and well-known modelling should be avoided.

2. *Internal logic* is composed of i) Key Affecting Factors (KAF), and ii) Estimating methodology. KAFs are factors that explain the behaviour of stochastic objects. Estimating methodology is based on subjective estimates, that is experts' judgements. The target is to have consistent estimates in the terms of amount of information available and the level of detail of estimates. Credibility of estimates highly depends upon the balance of the level of information available/missing and the level of detail of estimates. <u>Requirement</u>: The level of knowing or understanding the content and details of processes can vary greatly from one situation to another. For having plausible results the estimates need to match with this phenomenon.

3. *Integration* is addressing the overall applicability by linking the main results of stochastic process models to business and managerial logic. This is achieved by three concepts:

    i) Expectations are best estimates on what should happen on average,

    ii) Commitments are to be decided and show the level of performance present in contracts, and

    iii) Targets are internal objectives for stretching people towards higher performance and additional benefits.

They are used for presenting the key figures from the quantitative analyses. *Requirement*: Separate solutions from management decision making and daily management need to be avoided.

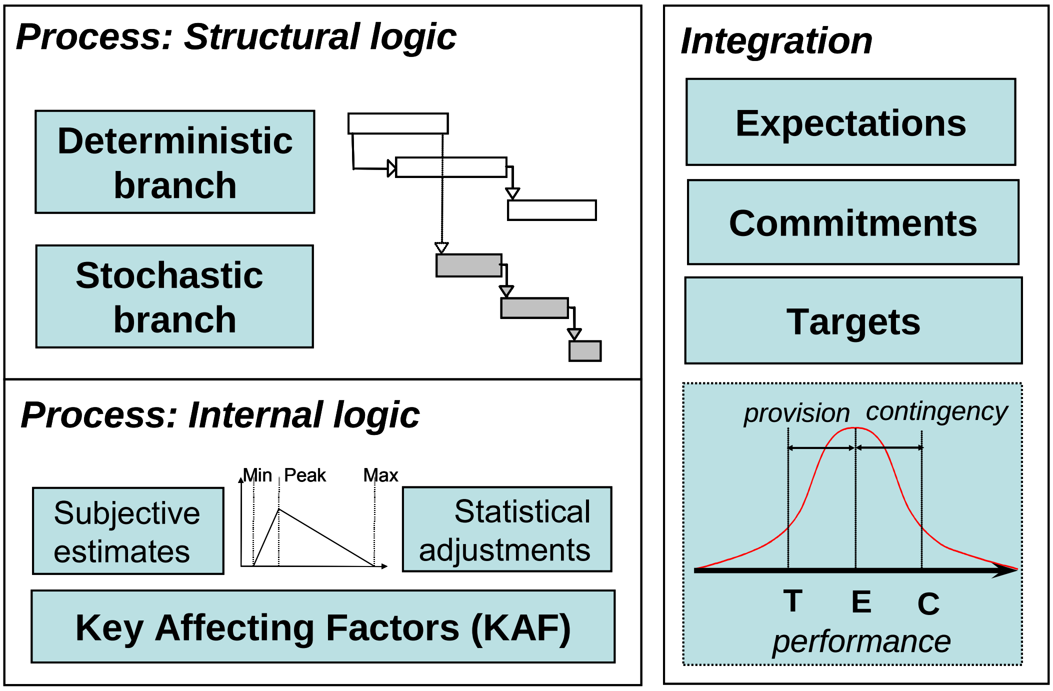

Figure 4: Key elements of stochastic process models for business operations

In the following chapters the key elements of stochastic process modelling are discussed further based on results from case studies.

A stochastic process modelling case study has been completed where a building element system delivery process was modelled. The motivation of modelling was to build a reference model in a situation where the company is starting to use the 3D modelling technology as a key tool in their product design operations. The modelling study was completed using Microsoft Project and @Risk for Project Professional software packages. The first software is a well-know tool for project management and for preparing models of projects for this purpose. The second software is an add-on tool for the first software for providing a stochastic dimension for a standard project management package. It can be used for demonstrating the appearance of the stochastic modelling key elements presented in the previous chapter.

From research viewpoint the main interest in the case study were the lessons learned from presenting the stochastic objects alongside the deterministic ones. The figure 5 presents the resultant model in the form of standard bar chart where the stochastic branches are separated from the deterministic ones using rectangles. It was found that the needs for having stochastic branches appear usually together with certain key activities, for example after reception of goods there is a chance for unexpected claims and waiting.

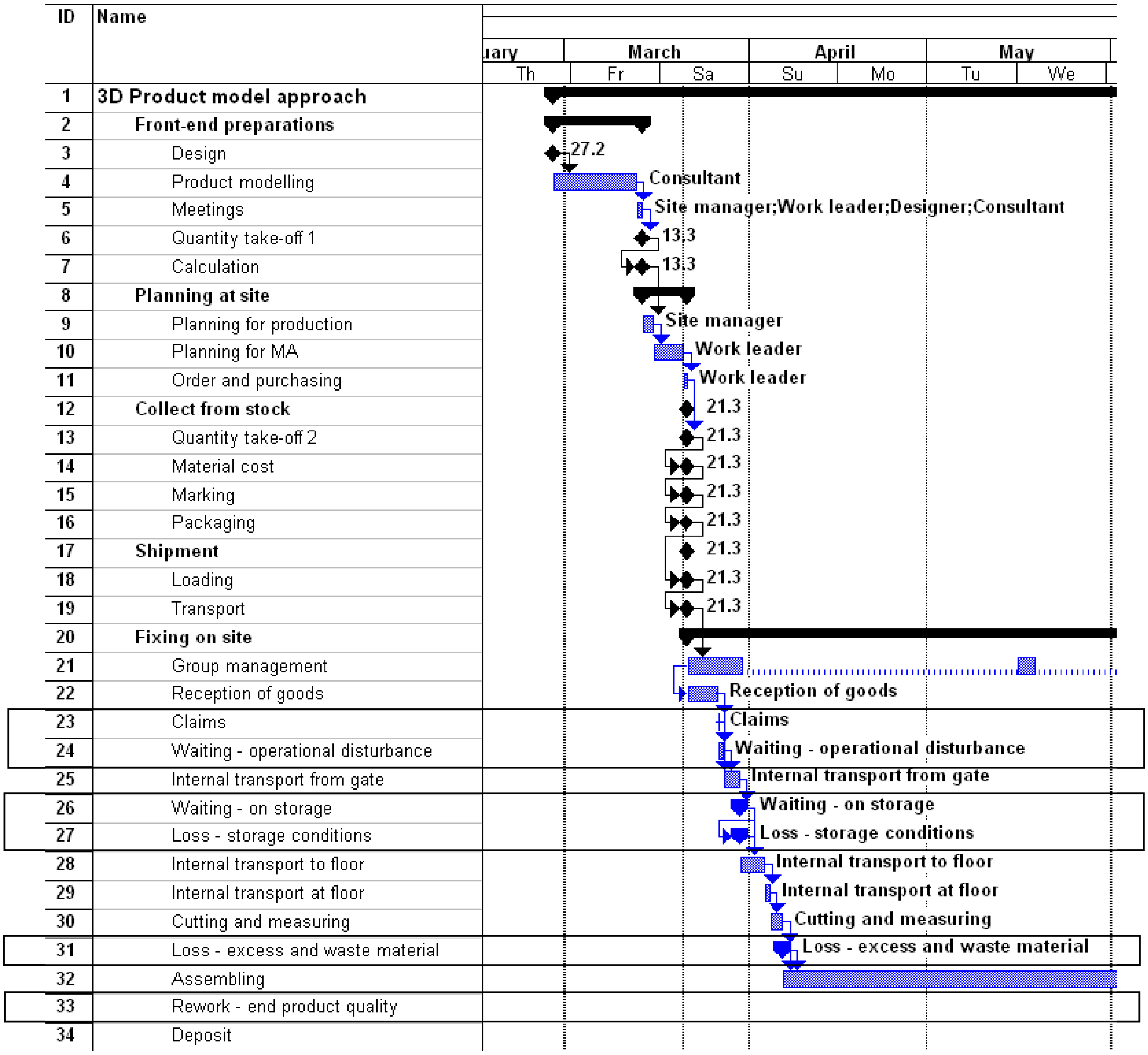

Figure 5: Case study where the stochastic processes modelling approach were applied. Stochastic branch are shown with rectangles in the model.

The resultant model can be considered as a active model capable to explain the behavioural aspects and dynamics of the process in question. The critical factors explaining the overall of the process or local performance of certain activities variances can be identified

DISCUSSION

This paper has presented stochastic business process modelling as an expansion to more traditional deterministic process modelling. The deterministic modelling has a full presence to be used for portraying the usual body of the process in question. However, after that the model can be equipped with stochastic branches that are realised only conditionally when signals from the performance are demanding that. By these feature the final model can reflect the uncertainty in live situations and resultant variances.

The stochastic modelling can be applied for understanding the deeper behavioural aspects inside the processes, such as waiting, rework and losses that are increasingly considered as key indicators to be managed. Stochastic models provide a link to model and understand the content of these aspects in an explicit manner.

Key elements of stochastic process models for business operations have been presented in this chapter. The main target is to define the content of stochastic process modelling in a way that is applicable in company environment. The requirements of the solution that were used as a starting point demonstrate the practical needs company people have when they are trying to expand process modelling towards probabilistic world. Perhaps the most important requirements are integration and communicativeness of the model. The resultant key elements present in a compact way the main objects to be taken into account when stochastic modelling is applied in companies.

Standardised services have usually of a repetitive nature. It is companies' interest to level statistical performance for these services in a way which leads to expected gains. By stochastic process modelling companies can have explicit access to factors, such as waiting, rework and losses, that include the biggest potential for process improvements.

CONCLUSIONS

Quantitative stochastic modelling has been presented in this chapter as a means to model standardised services and particularly systems supply. The key elements of stochastic process models also presented in this paper provide a framework that can be used as a starting point when companies commence modelling exercises that include also stochastic parts.

It has been demonstrated by cases how behavioural aspects of business processes can be modelled and understood in an improved manned with the aid of stochastic process modelling. Value adding can also be considered as a deep behavioural characteristic of business processes. This is a potential topic for further research.

REFERENCES

Anjard R. (1998) Process mapping: a valuable tool for construction management and other professionals, *Facilities*, Vol. 16, No. 3/4, pp.79-81.

Barrett, P. (2005) Revaluing Construction - A Global CIB Agenda, *CIB Publication 305*, CIB, Rotterdam, The Netherlands.

Hammer, M. and Champy, J. (2003) *Reengineering the Corporation: A Manifesto for Business Revolution*, Harperbusiness (HarperCollins Publishers).

Kenzo K, and Nobuyuki N. (2002) Efficient Monte Carlo simulation method of GERT-type network for project management, Computers and Industrial Engineering, v.42 n.2-4, p.521-531, June 2002

Kähkönen, K., Artto, K., Karjalainen, J., MArtinsuo, M. and Poskela, J. (2006). Management of Uncertainty, (Draft book), Helsinki University of Technology.

ManuBuild, (2005) *ManuBuild Newsletter 1* (available at www.manubuild.org), April 2005.

Mayer, R.J., Menzel, C.P., Painter, M.K., deWitte, P.S., Blinn, T. and Perakath, B. (1995) *IDEF3 Process Description*, Knowledge Based Systems, Inc., College Station, TX, USA

Phillips, D.T. and Garcia-Diatz, A. (1981) Fundamentals of network analysis. Prentice Hall International, USA.

Ristimäki, T. and Stephens, J. (2009) Logistics management, assembly planning and monitoring tool, Internal ManuBuild deliverable, ManuBuild consortium.

Savén, R.S. (2002) Process Modelling for Enterprise Integration: review and framework. *The Twelfth International Working Seminar on Production Economics Igls/Innsbruck*, Austria, February 18-22, 2002.

Schrage, M. (2000) *Serious Play - How the World's Best Companies Simulate to Innovate*, Harvard Business School Press, Boston, Massachusetts, USA.

Sterman, J.D. (2000) Business Dynamics: Systems thinking and modeling for a complex world. McGraw Hill.

RISK ALLOCATION IN JOINT VENTURES

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The method of risk allocation within joint-ventures differs from project to project. In a joint-venture the division of responsibilities and risks is not always clear for the participating parties. At this moment there is no model which can lead the risk allocation to good results within a joint-venture. This study has been developed by conducting a literature study and a case study in order to find a suitable model for risk allocation in joint ventures.

Using this model, the parties are more aware of risk allocation and it can serve as a guideline the process of risk allocation, as a result of which the participating actors will be able to get a handle on the process.

KEYWORDS: PPP (Public Private Partnership), joint-venture, risk allocation, process.

INTRODUCTION

Not all joint-ventures in construction have not been successful in the last ten years (Zeegers, Ysbrandy en van Ophem, 2004). The manner of risk allocation within the joint-ventures differs from project to project (Zeegers, van Ophem en van Overmeeren, 2007). Research points out that in a joint-venture the division of responsibilities and risks is not very clear for the participating parties and that it is a difficult task to allocate the risks in balance (kenniscentrum PPS, 2004-b).

The methods of risk management show how the risks can be analyzed and monitored. However, these methods do not show how risks must be allocated between the cooperating parties. At this moment there is no model which can lead the risk allocation to good results within a joint-venture.

The aim of this research is to develop a model for risk allocation within a joint-venture. This model can be used as a means for allocation of the risks during the initiative- and feasibility phase and can lead the risk allocation to good results. Using this model, the actors are more aware with risk allocation and the actors can be guided in the process of risk allocation.

METHODOLOGY

Four research questions have been used to achieve the aim. These questions are:

- Which aspects must be used for risk allocation within a joint-venture?
- What are the characteristics of the contracting process in a joint-venture?
- Which aspects of risk allocation are used in practice?
- Which aspects from the practice and the theory can be used in the model?

This research has been developed in four main steps:

1. The first part of the research is the literature survey. It is an exploring qualitative survey, concentrated on four main subjects. The research questions have been answered in this part. By means of the literature study a model for risk allocation has been developed.

2. The second part is the case study. By means of the theoretical framework that has been developed in the literature study, the case studies are carried out. For the case studies, the contracts are studied.

3. The third part is the cross-case-analysis. On the basis of a cross-case-analysis, the three different cases are compared with each other. This comparison gives a clear image of risk allocation in practice.

4. The last part is the design part. The comparison between the results from the practice and the theory must lead to a definite model for risk allocation.

Aspects for risk allocation

In the literature survey, three main aspects have been found, which are relevant for risk allocation within the joint-ventures. These are:

<u>Controllability</u>
- What is the originator of the risk? (RISMAN, 1999);
- Which actor is best at bearing the risk? (RISMAN, 1999; Wildenberg, 2003; de Greef, 2006);
- Which actor is best at influencing the risk? (de Greef, 2006; RISMAN, 2001);
- Which actor makes the most profits or disadvantages? (RISMAN, 2001; de Greef, 2006);
- How can the risks be shared in proportion? (RISMAN, 2001; Versteegen en Staal-Ong, 2004).

<u>Foreseeability</u>
- Which actor is best at foreseeing the risk? (Jones, 1996; de Greef, 2006);
- Which measures can be taken for unforeseen risks?

<u>Managing stability:</u>
- Which actor can best communicate with different actors within and outside a project? (kenniscentrum PPS, 2004-a; Lahaije, 2004)

Besides these aspects the actors must give a certain input, in order to allow the negotiation of risk allocation to run smoothly (Alexander, 1995). These are: reliability (RISMAN, 2001), commitment (Aken, 1996; RISMAN, 2001), flexibility, acceptance and respect (Alexander, 1995). Without this input, the actors will keep too much focused on their own interests and too little to combined interests (which will disturb the risk allocation process).

The characteristics of the contracting process within a joint-venture

Figure 1 shows the process at the start of a joint-ventures project. Risk analysis will be carried out during the actor analysis stage and during stage when a vision of how to cooperate will be developed. Activities within risk analysis are: to identify, to categorize, to assess and to prioritize the risks.

When the initiator decides how to cooperate in the project, the risk allocation will also be determined how (kenniscentrum PPS, 2004-a; kenniscentrum PPS, 2004-c; de Koning an Sproncken, 2001). This will obviously be done after having conducted the risk analysis.

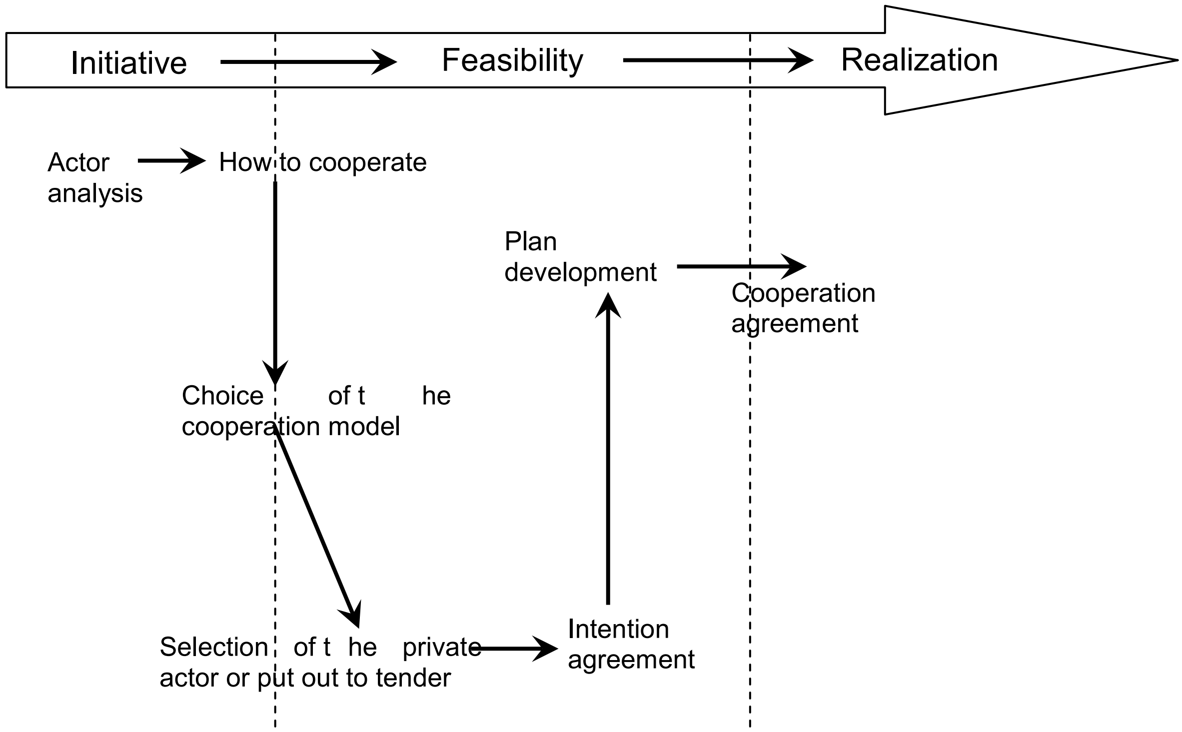

Figure 1: Process within the joint-venture (Source: kenniscentrum PPS, 2004-a)

The aspects used in practice

Using the knowledge from the literature, the contracts of three state development joint-ventures have been analyzed. The analysis has been focused on three major tasks that all three joint ventures had to accomplish. These were:

1) acquire land

2) clear land for building

3) distribute the lots

The agreements that the joint ventures had made on risk allocation in these tasks, has been taken into account. This has not been done for all the risks, but for six particular risks only. These risks were:

a) Participants are not able to finance the project

b) Conflicts of interests between the participants

c) No clear agreements between the participants on the three major tasks

d) One of the participants refuses to share risks

e) Changes in the scope of the project

f) No political or public support for the project

Ad a: In all three cases, the municipality has financed the project. In two cases, this has been done by a loan of the Dutch Municipality Bank. In the third case, it is not clear where the loan comes from.

Ad b: In all three cases, after some time, an independent director has been appointed. Next to that, other independent officials have been appointed for steering committees and decision making. Next to that, agreements have been made in the contracts for unsolved disputes.

Ad c: In two cases, an independent chairman has been appointed to make sure that the agreements that have been made in the project meetings are properly written down. In the third case, the steering committee looks after the proper downwriting of the agreements.

Ad d: In two cases, the project will be stopped if one of the parties can not or does not want to fulfil his job and take the agreed risks. In the third case, nothing has been directly agreed on this topic in the contract. The project can be stopped by a judgment of a arbitrator.

Ad e: The change of the scope if a project that is disadvantuous for the parties, will have to be paid by the party that wants to change the scope in all three cases.

Ad f: In all three cases, the municipality is responsible for the permits and approvals.

Model for risk allocation

The results from the literature study and the case study have led to a model for risk allocation within the joint-ventures. Figure 2 shows this model for risk allocation, which is the result of this research.

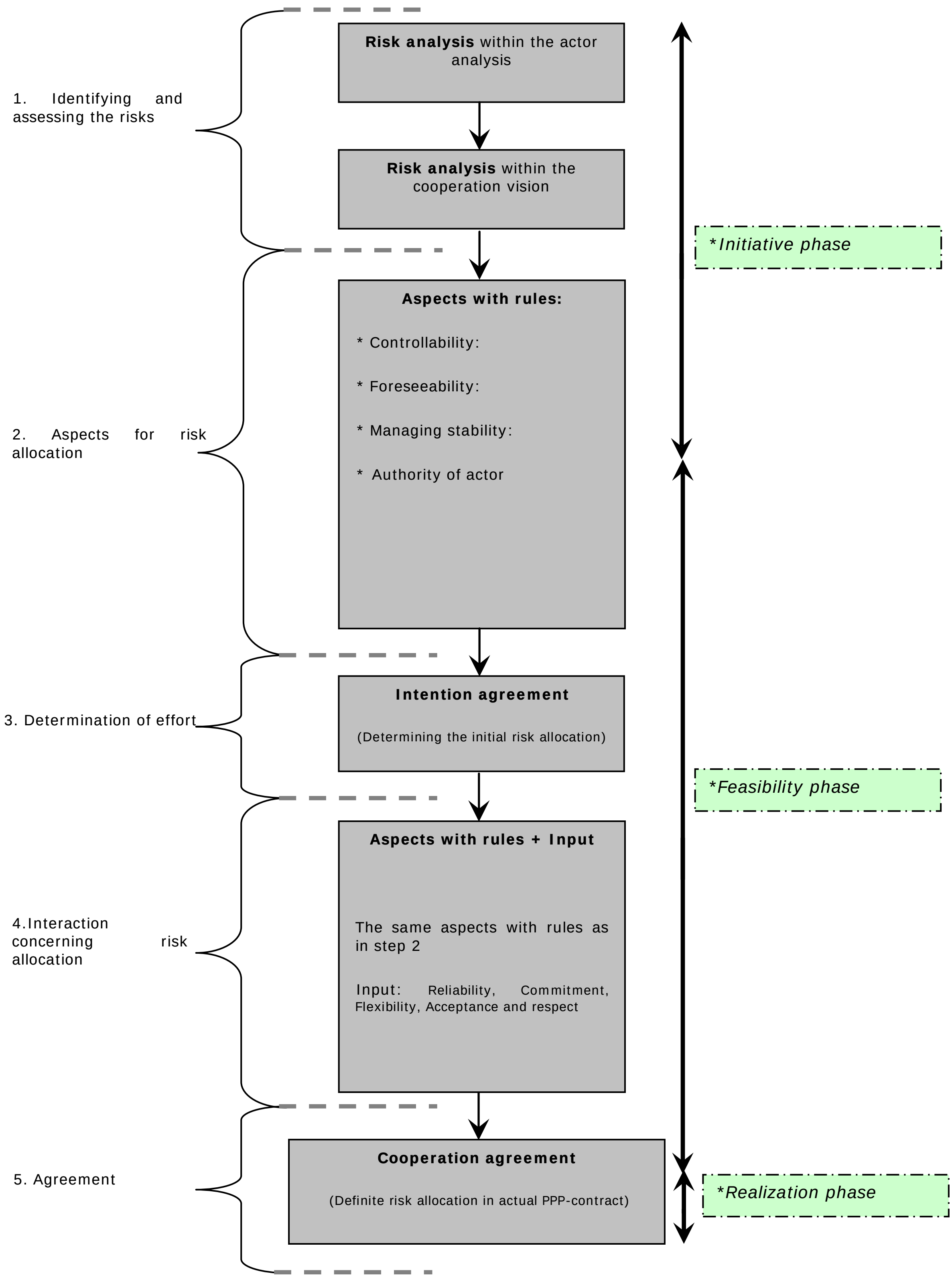

Figure 2: The model for risk allocation

- In the first step, the actor analysis and the cooperation vision are carried out. Within these two analyses, a risk analysis is carried out. A thorough risk analysis takes place during the first step, through which the risks of the project are being identified, quantified and measurements to manage these risks are determined.

- In the second step, the aspects below have been considered: Controllability, Foreseeability, Authority of actor, and Managing stability. After this step the actors will develop an initial risk allocation.

- In the third step initial risk allocation is determined and an intention agreement is signed.

- In the fourth step, there is interaction between the participating actors. Once again the aspects are being looked at: Controllability, Foreseeability, Authority of actor, and Managing stability. During the negotiation concerning risk allocation are commitment, flexibility, reliability, acceptance and respect the input of the actors.

- In the fifth step the cooperation agreement is signed. In this agreement definite risk allocation is determined.

DISCUSSION

The result of this research is the model (figure 2), which can be used for allocating the risks within a joint-venture. This model can lead risk allocation within a joint-venture to a good result. Using this model, the actors are more aware with risk allocation. This model gives also an accompaniment in the process of risk allocation, as a result of which the actors can be guided in the process of risk allocation

This research has been concentrated on the aspects for risk allocation, not on the process of risk allocation. It is important to examine the process of risk allocation in practice. Thus the process within the developed model must still be validated.

During the case study, three joint-ventures have been analyzed which have no final results yet. The projects are still in development. Therefore the `success’ of the projects could not be measured in terms of quality, time and money. A link between success and the manner of risk allocation was not possible.

The analyzed joint-ventures have 50/50 risk allocation between public and private actors. It is important to examine the applicability of the aspects in other risk allocations.

CONCLUSION

This research has given a clear answer on the research questions. In this research a model for risk allocation has been developed. Using this model the actors can handle more aware with risk allocation.

The objective of the model for risk allocation within joint-ventures is to decrease the total costs of risks in a project. By allocating the risks through the model, it is determined which actor can bear the risk against the lowest price by using the aspects Controllability, Foreseeability, Authority of actor, and Managing stability. With the actor, which can bear the risk for the lowest price, the risk should be allocated. By allocating every risk through the model, the total costs of risks in a project should be decreased. The decrease in total costs of a risk is also the consequence of a thorough analysis of the possible risks during the initiative and feasibility phase of a project. The added value of the model is to give guidance in the risk allocation process. By reproducing the risk allocation conveniently and transparently, the effectiveness of the project can be increased.

This research provides an important value to the other researches concerning Public Private Partnership (PPP), risk management, and risk allocation.

REFERENCES

Aken, van (1996), De weg naar projectsucces. Utrecht: De Tijdstroom

Alexander (1995), How organizations act together. Australia: Gordon and Breach

Greef de, P. (2006), Allocatie van risico’s. Universiteit Twente

Jones (1996), Philosophies of risk allocation- the case of forseeability, The international construction law review. vol. 13, issue 4, pag. 570-584

Kenniscentrum PPS (2004-a), Handleiding risicomanagement bij PPS-gebiedsontwikkelingsprojecten. Den Haag: Ministerie van Financiën

Kenniscentrum PPS (2004-b), Samenwerkingsmodellen en juridische vormgeving daarvan bij PPS gebiedsontwikkeling. Den Haag: Ministerie van Financiën

Kenniscentrum PPS (2004-c), Handleiding inrichting van het PPS-proces bij gebiedsontwikkeling. Den Haag: Ministerie van Financiën

Koning de, Sproncken (2001), Contractering bij bouwprojecten. Utrecht: Berenschot Osborne BV/Elsevier bedrijfsinformatie BV

Lahaije, G. (2004), Zekerheid in het verdelen van onzekerheden. Universiteit Twente

RISMAN (1999), Contract risicomanagement. Gouda: CUR

RISMAN (2001), Risman-publicatie nr. 01 ‘Inleiding tot het proces van risicoverdeling in contracten’. Gouda: CUR

Verschuren, Doorewaard, (2005), Het ontwerpen van een onderzoek (3e druk). Utrecht: Lemma

Versteegen, Staal-Ong (2004), Risicoanalyse in vroege projectfasen. BOSS magazine

Wildenberg, van den (2003), Een integraal afwegingsmodel bij infrastructurele projecten. TU Delft

Yin (2003), Case Study Research: design and methods. Thousand Oaks

Zeegers, Ysbrandy, van Ophem (2004), Spelregels voor geslaagde samenwerking. Utrecht: Berenschot Osborne B.V.

Zeegers, van Ophem, van Overmeeren (2007), Spelregels voor geslaagde samenwerking. Utrecht: AT Osborne B.V.

LOGISTICS IN INDUSTRIALIZED DETACHED HOUSE CONSTRUCTION FROM ECONOMIC AND ENVEIRONMENTAL ASSESSMENT

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In Japan, the industrialized housing has grown up rapidly along with high-speed economic growth. However, there is actually a current state that the delivery of building components is various. The research aims to analyze the logistics of construction projects. The survey of logistics was done for 4 detached wooden houses with the wood panel bonding method. First, this research investigates the delivery of building components from the factories to the construction sites. Secondly, this investigates the material flow of building components at the construction sites, and makes clear the relation between the delivery of building components and their stagnation at the construction sites. Thirdly, it investigates the collection of industrial wastes from the construction sites. As a result, main factors that affect the delivery of materials are the access roads, the construction site condition and the workload of building components at site.

KEYWORDS: industrialized house, delivery, material flow, industrial waste.

INTRODUCTION

The industrialized house is a house which applied an advanced industrial technology to the production. In Japan, the effectiveness of the applied technology has been demonstrated. However, the difference of productivity among construction projects is pointed out (Wu et al., 2008). Moreover, construction sites in the central area of Tokyo are small. There are no stock yards at construction sites. A general contractor is starting to adopt the sequential operation between the delivery and the lifting at site (Dobashi et al., 2001, 2004). Another general contractor is starting to adopt a little collection of industrial wastes from small projects (Hamada et al., 2004). The comprehensive logistics for detached house projects is necessary.

Objectives

The main objective of this research is to address the actual logistics in detached house construction projects affecting the productivity and the global environment, and focus on discussing a comprehensive logistics from the factories through the construction sites to the waste disposal sites from the standpoint of economic and environmental assessment.

Research Method

The logistics in this research has three sections: the delivery of building components from the factories to the construction site, the material flow at the construction site, and the collection of industrial wastes from the construction site to the waste disposal facilities. First, this research surveys the delivery of building components from the factories to the construction site, and explains the difference between construction projects. Secondly, this surveys the material flows at the construction site, and explains how their stagnation affects the productivity. Thirdly, this surveys the collection of industrial wastes from the construction site to the waste disposal facilities, and explains the impact for the global environment.

Construction Projects for Survey

The house manufacturer M in Japan has built the industrialized houses on the basis of Japanese industrialized system. Figure 1 shows the structure of wood panel bonding method by house manufacture M. The structure of house is mainly composed of floor panels, wall panels and roof panels. The panels are manufactured in the factory beforehand, and are joined with glue at construction sites. Nailing and screwing is necessary as a finishing operation. After the shell of the building with the panels is erected, the desired finishes are applied to both inside and outside. On the outside, the plywood is often covered with the siding. On the inside, the fabric is often applied.

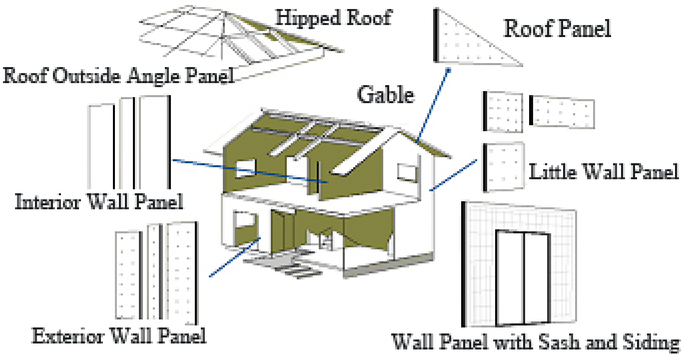

Figure 1: Structure of Wood Panel Bonding Method

Table 1 shows the outline of 4 construction projects for the survey: A, B, C and D project. They are located at Tokyo and the neighbouring prefecture in Japan. They are detached houses, and wood panel build 2-storied structure. The size of houses is similar.

Table 1: Construction Projects for Survey

Project	A	B	C	D
Location	Kashiwa City, Chiba, JAPAN	Kashiwa City, Chiba, JAPAN	Kita Ward, Tokyo, JAPAN	Itabashi Ward, Tokyo, JAPAN
Number of Stories	2	2	2	2
Site Area	260 ㎡	150 ㎡	100 ㎡	80 ㎡
Total Floor Area	115 ㎡	120 ㎡	105 ㎡	85 ㎡
Entresol Area	-	-	30 ㎡	20 ㎡
Construction Period	August, 2007 - September, 2007	July, 2008 - September, 2008	October, 2007 - December, 2007	May, 2008 - July, 2008
Structure	Wood Panel Bonding Method			
Site Condition	Good for Construction		Bad for Construction	
Assembly of Wood Panels	Pre-assembly of Wood Panels with Siding at Factory		Assembly of Wood Panels at Construction Site	
Number of Delivery	3	3	3 (Every Day)	5

DELIVERY OF MATERIALS FROM FACTORY

The survey of delivery of materials from the factories investigates the distance and packing methodology of building components. The standard number of times of delivery by the house manufacture is 3. The objects in the first delivery are wood panels of main frame. Those in other deliveries are interior and exterior finishing building components.

Delivery of Wood Panels

In the delivery of wood panels, the adoption of pre-assembly at factory is a matter for study. Both A and B projects adopted the pre-assembly of wood panels with the siding at factory. Both C and D projects could not adopt the pre-assembly because of small construction sites and narrow access roads. They assembled wood panels at construction sites. The adoption mainly depends on the condition of access roads. A big truck cannot run on narrow roads. A crane cannot work on narrow roads. The pre-assembly can reduce the workload at site.

Figure 2: Pre-assembly at Factory (left) and Assembly at Construction Site (Right)

Delivery of Interior and Exterior Finishing Materials

In the deliveries starting with the second delivery, the distance of factories from construction site is a matter for study from the viewpoint of both economic and environmental assessment. Table 2 shows the distance and carbon dioxide emission of major building components in 4 projects: flooring block, window frame, door frame and eave soffit. In the case of door frame, 4 projects are about the same distance. However, in the case of eave soffit, 4 projects vary in distance from 8.6 km to 187.9 km. The supplies from the house manufacturer are relatively long-distance migration. On the other hand, the elective components by clients are relatively short-distance migration.

Table 2: Distance and Carbon Dioxide Emission of Building Components in 4 Projects

Building Components	A Project		B Project		C Project		D Project	
	Distance (km)	Carbon Dioxide Emission (kg-CO_2)	Distance (km)	Carbon Dioxide Emission (kg-CO_2)	Distance (km)	Carbon Dioxide Emission (kg-CO_2)	Distance (km)	Carbon Dioxide Emission (kg-CO_2)
Flooring Block	18.4	8.4	54.8	24.9	54.8	24.9	54.8	24.9
Window Frame	275.6	125.1	17.3	7.9	269.6	122.4	275.6	125.1
Door Frame	269.6	122.4	269.6	122.4	275.6	125.1	275.6	125.1
Eave Soffit	129.6	58.8	413.9	187.9	18.9	8.6	18.9	8.6
Collection of Industrial Waste	13.9	6.3	10.8	4.9	44.1	20.0	44.8	20.3

MATERIAL FLOW AT CONSTRUCTION SITE

Especially, in urban area such as Tokyo, site areas for detached house construction are small. It is difficult to secure a stock yard for materials at the sites. Moreover, workmen must do works such as the unpacking, the processing and the installation in small indoor rooms. The material flow at construction site is related to the delivery to the site and the collection of industrial wastes from the site. This survey of material flow at construction site investigates the flow and stagnation of major building components, and explains each characteristic and requirement.

Research Method for Material Flow at Construction Site

The materials for survey are 10 building components: eave soffit, balcony, window frame, plaster board, door frame, thermal insulating material, flooring block, bathtub, lavatory sink, and toilet in 4 projects. They are big or long, or both. They can be obstacles at the construction sites. The survey draws flow diagrams of 10 building components with a digital camera and the worksheet for record. Figure 3 shows an example of flow diagram of flooring block in D project. The condition of building components is represented with terms: start, move, stagnation, unpacking, processing, and installation. Each period of conditions is recorded. Flow diagrams also explain the route and stagnation point of building components.

Stagnation of Materials at Construction Site

Figure 4 shows the timing of delivery, the stagnation period and the construction period of 10 building components in 4 projects. The standard number of times of delivery by the house manufacturer is 3. The above-mentioned building components are delivered at the second or the third. The second delivery is put into operation at the beginning of finishing carpentry. The third delivery is put into operation at the timing of the latter half of finishing carpentry.

Construction Projects with a Large Stock Yard

This type of project applies to A and B project. The number of times of delivery by the house manufacturer is 3. This type of project usually adopts the pre-assembly of wood panels at factory, and set crane at their delivery. In A project, eave soffits are lifted to the second floor with crane at the first delivery. This arrangement is reasonable. Other building components are delivered according to script. Their stagnation periods are long. Especially, the lavatory sink and the toilet delivered at the third time are more than 20 days. In B project, the tendency as a whole is the same as A project. On the other hand, the flooring block, the bathtub and the lavatory sink are delivered separately. Their stagnation periods are short.

Construction Projects with a Small Stock Yard

This type of project applies to C and D project, and usually cannot adopt the pre-assembly of wood panels at factory. The site condition of C project is extremely difficult. The house manufacturer delivered the building components to the warehouse. The carpenters stop by every morning and carry the necessary building components to the site. This means the just-in-time delivery. This system usually needs more cost and emit more carbon dioxide. The influence depends on the location of relay station. The condition of D project is similar to C project. The house manufacturer adopts the 5 times delivery, and divides the second delivery into 3 times deliveries.

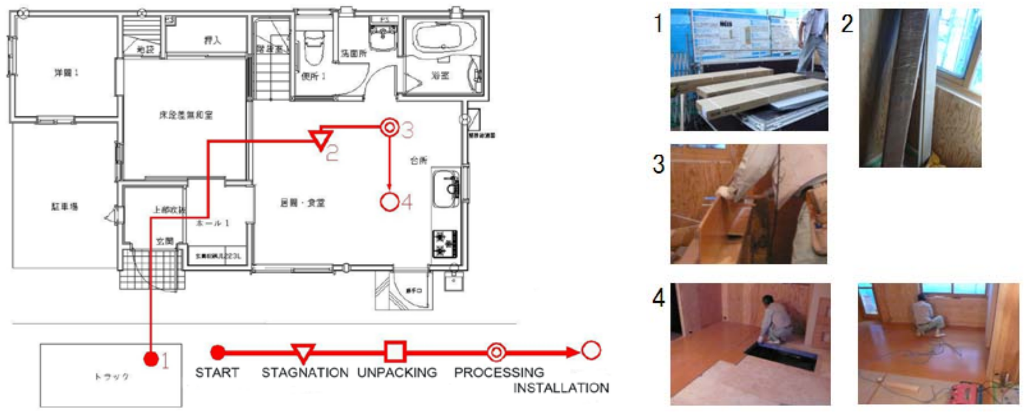

Figure 3: An Example of Flow Diagram of Flooring block in D project

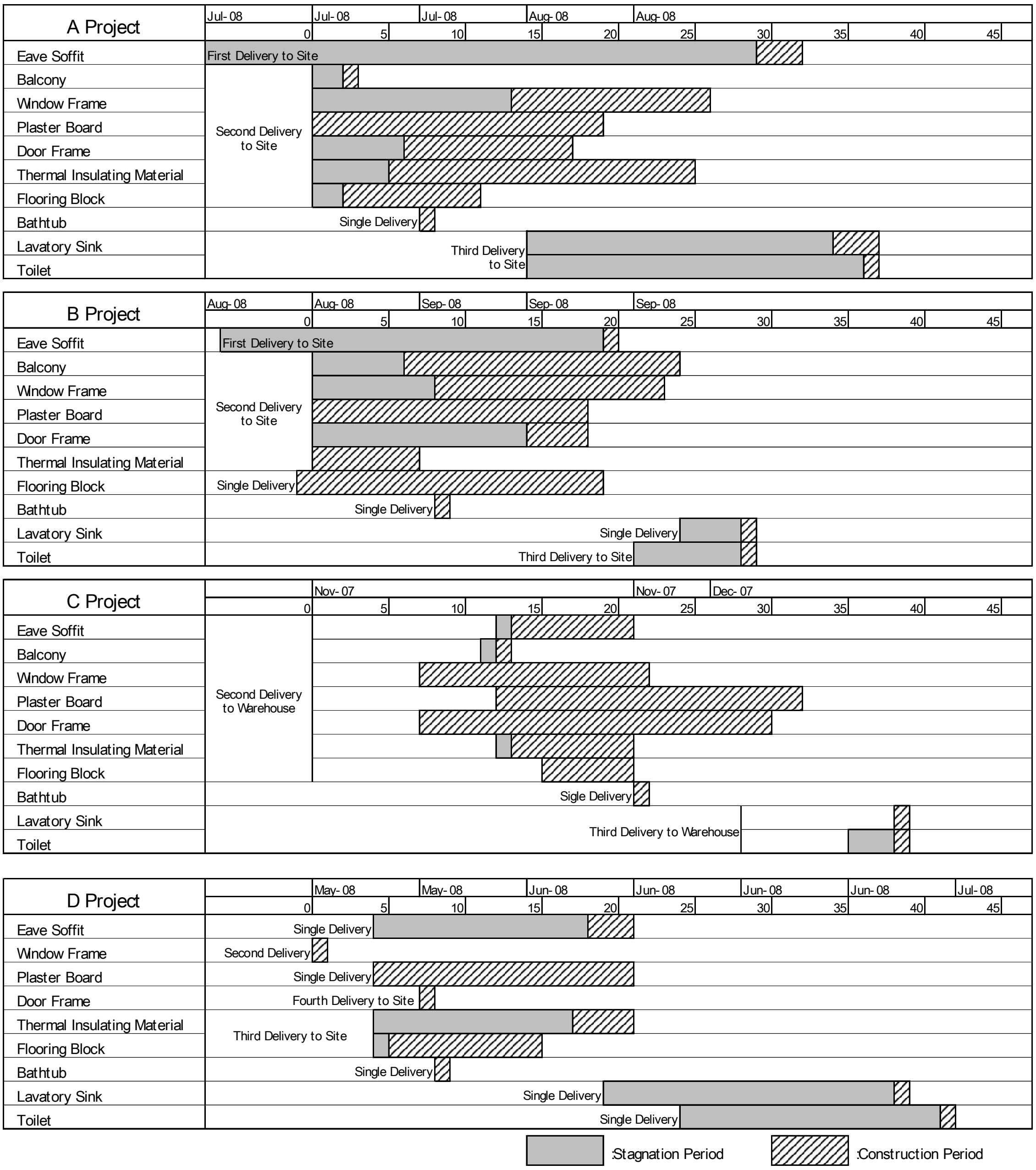

Figure 4: Stagnation Period and Construction Period of 10 Building Components

Patterns of Material Flow at Construction Site

10 Building Components in 4 projects have each characteristic and requirement. Table 3 shows 5 material flow models based on the survey: the direct model, the stock model, the outdoor stock model, the indoor stock and processing model, and the outdoor stock and processing model.

Table 3: Material Flow Models at Construction Site

Pattern	Stock and Processing	Material Flow Model at Site	Building Components
1	Direct Installation	Truck → Installation	Bathtub
2	Stock	Truck → Indoor or Outdoor Stock → Installation	Finishing Material Window Frame Door Frame
3	Outdoor Stock	Truck → Outdoor → Installation	Balcony Heat Insulating Material
4	Indoor Stock + Processing	Truck → Indoor Stock +Processing → (3)	Plaster Board Flooring Block
5	Outdoor Stock + Processing	Truck → Outdoor Stock +Processing → (3)	Exterior Finishing Material Siding Eave Soffit

Pattern 1 is the direct installation pattern. An example is a bathtub. The characteristic is that the stock is very difficult because the size of building component is very big. Therefore, the delivery is alone. The component is directly moved from a truck to the installation location.

Pattern 2 is the stock pattern. Examples are finishing materials such as window frames and door frames. They are stocked indoor or outdoor. Either will do. Most of materials apply to this pattern.

Pattern 3 is the outdoor stock pattern. Examples are balconies and heat insulating materials. The components are comparatively big, and are stocked outdoor. They are assembled or installed at construction site.

Pattern 4 is the indoor stock and processing pattern. Examples are plaster boards and flooring blocks. They are stocked indoor because they must be guarded against wet. Before the installation, they need a processing such as the cutting. This indoor stock sometimes blocks other works or deliveries. In this pattern, the stock area and route at site must be examined.

Pattern 5 is the outdoor stock and processing pattern. Examples are exterior finishing materials such as sidings. They are stocked outdoor. They need a processing such as the cutting before their installation.

In case of pattern 4 and 5, the relation between the stock area and the delivery route must be fully examined. The indoor stock area is usually in a Japanese-style room because the room will be finished last according to the field survey.

COLLECTION OF INDUSTRIAL WASTE FROM CONSTRUCTION SITE

The survey of the collection of industrial wastes from construction sites to waste disposal facilities investigates the distance and the waste ratio, and explains how the logistics and construction affects the global environment.

Research Method for Collection of Industrial Waste from Site

The facilities for the distance survey in 4 projects are the first waste disposal facilities. They are usually intermediate process facilities. Their function is mainly the separation of wastes and the disposal of some parts.

The material for the waste ratio survey is plaster boards because their wastes are the heaviest in the all wastes. The survey weighs the plaster board in B project at the time of both the carry-in and the carry-out. The weight of carry-in plaster board is converted with the number of sheets. That of carry-out plaster board is weighed directly with a spring scale.

Distance of Industrial Waste from Site to Waste Disposal Facility

Table 2 shows the distance and the carbon dioxide emission between the sites and the first waste disposal facilities. The distances in A and B project are similar. Those in C and D project are similar. That is, the distance depends on the site location because available facilities are limited.

Waste Ratio of Plaster Board

Table 4 shows the weight of carry-in and carry-out plaster board in B project. The number of times of carry-in is 4. The size of plaster board is only 2. The total number of sheets (1,810 mm high by 910 mm wide) is 116, and that of sheets (2,420 mm high by 910 mm wide) is 141. The total weight is 4,064.2 kg. The number of sheets in the fourth carry-in is only 6. It is considered to be an adjustment.

On the other hand, the number of times of carry-out is 9. The waste of plaster board is collected at the same time of other industrial wastes. Total weight is 634.1 kg. The waste ratio of plaster board is 15.6 %. This ratio depends on the adopted sizes of plaster board.

Table 4: Weight of Carry-in (left) and Carry-out (right) Plaster Board in B Project

Month	Day	910mm × 1,820mm (Number of Sheets)	910mm × 2,420mm (Number of Sheets)
8	25	70	0
9	3	40	80
9	8	0	61
9	13	6	0
Total Number of Sheets		116	141
Weight per Sheet (kg)		13.4	17.8
Sub-total Weight (kg)		1,554.4	2,509.8
Total Weight (kg)		4,064.2	

Month	Day	Plaster Board (kg)	Number of Carpenters	Work Area
8	25	74.0	2	Lathing
9	5	18.0	1	1F Wall
9	8	152.0	1	1F Wall
9	9	38.0	1	2F Wall
9	10	123.5	2	1F and 2F Ceiling
9	11	48.0	1	2F Wall
9	12	95.2	2	1F and 2F Ceiling
9	13	51.2	1	2F Ceiling
9	14	13.2	1	1F and 2F Partition
Total Weight (kg)		634.1	12	

CONCLUSIONS

There are two major objectives in this research. The first is to disclose the actual flow of major building materials in industrialized detached house construction, and to find the problems and rooms for improvement.

In the delivery of wood panels from the factories, the adoption of pre-assembly at factory is important because the pre-assembly can reduce the workload at site. It mainly depends on the condition of access roads and sites. A big truck cannot run on narrow roads. A crane cannot work at small sites. In the delivery of finishing materials from factories, the supplies from the house manufacturer are relatively long-distance migration. On the other hand, the elective components by clients are relatively short-distance migration. The evaluation of intensive purchasing power by house manufacturer is a matter for the next investigation.

The objects for material flow survey at construction site are 10 building components: eave soffit, balcony, window frame, plaster board, door frame, thermal insulating material, flooring block, bathtub, lavatory sink, and toilet in 4 projects. The number of times of delivery by the house manufacturer is 3. In the case with a large stock yard, building components are delivered according to script. However, stagnation period is relatively long. On the other hand, in the case with a small stock yard, a multiple delivery is necessary. Ultimately, the every day delivery is necessary.

According to the survey, material flow at construction site can be classified into 5 models: the direct model, the stock model, the outdoor stock model, the indoor stock and processing model, and the outdoor stock and processing model. 4 models need the stock, and its area blocks other works. 2 models need to be guarded against wet. 2 models need the processing such as the cutting. They need the processing areas, and are usually in a Japanese-style room because the room will be finished last according to the field survey.

The survey of the distance between construction sites and waste disposal facilities investigates the actual distance. The distance depends on the site location because available facilities are limited. The survey shows that the waste ratio of plaster board is 15.6 %. This ratio mainly depends on the adopted sizes of plaster board.

The second objective is to discuss the relation among 3 sections of logistics: the delivery of building components from the factories to the construction site, the material flow at the construction site, and the collection of industrial wastes from the construction site to the waste disposal facilities, and to incorporate 3 sections into 1 system.

In small sites of detached house construction projects, the cooperation among 3 sections is important. Even though industrialized house building system has showed the effectiveness in the production of skeleton, the systematizing method for finishing elements is not enough. The 5 models in this research can be useful for the detailed plan of logistics considering the relation.

REFERENCES

Dobashi, T., Uenami, T., and Yoshida, T. (2001) Development of the management method in the physical distribution of construction materials: a simulation method in physical distribution. in Proceedings of Seventeenth Symposium on Building Construction and Management of Projects, July, pp. 207-212.

Dobashi, T., Yamanaka, T., Banno, K., and Hayashi, M. (2004) Development of the management method in the physical distribution of construction materials: part2 case study on infill work with housing projects. in Proceedings of Twentieth Symposium on Building Construction and Management of Projects, July, pp. 163-168.

Hamada K., Doyama, A., Kawashima, H., Yamamoto Y., Saito, M., and Ine K. (2004) Experimental application of logisitics system for construction waste using computerized manifest system. in Proceedings of Twentieth Symposium on Building Construction and Management of Projects, July, pp. 407-414.

Hirano, T., Kraines, S, Oda, M., and Yashiro, T. (2007) Optimization of transport related to wood waste from building construction: a comparison of the Netflo model and the MAS model. in Proceedings of Twenty-third Symposium on Building Construction and Management of Projects, July, pp. 141-146.

Hook, M., and Stehn, L. (2008) Applicability of lean principles and practices in industrialized housing production. Journal of Construction Management and Economics, 26(4), 1091-1100.

Kimoto, K., Matsumura S., Kawasaki A., Morohashi K., and Wu Z. (2008) Material flow at industrialized house construction with a wood panel bonding method. in Proceedings of Twenty-fourth Symposium on Building Construction and Management of Projects, July, pp. 323-328.

Kuroda, M., Seike, T., and Kobayashi, A., (2002) A study on environmental loads caused by transportation of building materials. in Proceedings of Eighteenth Symposium on Building Construction and Management of Projects, July, pp. 105-110.

Wu, Z., Matsumura S., Kimoto, K., Kawasaki A., and Morohashi K. (2008) Work analysis in construction of industrialized house: case studies of detached house with a wood panel bonding method. The 36th IAHS World Congress on Housing Science.

COMPARATIVE STUDY ON STATE OF ART AND PROBLEMS OF CONSTRUCTION EXPENSE PAYMENT IN CHINA, JAPAN AND TAIWAN REGION

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The construction industry in China has become a large market due to high economic growth achieved since the Reform-Open Policy started in 1978. The amount of GDP in 2006 of the Chinese construction industry is 4,155 billion RMB, which is 20.3% increased from 2005 (Chinese statistical yearbook, 2007). However, following the quantity of construction project is increasing, more and more problems of construction expense payment occur. And it is a fact that the disputes concerning with construction expense payment have become a serious situation in Chinese construction industry. Therefore, it is necessary to discuss these problems of China. In this study, the difference of present situations of construction expense payment in China, Japan and Taiwan Region are clarified. And, the superior methods of Japan and Taiwan Region are drawing out which are compared to China. Then, the proper strategies are discussed to solve the disputes of above mentioned.

KEYWORDS: construction expense payment, disputes, China, comparison.

INTRODUCTION

Background

In 1978, China started the Reform-Open policy, the construction industry has been growing faster and faster during the past 3 decades. For instance, the investment of infrastructural facilities has been increasing fast, and more and more international conferences or events have been hold, such as the Beijing Olympic and the Shanghai World Exposition and so on. This situation makes the amount of GDP about construction industry increased to 20 times comparing to the figure before 1978.

The internationalizing of the construction market in China, also pushes the number of construction projects increases obviously. However, following the quantity of construction project increasing, a lot of problems of construction expense payment occur, such as flaw in legislation, deficiency in construction management and so on. By 2003, the unpaid money of construction expense in China is about 186 billion RMB, and there is about 5% of this money still unpaid by 2006 (Ministry of Housing and Urban-Rural Development of the People's Republic of China). The Chinese government makes efforts to solve these problems, but a lot of unfavourable criterion which worsen unpaid problems until now.

Therefore, to clarify the feature of the construction expense payment of China, it is not appropriate to only focus on the domestic situation. It is necessary to open other routes and find out different consideration from outside of China. The preliminary study of this paper indicates the proper study objects for comparison are Japan and Taiwan Region.

Japan is one of the developed countries in the world, has a lot of advanced technologies and management methods which are significant influence to China.

And, Taiwan Region has the same language and culture as China, but the construction industry of Taiwan Region has greatly introduced the technology and management of USA and Japan after the World War 2.

Purpose

In this study, the difference of present situation of construction expense payment in China, Japan and Taiwan Region are clarified. And, the superior methods of Japan and Taiwan Region are drawing out which are compared to China. Then, the proper strategies are discussed to solve the unpaid disputes.

Therefore, the major purposes of this paper are as following.

1. To clarify state of art of construction expense payment in China, Japan and Taiwan Region.

2. To suggest the proper strategies for individual problems and the common problems concerning with the construction expense payment in China and to solve the unpaid disputes.

COMPARASION OF CONSTRUCTION EXPENSE PAYMENT OF CHINA, JAPAN AND TAIWAN REGION

Definition of the construction expense payment

In order to clarify the problems related to the construction payment, the construction expense payment and related elements should be identified.

Unfortunately, in legislative contents, there is no standard definition about construction expense payment in China, Japan and Taiwan Region. Also, there is no definition in the standard construction contract. Moreover, public projects and private projects are not distinguished clearly in China.

Based on the situation, some questionnaire investigations and hearing investigations have been done (Questionnaire investigations and hearing investigation) in China, Japan and Taiwan Region to collect the consensus about construction expense payment. According to the results, the construction expense payment in this paper is defined as following.

Normally, general contractor submits the payment application to client according to their finished quantities of works during the construction. And, project supervisor of Supervisor Company should check the application and confirm the work quantity and quality in the job site. Then, project supervisor reports the results to client. Finally, following the payment procedure in the contract, client should pay to the general contractor on schedules. This process is generally called the construction expense payment.

Therefore, the construction expense payment used in this paper not only means pay the money to contractor, but also means the holistic consideration including related factors concerning with payment process during construction stage (Figure 1).

According to above definition, there are two main elements related to construction expense payment which are the method of construction expense payment and the confirmation of work quantity and quality. Those two factors are clarified separately as following.

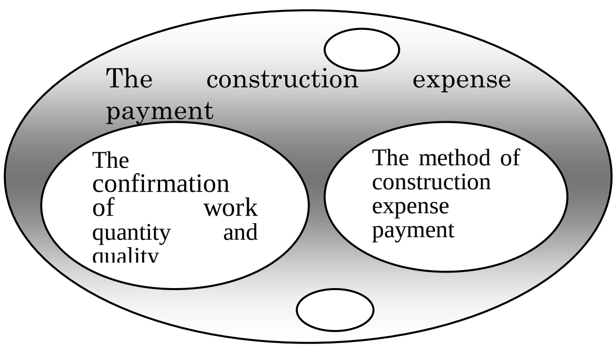

Figure 1: The factors related to the construction expense payment

The legislation about the method of construction expense payment

In China, the methods of construction expense payment are not distinguished clearly between public project and private project, and the contract stipulations of construction projects are the same. In this study, the public project means project which is invested by the government, otherwise project is called the private project.

Basically, the methods of construction expense payment are stipulated in INTERIM METHORD OF CONSTRUCTION EXPENSE ([2004] No.369). The detail descriptions are as follows.

For the advance payment, its description is “If there is no agreement in construction contract, the advance payment will be provided to 10~30% of the construction expense. On the other hand, if there is clear agreement in construction contract, the advance payment will be paid according to the contract”.

There are two methods of the subsequent payment are available. They are, “according to monthly construction quantity payment and milestone payment”. Both of the two methods are stipulated that “60~90% of the completed construction quantity of the present value should be paid”.

And, the description of reserved payment is “the reserved payment is about 5% of the construction expense, and the reserved period is one year”.

In Japan, according to the CONFERENCE NO.1946 OF MLIT [Note1], the methods of construction expense payment of public project are normally following the description “When construction expense of the projects is over 30 million YEN, the advance payment will be provided to 40% of the construction expense”. On the other hand, there is no regulation about the advance payment for private project in Japan.

And, there is no regulation about subsequent payment and reserved payment in Japan. The methods of payment depend on the mutual agreement of contract parties in each project.

In Taiwan Region, the methods of construction expense payment are not described detail as Chinese stipulation, and almost methods are depended on the construction contract. Especially, there are no provisions of payment methods for private project. It is similar to Japan that the methods of expense payment depend on the mutual agreement of contract parties in each project.

For the public project, according to the GOVERNMENT PROCUREMENT METHOD LAW, the advance payment is only stipulated to “In some big public project, the advance payment should be paid only when it is necessary to be paid”.

And, there are no standard provisions of the subsequent payment. The reserved payment is normally provided to be “Less than 5% of the construction expense”, but the reserved period is not described clearly.

The comparison on legislation of the methods of construction expense payment among China, Japan and Taiwan Region is illustrated in Table 1.

Table 1: The comparative on legislation of the methods of construction expense payment

	Public construction			Private construction		
	China	Japan	Taiwan Region	China	Japan	Taiwan Region
Advance payment	□10～30% of the construction expense or according to the contract	□40% of the construction expense	□In some big public construction project, the advance payment is provided only when it is necessary	□10～30% of the construction expense or according to the contract	none	none
Subsequent payment	□according to every month's construction expense □milestone In either method 60~90% of the completed construction quantity of the present value will be paid	□ according to the contract	□according to the contract	□according to every month's construction expense □milestone In either method 60~90% of the completed construction quantity of the present value will be paid	□ according to the contract	□according to the contract
Reserved payment	□5% of the construction expense, and the reserved period is one year	□ according to the contract	□less than 5% of the construction expense, and the reserved period is not provided	□5% of the construction expense, and the reserved period is one year	□ according to the contract	□according to the contract

Note) Author made this table according to INTERIM METHORD OF CONSTRUCTION EXPENSE ([2004] No.369) of China, CONFERENCE NO.1946 OF MLIT of Japan and GOVERNMENT PROCUREMENT METHOD LAW of Taiwan Region

In China and Japan, because the advance payment is provided on legislation, the construction expense which is used on construction materials and equipments by the general contractor is guaranteed. On the other hand, there is no regulation of the advance payment in Taiwan Region. Therefore, the situation of construction expense payment is favourable to the client.

As abovementioned, there are two available methods of subsequent payment in China. However, it is doubt that whether these two methods can accommodate to all kinds of construction projects. On the other hand, in Japan and Taiwan Region, the methods of the subsequent payment are not provided detailed as China, but it is considered that the methods of the subsequent payment can be chosen according to the different characteristics of the projects. That is to say, the methods of subsequent payment in Japan and Taiwan Region are more flexible than those in China.

The State of Art of the methods of the construction expense payment

The methods of the construction expense payment are clarified as abovementioned. But, what the state of art of the methods of construction expense payment will be like. According to the questionnaire investigations and hearing investigations (Questionnaire investigations and hearing investigations) in China, Japan and Taiwan Region, the situations of the methods of construction expense payment in real projects are found as follows.

□ China Almost public projects, the advance payment is provided to 10% of construction expense. On the other hand, there is no advance payment in private projects. About the subsequent payment, not only in public projects but also in private projects, it was only 30~50% of the completed construction quantity of the present value that has been paid. Moreover, the reserved payment is about 3% of the construction expense, and the reserved period is one year or two years in both public project and private project.

□ Japan In public project, the advance payment is provided to 40% of construction expense. On the other hand, there is no advance payment in private projects. The subsequent payment in public project has two payment methods, which are partial payment and interim payment. There is 90% of the completed construction quantity of the present term would be paid by both of the two methods. On the other hand, in private projects, 90% of the completed construction quantity of the present value would be paid every three month. However, there is no reserved payment in both public project and private project.

□ Taiwan Region There is advance payment for public project of construction expense is over 1 billion Taiwan dollars (about 3.5 YEN). Although the amount of the money of advance payment is different from project to project, the figure is normally 10~30% of the construction expense. On the other hand, there is no advance payment in private project. About the subsequent payment, it is 95% of completed construction quantity of half month, one month or two month that has been paid in both public project and private project. Moreover, the reserved payment is about 1~5% of the construction expense, and the reserved period is 1~3years in public project. But in private project, the reserved payment is about 5~10% of construction expense, and the reserved period is 1 year.

The comparison on the state of art for the methods of construction expense payment in China, Japan and Taiwan Region is illustrated in Table 2.

In China, it was only 30~50% of the completed construction quantity of the present value that has been paid for the subsequent payment of both public project and private project. This situation is different with legislation that “60~90% of the completed construction quantity of the present value will be paid”.

Why the subsequent payment is not paid by legislation, and whether general contractor can operate the project well or not by using the little money paid by the client. Moreover, poor construction quality maybe caused by lack of money and possibly leads to the disputes of construction expense payment. It is necessary to discuss and solve these problems in this study.

On the other hand, the methods of construction expense payment in Japan and Taiwan Region are not provided detailed as China. However, in Japan, it is 90% of the completed construction quantity of the present value would be paid in public project, and it is 90% of the completed construction quantity of the present value would be paid every three month in private project. In Taiwan Region, it is 95% of the completed construction quantity of present value that has been paid in both public project and private project. Comparing to China, it is clearly fair to general contractor in Japan and Taiwan Region. In addition, there are less troubles of construction expense payment in Japan and Taiwan Region than those in China.

Table 2: The comparative on the state of art of the methods of construction expense payment

	Public construction			Private construction		
	China	Japan	Taiwan Region	China	Japan	Taiwan Region
Advance payment	□10% of the construction expense or according to the contract	□ 40% of the construction expense	□ There is advance payment in those public projects whose construction expense is over 1 billion Taiwan dollars □ 10~30% of the construction expense	none	none	none
Subsequent payment	□30~50% of the completed construction quantity of that month would be paid	□ partial payment □ interim payment □90% of the completed construction quantity of the present value would be paid	□95% of the completed construction quantity of half month, one month or two month would be paid	□milestone □30~50% of the completed construction quantity of the present value would be paid	□90% of the completed construction quantity of the present value would be paid every three month □ interim payment	□milestone □95% of the completed construction quantity of the present value would be paid
Reserved payment	□3% of the construction expense, and the reserved period is 1~2 years	none	□1~5% of the construction expense, and the reserved period is 1~3 years	□3% of the construction expense, and the reserved period is 1~ year	none	□5~10% of the construction expense, and the reserved period is 1 year

Note) Author made the two tables according to the Reference (Questionnaire investigations and hearing investigations)

The executer of quantity and quality confirmation

In practical, the construction expense will be paid suitably to the completed construction quantity of the present value. But, the construction expense may not be paid because poor quality of construction. Therefore, it is an important factor that quantity and quality confirmation of payment procedure in the construction expense payment.

In China, according to the CONSTRUCTION SUPERVISION ENTRUSTING CONTRACT (GF2002-0202) , it is described to "Not only in the public project, but also in the private project, the Supervisor (Jianli-gongchengshi) cannot take the work if he or she is not employed by the construction supervision company 1 (Jianli-danwei) [Note 2] ", that is to say, if the Supervisor does not belong to the Supervision company 1, he or she can not start to work although he or she has the qualification of supervision.

However, in Taiwan Region, according to ARCHITECT LAW (Jianzhu-shi Law) and TECHNICIAN LAW (Ji-shi Law), the Architects (Jianzhu-shi) or the Technicians (Ji-shi) can be the executer of quantity and quality confirmation. The Architects can take the responsibility of building projects. On the other hand, the Technicians can take the responsibility of civil projects. And, the Architects or the Technicians can do the job, no matter with the Supervision company 2 (Jianzao-danwei). If the Architects and the Technicians belongs to the Architects office (Jianzhu-shi office) or Technicians office (Ji-shi office), he or she still can be the executer of the quantity and quality confirmation.

In Japan, there is no regulation about the executer of quantity and quality confirmation. But, in public project, the inspection staffs designated by client will do the job. In private project, client will do the job by himself.

That means the Architects or the Technicians in Taiwan Region can do their jobs more flexible than the Supervisors can do in China.

According to the questionnaire investigations and hearing investigations (Questionnaire investigations and hearing investigations) in China, Japan and Taiwan Region, it is illustrated the executer of construction quantity and quality confirmation and the comparisons are showed in Table 3and Table 4 separately.

Table 3: The executer of construction quantity and quality confirmation

	China	Japan	Taiwan Region
Contractor	□Supervision Company 1 (Jianli-danwei)	□In public project: government □In private project: none	□Supervision Company 2 (Jianzao-danwei), □Architects office (Jianzhu-shi office) □Technicians office (Ji-shi office)
Executer	□Supervisor (Jianli-gongchengshi)	□In public project: Inspection staff □In private project: client	□Architects (Jianzhu-shi) □Technicians (Ji-shi)

Table4 The comparative of executer of construction quantity and quality confirmation

	China	Japan	Taiwan Region
Business Monopoly	○ □Supervisor (Jianli-gongchengshi) is building business monopoly	×	○ □ Architects (Jianzhu-shi) and Technicians (Ji-shi)are building business monopoly
Difference between public and private construction projects	×	○ □In public project: Inspection staff □In private project: client	×
Difference between business	×	×	×

○ yes × no

Note) Author made the two tables according to the Reference (Li, Furusaka, Kaneta, Yoshida, 2004)

PROCESS OF THE CONSTRUCTION EXPENSE PAYMENT

Following the clarification of the legislation, the state of art for the methods of construction expense payment and the executer of quantity and quality confirmation, the process of construction expense payment in real project should be discussed. According to the questionnaire investigations and hearing investigations (Questionnaire investigations and hearing investigation), the processes of the construction expense payment in China, Japan and Taiwan Region are showed in Figure 2, 3, Figure 4, 5, and Figure 6, 7.

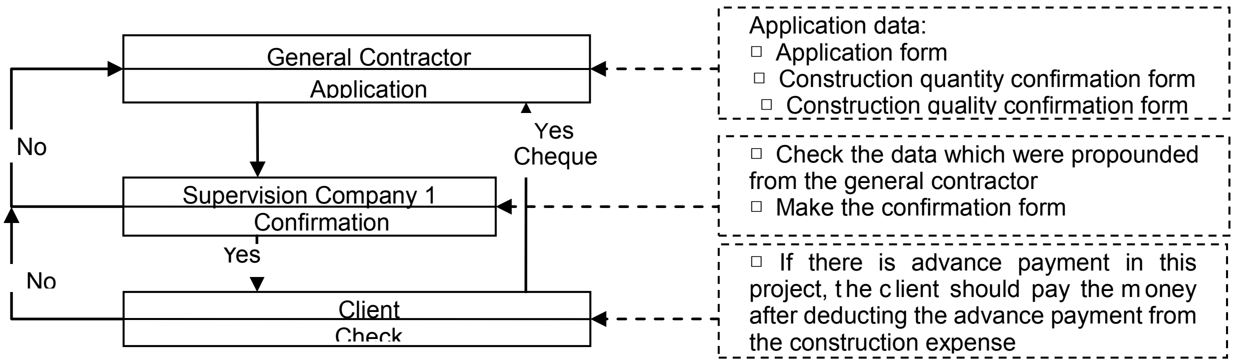

Figure 2 T he process of construction expense payment in general project in China

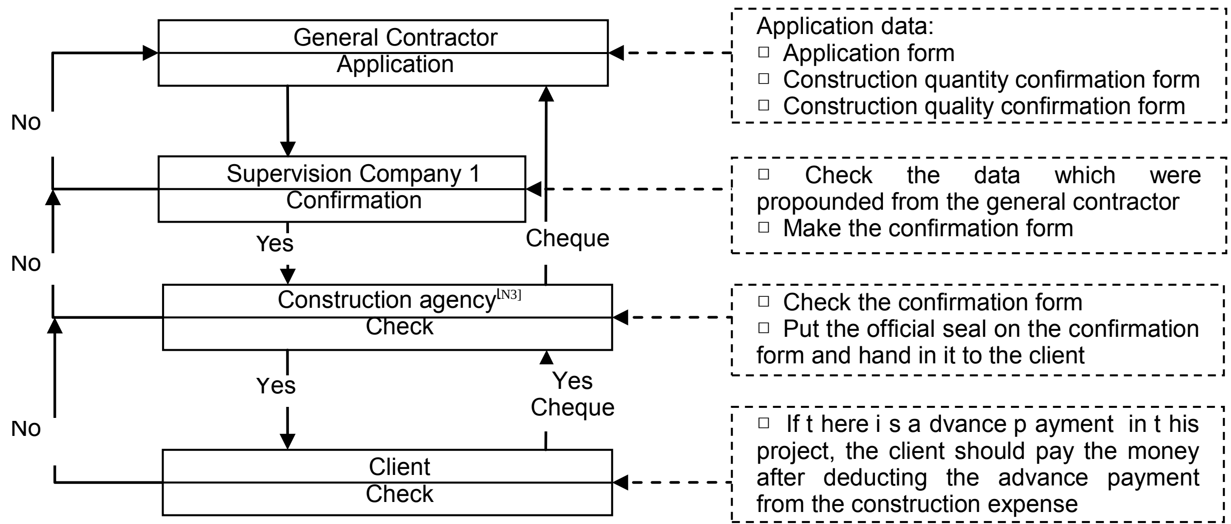

Figure 3 The process of construction expense payment in a part of public project in China

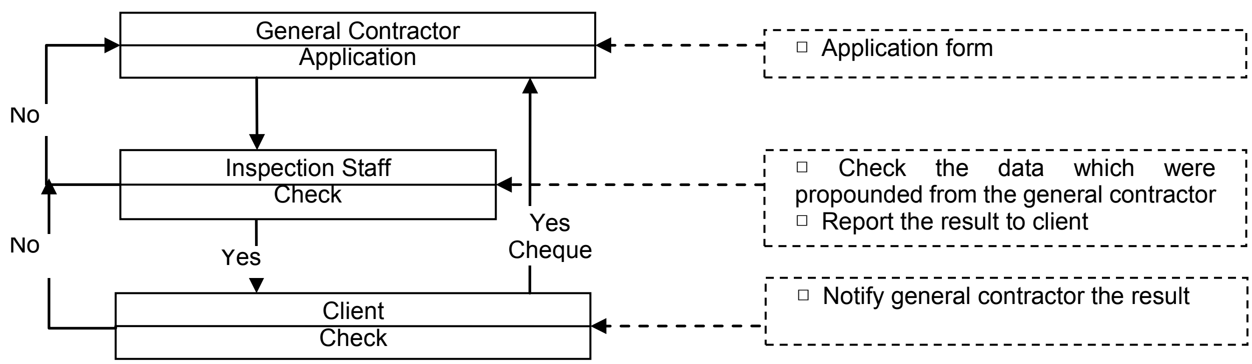

Figure 4 The process of construction expense payment in public project in Japan

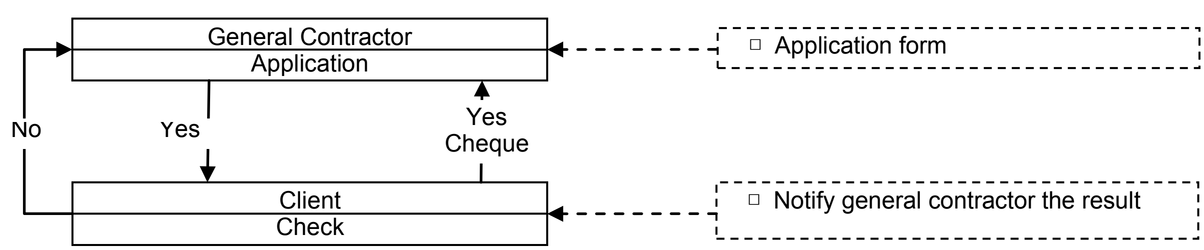

Figure 5: The process of construction expense payment in private project in Japan

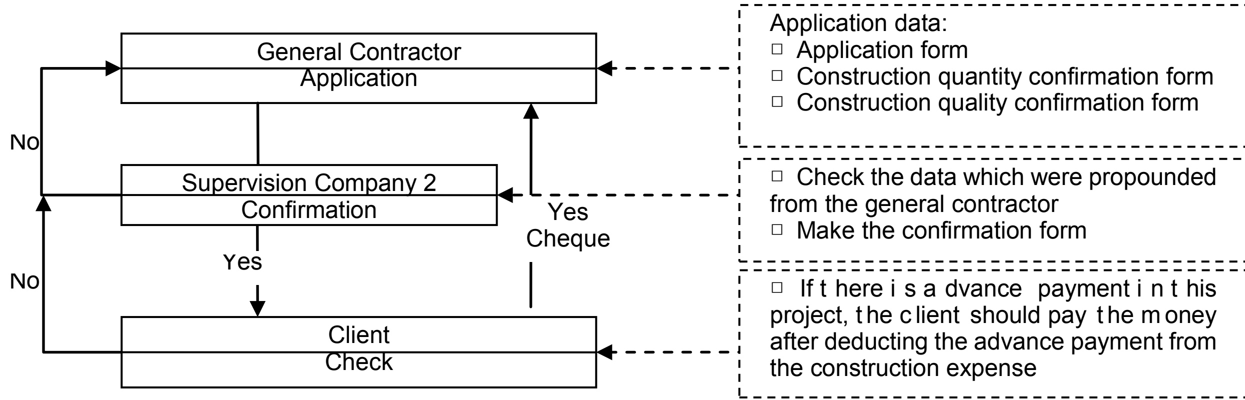

Figure 6: The process of construction expense payment in general project in Taiwan Region

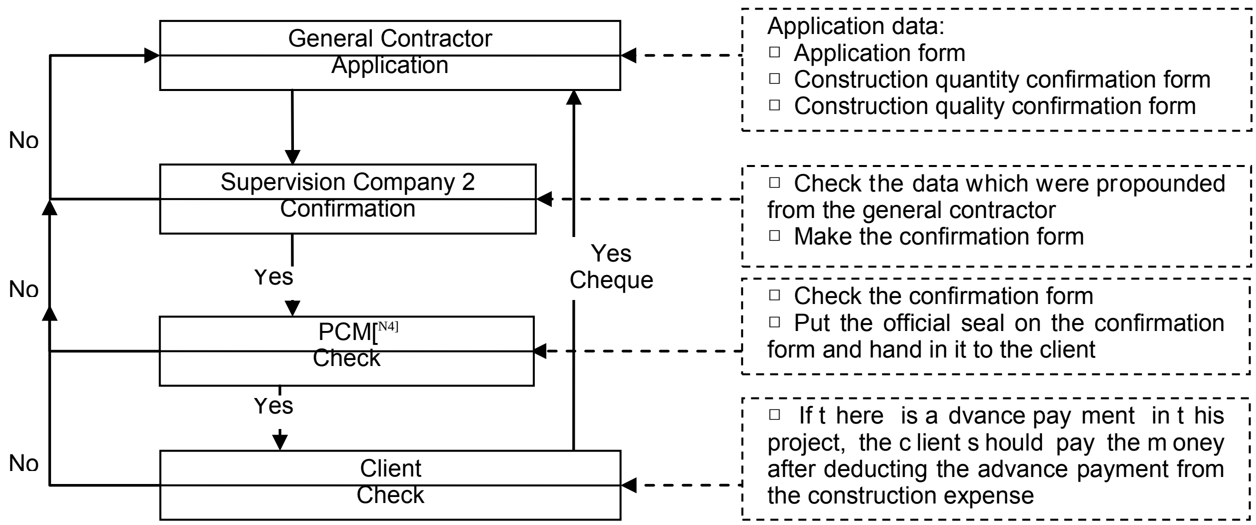

Figure 7: The process of construction expense payment in a part of public project in Taiwan Region

□ China In general projects (Figure 2), Supervision Company 1 makes the confirmation of construction quantity and quality. If confirmation is certified, client will pay to general contractor without through the Supervision Company 1. In most of public projects (Figure 3), the Construction Agency [Note3] is entrusted by client and almost has the same responsibility as client. If confirmation is certified, client should pass the construction payment to Construction Agency at first, and the Construction Agency will pay the money to general contractor.

□ Japan In public project (Figure 4), the inspection staff hired by client will check the data submitted by general contractor and report the result to client. In private project (Figure 5), client will confirm the quantity and quality by himself.

□ Taiwan Region In some of public projects (Figure 7), the PCM [Note4] is used. However, it is not certain whether the PCM can play its role or not until now. This topic may leave to discuss in future study. Normally, the PCM works as a consultant for client as shown in Figure 5. This way of project operation is different with the Construction Agency of China. But the general project as shown in Figure 6, the process is similar to China.

The find out from the figures 2 to 7, including the process of the construction expense payment in Japan is simplest. In other words, in Japan, client and general contractor are trust each other. This situation is better than those in China and Taiwan Region. According to the better mutual trust, it seems that the quality can be secured well.

CONCLUSION

In this paper, the legislation, the state of art for the construction expense payment and the process of construction expense payment are clarified. By comparison, the difference of the methods of construction expense payment in China, Japan and Taiwan Region has been found, and the executer of construction quantity and quality confirmation has been discussed. From these find outs, it is clear that the rights and the responsibilities among the client, the supervisor and the general contractor are ambiguous in China. In addition, the construction market is still immature by now.

The rights and responsibilities of the client are the focuses in the future study, by continually investigating and surveying some benchmarked projects in megacities of China, Japan and Taiwan Region.

ACKNOWLEDGEMENT

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NOTE

[1] MILT: Ministry of Land, Infrastructure, Transport and Tourism

[2] The construction project which not entrust the supervisor will not be discussed in this paper.

[3] Construction agency: professional construction consultative company who can do all jobs for the client

[4]PCM: Professional construction management

REFERENCES

Chinese statistical yearbook (2007)

"Ministry of Housing and Urban-Rural Development of the People's Republic of China", available at: http://202.123.110.3/zhibo5/content_330065.htm

Questionnaire investigations and hearing investigations in China during 2007.3 to 2008.10
Questionnaire investigations and hearing investigations in Japan during 2008.10 to 2009.1
Questionnaire investigations and hearing investigations in Taiwan Region during 2007.11 to 2008.5

Yue Li, Shuzo Furusaka, Takashi Kaneta, Yoshimasa Yoshida, The state of art in Chinese construction industry: A comparative study on construction project management between China and Japan Part 1, Journal of architecture and planning, No.582, pp.101-108, 2004.8

RISK MODEL FOR CONSTRUCTION PROJECTS RISK REGISTER SYSTEM

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One of the first phases of research on risk register was dealing with risk itself and resulted with risk model for construction projects risk register system. The model was developed based on research on existing risk models, risk management process and research and development of construction projects risk management system. After extensive research and testing on case studies we developed the risk model together with construction project risk register system. During this research we found that for better understanding of risk in construction projects and improvement of risk identification in practice we found useful to introduce a term uncertainty level as characteristic of risk to distinguish risk from planned event. This term is used to define risk as uncertain future event with uncertainty level higher than one of planned event which, if activated by driver, will cause consequence which will impact on project success.

KEYWORDS: risk, components, characteristics, risk register.

INTRODUCTION

The recognition of poor knowledge and practice of risk management in construction in Croatia initiated research into the topic at the University of Zagreb, Faculty of Civil Engineering in 1996. It was conducted under two research projects financed by Ministry of Science and Technology[i]. Initially the research was focused on the overrun occurrence. The aim was to get knowledge of qualitative position of construction industry in transition economies regarding the problem of planned budget and time overrun. The research included key project participants who provided initial perspective of the most frequent overrun sources resulting in risk breakdown structure (RBS). Later, the research was oriented towards linking RBS logic and risk drivers. We were investigating which event, issue, or other driver, turned on the risk from the passive to active position, and how the potentially successful project became less successful.

Today, risk management in construction is acknowledged as a very important part of project management and a very interesting subject to write about as well. It is frequently discussed, but the practice is still at an inadequate level. Reasons vary from case to case, from the lack of knowledge to implementation of risk management, or the lack of resources. However, the reasons are mostly related to a poor knowledge of risks per se. Just as humans learn and gain experience from their mistakes and the mistakes of others, so must companies be capable to do so by the use of a "permanent brain" of the company. Among other things, the risk register is considered as a repository of knowledge on risks; therefore aim of our last research phase is to come up with a risk register structure design to be used in construction companies.

One of the first phases of research on risk register was dealing with risk itself. There are many different approaches to risk and it was very important to determine what risk model will be used that is what concept is the most appropriate for construction projects risk register. It was the crucial part of this research since risk register structure directly depends on used risk model.

WHEN RISK IS A RISK?

Term risk is used in different ways, depending on context and purpose. Literature research resulted with conclusion that use of term risk is inconsistent and it is used to be described and explained with other words, such as hazard, danger, threat, uncertainty, probability, likelihood or chance. It has different meaning to different people.

However, the aim of this paper is to determine what risk is for project management, especially construction project management i.e. project risk.

Summarizing most definitions of project risk (Hillson, 2006; Barnes, 1983; Al-Bahar and Crandall, 1990; Kerzner, 2003) we can conclude that it is *future event*, *uncertain*, which can, if happens, have *impact on achieving project objectives* in terms of scope, quality or specifications, time and cost. It is considered as *event* it self, exposure, also with *probability* or product of expected consequences and probability of occurrence. For describing risk authors are using terms as probability, likelihood, chance, frequency and possibility.

Definitions by PMI (2000) and PRAM (Bartlett et al, 2004, p.5) are also focused on uncertain events, conditions or circumstances which is not in line with one of Chapman and Ward (2003) because it does not match when one discuses variability due to lack of clarity or ambiguity. Their definition tries to clarify that project risk management starts with management of sources of uncertainty on the project and state that "risk is an implication of uncertainty on level of performance ......".(p.48) Risk defined in this way is only one criteria of *risk efficiency*, while other *expected value* is one to determine performance outcome that can be expected. Main difference between this approach and other two previously mentioned is that opportunities and threats as well as uncertain events, conditions or circumstance are considered to be parts of uncertainty source and not risk it self.

Smith and Merritt (2002) have defined three main risk directions, which can serve as criteria for determining weather risk "candidate" is controlled or not: *uncertainty*, *possibility of loss* and *time* .(p.8) They argue that without *uncertainty* "candidate" is issue, *possibility of loss* is one of the main reasons of risk management existence, even in situations where real consequence can be turned into gain and *time* determines when danger of risk starts and when it stops otherwise is considered to be more of a permanent issue or nag.

RISK COMPONENTS AND CHARACTERISTICS

For the purpose of better understanding of risk it is necessary to determine and clarify its components. When researching literature it is noticed that different concept and views on risk result in different outlook on components hence different terminology, definitions and clarification.

Main risk component is considered to be **uncertain event**. When we discuss event as project risk component, Risk Management Committee (1992) has definition of risk as any specific identified activity or natural event, which can occur or impact on project outcome or results (pp.20-25). Event is incident or situation, which occurs in specific area and in specific time interval. (Standards Australia, 1995) **Consequence**, second component, is defined as result of event it self. Consequences of risk event in project are expressed depending on project objectives, including time, cost, scope and performance (quality). Third risk component is **cause**, which according to Carter at al (1994) observing from risk management aspect is the most important risk component, because only by influencing causes one can actively manage risk. (p.) Most commonly used risk components are shown in model in Figure 1.

Figure 1: Basic risk model

Two *main characteristics* for risk measurement, which have major role on risk assessment and decision on treatment, are **probability of event** occurrence and nature, **intensity and duration of effects** (CUT, 2000). For the purpose of estimating a possibility for event of risk it is necessary to identify risk drivers, which are defined as specific project characteristics, which can trigger risk event. According the Berkeley and other (1991) risk drivers are observable phenomenon, that are likely to drive possibility of risk consequence which depends, at least in part, on occurrence of this phenomenon.(pp.5-17) Possible risk drivers are identified as project size, location, duration, news, technical conditions, client characteristics etc. By identifying possible drivers it is possible to predict and actively manage project risk.

Risk models, which show basic entry data, way in which they affect and shape risk, consequence manifestation, mechanism and chain of events and finally enable systematic project management, make it possible to completely understand risk and its components.

Smith and Merritt (2002) have shown 4 risk models: simple, standard, cascade and Ishikawa risk model. (p.17-25) I this paper only two will be presented due to paper length limitation.

Standard risk model authors consider the best one for understanding project risk (Figure 2). This model consists of following components:

- *Risk event*– condition or event which causes loss
- *Event driver* – something that exists in project surrounding that can lead up to believe on risk event probability
- *Probability of risk event* – event occurrence probability
- *Impact (risk)* – consequence or possible loss, which can result in case of risk event
- *Impact driver* – something that exist in project environment, which can lead up to a believe in risk impact probability
- *Impact probability* – probability of activity with condition that risk event already occurred

- *Total loss* – size of a real value loss, which appeared when event occurred; measured in days, currency or other measure.

According to authors, this model represents essence in dealing with risk. By changing the event drivers one can reduce probability of event occurrence. Likewise, part related to impact enables development of total loss reduction concept by changing impact drivers, even in case when risk event can not be prevented. According to authors, model's advantage is that it supports relations of cause and consequence, while disadvantage is fact that it allows large time difference between event and action, which should be avoided. It is important to emphasize, regarding this model, drivers as critical information for planning risk mitigation.

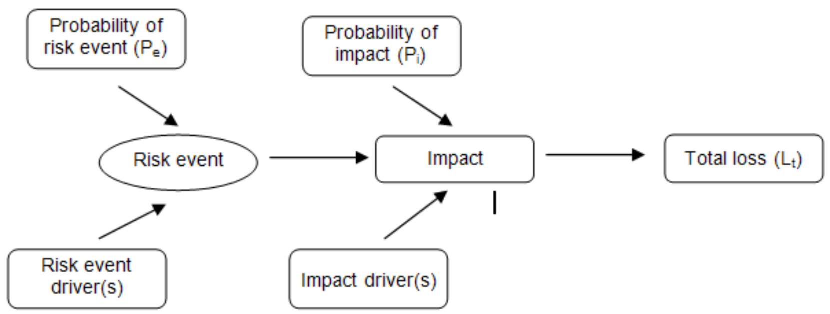

Figure 2: Standard risk model (Original source: Fastrack Training Inc. training material) (Smith and Merritt, 2002, p.)

Cascade risk model is multiphase model in which event causes consequence, which leads up to risk impact, in its simplest form has three phases (Figure 3). This model shows well way in which project risk unwraps because in practice it rarely happens that impact is direct result of risk event. Smith and Merritt consider this model useful when it is needed to analyze several risks due to complexity of links between them or need for detailed analysis.

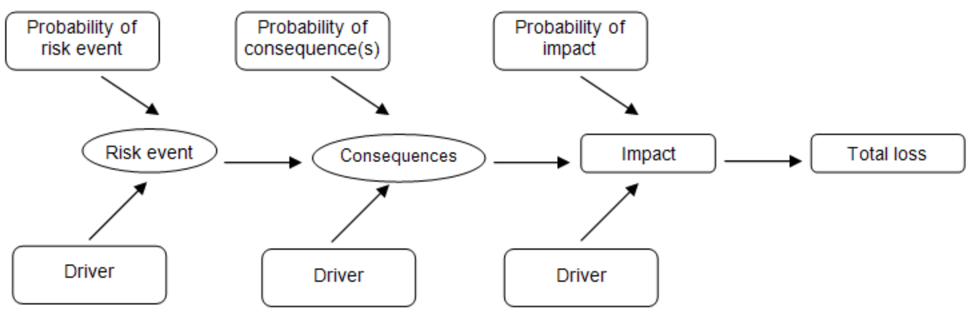

Figure 3: Cascade risk model (Smith and Merritt, 2002, p.)

Next to the source and event, as main three risk components, PMI (2000) sets also trigger sometime called the symptom or warning sign, which represent indicates that a risk has occurred or is about to occur. (p. 133) Risk sources are defined as possible risk categories, which can impact a project in good or bad sense. Usual risk sources are listed as request for change, errors, omissions or misunderstandings regarding documentation, bad defining or misunderstanding the role and responsibility, bad judgments, lack of professional staff. When describing risk sources following data are involved:

- Risk event probability from that source,
- Range of possible outcome,
- Expected time of event,
- Presumed frequency of risk event from that source.

Other component is risk event defined as event which can have impact on project, and described with:

- Probability of risk event,
- Possible alternative outcomes,
- Expected time of event,
- Assumed frequency of event.

Third component is considered to be risk symptoms, also known as triggers and defined as indirect manifestation of real events.

This way of risk modeling is very confusing due to the fact that consequence is included, that is outcome as data with which an event is described with and is not used as separate component. Also, defining probability and risk event frequency is questionable, because describing with one value excludes describing with other. By describing risk source with range of possible outcome it goes over to an area of identification of different risks, which have the same source, other three data are not in line with previous risk source definition.

Hillson (2006) has different, more simplified view on risk. (p.2) He uses basic model consisted out of three components cause, risk and effect. Causes are defined as events or sets of circumstances which exist in the project or its environment, and which give rise to uncertainty. Causes themselves are not uncertain since they are facts or requirements. Risks are uncertainties which, if they occur, would affect achievement of the objectives either negatively (threats) or positively (opportunities). Effects are unplanned variations from objectives, either positive or negative, which would arise as a result of risks occurring. They are contingent events, unplanned potential future variations which will not occur unless risks happen.

Risk model by Carter at al (1994) is shown in Figure 4. This model shows that one risk cause can have more impacts, but also one cause can lead to several risks and impacts attached. (p.17)

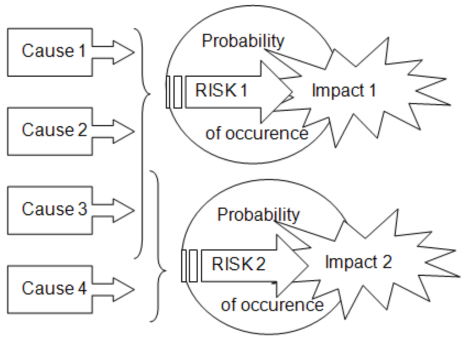

Figure 4: Risk model according the Carter at al (1994)

By levelling driver and cause, this model can be compared with simple risk model (Figure 4) because it does not make difference between probability of risk event and impact that is consequence. In this approach risk life cycle is emphasized as important component, which determines time interval when possibility of risk exists, starting with trigger event till the end of its impact and it consists from generating and active period, which can also overlap.

Generating period is time of factors occurrence, which can lead to risk event, while active period is time needed to implement risk control. Each of them is set by start and finish period dates and project phases which are part of mentioned dates. By further risk defining, Carter et al (1994) state probability law, which describes risk event probability and/or its impact or consequence through time included in active period, which leads to fact that probability of risk event and risk impact can be viewed separately as in standard risk model (Figure 3). (p.52) In this approach term trigger is used, which is defined as event which can be determined by management that will initiate activities in risk management for the sake of diminishing potential impacts of risk event.(p.61) These are temporal events which held project manager to see that situation can lead to specific risk if appropriate measures are not taken. Table 1 enables a comparative view on main risk components with definitions and sources (if applicable).

Table 1: Risk components – terms and definitions comparison

Component	Definition	Source
Event	Any specific identified action or natural event which can occur and impact on outcome or project result	Risk Management Committee (1992)
Event	incident or event which occurred on specific location and in specific time interval	(Standards Australia, 1995)
Event	Condition or event which causes loss	Smith and Merritt (2002)
Event	One that can occur to cause damage or gain to a project	Al-Bahar and Crandall, 1990
Event	occurrence (event) which can impact a project	PMI (2000)
Risks	uncertainties which, if they occur, would affect achievement of the objectives either negatively (threats) or positively (opportunities).	Hillson (2006)
Consequence	Outcome of event itself and is defined in relation to project objectives, including time, cost, scope and execution (quality)	
Action (risk)	Consequence or possible loss which can result in case of risk event	
Effects	unplanned variations from objectives, either positive or negative, which would arise as a result of risks occurring	Hillson (2006)
Cause	one risk cause can have more impacts, but also one cause can lead to several risks and impacts attached	Carter at al. (1994)
Cause	events or sets of circumstances which exist in the project or its environment, and which give rise to uncertainty.	Hillson (2006)
Risk sources	Categories of possible risk event which can impact a project in good or bad sense	PMI (2000)
Risk symptom (trigger)	Indirect manifestation of real risk events	PMI (2000)
Triggers	Event, which can be specified by a management, which will initiate risk management activities	Carter at al. (1994)
Driver	Specific project characteristics which can trigger risk event	
Driver	Seen phenomena which can probably trigger possibility of risky outcome, at least partially, depends on this phenomena occurrence	Berkeley and dr (1991)
Driver	Specific project characteristics which and trigger risk event, such as project size, complexity, location, duration, news, technological conditions, client characteristics etc.	CUT, 2000
Event drivers	Something that exists in project surrounding which leads to possibility of risk event	Smith and Merritt (2002)
Driver	Turns risk from passive into active state	Radujković

RISK MODEL FOR CONSTRUCTION PROJECTS RISK REGISTER

During the research on risk management in construction projects we understood that the main problem to project managers is thinking about risks and understanding risks what it is. The main problem is that they cannot distinguish risk from issue and they cannot differ what is risk and what is source. The literature review showed that risks and models which are representing risks are understood very differently. There are no clear descriptions what risk components and characteristics are. Source and cause are treated as synonyms, as well as consequence and impact. When we talk about risks in construction projects, source and cause can be treated as synonyms which why we casted out cause from our concept. Consequence and impact, on the other hand, have absolutely different meaning and function in this risk model – consequence is component and impact is its characteristic.

Risk model developed during this research is consisted out of five main components which are representing risk mechanism are risk/event, source, driver, consequence and impact. (Burcar 2005) Each of these components is described with their characteristics and therefore together with components, is completely describing risk. **Risk model** arising from this approach is shown at Figure 9. *Event/risk* is central part of the model which represents uncertain event, action or advent which if occurs will cause the consequence. *Source* of risk is defined as human or nature act array from which risk arises, or generates possibility of risk occurrence. It can be within the project or project environment and its important characteristics is *owner* i.e. stakeholder which is why the source exists. *Consequence* is condition, advent or event which will occur only if risk/event occur and affects the project success. The consequence will induce *risk impact* which will affect project objectives. Its main characteristics are *nature, value* and *location* by which is described how the risk will impact project, what project objectives and which part of project, WBS or activity will be affected.

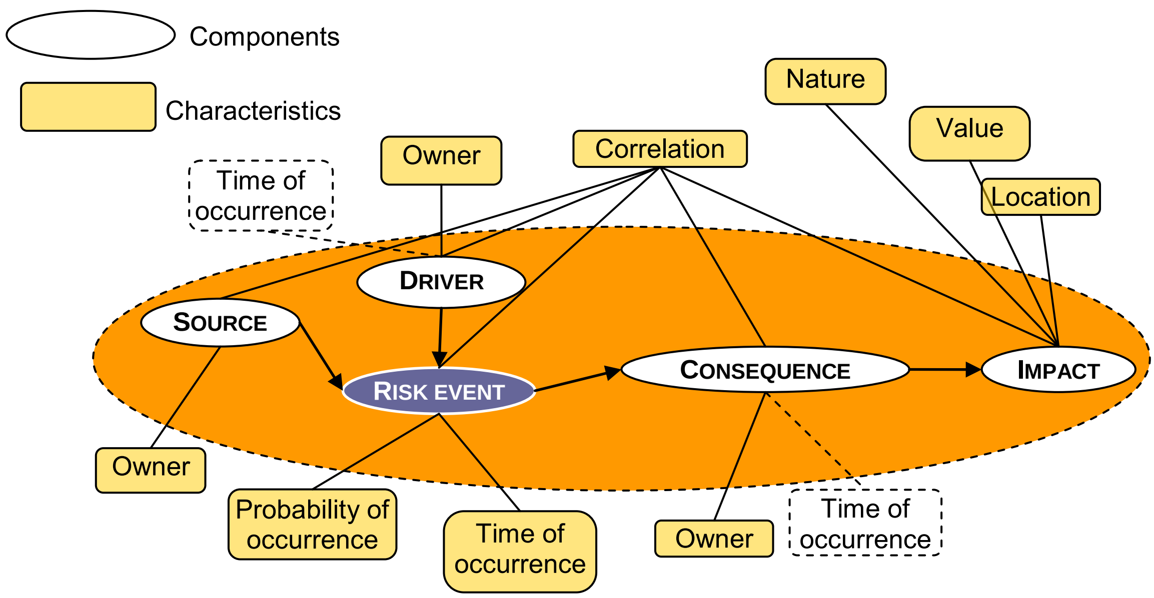

Figure 1: Risk model for construction projects Risk Register

The next risk component is *driver* which can be event or change of condition whose occurrence will activate risk mechanism. It will initiate the transformation risk into the actual event. With its activation risk will stop being risk and start to be an actual event or issue which needs a reaction. Risk can be described as mechanism in latent condition which will be activated only by driver. Driver and consequence also need to identify *owner*, the subject related to these two events. As it is important for risk management process to identify who will be affected with consequence it is at least as that important to know who is owner of source and driver, which enables proactive approach to risk management. *Time* and *probability of occurrence* are characteristics most frequently connected with risk in general but in this model are attached to risk/event as central risk component. Both characteristics could be attached to the driver which activates risk mechanism and time of occurrence to consequence as well. However, time spans between these three components are short and their order is known (driver-risk event- consequence), therefore we didn't want to ballast the model with attaching time of occurrence for all three components. Moreover, it would be better to represent this mechanism with occurrence of the first i.e. driver which starts the whole mechanism, but because of insufficient understanding and utilization of driver in risk mechanism in practice, we decided to link this information to risk event.

The same approach is applied to probability of occurrence, with difference that probability of driver and consequence occurrence can be consider in case of alternative drivers and consequences, but this is done in risk analysis phase using decision tree. *Correlation* is very important part of risk model which characterize the interaction between two risks. In developing this model our intention was to link all risk characteristics with risk components, but in case with correlation we made the exception defining it on risk level instead of component level. Correlation between two risks can include any component of each risk and they together with their interactions are used to describe and define correlation type and mechanism.

During this research we found that for better understanding of risk in construction projects and improvement of risk identification in practice we found useful to introduce a term *uncertainty level* as characteristic of risk to distinguish risk from planned event. Each planned event has certain level of uncertainty which is usually ignored or transferred to determine event in some other way. During each project life cycle phase uncertainty level should be determinate as threshold data between risk and planed event. How? It is not measured only with probability of risk event occurrence, it is given by uncertain nature of event or level of unknown information i.e. limited knowledge on event or advent. Uncertainty level should be lower as project approaches to its closeout phase as knowledge in project rises and it should be subject of top management decision in risk management planning phase. Now we can describe risk as *uncertain future event with uncertainty level higher than one of planned event which, if activated by driver, will cause consequence which will impact on project success.*

APPLICATION AND CONCLUSION

As we mentioned at the beginning, we applied this model to develop risk register for construction projects. As the result we developed Risk Register System (RRS) consisting of two parts, Project Risk Register (PRR) and Central Risk Register (CRR). Project Risk Register has the role of a platform which enables recording risk data throughout the whole risk management process in order to collect data for each construction project and tool for project risk management and communication. Providing continuous risk tracking it can become a medium for communication between project stakeholders. Risk data from all projects are stored in the Central Risk Register. This part of RRS has a function of "repository of knowledge" and a tool for project risk identification, and during long term utilisation it becomes a source for quantitative and qualitative risk data. As a source of data on risk response, tracking and controlling, it enables particular response efficiency evaluation as well as undertaking a consequence-based action.

Data and structure of RRS arise right from this risk model and risk management process; therefore, they involve all risk components and characteristics through all the stages of risk management process. From recording and structuring aspect there are two major groups of data: **project level data** describing project characteristics directly or indirectly related to risks, and **risk level data** describing *risk characteristics and components* necessary for generating information and needed for risk management process. Considering phases through which they are generated, risk data are grouped into three categories **planned (initial) data, monitoring data,** and **actual (final) data**.

Risk data are grouped into 3 groups so the application of the risk register can be performed in 3 stages which differ according to the extensiveness level of risk data and analysis application in risk management. **Required data** are including general data necessary for database functioning, basic, mostly *qualitative data on risk components and response* and all project level data. **Additional data** are closely determining *risk components and their characteristics*, while **advanced data** are including quantitative data for assessment and prioritizing risks, cost benefit analysis of responses and connection with monitoring data.

This RRS with data structure based on risk model enables to easily generate different project risk reports such as various project RBS reports, comprehensive check list for all risk components, risk monitoring reports etc. (Table 2, Table 3)

Table 2: Report example: List of drivers for given type of construction with information on type of work

TYPE OF CONSTRUCTION		
PROJECT CODE	**DRIVER**	**TYPE OF WORKS**
XXX	Driver X	Type of works X
YYY	Driver Y	Type of works Y

Table 3 Risk identification form

PROJECT CODE		PROJECT NAME				
ID	**RBS**	**RISK NAME**	**DRIVER**	**EVENT**	**CONSEQUENCE**	**IMPACT TYPE**
1.	**External**					
1.1.	*Legal*					
1.1.X.	Source X	Risk name X	Driver X	Event X	Consequence X	Impact T X
2.	**Internal**					
2.1.	*Project management*					
2.1.Y.	Source Y	Risk name Y	Driver Y	Event Y	Consequence Y	Impact T. Y

This flexible structure enables its application regardless of risk management level performed. It can be used in organisations with advanced as well as in those with lower risk management practice and knowledge, supporting and directing progress in risk management practice towards complete application. Other than the most common risk characteristics probability of occurrence of risk event and value of impact, identifying for each risk owner of source, driver and consequence will give us information for proactive risk management approach as well as for effective response development. Even at lowest level qualitative data on risk components and response are collected and recorded which are important and valuable data for future risk management actions.

REFERENCES

Al-Bahar, J.F., & Crandall, K.C. (1990). Risk Management in Construction Projects: A Systematic Approach for Contractors, CIB 90 Conference, University of Technology, 14-21 March.

Bartlett at al. (2004), PRAM-Project Risk Analysis and Management Guide, APM Publishing Limited

Barnes, M. (1983). "How to allocate Risks in Construction Contracts". International Journal of Project Management, 1(1),

Berkeley, D., Humphreys, P.C., and Thomas, R.D. (1991). Project Risk Action Management. Construction Management and Economics. pp.5-17

Burcar, I. (2005). Risk register structure for construction projects. Faculty of Civil Engineering, Department of Construction Management and Economics. Zagreb, University of Zagreb. M.Sc. thesis.

Chapman, C.B. & Ward, S.C. (2003), Project Risk Management: Processes, Techniques, and Insights, London: John Wiley & Sons, Ltd.

Curtin University of Technology - CUT (2000), Risk Management (RM641), School of Architecture, Construction and Planning

Flanagan, R. and Norman, G. (1993), Risk Management and Construction, Oxford: Blackwell Science Ltd.

Godfrey, PS (1996) Control of Risk – A Guide to the Systematic Management of Risk from Construction. London: CIRIA.

Hillson, D. (2006), When risk is not a risk, Project Manager Today

Kerzner, H. Ph.D. (2003), Project Management – A System Aproach to Planning, Scheduling and Controlling, London: John Wiley & Sons, Inc.

Radujkovic, M (1999) The Causes of Cost and Time Overruns in Construction Projects. In: Bowen, P and Hindle, R (Ed.), 9th International Joint Triennial Symposium W65/W55/W92, 5-10 September 1999, Cape Town: Conseil International du Batiment CIB, 223-235.

Smith, P.G. & Merritt, G.M. (2002), Proactive Risk Management – Controlling Uncertainty in Product Development, New York: Productivity Press.

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ARCHITECTS' ROLES TAKEN IN DESIGN AND CONSTRUCTION STAGE: BUILDING CONSTRUCTION PROJECTS IN JAPAN

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In former days, the high quality buildings were realized constantly in the construction projects participated in by the architects in Japan. Today, while the legal system has been enacted to ensure the further quality confirmation, there occur many construction defects. First purpose of this study is to show the architects' roles and the typical methods taken in the projects participated in by the architects. Second one is to consider how consistent such methods are under the present legal system and how to make use of such methods. The following are the main findings. Firstly, the former architects took three parts of roles in the projects participated in by the architects. They are a designer, a design manager and a construction manager. Secondly, there are three issues to make use of such architects' practice in today's situations. We also show three suggestions to confront the issues under the present legal system.

KEYWORDS: architect, constructor, drawings and specifications, communication.

INTRODUCTION

In Japan, the high quality buildings have been built in the design-build process by general contractors and the traditional process, in which separate organizations take design and execution of the work, and so on. In the traditional process, Ministries, Offices and local government might take design as public works. Design firms might take design too. Many high quality buildings have been realized in the projects participated in by the architects too. How were such projects progressed concretely?

On the other hand, in recent years, the Structural Documents Scam Issue happened and then the Building Standards Law and the *Kenchiku-shi* Law were revised. A *Kenchiku-shi* is a designer or a building engineer who has a national qualification. By the *Kenchiku-shi* Law, he/she has the exclusive rights of designing and *Kouji-Kanri*. *Kouji-Kanri* is, as defined by the law, to check the executed works with drawings and specifications and to confirm whether the works are executed according to the drawings and specifications. In actual services/tasks, *Kouji-Kanri* is a concept which includes 'supervise' and 'inspect' in the U.S.A. and the U.K.

The No. 15 bulletin of the Ministry of Land, Infrastructure, Transport and Tourism was put out in January, 2009 as revision of the No. 1206 bulletin of the Ministry of Construction put out in July, 1979. Such bulletins were aimed at providing the standards of fees for service of *kenchiku-shi*. Thus, it has been tried to make the legal system more orderly (Hirano and Furusaka, 2008). However, there are gaps in sharing of roles and responsibilities and defects in quality (Furusaka and Hirano, 2008) although the systems of sharing of roles and responsibilities and quality confirmation have become more strictly. This may not be the only way to confirm quality of buildings. It is also necessary to study the methods of quality confirmation in the projects participated in by the architects.

This study has two aims. First one is to show the architects' roles and typical methods taken in the former projects participated in by the architects in Japan. Second one is to consider how consistent such methods are under the present legal system, which have gotten more strictly and how to recognize such methods.

JAPANESE ARCHITECTS

In Japan, until the Edo era, the design-build process by a master builder of wooden construction was the main project delivery system (Hashimoto, 1995). The master builders pulled carpenters together, and built houses, temples and shrines in Japanese traditional method of construction. The master builders performed not only designing buildings but also constructing them in person. It can be said that the origin of architects in Japan is the master builders (Fujii and Tsurumaki, 1997). In the Meiji era, a concept of "architect" was imported from Europe and the U.S.A. Architects came to be trained in the department of architecture at Engineering University, the following Tokyo University (Yamamoto, 1980). A professional institute was also established by imitating RIBA (Royal Institute of British Architects) and AIA (the American Institute of Architects).

The architects' service in these days was "Guide and Supervision" type. Mainly in public works, the architects designed buildings and also had broad responsibility and authority thorough a construction process as the Architects/Superintendents, who were commissioned by the owners. The architects, who were educated in modern architecture supervised and directed even execution of the work because constructers were poor at ability and knowledge of modern architecture.

The more modernized the building industry was, the more developing and multiple techniques of architecture became. Constructers' ability of site work management also improved. After the World War Ⅱ, in the rapid economic growth era, demand of buildings, especially private buildings increased rapidly. The number of architects were inadequate to perform the service as "Guide and Supervision" type. As a result, site work management by constructers themselves became more important. The architects' service had changed into "Recognition of Constructers' Assurance" type. In "Recognition of Constructers' Assurance" type, architects perform design and *Kouji-Kanri*. About execution of the work, they recognize results of site work management by constructers themselves. (Ministry of Construction, Housing Bureau, Building Guidence Division, 1984). See Figure 1.

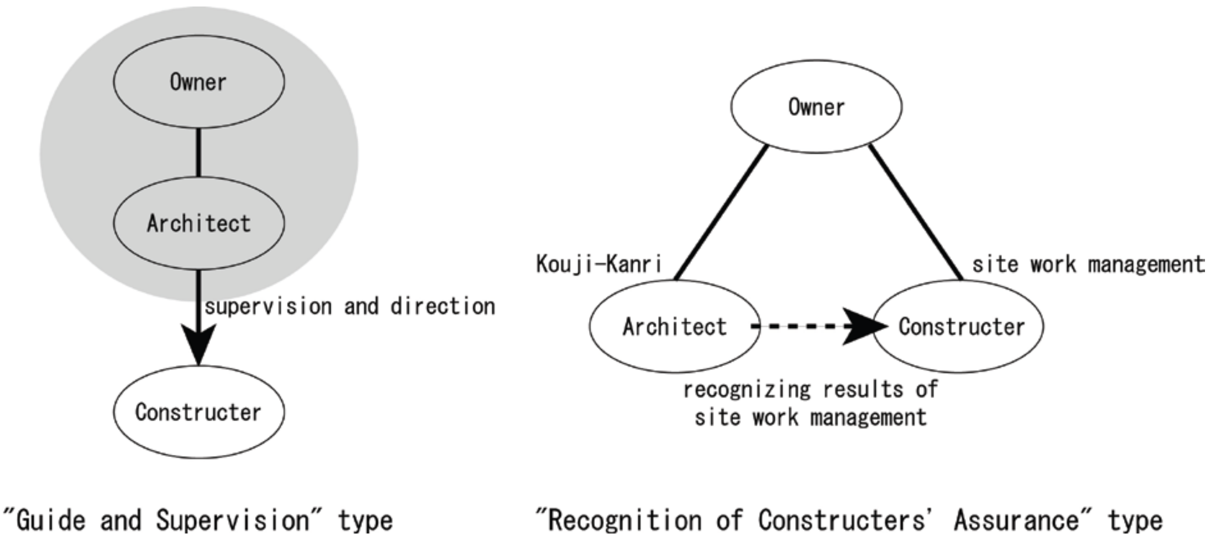

Figure 1: Two Types of Architects' Service

ARCHITECTS' ROLES

Three Roles

Based on some interviews (Fujii, Tsurumaki, 1997), we give three roles of the architects taken in the former projects participated in by the architects. First one is a designer. Second one is a design manager. Last one is a construction manager.

Firstly, the architects took a role as a manager. Some architects designed detail in person. Other architects showed basic concept and direction of design, and then staff of the architects' firms designed materially and made drawings.

Secondly, the architects took a role as a design manager. The architects supervised staff of their firms, and then coordinated and put staff's design together. When staff of the architects' firms and constructers made drawings from the architects' schematic design, the architects confirm the drawings and gave instructions.

Lastly, the architects took a role as a construction manager. Some architects tried to realize the buildings faithfully to their design. Other architects made much of quality confirmation in the construction stage. Such architects actively participated in not only design but also execution of the work. Especially when owners asked the architects to design through direct selection, some architects participated in the projects from the programming stage.

It depends on each architect what roles they took and what roles they made much of. Concerning the same architect, there seems to be some changes accompanying changes of the legal system and social situations. Anyway, it is considered that they are between "Guide and Supervision" type, which started in the Meiji era and "Recognition of Constructers' Assurance" type, which became the main style after the World War Ⅱ.

Comparison with Architects in the U.S.A. and the U.K.

As was stated above, AIA and RIBA, the architects' professional institutes in the U.S.A. and the U.K., exerted great influence on Japanese architects. However, 'architect' is a commonly used name and has no legal corroboration in Japan. On the other hand, architects have the exclusive right to the name. How about to compare such architects in Japan with in the U.S.A. and the U.K.?

AIA is the largest architects' professional institute in the U.S.A. and was established in 1857. RIBA is the largest architects' professional institute in the U.K. and was established in 1834. A charter was given to RIBA in the U.K. in 1837. These professional institutes have made a system of education and qualification and regulated for practice in the U.S.A. and the U.K. In the Mandatory Code of Ethics to members, it was provided that they should exercise unprejudiced and unbiased judgement on their behalf. It was not allowed architects to engage in building contracting till the early 1980s. After that the ban on contracting was removed and architects became able to engage in design-build process. However, a rule was adopted that an architect should disclose conflicts of interest to clients and that the circumstance is accepted by them.

In Japan, State made an educational system and consequently professional institutes were established. Early Japanese architects engaged in construction unifying into the owners as the Architects/Superintendents, who were commissioned by the owners. A feature of Japanese architects, who have such history, is that they are lack a consciousness of an agent for a client. Furthermore, in Japanese construction process, contents and range of practice of design, *Kouji-Kanri* and construction are fuzzy. So it is difficult for architects to have independent standpoints of constructers. However, following methods which designers collaborate with constructers and confirm quality of buildings arose thus. The Bridging method was developed by imitating such methods.

METHODS OF PROJECTS PARTICIPATED IN BY ARCHITECTS

We assume that there are the standard drawings and specifications in the traditional process in Japan. Then we can classify the methods of the projects participated in by the architects into two types based on how far to make drawings and specifications. See Figure 2. In Japan, drawings and specifications are defined in the Building Standards Law as "drawings and specifications which are required to execute the work to construct a building (excepting full size drawings and such drawings)". The No. 15 bulletin of the Ministry of Land, Infrastructure, Transport and Tourism gives more detailed kinds and names of drawings. However, there is no reference to what drawings and specifications are required concretely.

In the practice with the standard drawings and specifications, designers design and make drawings and specifications in the design development stage and the construction document stage. Based on the standard drawings and specifications, a contract with a general contractor is made and the works are executed to realize drawings and specifications. In the construction stage, *Kouji-Kanri* is performed by a *Kouji-Kanri sha.* A *Kouji-Kanri sha* performs *Kouji-Kanri* and he/she must be a *Kenchiku-shi*.

One of the typical method of the projects participated in by the architects is "Papers Communication" type. In this type, designers make full size drawings and detail drawings surpassing the standard drawings and specifications. They even examine and suggest construction methods. Thus, they confirm quality of the buildings. Another one is "Human Communication" type. In this type, designers start collaboration with constructers in the design stage. The designers attached much importance to shop drawings and directions on a building site. Thus, they confirm quality of the buildings. Practically, many architects make projects progressed in a method which is between these two types, namely in a method which have features of the two types.

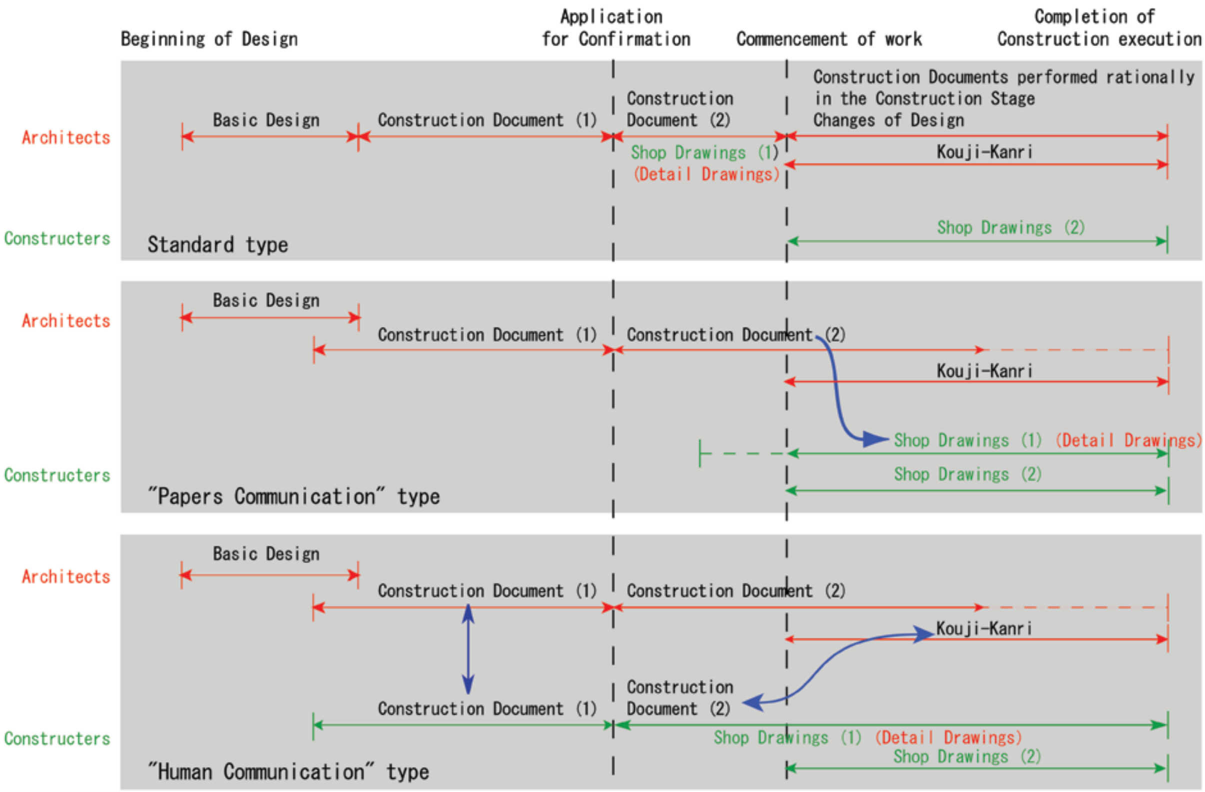

Figure 2: Two Types of Architects' Methods

MAKING USE OF METHODS IN TODAY'S SITUATIONS

Issues

In today's situations, there is three issues to make use of methods of the former projects participated in by the architects.

Firstly, in such practice, it was assumed that design is also performed in the construction stage. However, it has become difficult to continue to design in the construction stage like a conventional practice. At the active Building Standards Law, if we want to change contracts of buildings which have finished the Application for Confirmation, we must perform the Application for Confirmation again, except for small changes which are provided by the bulletin of the Ministry of Land, Infrastructure, Transport and Tourism. In Japan, we must not commence any works before the Application for Confirmation. Meanwhile, the present fees for design are not enough to continue design in the construction stage. It is necessary to clarify design in the construction stage as change of design, and thus to gain fees for that service. In this connection, based on some interviews (Furusaka, Hirano, 2008), it is almost the actual conditions that after selection of general contractors, they make shop drawings and designers consider them. Therefore details are designed and the Application for Confirmation is performed.

Secondly, in the direct employment process, the architects once had much broader responsibility and authority as owners than today. Such “Guide and Supervision” type practice of the architects has changed through professional differentiation after the World War Ⅱ and is seldom found in the today’s construction projects. Under the active legal system, the roles which were once taken by the architects in “Guide and Supervision” type practice are shared between architects, owners, construction managers, site work managers and special constructers. On the other hand, there is some influence of “Guide and Supervision” type practice upon the standard form of contract agreement.

Lastly, it is not strictly defined what should be made as drawings and specifications and what should be performed as *Kouji-Kanri*. Techniques of architecture have developed. A number of mechanical services and special constructers has increased. Projects have become larger scale. Therefore, a numbers of drawings and specifications to construct buildings has increased. Moreover, there is considerable difference between constructers’ ability. There is the typical methods of the former projects participated in by the architects as the types mentioned above. However, each project’s method was very various. If what should be made as drawings and specifications and what should be performed as *Kouji-Kanri* are not shown clearly, gaps in sharing of roles and responsibilities and some services left behind will possibly swell up. On the other hand, if they are shown, the architects’ roles in some methods will not be consistent with the present legal system.

Suggestions

We give three suggestions to confront the three issues mentioned above under the present legal system and to make use of such methods in today’s situations.

Firstly, if design is also performed in the construction stage, it is necessary that designers make a design agreement with owners on such assumption. In the agreement, it should be shown clearly for what design will be performed in the construction stage. Constructers also have to negotiate with owners about ways to change costs and time of completion when design is performed in the construction stage. Moreover, in drawings and specifications, designers should write what and how design will be performed in the construction stage clearly. The No. 15 bulletin of the Ministry of Land, Infrastructure, Transport and Tourism defined “the standard service of making construction documents which is performed rationally in the construction stage”. The contents are the following. The first one is question and answer and explanation to tell constructers what designers intend exactly. The second one is consideration and advice from designers’ standpoints to select materials and mechanical services.

Secondly, if an organization has ability to perform “Guide and Supervision” type service by itself, such organization provide that it has responsibility and authority like owners in a *Kouji-Kanri* agreement with owners. However, in fact, organizations which have such ability may be very few. It is more practical that owners, designers, general contractors and sub contractors, who share services of “Guide and Supervision” type practice, cooperate systematically. Therefore the same organization is able to participate in construction projects from the design stage to the construction stage as the Architects/Superintendents. Communication between designers and constructors is also done there.

Lastly, it supposes that the model of drawings and specifications and the manual of *Kouji-Kanri* are prepared. After how far to make drawings and specifications and what should be performed as *Kouji-Kanri,* designers and *Kouji-Kanri sha* will make an agreement about their service taken in each project. Today in Japan, the standard forms of contract agreement are about design service and *Kouji-Kanri* service. So design service has to be divided into basic design, detailed design and design in the construction stage on the standard forms of contract agreement. *Kouji-Kanri* is also to be ramified. Then each contract will be made about each service. Therefore, sharing of roles and responsibilities will be clarified and become more flexible under the legal system.

CONCLUSIONS

In this paper, we studied the architects' roles taken in the former projects participated in by the architects and considered the issues and the suggestions to make use of such architects' practice in today's situations. The main findings are the following.

(1) The former architects took three parts of roles in the projects participated in by the architects. First one is a designer. Second one is a design manager. Last one is a construction manager.

(2) There are three issues to make use of such architects' practice in today's situations. First one is that design was assumed to be also performed in the construction stage. Second one is that the architects once had much broader responsibility and authority like owners. Last one is what should be made as drawings and specifications and what should be performed as *Kouji-Kanri* are not strictly defined.

(3) We gave three suggestions to confront the issues mentioned above under the present legal system. First one is that if design is also performed in the construction stage, designers have to make such design agreement with owners. Second one is who share services of "Guide and Supervision" type practice will f cooperate systematically. Last one is that the standard forms of contract agreement should be prepared for more detailed service.

In the future study, we want to consider the practice more concretely in the former projects participated in by the architects.

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APPENDIX

[1] The authors had interviews with four members of staff of the architects' firms and two constructers between July, 2008 and February, 2009. We would like to take this opportunity to express our deepest gratitude for them.

[2] The authors discussed at the workshop on a model for cooperative design and practice between July, 2008 and March, 2009 in Kyoto.

REFERENCES

Fujii S., Tsurumaki S. (1997) Track of Architects' Profession in Japan: Until Establishment of JIA: Kensetsutsushin Shimbun

Furusaka S., Hirano Y. (2008) Mechanism of Ensuring Quality and Open Seam/Failure Model for Building Construction Project in Japan –Preparation work of comparative study on mechanism of ensuring quality among Japan, China, the South Korea and Taiwan–: Proceedings of 1st Symposium on Comparative Study on Mechanism of Ensuring Quality among Japan, China, the South Korea and Taiwan, pp.59-65

Hashimoto T. (1995) Historical Change and Diversification of a Building Construction Process (2): Research Institute on Building Cost, RIBC, pp.32-41

Hirano Y., Furusaka S. and Egashira T. (2007) To Ensure Quality under the Multi-layered Structure of Construction Project Teams, AIJ, Proceedings of 23th Symposium on Building Construction and Management of Projects, pp. 287-292

Hirano Y., Furusaka S (2008) Institutional Framework and Standards for Building Project Administration in Japan: Proceedings of 1st Symposium on Comparative Study on Mechanism of Ensuring Quality among Japan, China, the South Korea and Taiwan, pp.23-28

Koma K., Furusaka S., Kaneta T., Hirano Y. and Egashira T. (2008) The Fragility in the Building Delivery System Thorough the Construction Failures: Journal of Architecture and Planning, AIJ, 73(623), pp.183-190

Ministry of Construction, Housing Bureau, Building Guidence Division (1984) Kouji-Kanri of Buildings: Japan Federation of Architects & Building Engineers Association

Nishino S. (2008) Study on Profession of Architects Based on Removing of the Ban on Contracting in Design/Build Contracting Issue in the U.S.A and the U.K., AIJ, 73(633), pp.2461-2466

Nishino S. (2008) Study on Design/Build Contracting Issue in the U.S.A. and the U.K. and Contractor-Designer Issue in Japan, AIJ, Proceedings of 24th Symposium on Building Construction and Management of Projects, pp. 83-88

Yamamoto M. (1980) Architects and Profession –What is profession of architects–: Seibun-sha

PRIVATE AND PUBLIC REQUIREMENTS IN CONSTRUCTION: INFLUENCE ON PROJECT MANAGEMENT

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Three groups of requirements can always be recognised in the realization of construction work: requirements of the client (private sector), requirements of regulations (public sector) and requirements of the project management system. Many requirements, such as the requirements relating to construction and other products built into the project, and requirements relating to individual parts of the project, and to the project as a whole, actually form a set of requirements that can be characterized as the totality of the client's requirements relating to the quality of the future facility. In public sector, the planned facility must meet the following six basic requirements (mechanical resistance and stability; fire protection; hygiene, health and environmental protection; safety in use; noise protection; energy savings and environmental protection). Requirements of the project management system are rules that have to be followed in order to meet the needs of the private and public sectors and in accordance with appropriate standards.

KEYWORDS: project management, basic requirements.

INTRODUCTION

Three groups of requirements can always be recognised in the realization of construction work:

- requirements of the client (private sector)
- requirements of regulations (public sector)
- requirements of the project management system.

Requirements of the client can be put down in a few words: the client wants his construction work to be done in due time, within the budget and in keeping with proper quality standards.
Requirements of the regulations can briefly be explained as the need to make the construction work compliant with some requirements that have to be fulfilled in order to protect public interest.
Requirements of the project management system are rules that have to be followed in order to meet the needs of the private and public sectors and, at the same time, to make certain that parties to the Project are performing their tasks efficiently, on time, and in accordance with appropriate standards.

REQUIREMENTS OF THE PRIVATE SECTOR

REQUIREMENTS RELATED TO THE QUALITY OF WORK, COMPLETION TIMES AND CONSTRUCTION COST

In general terms, the investor (client) sets its requirements regarding the quality of construction work through the design (1) which is an integral part of the construction contract (2). The design has to contain all data about the properties of construction products that are built into the building/built facility, requirements for linking these products into technical and/or functional entities including the ways in which they are linked together, so that the resulting entities can have appropriate technical properties. The design also sets the way in which all these technical and/or functional entities are united into a single construct we call a building or a built facility.

Many requirements, such as the requirements relating to construction and other products built into the project, and requirements relating to individual parts of the project, and to the project as a whole, actually form a set of requirements that can be characterized as the totality of the client's requirements relating to the quality of the future facility.

In the scope of these deliberations, we have to take into consideration the position of the investor (client) as related to its role after completion of the construction work.

In fact, according to one scenario, the client can be just the orderer of the work, i.e. the entity that orders the construction work either on its own behalf or on behalf of someone else. When acting in this capacity, the orderer submits to the contractor its design in form of a very detailed order with quality requirements. Here the contractor can not influence the designed quality of the construction work. In some cases, the client deliberately selects quality standards that are below those normally applied on similar construction projects. In this event, the contractor can not influence the quality of work (except at his own detriment) for the benefit and satisfaction of end users who are in fact real purchasers of the construction work. In this situation, one of the basic of the quality management (3) assumptions - user satisfaction - is brought into question.

The situation is somewhat different when the client is at the same time the end user of the construction project. In this situation we can also differentiate between two cases: in the first case the contractor is building the project based on its own design and so the contractor is also well aware of the desired level of quality. In the second case we have the situation orderer = end user where (just like in the previously described case) the quality requirements are defined in the design. Here the quality requirements will probably be somewhat more stringent as the client is ordering the construction work for himself.

It is quite logical that the client will also place appropriate requirements relating to completion times. Depending on the investment plan related to construction of a facility, and the obligations the client may have to some third parties (if for instance it is a manufacturing facility that has to start operating at a specific date), the client will place very strict requirements as to the respect of completion times.

It is however understandable that completion times may be changed, either due to unexpected on-site events, or because of some unpredicted (and unpredictable) conditions encountered during construction.

The third significant element which is an integral part of every construction contract is the price to be paid by the client for building the facility. Once the contract has been awarded and after negotiations regarding contract details have been finalized, including the price of individual works and the total price, the client rightfully expects that the facility will be built with the budget defined in this way.

Depending on the type of contract, the initial price may be subsequently modified to some extent, particularly if it becomes necessary to perform some works that have not been included or foreseen in the design (for instance, due to inadequate design, unexpected occurrences on the construction site, or unexpected conditions encountered during construction). The situation in which the price is changed due to some additional requests formulated by the client is however beyond the scope of this paper, as in this case we have an agreed change, initiated by the client, the price of which is separately negotiated between the parties.

DOCUMENTS ON THE QUALITY, COMPLETION TIMES AND CONTRACT PRICE

In order to check whether his investment is progressing as anticipated, and to see whether the quality of the work is in accordance with the contract, the client will insist on getting appropriate evidence on the fulfilment of requirements regarding the quality, completion times and price.

As to the quality of the facility, the client will require documented information about the type of construction products that have been ordered and installed or incorporated in the facility that is being built for him, and also the evidence that the products are compliant with the design requirements. As to technical and/or functional parts of the facility, the client will require evidence that the construction or other products are joined together in an appropriate way and, if necessary, he will require that such parts of the facility be tested to check whether they meet requirements set in the design. The same procedure will be applied for connection of individual parts into the final entity, i.e. into an overall facility made for the client.

As to meeting deadlines and building within the budget set in the contract, the client will certainly require submittal of documents proving that the works that had to be completed in a previous period have actually been completed, and that the related payment can be made. As the inflow of money allocated for construction work follows a certain predetermined pattern that the client has adjusted to the progressive payment of works, the completion of planned work must be documented in order to properly monitor fulfilment of contractual obligations, and to avoid situations in which unplanned work must subsequently be carried out due to faulty monitoring.

REQUIREMENTS REGARDING PERSONNEL, TECHNICAL CAPABILITIES AND OTHER CRITERIA BY WHICH CONTRACTOR'S ADEQUACY IS MEASURED

During the contractor selection process, one of significant criteria for choosing the most favourable contractor will be its capability to realize the facility the client wishes to build. In this respect, the client will require, prior to contract award, extensive data about the personnel, technical capabilities and other contractor capability parameters that the client deems to be important for realization of his facility. The client will probably also exert some influence on the selection of key personnel to be included in the realization of the project.

Subsequently, during realization of the project, the client will probably also monitor whether the contractor to whom he has awarded the contract has maintained its capabilities (or even improved these capabilities, if such requirement was adopted during the contract award negotiations).

REQUIREMENTS OF PUBLIC SECTOR

REQUIREMENTS RELATED TO THE PLANNED FACILITY'S COMPLIANCE WITH RELEVANT LAWS AND REGULATIONS

This group focusing on public sector requirements can partly be regarded as similar to the client's requirements regarding quality of the planned facility.

In public sector, the planned facility must meet the following six basic requirements (mechanical resistance and stability; fire protection; hygiene, health and environmental protection; safety in use; noise protection; energy savings and environmental protection). In the Republic of Croatia the seventh requirement to be met by planned facilities (equally significant as the six above mentioned requirements) is their accessibility to people with reduced mobility. In addition, the facilities must meet the location requirements, i.e. requirements relating to the locality or site on which the facility will be built. These requirements are defined in keeping with the properties and planned use of the facility.

As these conditions and requirements are mandatory, they are independent of the will or wishes of clients relating to the quality of the facility (in fact, these requirements may be met by a higher quality facility as well as by the inferior quality facilities).

However, as the compliance with legal requirements is in many cases measured by the parameters that are similar to those for measuring quality of either some parts of the facility or of the facility regarded as a whole, it is safe to say that in this segment the client's requirements are similar to public sector requirements, although the requirements set by the public sector represent the lowest limit, i.e. the limit below which no approval can be granted.

COMPLIANCE RELATED DOCUMENTS

In the sphere of the above described compliance of planned facilities with requirements set in laws and regulations, it is quite understandable that the public sector also requires an appropriate proof that the compliance has been achieved.

In this respect, the contractor is required to create evidence on the construction site, i.e. to keep and safeguard the site diary and other required documents throughout the construction period, and to present such documents during the final inspection of the facility, prior to delivery of the use permit. These documents are the proof that the facility has been built in full compliance with requirements set during the building permit delivery process.

To this end, some legally required on-site actions must be taken with respect to construction products and their properties that are relevant for fulfilment of requirements significant for the facility (i.e., usually not all properties that are asked for in the design). Firstly, the contractor has to check whether the construction product supplied to the site is backed by appropriate technical instructions for the placement/installation of such product. Furthermore, the contractor must check whether the declared values furnished for such products are compliant to those set in the design and, finally, whether the shelf (storage) life of construction products has expired.

In order to prove that he has made all these checks, the contractor must make an appropriate record in the site diary, and must file relevant documents together with other on-site documents. After that, the supervising engineer approves placement/installation of this construction product by making an appropriate record in the site diary.

As to technical and/or functional entities that have to be assembled, based on design requirements, on the construction site, the contractor is required to record in the site diary conditions prevailing on the site during realization of works on the said entity, and to make checks if checking is required for such entity (e.g. measurements, sampling, analysis of samples, etc.). In the end, the contractor must test technical and/or functional entities if that activity is specified or defined in the regulations or in the design. All these activities must be documented by making an appropriate record in the site diary, while documents relating to measurements, testing, analysis, etc. must be filed and stored together with other documents that must be kept on the site.

CAPABILITIES OF CONTRACTOR AND PERSON IN CHARGE OF THE CONSTRUCTION SITE

The public sector has also set requirements relating to the contractor, in his capacity as the legal or physical person that builds a facility/structure, as well as requirements relating to persons that bear certain responsibilities for activities taking place on the construction site.

As to contractors, a licensing system (4) has been established in the Republic of Croatia by which the capability of a contractor (measured through the number of employees and their qualification structure) is related to the value of the facility that is being built.

As to persons in charge of the construction site, the public sector has set requirements relating to persons directing the construction work (i.e. leading all activities that are taking place on the site) and to those directing some of the works, as well as requirements for the supervising engineer, in his capacity as the person responsible for controlling work done on the construction site. All these persons must meet requirements relating to their qualifications, work experience, and knowledge of relevant laws and regulations.

REQUIREMENTS OF THE PROJECT MANAGEMENT SYSTEM

The project control/checking is an integral part of project management activities, which in other words means that every step or point in project management will most probably have an appropriate control mechanism.

Despite their differences, various approaches to project management generally coincide in the following assumptions (5):

- every project is managed in an integrated manner, i.e. appropriate mechanisms are established in order to identify, define, combine, unify and coordinate various project management processes and activities, which includes actions needed to:

  - formalize integral parts of the project or of individual parts of the project,
  - define requirements to be met by the project,

    - document all activities that are needed to define, prepare, integrate and coordinate all lower-level plans into the project management plan,
    - realize activities defined in the project management plan, so as to meet requirements defined in the document which sets the scope of the project,
    - monitor and control processes through which the project is initiated, planned, realized and completed, so as to meet efficiency objectives defined in the project management plan,
    - consider all requests for changes and approval of changes, and control changes relating to deliverables and process management issues,
    - complete all activities related to all project management process groups, in order to formally end the project or a project phase.

- every project is managed with regard to its scope, i.e. management activities are focused on processes that are needed to make sure that the project includes all works and activities, but are however limited to only those works and activities that are strictly necessary for successful completion of the project, which includes actions needed to:

    - prepare the project scope management plan so as to document how the scope of the project will be defined, verified and controlled, and how the WBS will be prepared and defined,
    - prepare a detailed statement about the scope of the project, which will be the foundation for decision making during implementation of the project,
    - divide greater project deliverables and assignments into smaller more manageable parts,
    - formalize acceptance of completed project deliverables,
    - control changes in the scope of the project,

- project progress management, i.e. management of processes needed for timely completion of the project, which includes actions needed to:

    - identify time-dependent activities that have to be carried out to enable submittal of appropriate project deliverables,
    - identify and document the dependence among individual time-dependent activities
    - estimate the type and quantity of resources needed to realize each of the time-dependent activities
    - estimate the number of time periods needed to realize each of the time-dependent activities
    - analyze the dependence, duration and resources for all time-dependent activities, as well as relevant time constraints, in order to prepare the project programme
    - control the project programme changes.

- costs are also managed during realization of the project, i.e. processes related to the planning, estimation, analysis and checking of costs are managed so as to avoid cost overruns, which includes actions needed to:

    - prepare cost approximations for resources that are needed to carry out activities on the project

- group together estimated costs of individual activities or groups of activities in order to define the basic price
- influence factors that bring about cost changes, and control project cost changes

- project quality management, i.e. management of all contractor's activities that define quality policies, objectives and responsibilities, so that the project can actually meet the needs that gave rise to its realization, which includes actions needed to:

    - identify relevant quality standards and define the way in which these standards will be respected
    - apply systematic and well planned quality-related activities so as to ensure realization of all processes that are needed to meet the requirements
    - monitor appropriate project results so as to determine whether they are compliant with relevant quality standards, and identify ways to eliminate reasons for inadequate performance

- management of human resources is also needed in the scope of the project, with processes for project team organisation and management, which includes actions needed to:

    - identify and document individual roles in the project, including responsibilities, reporting requirements, and preparation of the staff management plan
    - add staff as necessary for proper completion of the project
    - improve competencies and interaction among team members in order to enhance effects of the project
    - monitor efficiency of team members (including an appropriate feedback), solve outstanding issues and coordinate changes to enhance effects of the project

- management of project communication requirements, i.e. management of resources needed for adequate and timely generation, collection, distribution, storage, reuse and final storage of project data, which includes actions needed to:

    - identify the project participants' needs in the sphere of communication and information submittal
    - provide on time all available information to participants in the project
    - collect and distribute efficiency information - including progress reports, progress monitoring activities and forecasting
    - communication management in order to meet requirements and solve outstanding issues with participants in the project.

- the risks likely to jeopardise the project are also managed during realization of the project, i.e. risk management processes are conducted during the planning, identification, analysis, response study, monitoring and control of the project, which includes actions needed to:

    - decide how to approach, plan and implement risk management practices on the project
    - determine which risks can have impact on the project, and document properties of such risks
    - define risk priorities to enable subsequent analysis, i.e. assessment of risk or risk combinations and probability of their occurrence and possible effects
    - make numerical analysis of effects the identified risk can have on the overall project objectives

    - carry out activities needed for the identified risk monitoring, for the solved risk monitoring, and for identification of new risks and implementation of risk response plans, as well as for evaluation of their success in the course of realization of the project.

- management of acquisition and supply activities on the project, i.e. management of processes for the supply or acquisition of products and services, or the results of such services when they are outside of the scope of work of the project team, and are required for completion of work on the project, which includes actions needed to:

    - identify what to ask for and deliver, and determine when and how to do it
    - document products, services and results, and identify potential suppliers
    - gather information, bid offers, tenders or proposals, as appropriate
    - analyse bids, select potential suppliers and negotiate written contracts with every supplier
    - manage contracts and purchaser & supplier relations, check the supplier's past and present efficiency to define corrective actions and to ensure future relations with the supplier, manage contract changes and (when appropriate) manage contract relations with purchasers external to the project.

MUTUAL INFLUENCE OF THE REQUIREMENTS

It can be concluded from previous analyses that some of the project management requirements are quite similar for both private and public sector operators. It is therefore quite clear that there will be an interaction among these requirements, and that project management practices will have to be adjusted, for every facility which is a single and one-time project (6), to concrete requests of the clients and the public sector. At that, it can be said that adjustments to client's requirements will be more versatile than adjustments to laws and regulations, as the latter ones are less subject to changes.

In the scope of integral project management requirements, project management practices will have to adjust to requirements of private and public sector operators and this through individual project management segments, as explained in the following text.

Requirements relating to project scope management practices will have to adjust to the client's requirements in the segment in which decision is made about WBS. In fact, as we here have the division of greater project deliverables into smaller more manageable parts, these project deliverables with have be adapted to the client's expectations about the time sequence/schedule of project deliverables, and the same will also apply to formalization of acceptance procedures for project deliverables.

The situation is quite similar in case of public sector requirements, which usually apply to individual portions of facilities, and these portions are regarded as entities whose compliance with laws and regulations can easily be assessed.

The second field of project scope management practices which have to be adjusted to the client's requirements is the control of changes in the scope of the project. In fact, as the project scope is directly related to the content of construction contracts, it is quite clear that the control of changes in project scope has to be adjusted to the requirements set by the clients.

Similarly, as the construction of man-built facilities is subject to approval by the construction authorities (public sector), the building permit implies that the approval has been granted for a specific scope of the project. Thus if we wish to change the scope of the project we then again have to ask for approval of a changed situation, and so the management of changes in project scope still has to be conducted in accordance with requirements specified in laws and regulations.

In the sphere of management relating to time scheduling of projects, the adjustment to the client's requirements is necessary as the client has specific plans for the financial and other monitoring of the project. Therefore, the time-dependent activities that have to be conducted to obtain specific project deliverables will have to be realized in keeping with the client's plans.

Similar principles will also be applied for controlling changes as related to the duration and resources of all time-dependent activities and time limitations, as changes in the programme of the project will have to be made in compliance with the client's plans.

The project cost management is yet another element that will be influenced by the client's requirements relating to the need that the project be completed with the planned budget. This especially concerns cost control, i.e. influence on factors that generate changes in cost, and the control of changes in the budget set for the project.

As to project quality management, this activity is directly related to the client's requirements as set in the design for the facility. Therefore, the activity aimed at identifying which quality standards are relevant is directly influenced by the design document which serves as the basis for construction of the facility. Furthermore, the quality control procedure, i.e. the monitoring of some results in order to determine if they are compliant with relevant quality standards, and to identify ways to eliminate causes of unsatisfactory effects, will have be made in the way set by the designer through the Quality Assurance and Quality Control Program contained in the design document (1), and also by the client in the construction contract.

The situation is similar in the sphere of public sector requirements relating to compliance of facilities to provisions set in laws and regulations. In fact, as explained above, the compliance of the facility can in a way be based on quality requirements (i.e. on quality criteria), and so conclusions on the need to adjust project quality to the client's requirements can also be applied to requirements valid in public sector.

As to the management of human resources, i.e. in the segment of organisation and management of project teams, adjustments will be needed to take into account the client's requests regarding the persons participating in the realization of the project. Similarly, provisions set in laws and regulations relating to contractor's capabilities, and to the persons in charge of the construction site, will also influence the way in which human resources will be managed in the scope of project management practices.

The management of processes needed to ensure appropriate and timely generation, collection, distribution, storage, reuse and final storage of project information, will also be influenced by the client's requirements and, in this segment, the project management practices will have to be adjusted to such requirements.

As to the public sector requirements, the management of communication practices will have to be adjusted to appropriate requirements relating to submittal of various applications and conduct of various procedures, both in the phase prior to construction (procurement of building permit and other permits) and in the phase of construction and use (communication with construction authorities and inspectorates, procurement of use permit, etc.).

The project risk management will have to be adjusted to the client's requirements to the extent the project-related risks are important to the client.

In fact, in construction contracts, the project realization risks can be divided in many ways among participants in the project. Accordingly, the greater the risk management zone controlled by the client, the more the risk management activities will have to be adjusted to the client's requirements.

In the segment of supplies and acquisitions for the project, the adjustment will have to be made with respect to design requirements, and so we have here simultaneous adjustment to private and public sector requirements. In fact, in the segment in which the required properties of building products and other products, technical and/or functional entities or facilities regarded as a whole, are related to quality, the adjustment is related to private sector requirements. However, in the segment in which these requirements are related to compliance to laws and regulations, we have a simultaneous adjustment to private sector and public sector requirements.

CONCLUSIONS

Construction is a traditionally regulated field in which both private and public sector requirements have always been present (the client always requires quality consistent to his investment and, similarly, building authorities always require the facility to be compliant with appropriate reliability criteria). That is why specific activities required by the tradition, regulations, as well as business rules and practices, are applied in the way that influences the project management system, and so the latter has to adjust to requirements set by the client (private sector) as well as by the community (public sector).

At that, it should be noted that adjustment to client's requirements will be needed in a greater number of cases, and that it will be more versatile when compared to the need to adjust to requirements set in laws and regulations, as the latter are less susceptible to change.

REFERENCES

Law on Physical Planning and Construction (Official Gazette No. 76/07 and 38/09) (in Croatian).

Law on Obligatory Relations (Official Gazette No. 36/05 and 41/08) (in Croatian).

HRN EN ISO 9001:2002 Quality Management Systems - Requirements (ISO 9001:2000, EN ISO 9001:2000). National Office for Standardization and Metrology, 2002 (in Croatian).

Law on architectural and engineering operations and activities in physical development and construction practices (Official Gazette No. 152/08) (in Croatian).

A Guide to the Project Management Body of Knowledge, Third Edition (PMBOK Guide). Project Management Institute, Inc., Pennsylvania, USA, 2004.

Radujković, M., Project Leader, Građevinar 52 (2000) 3, 143-151 (in Croatian).

EXPERIENCES CONCERNING THE INTEGRATED MANAGEMENT SYSTEM IMPLEMENTATION IN CONSTRUCTION COMPANY AND BUILDING

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In contribution there is presented structure of Integrated Management System (IMS) according to international standards ISO 9001:2008, ISO 14001:2004 and STN OHSAS 18001:2008, which consists of 3 management systems focused to quality, environment and safety of building processes. The purpose of paper is describe basic steps concerning the development of IMS. There is used analysis of basic processes of IMS like company vision, IMS planning, implementing, monitoring, revive and improving. There is including basic documents concerning the IMS as result of IMS standard analysis. Special part of contribution is IMS planning and brief steps of environment and safety risk evaluation and management. This methodology was successfully implemented into 20 Slovak construction companies. Author on the bases of practical experiences during the process of IMS development and implementation in construction firms and buildings informs about effects influenced by this management system during the process of building planning and realization.

KEYWORDS: management, system, quality, environment, safety.

INTRODUCTION

One of the most important factor for construction company to be successful on market is assuring :the quality and reliability of buildings, health and safety of all employees, the quality of environment on site and in region, where building is construct. The key for effective management of all these aspects is development and implementation of effective *Integrated Management System* (IMS) in construction company. In contribution there is presented structure of *Integrated Management System (IMS)* according to international standards ISO 9001, ISO 14001 and OHSAS 18001, which consists of 3 management systems: Quality Management System (QMS) according to ISO 9001:2008, Environmental Management System (EMS) according to ISO 14001:2004 and Health Protection and Safety Management System (HPSMS)according to STN OHSAS 18001:2008. Author on the bases of practical experiences during the process of IMS development and implementation in construction firms and buildings informs about effects influenced by this management system during the process of building planning and realization. Development, implementation and improvement of effective integrated management system (IMS) in construction companies can lead to quality production improving, safety of all employees of construction company, application of all national and international standards concerning the environmental aspects and finally to customer satisfaction. It is essential, that IMS must be understand and implement by all employees. IMS is not aim, but way to satisfaction of construction company clients, better work conditions of company employees, success on market and reputation in own country and abroad.

1. DEVELOPMENT OF IMS

During the process of IMS development is useful start with QMS according to requirement of ISO 9001, because most of the documents required by this standard is possible implement also for next two management systems: EMS and HPSMS. The basic processes of EIMS are in table 1. The whole process of IMS development starts by input audit of existing company system (FIG 1). This audit can be provided by trained employee in all three management systems, or by external qualified expert. The result of this input audit is

level of confidence of existing management system of construction company to requirements of ISO 9001, ISO 14001 and OHSAS 18001. The key person in whole process of IMS development and implementation has director of construction company (Szalayová, 2004). This person is responsible for vision of his company defined in IMS by:

- quality policy,
- environmental policy,
- health and safety policy.

All employees of construction company must be inform about these policies and try to keep it in practice.

Director of company determines one person of top management for function: manager of IMS. This person is responsible for development, implementation and improvement of IMS. Manager of IMS must be trained in all three management system before starting his or her work at this very important function.

During the process of IMS planning is useful start with QMS and analyse of all processes according to ISO 9001 (Jarský,1996), create interaction of these processes, approve quality documents and forms of future records (see table 2). The most important steps concerning the development of EMS are :

- design of register of environmental aspects and impacts in all important areas of company: administrative building, machine park, buildings etc. (example of environmental aspects – emissions to air, releases to water and land,, waste and by products etc.)
- determination of environmental aspects and impacts with high and middle level of risk,
- setting of environmental targets for aspects with high and middle level of risk,
- determination of programme, how to meet environmental targets.

During the process of HSMS we can go by similar way:

- design of register of dangers and threatens in all important areas of company: administrative building, machine park, buildings etc. (example of dangers and threatens - mechanical, physical, chemical, biological etc.)
- determination of dangers and threatens with high and middle level of risk,
- setting of health and safety targets for dangers and threatens with high and middle level of risk,
- determination of programme, how to health and safety targets fulfil.

Table 1 Model of IMS

N.	Basic processes of IMS	SUBPROCESSES		
		QMS (ISO 9001:2008)	EMS (ISO 14001:2004)	HSMS (STN OHSAS 18001:2008)
01.	**Construction company vision**	Quality Policy	Environmental Policy	Health and safety Policy
02.	**IMS Planning**	1. QMS processes analysis 2. Interaction of QMS proce-sses 3. Legislation 4. Quality targets 5. Quality Plans	1. Analysis of environmental aspects and impacts 2. Registration of law and other requirements 3. Risk evaluation 4. Environmental objectives and targets 5. Environmental programme	1. Identification of dangers and threatens 2. Registration of law and other requirements 3. Risk evaluation 4. Health and safety objecti-ves and targets 5. Health and safety programme
03.	**Implementation and operating of IMS**	1. Resources, roles, responsibility and authority of employees 2. Competence, training and awareness of employees 3. Communication 4. Documentation 5. Control of documents 6. Operational (building) control 7. Emergency preparedness and response		
04.	**Checking, corrective and preventive action**	1. Monitoring and measurement 2. Evaluation of compliance 3. Nonconformity, corrective action and preventive action 4. Control of records 5. Internal audit of IMS		
05.	**Management review**	Management review of IMS		
06.	**Improving of IMS**	Continually improvement of IMS due to its analysis		

QMS - Quality Management System
EMS - Environmental Management System
HSMS- Health and Safety Management system
IMS - Integrated Management System

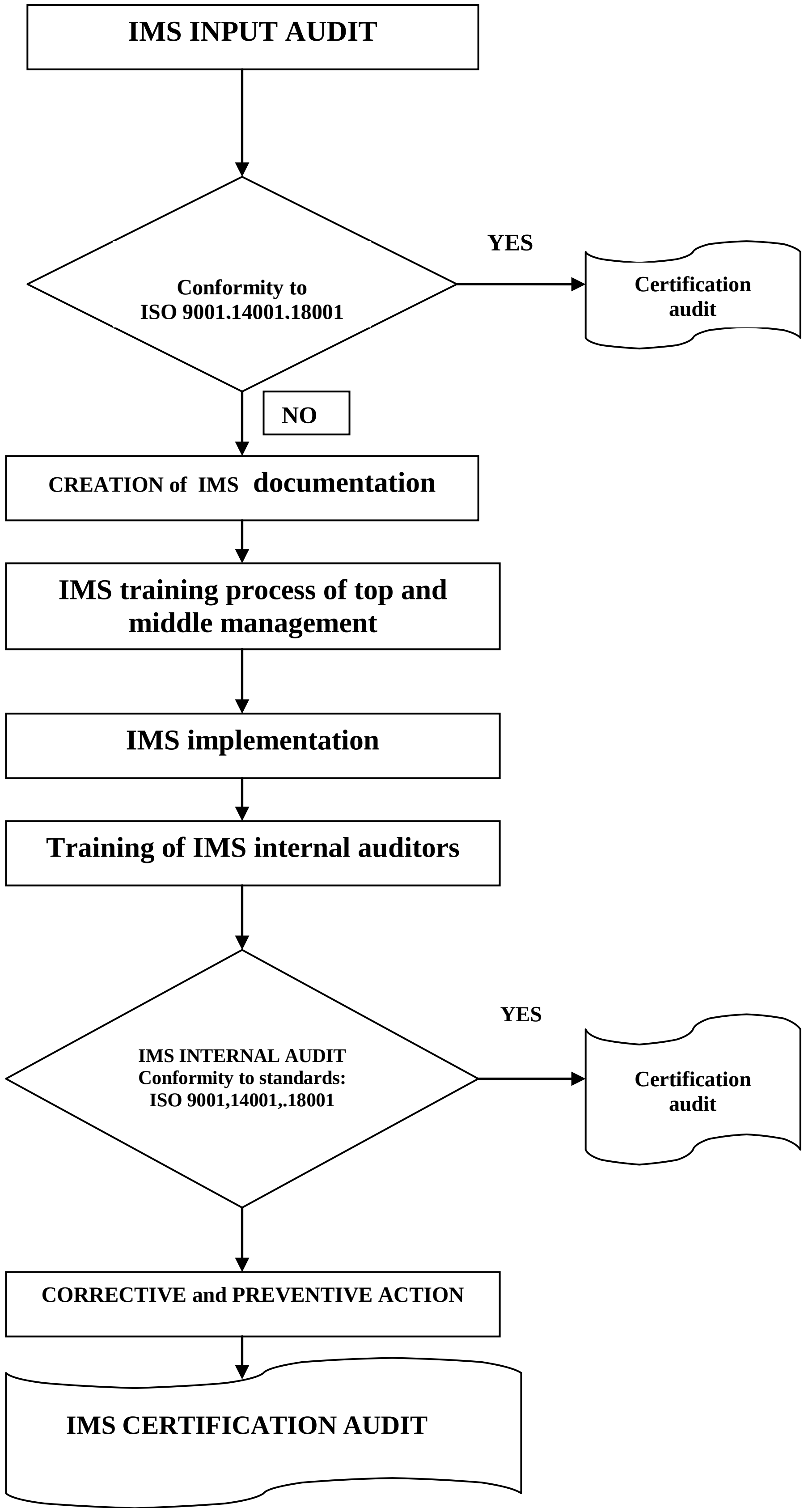

Figure 1: Basic steps concerning the IMS development

2. IMS DOCUMENTATION

The basic document of integrated management system is IMS manual, in which are described these information:

- profile and basic information about construction company,
- organization vision including quality, environmental, health and safety policy ,
- organizational structure with presentation of all key employees including representative person for IMS,
- brief description and interaction of QMS processes with reference to related documents (procedures, internal instructions, QMS documents and records etc.)
- brief description of elements and processes of EMS and HSMS with reference to related documents (procedures, internal instructions, EMS and HSMS documents and records etc.)

In organizational instruction are except of organizational structure said competences (responsibilities and authority) of all company members in area of all three management systems.

All, by ISO 9001 required work procedures, like control of documents and records, internal audit, control of nonconformity, corrective and preventive actions, can be implemented for all management systems. In table 2 there is list of documents and records required by ISO 9001:2008. Those documents and records, which can be used also for next two management systems, are signposted by symbol IMS.

For EMS are useful except of IMS manual procedures concerning the environmental aspects related to building processes and site conditions. For HSMS is useful health and safety building manual, in which are described necessary health and safety preventive actions for building employees.

The basic documents concerning the quality, environment, health and safety monitoring on building is *inspection and test plan*, in which are described these information:

- brief description of quality, environment , health and safety tests,
- quality, environment , health and safety criterion (legislation, law, notices, European and state standards),
- the result of tests (conformity or non-conformity to criterion)
- name, datum and signature of persons responsible and competent for test realization and evaluation.

3. IMS PLANNING AND RISK EVALUATION

One of the most important document on building site is Project Quality Plan (PQP) and its part Inspection and Test Plans (ITP). The content of these documents is in Figure 2. The most important steps concerning the development of EMS and HSMS are described in chapter 2.Risk evaluation “R” depends on probability of incidence of environmental aspect and impact (EMS) and dangers and threatens (HSMS):

$$\mathbf{R = P.C} \qquad \mathbf{(1)}$$

where:

R - environmental or safety risk

P - probability of incidence of environmental aspect and impact (dangers and threatens) – see table 3

C - consequence to environment and to health of employees –see table 4

Table 2: List of IMS documents and records (Gašparík, 2005)

N.	Document or record	Document or record description	Responsible person
01.	D –IMS 4.01	List of documents and records	IMS MANAGER
02.	D 4.02	Interaction of QMS processes	IMS MANAGER
03.	R –IMS 4.03	Distribution list of documents and	IMS MANAGER
04.	R – IMS 4.04	Declaration about document study	IMS MANAGER
05.	D- IMS 4.05	List of internal and external operating documents	IMS MANAGER
06.	D – IMS 4.06	Overview of organization readings	IMS MANAGER
07.	R – IMS 4.07	Document remark	IMS MANAGER
08.	R – IMS 4.08	Overview of document changes and revision	IMS MANAGER
09.	D 5.01	Strategy of quality management and improvement	Director, IMS MANAGER
10.	D–IMS 5.02	Quality, environmental, health and safety policy	Director, IMS MANAGER
11.	D–IMS 5.03	Quality, environmental, health and safety targets	IMS MANAGER
12.	D –IMS 5.04	Decree (certificate) for IMS manager	IMS MANAGER
13.	R –IMS 5.05	Records of management consultation	IMS MANAGER
14.	R –IMS 5.06	IMS management review	IMS MANAGER
15.	D –IMS 6.01	Competences of organization employees	Personnel manager
16.	D–IMS 6.02	Plan of employee training	Personnel manager
17.	R–IMS 6.03	List of trained people	Personnel manager
18.	R–IMS 6.04	Evaluation of training process effectiveness	Personnel manager
19.	R–IMS 6.05	Records from internal training process	Department manager
20.	D–IMS 6.06	Infrastructure of organization	Economist Director
21.	R–IMS 7.01	Contract review	Director
22.	R 7.02	List of material needs	Site manager
23.	R–IMS 7.03	Selection and evaluation of material and work suppliers	Purchaser
24.	R–IMS 7.04	Evidence list of monitoring and measuring devices	Person responsible for metrology
25.	R–IMS 7.05	Evaluation of software topicality	Employee working with software
26.	R–IMS 7.06	Inspection and test plan	Site manager
27.	R–IMS 7.07	Building effectiveness evaluation	Site manager
28.	R–IMS 8.01	Timetable of IMS internal audit	IMS MANAGER
29.	R–IMS 8.02	Report from internal audit	IMS MANAGER
30.	R–IMS 8.03	Corrective action	IMS MANAGER
31.	D–IMS 8.04	Preventive action	IMS MANAGER
32.	D–IMS 8.05	Monitoring and measurement of IMS processes	Department manager
33.	R–IMS 8.06	Evaluation of organization by customer	IMS MANAGER
34.	R–IMS 8.07	Records concerning the complaints, environmental problems and work injuries	IMS MANAGER
35.	R–IMS 8.08	Analysis of IMS readings	IMS MANAGER

D -document *R - record*

PROJECT QUALITY PLAN

1. **Building Characteristics**
2. **Building Site Characteristics**
3. **Organization of building processes**
4. **Building process participants and their competences**
5. **Description of building quality assurance system**
6. **Inspection and Testing plans:**
   - **Building process indication**
     - **Identification of testing or inspection needed for building process**
     - **Person responsible for inspection process**
     - **Testing method description**
     - **Quality criterion (standards, regulations)**
     - **Result of test (conformity or non conformity)**
     - **Name of person responsible for testing, datum and signature**
     - **Records (certificates, audit opinion etc.)**

Figure 2: Project Quality Plan

On the value of risks we can determine risk categorization and management –see table 5.

Table 3 Probability „P“ of incidence of environmental aspect and impact or dangers and threatens (example)

Probability	P (points)
low	1
middle	3
high	9

Table 4 Consequence „C“ to environment and to health of employees (example)

Consequence to environment	Consequence to health and safety of company employees	C (points)
Minimal (non important)	Small hurts Ability not to work max. 1 day	**1**
Small influence to environment	Small hurts with treatment Ability not to work (1 day-2 weeks)	**3**
Important influence to environment Temporary transcendence of limits	Health damage without permanent consequence Ability not to work (2 weeks- 6 months)	**9**
Very important influence to environment Seriously damage of environment	Heavy damage of health, death Ability not to work (more than 6 months)	**15**

Table 5 Risk categorization and management (example)

Index	**Risk „R“ (points)**	**CATEGORIZATION OF RISK**	**RISK MANAGEMENT**
I.	1-14	Insignificant risk	Not required
II.	15-80	Plumbless risk	Is required
III.	81-135	Seriously risk	Is necessary

4. IMS IMPLEMENTATION AND OPERATION

Before IMS implementation and operation there is necessary to assurance training of top and middle management of construction company in all three management systems to better understand requirements of ISO 9001, ISO 14001 and OHSAS 18001. The trained members of top and middle management in IMS through internal training process give necessary information to other employees. There is important during the IMS implementation and operation to understand IMS documentation in all function of organization and managing and keeping of all required records through the year. IMS must be implemented and operate in all buildings and plants. Another important feature during the implementation and operating of IMS is fulfilling of IMS programme, which arise front out of determination of aims of all three management systems. The requirement of EMS and HSMS is to prepare employees of company to possible emergency situation.

5. INTERNAL AUDIT OF IMS

After some time of IMS implementation and operating (min. 3 months) is necessary before external audit by certification body to do internal audit of IMS according to ISO 19011:2002 “Guidelines for quality and/or environmental management systems auditing”.
Construction company shall ensure that internal audits of IMS are conducted at planned intervals to:

- determine whether IMS conforms to requirements of ISO 9001, ISO 14001 and OHSAS 18001 and has been properly implemented and is maintained,
- provide information on the results of audits to management.

Internal audit of IMS can be done by trained internal auditors in all three management systems or by external qualified auditor. For nonconformity finding out by internal audit must be receive corrective actions.
The last step before certification process of IMS is its management review. The top management of company shell review of IMS at planned intervals (min. once a year) to ensure its continuing suitability, adequacy and effectiveness. Reviews shall include assessing opportunities for improvement and the needs for changes to IMS including the quality, environmental, health and safety policy, objectives and targets.

6. EFFECTS INFLUENCED BY IMS DEVELOPMENT AND IMPLEMENTATION

By the process of integration of 3 management system into one we can reduce documents about 40 % (see table 1 and 2) against three separated management systems. Practically all procedures required by ISO 9001 for QMS we can implement for IMS (control of documents, control of records, corrective and preventive actions, internal audit etc.). In a case of internal and external audit of IMS in departments and buildings we can do it at the same time take into account quality, environment and safety aspect.

Another effects of IMS development and implementation:

- continually satisfaction of external and internal customers,
- building quality assurance right the first time with the aim of minimization of finance loss due to corrective actions during the building process realization,
- minimization of reclaims during the building guaranty time,
- respect of valid technical standards (EN, ISO, national) involving them into technological procedures and inspection and test plans,
- increasing the culture of building management and realization by application of modern information technology,
- consistent respect of valid legislation documents concerning the environments and safety,
- elimination or minimization of problems concerning the quality, environment and safety by effective application or preventive actions,
- prevention of ecological accidents and problems during the building realization,
- prevention of fatal accident or long term incapacity to work of construction company employees,
- order on building site, waste separation and recycling, prevention of land and ground water contamination, air and noise protection, elimination of dustiness etc.,
- consistent application of health protection and safety of all persons (employees, suppliers, visitors) in building site by application of personal protective work tools.

CONCLUSION

Development, implementation and improvement of effective integrated management system (IMS) in construction companies can lead to quality production improving, safety of all employees of construction company, application of all national and international standards concerning the environmental aspects and finally to customer satisfaction. It is essential, that IMS must be understand and implement by all employees. IMS is not aim, but way to satisfaction of construction company clients, better work conditions of company employees, success on market and reputation in own country and abroad.

REFERENCES

Szalayová,S., *Management of quality in construction firm*, In proccedings of 4th international conference TECHSTA 2004, CVUT Praha, 2004

Gašparík J.: Manažérstvo kvality v stavebnej organizácii, ES STU Bratislava, 2005

Jarský, Č.: Computer Modelling of Planning, Management and Maintenance of Structures. Zborník z medzinárodnej konferencie „Developments in Building Technology“. Bratislava: Stavebná fakulta STU, 1996.

A WAY TO SUCCESS: CROATIAN MOTORWAYS Ltd. – A SPONSOR OR A MANAGER

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The intensive construction of motorways in Croatia that has marked the previous decade posed great challenges before all participants in what is undoubtedly the greatest Croatian infrastructure project in the history. Motorways are public good and as such are of national importance which makes the role of the Government and of Croatian Motorways Ltd. (Hrvatske Autoceste - HAC) that operate the network on its behalf very responsible. Before opening to traffic kilometres of motorways, a series of procedures had to be implemented including planning, design development and construction during which many subjects and institutions were engaged and often for long periods of time. This has resulted in such projects being subject to many political, economical, social and other impacts that directly affect their completion. The paper shows their relations and envisages the role of the investor as a sponsor i.e. operator within a specific institutional framework as is Hrvatske Autoceste company that has established, in the conditions of accelerated development, a professional, competent and motivated structure open to new knowledge and willing to accept new ideas and changes. The cooperation of all participants is a guarantee of success.

KEY WORDS: construction of motorways, the role of investor, institutional framework, success.

INTRODUCTION

An efficient transport system is of great importance for any country's economy. The development of transport infrastructure depends on political, economic and sociological conditions of regions. Since these are structures of national importance the models for the construction of this infrastructure are based on the adopted transport policy. The network of high serviceability roads in the Republic of Croatia after its achievement of independence had been very modest which is a consequence of the transport policy of ex Yugoslavia. Therefore, the transport value of its position could not be fully utilized. This has resulted in the determination of the country to undertake a project of connecting all its regions by modern motorways.

The figures witnessing the motorway completion in the times preceding the country's achievement of independence and those showing the status of motorway completion today are an evidence of a notable success of the motorway construction projects.

Figure 1: Republic of Croatia Motorway Network

Key:
Completed by 1990:
A1 Zagreb – Karlovac 38.0 km
A2 Zaprešić – jankomir 8.2 km
A3 Jankomir – Sl. Brod west 197.2 km
A6 Oštrovica – Orehovica 17.8 km
A8 Cerovlje – Učka interchange 26.6 km
Total 287.8 km

Figure 2: Republic of Craoatia Motorway Network

Key:

Completed by 2009 **1196.0 km**

Completed in 2009 **42.3 km**

A2 Slovenian border – Macelj (0.8 km)

A5 Osijek – Đakovo (32.5 km)

A 11 Velika Gorica (South) – Buševac (9.0 km)

Total **1238.3 km**

The determination and the support of the state has been a basic precondition for the implementation of great infrastructure projects which has been proven through long-term experience and asserted in many scientific and professional papers discussing the subject. The success of subsequent activities (creation of institutional frameworks, passing laws and regulations) depend on that support.

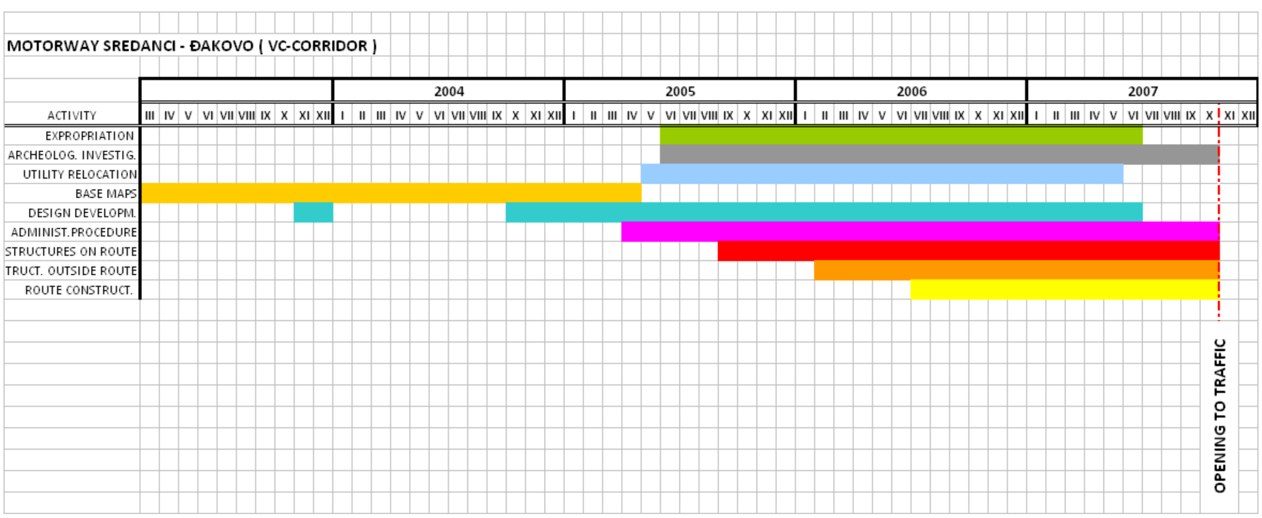
PROJECT AND ITS BACKGROUND

With the Government's recognition of the motorway construction as an important strategic project that will contribute to the economic growth, a period of intense motorway construction started. The results have been very palpable – a total length of the motorway network in Croatia today is four times as big as the one in 1999!

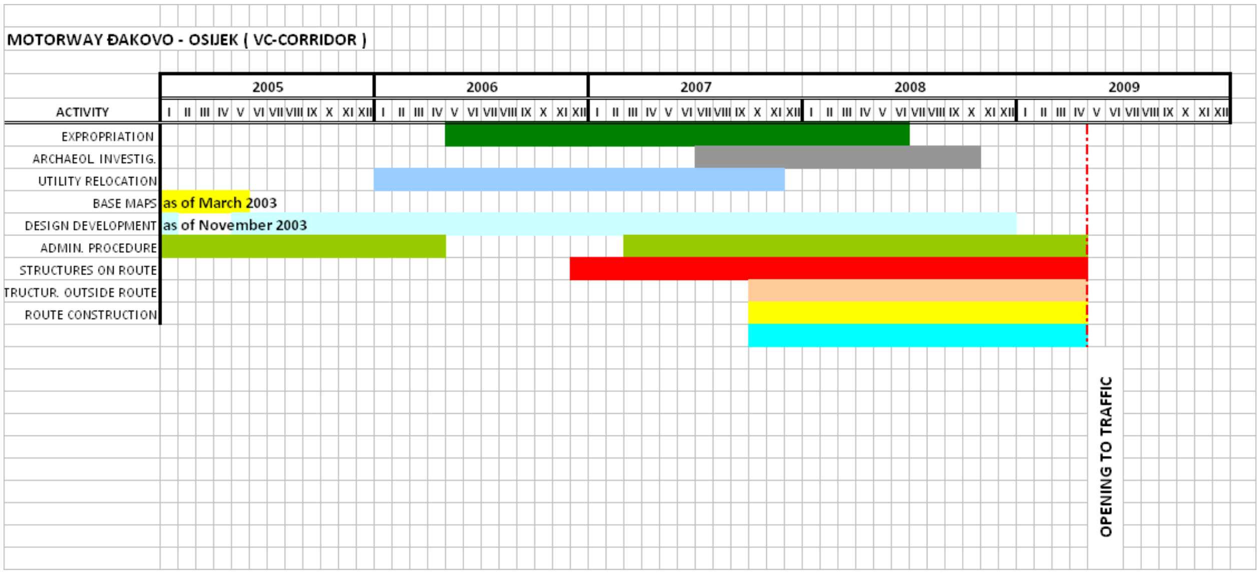
From 2003 to 2009, 622 km of motorways were built under the management of the Hrvatske Autoceste company. According to the motorway construction programmes about HRK 27 billion were spent in that period which is about €3.75 billion. With regard to economic indicators and the scope of individual projects we can talk about accelerated construction of major infrastructure projects. Managing such projects is very demanding and implies specific principles, risks and methods.

The projects of construction of individual motorway sections are carried out over longer periods of time. They include many activities during preparation, pre-investment process and the implementation itself. This proves great risks in the realisation of projects. For instance, in line with the Construction Programme for the period from 2005 to 2008 a part of the pan-European corridor Vc was completed. It includes the sections Sredanci – Đakovo and Đakovo – Osijek. The following graphs of main activities show the relations between individual activities and their duration and provides a comparison with the same activities in different projects.

Graph 1: The main individual activities and their duration on SREDANCI – ĐAKOVO MOTORWAY (Vc corridor) - 23 km



Graph 2: The main individual activities and their duration on ĐAKOVO - OSIJEK MOTORWAY (Vc corridor) - 35 km



Although these are similar projects, some differences can be noticed. This is a result of the changed circumstances different from those that were present at the time of initiating the project. Therefore, projects were adapted to changing economic and political circumstances. The main objective was the time of completion. This fact can be used to explain the characteristics of activities. With a different schedule priorities and activities would be distributed differently. By giving priority to lower costs in relation to the fixed schedule of completion the characteristics and the relations between activities would be different. Land expropriation and archaeological investigations would coincide with the construction because they would be performed during preliminary activities. However, the circumstances influenced a different development of the project. The stated example shows to what extent the performance criteria depend on the influences to which they are exposed. Influences are numerous and range from political, economic, social and other. They directly affect the price, the time of completion and the quality of works. At times they can even stop the implementation of the project altogether.

In the last stage of its completion the Đakovo – Osijek project was affected by the world financial crisis. This has disrupted the financial monitoring of the project and the efficiency of works. Regular procurement of material and power sources and functioning of companies hired to do the works were made difficult. Despite that, the project was completed within the scheduled period of time most of all owing to the powerful institutional support of the Hrvatske Autoceste Company.

The International research project of managing great civil engineering projects (IMEC) (R.Miller and Lessard, 2000; Miller and Hobbs, 2002) focuses on long and complex entry phases that have been summarised into eight subjects1. They also include the importance of adjusting large projects with the institutional frameworks so that they can resist uncertainties. Based on experience it can be said that the remaining seven subjects depend on the institutional framework that is being developed. They are:

- Long, complex and critical entry phases,
- Creating coalitions within the network of relations,
- Great uncertainties and great risk,
- Development through stages of project elaboration,
- Strategic depth,
- Powerful sponsors,
- Thorough review.

The framework that is provided by Hrvatske Autoceste is successful in connecting the sponsorship role that has been shared by the Government and Management Board. The structure of the company permits a connection towards the outside but also a connection with the management of the specific project. The creation of particular portfolios that ensure collecting of their own income, distribution within the company, different types of analyses and support services give company certain independence. With this a part of the risk can be reduced or even better avoided. The projects are separated from the current political situation which is a prerequisite for their successful completion.

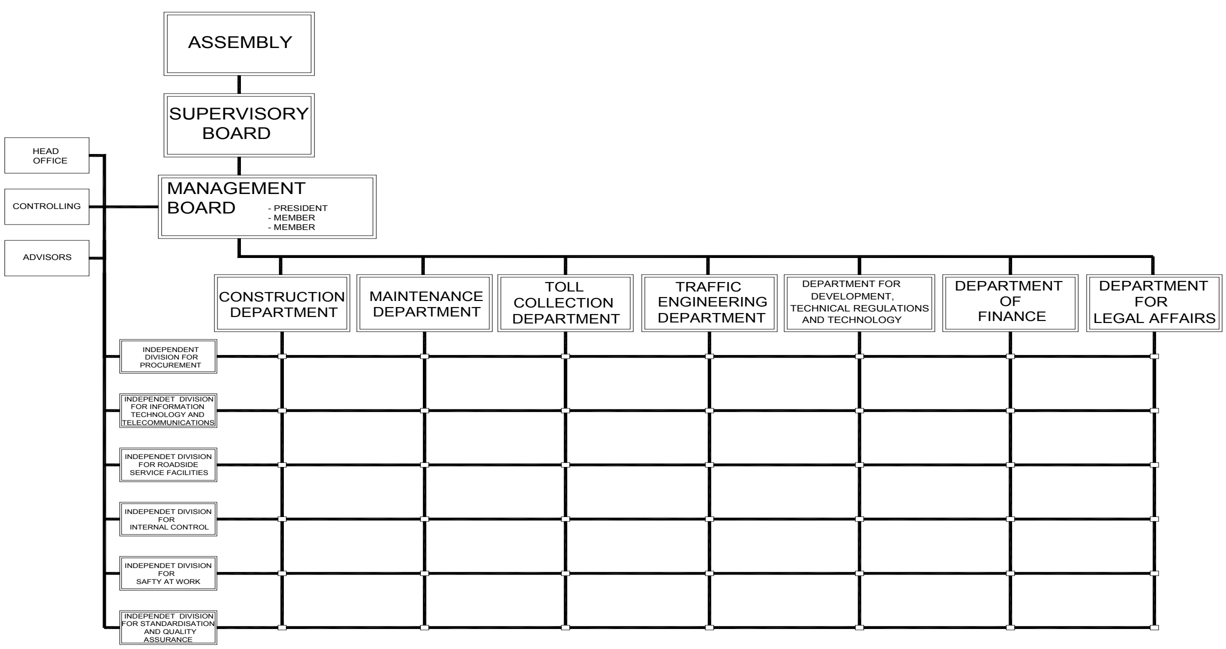


Figure 3: Organizational Structure of Croatian Motorways Ltd.(Hrvatske Autoceste d.o.o.)

[1] R. Miller; B. Hobbs: Governance Regimes for Large Complex Projects, Project Management Journal, September 2005.

However, we can't talk about full independence. Different groups, interested parties, politics through the sponsorship role influence the choice, dynamics, solution and the support to individual projects. If projects are widely supported, their preliminary stages are a lot shorter, the performance of works is faster and the financial and logistic support is considerable. Recognizing these relations and circumstances as well as the communication and relationship with the public is achieved through the company's Management.

The projects of construction of individual routes were subject to several changes in the political environment. The Zagreb to Split motorway (A1) which is one of the greatest investment and civil engineering projects ever completed in Croatia shows the continuity supported by institutional framework. The importance of this motorway which is a vital link between north and south is seen in its designation: A1. The 380 km long motorway was completed and opened to traffic in June 2005. The idea about construction of this motorway arose in different study variants as early as in the 1960's. The entire decade was marked by the elaboration of the design documents and by the preparation of investment plans for parts of roads on different routes. Unfortunately, political changes in 1971 in Croatia stopped abruptly all activities. The project was resumed in the 1970's but was soon stopped due to the lack of financing. This delay went all the way till the breakdown of the former state when the circumstances that determined the whole project changed greatly. The variants that would make use of the natural advantages of the Una river valley had to be abandoned since that route would pass through the border area of two countries. The chosen route in direction to Rijeka and Split coincides until Bosiljevo and later via Lika and Gospić it connects Zadar, Šibenik and Split. In 1997 Maslenica Bridge was completed which was the first structure on that section to be built after the country had reached its independence. At the same time Sv. Rok tunnel was built. The further step was the preparation of design development and issuance of the Transport Development Strategy. In 2000 the works on the section through Lika started. Upon completion of the part of A1 motorway to Split the works shall be resumed in direction to Dubrovnik. The project was going on under several Governments and it took about forty years. The determination of Government was crucial in overcoming all difficulties. This shows the importance of sponsor whose role is crucial for the success of the project.

INSTITUTIONAL FRAMEWORK FOR THE CONSTRUCTION OF MOTORWAYS

Successful implementation of strategies implies creating institutional frameworks that will allow the completion of the planned projects. In such institutional framework the broadest aspects that influence the strategy and management of particular projects have to be complied. A question arises: What role is to be assumed by such institutional framework? Is it a sponsorship issue or the issue of project management? It is exactly in overcoming or preferably integrating these roles where the key of success lies. In practice and in scientific works the role of sponsors has been recognized as one of the most important elements of success of a project. Bryde[2] /1/ stresses the

[2] D. Bryde; Perceptions of the impact of project sponsorship practices on project success; International Journal of Project Management; 2008; vol.26

role of the sponsor as one of the crucial factors of success. Based on experience, especially in case of large infrastructure projects the determination of the sponsor is not only a crucial factor but a requisite.

The associations and institutes that deal with the project management define sponsors and try to determine their role and significance. The definitions are reduced to two characteristics: Who assumes the risk? Who is securing financing?

Pursuant to the Public Road Act, the company Hrvatske Autoceste,. (HAC) that was opened for business in April 2001 was charged with the task of construction and maintenance of motorways in Croatia.

The company is 100% state-owned, and uses its own income for business operations. The income is generated from the following sources:

- Fuel tax
- Toll income
- Charge for the use of roadside land and from roadside services
- Long-term loans.

When considering the relation between HAC and the Government of the Republic of Croatia as the owner's representative the first task would be to determine whose funds are used to build motorways and who assumes the responsibility. Clearly, in failed public projects the Government assumes the risk of public criticism, the risk of economic activities of the subjects etc. Equally, it is also clear that the funds that were distributed pursuant to the Public Road Act are collected by the Government and given to the company. It can be said that the Government has a certain role of a sponsor. The Government can make a decision on the termination or commencement of works. At the same time the Government does not make all the decisions that pertain to a sponsor. That role is on its behalf assumed by the agency or a state-owned company. Therefore, a part of the sponsor's role is assumed by the Management Board. The Management Board perceives the Government partly as a sponsor and partly as a client. Then, the Board assumes the role of a sponsor. Such relationship requires knowledge and information from several areas of social, political or technical aspects. Based on these information the Management Board can play the role of a sponsor in determining strategies and goals for the implementation of the project. Based on these findings the Management Board can play the role in determining the strategies and goals for the implementation of the project. In that regard we can talk about the messages of IPMA Competence Baseline /3/ in evaluating specific situations prior to making decisions. One of the crucial roles of the Management Board is to create structure that will permit successful completion of large projects. The way the structure works, the performance criteria and the critical factors of performance as a phase of the project implementation are not part of these contemplations. It is necessary to stress the link of the Management Board with individual projects through organisational units that either support projects or direct and review them through portfolios. The criteria and conditions for managing portfolios, programmes and projects will not be observed either.

Except for the vision of those that have initiated it, the success of each project depends on professional abilities, competence, and motivation of those that work on the implementation of the project. In other words, the qualified and motivated employees are a vital force of HAC. To lead large capital infrastructure projects a large number of highly-educated experts from different professions are required. In that regard a great progress in project management was noted that is primarily owed to the durability of the management structure. Namely, long-term experience through a range of projects has contributed to a better company structure by establishing efficient communication channels, advanced skills and ways of communication etc. At the operational level (which is a stage following the annual plan of construction) the structures are formed that are working on evaluation of the project, use of experience, development and control of plans. By strengthening the power of structures that evaluate the projects and decide on the scope and priorities based on the implemented analyses, business operations can be improved.

CONCLUSION

For the purposes of accelerated construction of motorways Hrvatske Autoceste Company was developing very quickly. A structure has been created that is dynamic and capable of reacting quickly to the changed circumstances. The very structure has changed in time in order to increase efficiency. Simultaneously with the construction staff has evolved and valuable experience has been gained. All that is motivating us to pursue the company's development and to improve business processes.

Specific characteristics of works on motorways require systematic approach to preparation, investment management, result analyses and application of experience. Besides that, the projects themselves are part of a wider structure with which they are in the interaction. That structure must support the project, but project itself contributes to the strengthening of structure. The compliance of all parts of institutional framework is a guarantee for the success of large infrastructure projects.

REFERENCES:

R. Miller; B. Hobbs: Governance Regimes for Large Complex Projects, Project Management Journal, September 2005;

D. Bryde; Perceptions of the impact of project sponsorship practices on project success; International Journal of Project Management; 2008; Vol.26;

Monograph of Hrvatske Autoceste, Zagreb, 2006;

G. Caupin; H. Knoepfel; G. Koch., IPMA Competence Baseline; Version 3.0; IPMA; June, 2006.

SMALL PUBLIC PRIVATE PARTNERSHIPS: THE ANSWER TO LOCAL PUBLIC AND PRIVATE NEEDS, YET AN UGLY DUCKLING?

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Public Private Partnerships (PPP) are frequently mobilized as a purchasing form suitable for large infrastructure projects. And it is commonly assumed that transaction costs linked to the establishment of PPP make them prohibitive in small sizes. In a Danish context this has been safeguarded by the authorities, which recommend sizes over 13,5 million € (100 million DKr).

PPP is here understood as Design, Build, Finance and Operate projects. The paper shows, when looking at Germany, Italy and United Kingdom, that small PPP (below 13,5 million €) are widespread in two investigated countries; United Kingdom and Italy, whereas German projects are still emerging. Quantitative material on small PPP in Italy and UK shows no lower limit in size for these established PPPs. This apparent paradox is then qualitatively investigated. Only small projects are investigated, and these seem largely to be sound businesses and represent operable units for the clients and citizens. Cases are focused within education and healthcare.

The analysis suggests that another type of economy apparently is in play. It is thus characteristic within education projects in UK that the largest portion of small PPPs are of a size below 5,4 million € roughly reflecting the lower limit of obligatory tendering according to EU-law. Among these there are indeed a good portion of "real" PPPs.

KEYWORDS: public private partnerships, SME, Italy, United Kingdom, Germany.

INTRODUCTION

Public Private Partnership proliferates around the globe and in a number of different contexts of national and regional economies and governance regimes (Grimsey &Lewis 2004). The financial crisis has however struck project finance and thereby the establishment of public private partnerships. A large number of banks and financial institutions (Lehmann Brothers being the most known) have been forced to withdraw from the market of private financing of the buildings and more elements of public services (Drapak 2009).

The aim of this paper is to examine the lower part of the PPP-area, namely the small PPPs. A number of public institutions would benefit from a built environment which is small in size.

Municipalities especially encompass a number of services, which, if they are to be maintained locally and close to the citizen, have to be small. Several types of purchasing and contracting would be able to meet these demands. Public Private Partnerships are however increasingly being promoted throughout Europe as a possible solution. It is commonly assumed that transaction costs linked to the establishment of PPP, make it prohibitive to make them too small. The Danish authorities are using as a rule of thumb a limit of 13,5 million €s (100 million Danish DKr., EBST 2005). There is at the same time a strong local interest in developing cooperation between private and public parties in building projects.

In the paper these results is discussed *vis a vis* the development of public policies. Those are however only presented in a sketchy manner maintaining the focus on the small PPP. For further discussion of governance of PPP see Buser & Koch (2006). The paper is structured in the following way: an initial section of method is followed by theoretical considerations of PPP. Then follow three case sections on United Kingdom, Italy and Germany. Finally a discussion and the conclusion.

METHOD

This paper builds on a combination of quantitative and qualitative methods and data using a mixed methods approach (Bryman and Bell, 2007), with interpretive sociology as the underlying paradigm. Three countries were selected according to their degree of PPP development. The *United Kingdom case* is well described with a number of sources accessible. In generating the statistics on size and as source for examples we have extensively used the webdatabase of PartnershipsUK, www.partnershipsuk.org.uk. During a three day visit in January 2006 telephone interviews was carried out with public and private actors within health sector and education PPPs. The case of Victoria Dock Primary School is however collected from two major sources RICS (2005) and Heinecke (2002) supplemented with internet accessible information. In the *Italian case* the material stems from the national observatory, Osservatorio Nazionale Project Financing, accessible at the webpage www.infopieffe.it. The observatory was established in 2002 and our data cover 2003-2006. We have chosen not to analyse data on small PPPs from the period 1999-2002, which is difficult because statistical data is organized in a different way. To make Italian data comparable with UK, we had to reorganize them according to difference contract and size classes, to enhance the focus on article 37 bis and quarter and on projects below 13,5 million € (which is our definition of small, see below). Moreover it should be emphasized that our figures represent work-in-progress and they need further validation. The qualitative part of the study of Italy encompasses 11 semistructured interviews with a series of players in November 2006.The case of a Sports facility presented is from Bougrain et al 2005, to which one of the authors contributed, in combination with desk research. The *German case* was developed in a slight different way as there are only a few PPPs in action. The data for an overview was gathered from a combination of private and public sources (Freshfield 2005, Difu (2005). The qualitative part of the study of Germany was carried out in September 2006 and encompasses the development of PPP in Nordrhein-Westfalen (NRW) and the first DBFO PPP in NRW. This included semi structured interviews with public and private actors on the emergence of the state-led PPP policy as well as a personal interviews and a group-interview with the central actors involved in the first PPP project.

DEFINITION OF PPP -A CORE AND THE VARIANTS

It seems hardly possible to provide a single definition on public private partnerships. Akintoye et al (2003) in their discussion, departing from a UK experience, suggests that several key concepts are mutually overlapping, such as PPP, DBFO, BOT and others (explanation follows). As a core definition we her understand Public Private Partnerships as an arrangement where the public partner contracts to purchase quality services over a long period from a private operator. We would argue that through the evolved practice there is a propensity to understand the built environment and/or the infrastructure of society as core elements in PPP. At least this is where the present contribution focuses. Given that it is the built element of a public service which is in the focus, it makes sense to characterize it by the involvement of the private partner in the design (D), the building (B), the financing (F) and the operation (O) of the built product. DBFO is thus considered as the core here. The idea of maintaining this comprehensive scope is to assume that ownership and lifecycle involvement of the private will generate a more profound commitment for long term sustainable solutions. However a number of variants PPP contradict that. As examples in a Danish context the so-called "PPP-light", suitable for small public and private players, is characterized by no private financing and occasional omission of design and building. The variation on financing is that the public part finances fully and the design/ build is sometimes substituted with a long term operation contract and/or possibly a renovation activity. In an Italian context, the so-called article 19 b (under the Merloni law), projects, which are general contracting with design and build activities, encompasses an element of financing from the private part, but no ownership nor operation involvement. These two examples show how local contexts reshape and challenge the general basic ideas and finds fertile grounds in their countries. The differences moreover illustrate that comparing costs and other features across national settings is problematic. Neither of the two examples is in our opinion close enough to DBFO to justify comparison, and we therefore elaborate a sample of Italian projects which posses DBFO and we do not take the article 19 projects on board. In a broader perspective PPP is part of a reform process of the public sector department from classical government to mobilizing and networking with a range of partners (Buser & Koch 2006). New public management initiatives are central in this process. But another important issue is the recognizing of the increased need, due to product complexity, for exploiting complimentarily amongst players, be it in networks (Hakansson & Johansson 1993) or as other new form of organization and governance between market and hierarchy (Williamsson 1975, 1990).

The establishment cost – is there a lower limit for accountability?

It is broadly recognized that established PPP-s involve increased costs for the parties in the initialization phase. With reference to transactions costs it is assumed that there is a lower limit value balancing initial additional costs with cost reduction in build and operation. This assumption is usually built into the calculation of the feasibility of a PPP (for example in comparators as the British, the Dutch and Danish version). There is however quite some uncertainty in these calculations and it is therefore important to "reality check them". In 2003 the British ministry of finance (HM Treasure) published the report "meeting the investment challenge", critically discussing small PPPs, which here meant projects below £20 million (27 mill. €). HM treasury investigated a number of practically operating PPP (35 projects). The main findings were (HM Treasury 2003):

• Construction and operational performance were good, in line with larger projects. Over 80 % of projects were delivered on time or early, and over 90 % met client expectations.
• The procurement process for small projects was of comparable length to that of major capital schemes. This indicates that, in relation to capital investment undertaken by the schemes, procurement times are disproportionately long, and procurement costs disproportionately high.

The Government therefore signalled that they in the future would consult on an appropriate minimum level of capital expenditure below which alternative means of procurement should be preferred (HM Treasury, 2003:77). HM treasury describes the problem of initialization costs like this (HM treasury 2003 p53):

"All PFI schemes face the cost of using third-party finance and small schemes typically face the same level of legal and technical documentation, complex due diligence requirements and financial modelling that lenders require for much larger projects. As result, the costs of private finance are relatively higher for small schemes".

In 2005, The Scottish Further Education Funding Council (SFEFC) suggested that PFI should be abandoned for projects less than £30m, following a catalogue of problems with PFI for further education projects in Scotland. The Auditor General for Scotland warned of the financial problems facing three small PPPs Inverness, Lews Castle and West Lothian Colleges in a report to a Parliamentary Audit Committee in 2005. The Danish EBST (2005) study carried out by KPMG adopts the 100 million DKr limit in its market survey and thus contributes to enforcing this limit.

UNITED KINGDOM

However it turns out that small PPPs are rather common. In the Partnerships UK (2006) database 700 Private Financing projects are listed. Out of those 261 projects are below 10 million £. Moreover a possible lower threshold value does not seem to be visible:

Budgetsize (£), small PPP	Projects	Operational
8-10 mill.	38	21
6-8 mill.	31	23
4-6 mill.	34	28
2-4 mill.	76	66
0-2 mill.	82	68
Total	261	206
under 4 mill.	158	

Table 1: Small PPPs in UK ordered in size classes below 10 mio. £.
"Operational" means that the PPP has reached the operation phase, whereas "project" means that the PPP is established, but still in the design build phase. Source PartnershipsUK accessed in 2006.

This table shows that there is not a clear limit value such as 13,5 million € or lower. If these figures show any limit, then it is related to European tendering law, which makes tendering obligatory for public players around 4 mill £. The change in government politics in 2003 had profound consequences for small PPPs however. Very few projects have been announced since then.

According to Partnerships UK database, 2005 and 2006 have had no such small projects. Simultaneously the tendering of bulk-PPPs , bundled schools for example, have developed. Over 40 bundled projects are by 2006 registered in the Partnerships UK–database.

UK Single case: Victoria Dock Primary School

The Private Finance Initiative (PFI) was established in 1992. The Victoria Dock Primary School realization began in 1996. The school is a primary school in Kingston Upon Hull in eastern England. A new city development, in a previous industrial area was established without a school, to the discontent of the new citizens. The local municipality consented to the opinion of the citizens and administration began preparing a ”business case” and the comparator calculations (Public Sector Comparator, PSC). In the first tendering several bidders competed, but it was Sewell, a small local company, which was selected as preferred bidder. Where the first calculations of the PSC gave a discomforting result, the municipality chose to emphasize local employment, which was not included in the PSC. Moreover the public part of the financing was increasing.

Sewell is a medium sized family owned company operating within construction and maintenance. Sewell had previous to its PFI engagement a yearly turnover around £10 mill. The company at that time had app.120 employees within construction and facilities management, while sales of gasoline employed 80 persons. Sewell had before the Victoria Dock-project failed on a hospital-PFI, where they not deliver a qualified bid, after which they realised the need for additional external expertise.

The Victoria Dock-project posed in the beginning some difficulties, and during the contract negotiations even the external experts were in doubt on how to describe the conditions for an education project. Especially the risk distribution caused problems, which made Sewell's bank connection abandon the project. The project includes financing, design, construction as well as operation. The financing of the first part was shared between the private and the public part, as the state supported the municipality with 20% of the finance of £200.000. This was necessary to establish a satisfactory economy, according to calculations based on the comparator. On the private side, Sewell themselves entered the project with £250.000, while the remaining part of the total investment (£1 mill.) was financed by a bank loan.

Design and construction was handled by Sewell, who used its expertise from former school projects and designed the school aiming for long-term operation, energy savings and prevention of vandalism. An operation company was established, taking care of maintenance of buildings and site, security, window cleaning and delivery of IT-hardware. A kitchen was built on the school, but the municipality wanted to produce the food elsewhere, and did not keep this function. The first stage, which included 60 pupils and a child-care class for 26 pupils, two classrooms, a playground, sports facilities and administration, was ready for use on January 1999. After this, two later stages (until 2003) have extended the school to 240 pupils. The operation company rents the site from the municipality on a 40-year basis, but with the clause that the buildings can be used for other purposes after 25 years. Sewell assessed that they could obtain 10-15% interest p.a. of the operation company, compared to 5% p.a. by a traditional bank deposit, making the operation company deliver a long-term stable money-stream. The school has been well-functioning and has experiences an increased demand, also outside the original target area of the new neighbourhood. Sewell has incorporated a "community dividend" in the contract, implying that the school receives a share of the surplus from the operation, which in 1999 amounted to £5.000 and in 2000 £35.000.

The operation company has taken over all traditional risks related to building operation, but there are clauses on the development in education- and health-law where the municipality carries the risk. The contract is based on access of space and performance. Therefore insurance has been signed, covering the company against illness amongst the staff (which influences on the performance of the company), vandalism and other risks. The financing of the insurance is part of the operation budget. In the programming- and design-phase some expenses grew drastically, which the company has to carry, and in general the project is more expensive and problematic than normal public building projects in the initial phases. The larger expenses on this stage therefore must be collected by benefits in the long-term operation of the buildings.

In 2005 Sewell expanded its portfolio to another and far bigger PFI-school project in the York area. Sewell underlines its position in the area, and extends its competences. Here, Sewell has employed local staff, and as this company is located in short distance to the Victoria Dock School, the possibilities for offering good maintenance service are better. Such benefits are not included in the mandatory comparator calculation (RICS, 2005). The school at Victoria Dock has almost become an icon of PFI and is counted as one of the first PFI-projects within education.

ITALY

The Italian PPP was established in 1994 under the so-called Merloni laws (Bougrain et al 2005) Project financing is an instrument for financing a public service project while generating cash flow so that the financial (private) party obtains revenue of the investment. The legal form of PPPs used in project financing are under the articles 37 bis and 37 quarter of the Merloni laws with subsequent revisions (four of them in total). Within this model, the concession licensee undertakes to build, finance, manage and hand over the facility to the employer once expired the concession period which is typically around 20 years (however some projects, parking facilities use concessions up to 80 years (ONPF 2005). The first crucial point is the definition of an economic-financial plan showing the project capacity to generate reasonably certain cash flows in order to refund providers of both loan and venture capital. This implies the ability of defining and evaluating the components of operating cash flows: building costs, running operating costs, and operating revenues. The project financing (PF) procedure has two main phases, where the first is usually a proposal phase where private developers can describe and submit projects on developing public services, on the basis of the announced three year plans from the various public authorities. A project company is established by the project developers, with the sole purpose of carrying out and managing the project. All rights and obligations relating to the investment pertain to it. All actors involved, whose number can change depending on the interests involved, the size of the project and of its complexity, revolve around the project company. Apart from the design, build, finance and operate the project finance initiative also encompass other forms, design built contracts and concessions.

The focus here is on the 436 projects in phase 2 in 2003-2005. According to the quarterly reports from these three years the following are below 13,5 million €. In 2003, 51 project contracts were signed of either article 37 bis or articles 37 quarter. In 2004 the same figure was 61 and in 2005 it was 162, a total from these three years of 274 below 13,5 million €, compared to the total of 436 project in the same period, which is more than half of the projects.

Amongst these parking facilities, graveyards and sports facilities are the most widespread. It should be noted that these three types also are realized in a large number of general contractor/ design build- projects (art 19 bis). In the area of public parking, for example, at least ten firms have specialised in" building and management of parking facilities", making a strategic reorientation of their business. However some small players and companies only enter the area occasionally. The large specialised companies use standardisation of the process to reduce the costs of establishment.

Italian Case: Cividale del friuli

Cividale del Friuli, a small municipality in the vicinity of Udine in North-eastern Italy wanted to establish improved sport facilities. The municipality is small with 11.200 inhabitants. The sport facility in the main town of the municipality is an early example on the 1998-projects. It consists of three buildings, the first and largest is a sports hall on 4.600 sqm., for 3.000 spectators. The other two buildings contain other sport facilities, including a handicap centre, support functions, a discotheque and a bar. The initial contact between municipality, contractor and designer was established in November 1998. The municipality was originally interested in further development of its sport facilities, as a neighbouring municipality had taken the same steps with the same contractor and designer. The municipality wanted to use the possibilities for PF-financing, as they were not able to finance the facilities on their own. In the first project proposal, the expenses for the plant were estimated to 5,96 mill. € with an annual operation budget on 361.000 €. At this stage the finance was prepared in collaboration with a bank, but no other consultants were used. The private main partner, SACAIM, a middle-sized contractor with 400 employees, operates mainly regionally in Northeast Italy. SACAIM used the PF-model as they contended they had good chances of winning the contract. At the same time, they assessed that the costs for preparation were approximately the same as for a traditional building project. SACAIM had established collaboration with an architect company, to assist them. After the development of a project proposal and completing the public tender, the municipality found out that the common operation company would be able to take over parts of the administration related to collaboration with sporting associations and others, who were going to rent parts of the facilities. The architect realised that the reference to projects in the neighbour municipality would mean less problems with the quality of the design in the process. At the same time, the combination of design and operation over 32 years in the contract gave possibilities of using other materials in the design that would traditionally have been suggested. Finally SACAIM were right in their assumption about competitive advantages, as no other bidder reacted on the public procurement (this is accepted in the Italian PF-law from 1994). During the construction phase the partners agreed to modify the contract, increasing costs to 6,37 mill. € and the operation budget to 384.000 €. There were especially difficulties of rentals of the large sports hall. Therefore the partnership was extended with more sports facilities, to secure more rentals. Construction finished in 2003, and the 30-year operation phase started.

This PPP includes financing, design, construction and operation. The financing is shared equally between the private and the public part, and the public part is split equally between the region and the municipality. Design and construction was carried out by the architect and the contractor. Already during the construction phase, the operation company was established, contracting with sporting associations, restaurant keeper and others. The operation company administrates the sports hall within the framework of an "administration package" of 500 hours annually, containing cleaning, tickets sale, admission control and others. The contract settles rentals for the facilities and prices for the operation costs (heating, payments and others), and these can be re-negotiated each year. The municipality pays a so-called rent guarantee, which is a contribution to the rentals (75.000 € per year) and is committed not to create competition to the sport facilities through its other sport facilities. The private part must find its surplus from the administration contribution, fixed at 177.000 € per year, and / or on the operation of the discotheque, bar and restaurant. The latter is in practice limited to a square meter-based rent for the operation company. The two large expenses for the operation company are paying for the loan (207.000 €) and to accomplish the administration package. The public and the private part agree that the risks of the project are mainly carried by the private part. The risk distribution during operation implies that the operation company's risk is limited by the rental guarantee and the agreement on no competition from the municipality's other sport facilities. Also, there are no limitations on the use of discotheque, bar and restaurant.

The public part assesses that the chosen project finance has delivered clearly less preparatory work, compared to traditional procurement. The assessment of the bid from SACIAM was more thorough than normally, but the balance between advantages and disadvantages are expected to clearly improve, when it becomes an integrated part of the administration. SACAIM estimates that the bidding preparation expenses were 30-60% higher compared to traditional procurement. This is outbalanced by the strategic advantages entering the area, and enabling a learning process.

GERMANY

After the German reunification in 1989, public spending in buildings and infrastructure decreased drastically. This includes federal, state and municipal levels. For instance, investments on federal level in 2005 were 59% of the investments in 1994. A similar decrease has taken place on municipal level where investments were reduced by 43% between 1992 and 2004. At the same time, the budget deficit in German cities increased (Boll, 2006). This has lead to a large investment gap in buildings and infrastructure. Therefore PPP has been seen as an alternative route to these problems. There are a number of different PPP-models being used locally and on different administrative levels in Germany (Freshfields, 2005). This reflects the decentralised administrative structure in Germany, where there is no central authority to approve PPP-projects, decide on certain procedures etc. Here we want to focus on DBFO projects, but a 2005 survey concluded that about 200 projects were completed, and about 300 new projects were about to be planned or implemented (DiFU, 2005). These include projects with at a broader interpretation of PPP. According to Lohmann, (2006) until now, 31 projects using a DBFO-model has been completed, and 116 projects are in preparation. This compares approximately 15% of the total portfolio of PPP projects. Amongst those we found at least six below 13,5 mill euro, this include four school projects; Bedburg, Engelskirschen, Northeim Vocational School and Witten, one sportarena (Munster) and a parking facility (Bundeswervaltungsricht) (Fischer 2006).

German Case Paul-Kraemer School in Frechen.

The Paul-Kraemer School in Frechen was the first PPP-school project to be completed in Germany. It involves planning, building, financing and operating of a special-needs school-cum-gymnasium and a three-court gym close by. It was procured by the Rhein-Erft-Kreis (county), and was also a pilot project of the North-Rhein-Westphalia PPP-Taskforce. It is financed as a PFI-project with an investment volume on app. 15 mill. € and a total project volume on 48 mill. € (including operation in 25 years). It was completed in September 2005, and has been in operation since then.

The first step was to make a comparator (psc)-calculation of the project, which was carried out by the consultant. This showed that savings between 2% and 10% should be expected, compared to traditionally procured projects. The bids that were received showed savings on 10%, which justified the assessment from the comparator-calculation. The planning and building period was only 18 months (of which 12 months was for construction), which is much faster than for similar building projects, which increased the benefit to 12% (according to the pcs-calculator). The school was not 100% finished, as there were smaller details missing, but it was ready for use. The procurement was output oriented, i.e. based on the demands for the functions the buildings should deliver, and not the specific details (except in very specific situations). For each room an out-put description was made. Describing these demands was not a problem, but demanded a lot of work. To prepare the county and school-team for specifying outputs, a study trip was arranged to a new school. The awarding procedure began with a public tender, in April, 2003. There were 15 bidders that showed interest in the procurement, but only 5 handed in actual bids. From these, the bid from the VICO-consortium was selected. Before the awarding it was decided to weigh price by 50% and the "soft" parameters (architecture, quality etc.) by 50%, and on both points, this was the best project. "It spoke to the heart", as the school director put it. The contract was signed in February, 2004, with Hochtief/VICO and 18 months later the school and the gym were handed over to Rhein-Erft County.

The school-board and the county are very satisfied with the result. In general the quality is higher that comparable schools, and there is more space per pupil than traditionally. This is important as there are many wheel-chair drivers in the school, for who sufficient space is essential. In a traditional procurement they school-board would have to "fight for every square meter", which would require many and long negotiations with the state. A main reason for the satisfaction is that the school-board was involved from the beginning of the project, and has participated in every meeting. This has developed a real ownership and a lot of identification with the project.

The operation of the school includes housekeeping, i.e. cleaning, secretary, catering and outdoor areas. Hochtief takes care of these functions, except elevator-maintenance, fire-conditions, catering and gardening. These tasks, Hochtief has contracted to local firms, which was also a political demand. According to the contract, breakdowns on the school must be fixed within 2 hours. This is often a strong incentive for the facility manager to enter with local firms, but in this case, Hochtief's headquarter is located in Cologne, which is just a few kilometres from Frechen. Hochtief has placed a secretary and a janitor at the school, to which the users can contact for practical daily questions and reports on problems and break-downs on the building and equipment. In the contract, a detailed list of assignments is described for the hausmeister.

DISCUSSION

Our quantitative and qualitative material reveals quite a vivid "subculture" of small PPPs in the investigated countries.

Sewell, the UK example of a PPP-contractor, departed from the experiences in building and operations. Sewell decided to enter as long-term financial partner with the local municipality on the basis of the 90ies crisis, as well as the project broke with many small construction companies narrow trade-focus. From the example it is also clear that the PFI-arrangement demanded a good bank connection and counselling. After the establishment of the PFI-arrangement Sewell has managed to integrate their business-areas and has been able to use this as a lift-off to achieve another school-contract. As a broader UK trend it seems that *small PPP-s was "talked away"* by HM treasury in 2003. The use of bundles in schools projects as well as the healthcare example of LIFT, does represent further initiatives to provide local and small public service infrastructure. The legal framework for PPP in *Italy* was opened with new possibilities and barriers in 1999. The PF-option opens a new pathway for the local actors, which especially the private parties (i.e. contractors a.o.) have taken up and small PPP are central in this trend. From 2000-2005 Italy have experienced a very remarkable growth in the proposals from the private side. In our single case Project Financing is perceived of, especially by the public part, as a simpler method of working, where work can be outsourced to the private part. The possibility of accepting only one bid, and reject an architectural competition was also important. Finally, a relaxed interpretation of the rules on re-negotiation from the public part contributed to enabling a reformulation of a more realistic project. All partners tried PF for the first time. The experiences from the operation period are still limited. It can be noted that the small local administration and the relatively small regional company largely managed the process – with support "only" from the bank and the regional authorities.

The Italian small PPPs are parking facilities, graveyards and sport facilities, thus markedly different from the UK healthcare and education dominance. The Italian case is thus showing an innovative alternative to UK both in content and in size. The two countries does share however that small PPPs can be realized by a range of different players and do not by themselves assure small local enterprises to be central. As we have pointed out, the PPPs in UK, Italy and Germany still represent a fairly new development with restricted experiences from the long operation phase. It derived from our cases as well, that public and private players have engaged in these projects – also- because learning from first examples was an attraction. It thus clearly plays a role vis a vis a more narrow economic and cost oriented understanding. And this willingness to assign broader, purposes to the first partnerships, create another balance in the costs and benefits.

A further aspect is the element of voluntary innovation. Von Hippel (2005) points out that new products and processes also come about because users (in a broad sense) actually engage in the development. And they do this in a way which does not follow private profit motivation, or collective action models. Von Hippel sees the strength in user driven innovation in its ability to mobilize hidden and informal resources in the innovation (Von Hippel 2005). Applied to PPP it means that private and public actors engage in realization of PPP without expecting or demanding a narrow reward and that this alternative economy removes barriers.

CONCLUSION

This article investigated an apparent paradox of small Public Private Partnerships. On the one hand classical economics would tell us that under a certain size they are not feasible. Yet on the other hand, the two markets discussed, UK and Italy, exhibit a very large number or small PPP and our third emerging market, Germany have already got several small PPPs. In this way the players seem to overrule the economical concern. We explain this by pointing at three conditions: First there seems to be another economy, than the one suggested by transaction costs. Second, it is likely that the players protect the first experiments to enable learning, which would imply that the small would die out as we witness in UK. Third that small PPP might continue to be established as voluntary innovations, which is long term attractive for the actors. The implications of these findings is that new national communities engaging in PPP could be more focused in enabling this type of user driven innovation and thereby contribute to maintain a local structure in the European public sector. It appears that local public units endeavour in PPPs because they have local needs to be met, they are attracted by the innovation and the companies partnering with the public side seem for a large part to be willing to see the small projects as incubation process, where special conditions can be defended in order to develop competences. Neither Italy, UK nor Germany has sufficiently profound and longitudinal examples to rule out this thesis of incubation or insist in the voluntary innovation explanation. Interestingly the central governance initiatives continue to focus elsewhere making the incubation more of an ugly duckling infancy than something strived for.

REFERENCES

Akintoye A., Beck M. & Hardcastle C. (2003) Public-Private Partnerships. Managing risks and opportunities. Blackwell Science.Oxford.

Boll, P. (2006) Equity investments in German Public Private Partnership projects. Paper presented at the ERES conference.Weimar.

Bryman A, & E. Bell (2007) Business Research Methods. Oxford University Press. Oxford.

Bougrain F., J. Carassus, M. Colombard-Prout. (2005) Partenariat Public et Bâtiment en Europe: quels enseignements pour la France? Paris: Presses de l'Ecole Nationale des Ponts et Chaussées.

Buser M. & Koch C. (2006) Emerging Metagovernance as an Institutional Framework for Public Private Partnership Network in Denmark. Internat. Journal of Project Managem. (24) 7, 548-556.

DiFU, Deutsches Institut für Urbanistik (2005) Public Private Partnership Projects in Germany. A survey of current projects at federal, Land and municipal level. Summary. Commissioned by PPP Task Force at the Federal Ministry of Transport, Building and Housing (BMVBW).

Drapak F. (2009) How has financial crises changed PPP market? World Bank Institute. Accessed at www.scribd.com/doc.

EBST (2005) OPP-Markedet I Danmark 2005-2010. København: Erhvervs- og Byggestyrelsen.

Fischer, K; Jungbecker, A; Alfen, HW (2006) The emergence of PPP Task Forces and their influence on project delivery in Germany. Intern. Journal of Project Managem. (24)7, 539-547

Freshfields (2005) PPP in Europe: an overview. December 2005. Freshfields Bruckhaus Deringer

Grimsey D. & M.K. Lewis (2004) Public private partnerships. The worldwide revolution in infrastructure provision and Project Finance. Edward Elgar. Cheltenham

Hakansson H. & Johansson J. (1993) The Network as a governance structure; interfirm cooperation beyond market and hierarchies. In Grabher G. (ed) The embedded firm: on the socioeconomics of industrial networks. London, Routledge.

Heinecke B. (2002) Involvement of Small and Medium Sized Enterprises in the Private Realisation of Public Buildings. Workpaper. Freiburg University. Access: http://www.tu-freiberg.de.

HM treasury (2003) PFI: meeting the investment challenge. HM Treasury. London

Koch C., M. Buser & C. Thuesen (2004) Managing Projects with the Public, -bringing Partnering, Contracts and Financing together in Building Public Services. In De Meyer A., Van Wassenhove L. & Yücesan E. (eds): Operation Management as a Change Agent. Proceedings the 11th international Conference European Operations Managem. Assoc. (EurOMA). INSEAD, Fontainebleau. 199-208.

ONPF (2003) Il mercato del Partenariato Pubblico Privato nel 2003. Osservatorio Nazionale del Project Financing (ONPF).

ONPF (2004) L'onda Montante del Partenariato Pubblico Privato. ONPF.

ONPF (2004) Il project Financing in Italia. Rapporto trimestrale I-IV. ONPF.

ONPF (2005) Il project Financing in Italia. Rapporto trimestrale I-IV.ONPF.

RICS (2005) Quantifying quality-A report on PFI and the delivery of public services. Salford. Royal Institute of Chartered Surveyors (RICS).

Von Hippel E. (2005): Democratizing Innovation. MIT press Cambridge Mass.

Williamson, O.E. (1975) Market and Hierarchies. New York: The Free Press.