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Abstract

A famous architect once said: "A great building is a result of a good project program, an adequate building site (adequate for the purpose of the building with its size and disposition) and a smart investor.

The reconstruction of old buildings representing historical and cultural heritage demands an integration of all participants not only in the phases of execution and usage, but through the phases of conception and definition.

The conflict between the investor – user and all of the other participants in the project of building reconstruction are widely known, but are specially emphasized in the conservation and reconstruction of buildings representing historical and cultural heritage. Problems such as the financial limitations, inability of phase construction due to the uneven financial income, or technical and technological limitations demand a very clear and distinct distribution of roles in the project.

This article will provide experience from a few concrete examples of such reconstruction projects and will provide an overview on the complexity of the whole management process of such projects from the project manager's aspect.

Keywords: building reconstruction, historical and cultural heritage

1. Reconstruction and maintenance of buildings that represent cultural heritage

All buildings that represent cultural heritage demand suitable maintenance, which puts specific problems and demands in front of the owner. Primarily it is related to the limited usage of modern materials and technologies in the adaptation process, and to the necessary coordination of the sometimes contrary demands of conservation and preservation of such objects on one side and the necessary modern standards and rules on the other side. Such buildings are in need of constant modification and adaptation to the owner's demands. It can also cause problems in regard to the differences in the room usage in the history and room usage today. The main differences in room usage are the usage of modern installations of telecommunications, electrical installations or many different heating/cooling systems, which were not used (or predicted) in the period when the building was being built. Except the necessary maintenance, there is sometimes a need for reconstruction, so that he building would be better adjusted to the new safety demands which emerge during the building usage period or to change the deteriorated elements of the bearing construction. All of the above conditions a systematic, detailed and careful approach to the problem solving of this very complex process.

2. An example of a carried out project of a building under conservationist protection – The School of Public Health "Andrija Štampar"

The Reconstruction of the School of Public Health "Andrija Štampar" is a typical example of a reconstruction approach of a building under conservationist protection, with all of the possible outcomes such as the partial reconstruction, significant extension of work duration and increased consumption of financial assets.
The School of Public Health "Andrija Štampar" was built in 1927 under the name of Palace of Public Health (The Hygienic Institute), as a result of a first-awarded work of the author Juraj Denzler and co-author Mladen Kauzlarić on a architectural competition in the year 1925.
The building is distinguished in a functional layout appropriate for the building purpose and a façade built in classicistic style.
It was built with the resources of the Rockefeller foundation for building and aiding of medical and other health institutions.
Inadequate maintenance and adjustments made during the school development did not significantly perturb the building layout and organization. The added north wing of the building which contains the laboratories was built in the period when the building was not under conservatory protection.

Figure 1. The School of Public Health “Andrija Štampar“ - The Hygienic Institute 1929. g.

The investor – user, bearing in mind the limited funds (financial means from the state budget) and limited period of reconstruction, decided to modernize the part of the education and to raise the dormitory standards, with the necessary reconstruction, improvement and adaptation of only the parts of the building which were affected by the adaptation and the parts of the building that were in danger.

The City Department for the Conservation of Cultural and Natural Monuments, City Archive and the user himself did not posses the relevant documents about the building, such as the original, detailed plans, or façade data, except the photograph of the main façade from the year 1927.

The entry data was represented by the inadequate and incomplete building plans saved with the self initiative of the school workers. In the installation and maintenance part there were no plans of the current state modifications.

The time and financial limitations of the process of making the project documentation defined the scale which concentrated only on the part of the building being reconstructed.

The reconstruction of old and protected buildings is a complex process and many of the problems are appearing in the building phase when the bearing construction is scraped off of its finish layers.

However, the materials and technology used on the reconstruction is assumed on the basis of the building process period.

The state of the assumed bearing construction was determined with visual inspection, without the removal of the final layers of the floor coverings.

The designers were conscious of the inadequacy of such documentation and the need for its fulfilment during the design process, which requested the extension of the period needed for the making of the project documentation.

The contract with the building contractor was signed on the basis of the technical documentation built by an incomplete and technically unfeasible project assignment.

The supplementation of the existing state building plans and the subsequent defining of the bearing construction state needed for the reconstruction caused the redesigning and deviation from the project assignment due to the reconstruction inability and to the adaptation to the new situation.

The state of the installations and the new technological procedures requested the complete and complex building solution for the whole building and not only for the parts of it being affected with the reconstruction.

All of the mentioned above caused a series of changes on other projects, which required new approvals and new building limitations and requirements.
Unrealistically estimated period of two months needed for the making of the project documentation was significantly increased to approximately one year (without the time needed for the measuring of the building and the time needed to obtain all of the necessary approvals from the amenable city and state institutions.
The changes caused by the modifications on the project documentation, reflected on the drastic increase in the period needed for the building reconstruction process and on the significant increase of the financial assets necessary for the completion.
The possibility of occurrence of such problems during the reconstruction on the School of Public Health "Andrija Štampar" building, could be drastically reduced or even avoided during the preliminary and research works phase, a good project assignment and eventually a more complete technical documentation.

3. Project management process, of building reconstruction or maintenance in buildings that represent cultural heritage.

In the previous example of a project of reconstruction of a building representing cultural heritage we saw a number of inconsistencies and vagueness which caused problems during the realisation of the project. Those problems are mostly in direct link with the management of such project.
In Croatian building praxis it is most often that the investor takes over the project management function, because he does not have a legislative obligation to give a mandate to a professional organization or a person, who is going to manage the project execution for him. Unfortunately in most cases he does not have the necessary skills and knowledge, to perceive and anticipate all that is needed for the quality project execution.
The investor in that case coordinates alone with all of the project activities and participants on the project, he articulates the project assignment, he contracts the making of project documentation with the designers, and he contracts the execution of works on the basis of the project documentation, he contracts expert supervision…
The biggest problem arises from bad coordination with all of the participants and the inability (quite often because the investor is not a competent person for the management and building areas) to perceive the complexity and the entirety of the whole project, and from untimely coordination and distribution between the project participants.
Fore mentioned problems are specially emphasised on the example of projects which include conservatory protected buildings, where the number of participants is increased, and which will be revised in further text.
The investor could timely avoid all of the mentioned anomalies, giving the mandate to manage the building process to a professional organization or an individual who can vouch for the quality realisation and fulfilment of all tasks that are placed before the project with his references and knowledge proved on similar projects.
The reconstruction of a building that represents cultural heritage can be considered as a project with all of the standard phases, such as

1. Conception
2. Definition
3. Execution
4. Usage

In all projects it is important that the project manager directs his maximum attention to the quality of the project elaboration through the first two phases of conception and definition, because it always has a great impact on the later phases of execution and usage. The specificities of the project management process, of building reconstruction or maintenance in buildings that represent cultural heritage, demand from the project manager to dedicate extra attention and time to the first two preliminary phases. Through the mentioned two phases the project manager has to manage the collection of all original building data and data on the state of the building construction elements. Also it has to manage and coordinate the work of a large number of standard and specific project participants, like conservers, archives, special authority designers (3) for different parts of the building and special authority contractors, as well as many special institutions and individuals. Except through the phases of conception and definition, the project manager has to manage the continued monitoring and control of the project with intense conservation and expert supervision throughout the phases of execution and usage.

The above mentioned specificities are applicable to all of the projects of reconstruction or maintenance of buildings that represent cultural heritage. In the case of Croatian legislation (1),(2),(3), the project management process, of building reconstruction or maintenance in buildings that represent cultural heritage would conduct in the following way as shown on figure 2. In the centre of the picture is an institution or an individual who manage and coordinate all of the tasks and participants on the project.

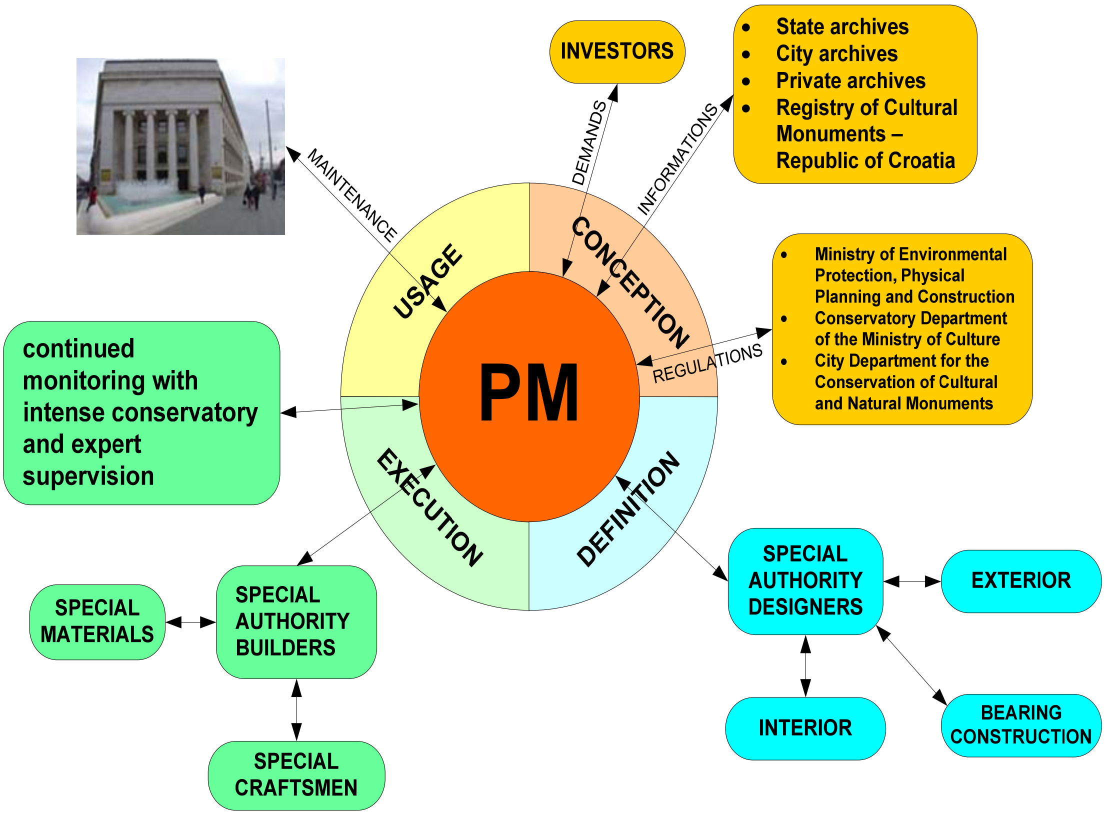

Figure 2. The process of managing a project of reconstruction or maintenance of a building which represents cultural heritage.

4. A possible project management methodology in reconstruction of old buildings, which represent cultural heritage.

Because of all above mentioned specificities of the project of reconstruction or maintenance of buildings that represent cultural heritage, it is necessary to develop a special methodology in managing such a project. The steps of a possible methodology would be:

1. To organize the collection of a satisfying amount of available data about the original look of the building and about all of the reconstructions that took place during the building usage period, and if necessary, to contact all available institutions and individuals, who can have such data. If the data from the archives and that is a common case, are not sufficient, it is necessary to perform a quality and precise research and measurements in the building. With the help of those, and the rest of the collected data, used as a basis, it is necessary to reconstruct the missing original documentation.
2. To coordinate all of the necessary processes needed to establish the state of the bearing construction elements, and to determine the necessary extent of the works (reconstruction or maintenance)
3. To coordinate all of the necessary processes used to compare the existing state of the bearing construction elements to the existing safety regulations (stability, seismicity) (1),(2).
4. To organize the making of detailed plans of the current state of the building which will be made using precise measurements and recordings on the building itself.
5. To consult all of the authoritative institutions, and get to know their specific demands towards the project (1),(2).
6. To organize all of the necessary processes needed for the design of the new building state, and to accept all of the specific demands of the authoritative institutions (3).
7. To organize and manage the phase of execution with the use of continued monitoring and control, and to coordinate the work of the conservatory and expert supervision (3).
8. To provide the systematic monitoring and quality maintenance through the whole usage phase (1),(2).

Figure 3. A project management methodology in reconstruction of old buildings, which represent cultural heritage

5. Conclusion

The goal of this paper was to show that the project of reconstruction or maintenance of buildings that represent cultural heritage, requires a unique, systematic, detailed and careful approach to the process of managing a project, and that it is significantly more complex than a new building project, because it is necessary to provide a series of conditions needed for his quality finishing. This is often disturbed by the takeover of the project management process by the investor. With that kind of projects it is significant to direct additional attention to organising and coordination of processes which occur during the phases of conception, definition and execution, due to the large number of additional special participants and special demands that those participants put in front of the project. It is also necessary to dedicate additional time used for the collection of available information about the building, reconstruction of the missing data and details, and design of the new building state. All of that is necessary to minimize or completely remove the probability of a problem occurring in the later execution and usage phases. While keeping in mind all of their specificities, it is necessary to especially, carefully, continually and entirely monitor all of the mentioned phases of the project, from a quality, time and financial point of view, because these buildings represent cultural and historical heritage and it is needed that they must be preserved in their original state for the future and the generations yet to come.

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ORGANIZATIONAL CULTURE OF FACULTY OF CIVIL ENGEENIRING, UNIVERSITY OF ZAGREB

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Abstract

Since 1981, when Peters and Waterman introduced term organizational culture in organizational science, organizational culture has become a very important field of investigation. The reason why organizational culture became so popular is connection between appropriate cultures and efficiency and productivity of organizations. However, there is no universal organizational culture applicable to all type of organizations. Hence, this paper analyzes organizational culture of the Faculty of civil engineering, University of Zagreb, and it tries to investigate whether this culture enables optimal fulfillment of Faculty' goals. According to a survey, presented in this paper, lecturers are moderately satisfied with interpersonal relationship, with selection of new employees, with the opportunity for professional promotion and with the ceremonies at the Faculty. Nevertheless, lecturers are not satisfied with the value system. In addition, a high percentage of members of faculty think that clear rules of behavior for students should be established.

Keywords: Organizational culture, University, Faculty, Civil engineering

INTRODUCTION

Only 30 years ago, term organizational culture was almost unknown in organizational theory. Peters and Waterman, in their seminal book "In search of excellence (1982)," were the first to introduce this term in organizational science, and first scientific works about organizational culture appeared at the beginning of 1980s. Since than organizational culture become a very important field of investigation which is evident by the fact that modern business schools regularly have a course about organizational culture. Today, it is almost impossible to analyze modern organizations without mentioning their organizational cultures.

However, analyses of organizational cultures face many challenges. First, it is not easy to define this term. It is out of the scope of this paper to provide many different definitions of organizational culture. Therefore, this paper will only quote the most frequent type of definition. According to Jones, organizational culture is "the set of shared values and norms that controls organizational members' interactions with each other and with people outside the organization (Jones, 2004, 195)."[1] There are many different norms that define organizational culture of a firm. According to Shein (2004, 12-3), the following categories are the most important in defining certain organizational cultures: behavioral regularities, group norms, espoused values, rules of the game, linguistic paradigms, symbols, formal rituals and celebrations etc.

The reason why organizational culture became so popular is connection between appropriate cultures and efficiency and productivity of organizations. According to Jones, "organizational culture affects organizational effectiveness because it can (a) provide an organization with a competitive advantage, (b) improve the way an organizational structure works, and (c) increase the motivation of employees to pursue organizational interests (Jones, 2004, 222)." However, there is no universal organizational culture applicable to all type of organization. Different types of organizations demand different cultures. For example, an efficient organizational culture of a firm that produces software for computers can be completely inefficient in a civil engineering firm. Therefore, each organization should try to find a culture that is the most suitable for this firm. However, organizations that produce similar types of products or services usually do have reasons to learn one from each other. For example, for a period of time, organizational culture of Microsoft became a model for other firms in informatics industry. Hence, this paper will analyze organizational culture of the Faculty of civil engineering, University of Zagreb and it will try to investigate whether this cultures enables optimal fulfillment of Faculty' goals. This is especially important since, according to Kovač (2006, 5-6), "the university organizational culture can be recognized, evaluated and interpreted, but what is even more important is that it can be modified and changed to the desired way of functioning."

ORGANIZATIONAL CULTURES OF UNIVERSITIES

If Jones' definition of organizational cultures is applied to universities than it can be concluded that university organizational culture is the set of shared values and norms that controls university members' interactions with each other and with people

[1] Similarly, according to Vecchio, "we can define organizational culture as the shared values and norms that exist in an organization and that are taught to incoming employees (Vecchio, 2000, 342)." For different types of definitions see Shein (2004).

outside the university. In university settings it is especially important to investigate interactions between member of faculty and between faculty and students. There are many different ways how university culture can be assessed. For example, Becher (1989) differentiate four types of culture (collegial, hierarchical, anarchical and political) on the basis of the type of authority. Fjortoft and Smart (1994) differentiate university organizational cultures on the basics of dynamism and externalism. So, certain universities prefer stability more than dynamism and vice versa. Also, universities could prefer either external or internal orientation. However, for this paper, the most important classification is one proposed by Sporn (1996). She differentiates two types of university organizational cultures: strong and weak. Strong university culture is characterized by shared values, strong norms of behavior and willingness of faculty to obey these norms. In contrast, a weak culture is characterized by disagreement about main values, absence of norms, and violation of written and unwritten norms of behavior at university. In addition, weak university culture frequently produces many subcultures inside universities. Following Sporn's classification, the main purpose of this article is to investigate whether organizational culture of the Faculty of Civil engineering, University of Zagreb should be classified as strong or as a weak one. In other words, this article investigates whether Faculty of civil engineering has clearly defined values and norms shared by the members of the faculty.

Description of organizational culture of Faculty of Civil engineering, University of Zagreb

There is not many works that analyze organizational cultures of Croatian Universities. The most comprehensive one is *Understanding University Organizational Culture: The Croatian Example* by Kovač et al. (2006). This book examines organizational culture of all Croatian Universities. The main conclusion of the book is that departments at faculties in Croatia are predominantly collegial types of organization (emphasis on common values and goals, participation, consensus, connection and family atmosphere). In contrast, faculties and universities are principally bureaucratic types of organization (emphasis on rules, regulations and hierarchy) Kovač (2006, 69-70). However, this book is focused on type of governance of Croatian Universities and does not get to details concerning norms, patterns of behavior, rituals, language and other important elements of organizational culture. Therefore, this article will try to investigate these neglected elements in their investigation. In other words, topics of investigation are values, norms, ceremonies, rites, myths, etc. Since both authors of this article are employees of the Faculty, they had an opportunity to analyze the culture as insiders, following Schein's observation (in Vecchio, 2000, 343) that "achieving and understanding of an organization's culture can be aided by locating a motivated insider within the organization, someone who is capable of deciphering the organization's culture and is motivated to discuss it."

In order to do it, it is necessary to define key terms used in this investigation. Values are "general criteria, standards, or guiding principles that people use to determine which types of behaviors, events, situations, and outcomes are desirable or undesirable (Jones, 2004, 195)." Furthermore, norms are "standards or styles of behavior that are considered acceptable for a group of people (Jones, 2004, 197)." Important elements of organizational culture are also customs, ceremonies and rites being defined as "regular behaviors that stimulate identification of individuals with an organization (Bahtijarević-Šiber, 1993, 596)."

So, what is the main value at the Faculty? It is important to note that many universities in the world face dilemmas concerning values they should focus on. Dill (1995) and Clark (1998 and 2004) concluded that the main trend in American and European universities is commercialization of research results. In other words, the main value has become profit, rather than teaching quality and research excellence (although these three elements are not necessarily in conflict). One of the purposes of this research is to investigate whether the same process has happened at the Faculty of civil engineering. Lecturers at Faculty assessed the hierarchy of values at Faculty (profit, research excellence, teaching excellence).

Concerning norms, Faculty does have a statute with written norms about duties of lecturers, other employees and students. However, the Faculty is a prime example for Jones (2004, 197) assessment that "many of the most powerful and crucial values of an organization are not written down. They exist only in the shared norms, beliefs, assumptions, and ways of thinking and acting that people within an organization use to relate each other…" For example, in Department for Construction Management and Economics there is an unwritten norm that people should celebrate at work not only events connected with their professional promotion but also their personal events (birthday, birth of a child or grandchild, wedding, etc.). Furthermore, members of this department meet each other in their spare time celebrating, for example, Christmas, end of a school year and other events. Such a habit has, for sure, a positive effect on interpersonal relations at the department. These meetings are a way of "team building," and they are an effective way of improving personal relations. It is important to note that people in the department follow these unwritten norms that constitute a subculture of the department inside an organizational culture of the Faculty.

Like many others organization, Faculty of civil engineering has regular ceremonies. The most important are graduate ceremonies (for students), Christmas party, opening of a new school year, Faculty day, and ceremonies for people that live the Faculty for retirement. These ceremonies promote sense of unity, strength organizational culture and transfer norms and values to new employees. Speeches at these ceremonies stress Faculty' successes and call for further efforts that should improve Faculty' effectiveness.

Myths and legends also exist at Faculty. Older professors tell stories about their own professors who were tough, demanded strong discipline but also were experts in their field. Functions of these myths are similar as in other organizations. According to Miller and Form (1964, 271), "some myths function to preserve group values, some 'explain' the social system, some maintain moral; other are fabricated consciously by leaders to achieve certain ends."

Though there an official dress code for the Faculty does not exist, unwritten rules do exist. For example, it is expected that faculty members do wear suits and ties during students' defense of bachelor, master and doctoral thesis. The same unwritten rules apply for opening ceremony at the beginning of an academic year and during the ceremony on Faculty day. Less strict rules apply for the dressing of lecturers during the regular teaching and research activities. There is also no written rule concerning dressing of students. However, this situation produced smaller incidents when lecturers did not want to meet inappropriately dressed students (according to criteria of this lecturer). Therefore, one of the questions in the survey was whether an official dress code for the Faculty should be established.

Finally, an element of organizational culture is also arrangement of working space. According to Sikavica (1999, 612-3), “open offices lead to more open communication and participative culture. In contrast, closed offices are closer to authoritarian culture… Those organizations that have a round table in the meeting room usually have participative and democratic culture…” Faculty of civil engineering has closed offices. There is an unwritten rule that assistant professors, associate professors and full professors have their own offices but research and teaching assistants usually share closed offices. In this respect the Faculty is closer to an authoritarian type of culture. However, meetings of the Faculty’s Council are organized around a U-shaped table, which suggest a more democratic culture. Indeed, Faculty’s Dean is rather *primus inter pares* than an authoritarian leader, which is a logical type of organization for university settings.

SURVEY

This research will try to investigate organizational culture at the Faculty on the basis of questionnaire submitted to lecturers at the Faculty. Although questions do not address organizational culture directly, they address the most important elements of organizational culture, especially satisfaction of lecturers with organizational climate.[2]

The survey consists of fourteen questions about organizational culture. Altogether 47 out of 69 senior lecturers filled the questionnaire.[3] They are selected because, according to Budd (1996, 156), “the faculty are a key element in the organizational culture of the university.” Since values are “backbones” of organizational cultures, two questions address values at the Faculty. In first of them, lecturers assessed what is the most important value at the Faculty.[4] According to the survey, teaching quality is the most important value followed by research excellence. Profit is only at the third place. It can be concluded that a process of commercialization is still not prevalent at the Faculty, which has its positive and negative consequences. It is positive that teaching is considered as the most important activity. Probably the most logical explanation is the way The Ministry of science finances higher education, including Faculty of civil engineering. However, obviously, majority of lecturers do not consider that market is the most important criteria for evaluation of their activities. It is important to note that lecturers are rather dissatisfied with existing hierarchy of values. The average level of satisfaction is only 2.89 at the scale of five. It is difficult to assess what is the main reason for their dissatisfaction but one possible explanation is that lecturers actually do want a higher level of commercialization of the Faculty. Nevertheless, such a claim demands further investigation.

One important element of organizational culture is the way how new employees are selected. For example, United Postal Service in USA selects employees almost exclusively among students that work for the company during their studies (Sikavica, 1999, 615). In this respect, the Faculty has similar policy because employees at the Faculty are mainly former students. Consequently, a question in the survey asks respondents whether they are satisfied with the selection of new

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[2] See questionnaire in appendix.

[3] Dean and four vice deans also filled the questionnaire.

[4] Hierarchy of values was assessed on the basis of a semi open question (see appendix, question 10). Two lecturers added professional work into the hierarchy, putting it on the third place. One lecturer added professional prestige as the most important value, and one considered organization of work as the most important one.

employees. The average level of satisfaction is 3.21 at the scale of five, which cannot be considered as a high level of satisfaction with this element of organizational culture. However, respondents are more satisfied with the opportunities for promotion during their careers (3.85).

Four questions in the survey (6-9) deal with ceremonies and rites. Lecturers are the least satisfied with the rites of passage (3.43) and rites of enhancement (3.55). However, they are satisfied with rites of integration (like Christmas party). Here the average grade is 4.00. Furthermore, the highest level of satisfaction - in entire interview - responded expressed about rites of promotion for students (4.21), probably not without reason. Indeed, the entire rite, from the moment when students defend their thesis, to the moment when they receive their diploma, is filled with the sense of dignity. In these moments both lecturers and students follow unwritten rules about behavior, language, cloths, etc.,[5] which give a sense of "glamour" to the ceremonies.

Concerning norms, as high as 91 % of lecturers think that set or rules about students' behavior should be established. Although existing Statute of the Faculty contains some basic norms concerning students' behavior,[6] it is obvious that lecturers think that a more precise set of rules should be established. In this respect, it seems that respondents want a "strong" Faculty's culture.[7] However, less than fifty percent of respondents (41.3 %) think that the Faculty should have dress code for students and even lower percent is in favor of a dress code for lecturers.

Finally, it is important to investigate the level of general satisfaction with the organizational culture of the Faculty of civil engineering. The most logical way to do it would be to ask respondents whether they are satisfied with the organizational culture. However, this is not an easy task. Term organizational culture is not well-known, especially not for the people who belong to technical intelligentsia. Therefore, level of satisfaction was measured through satisfaction of respondents with the interpersonal relations at the Faculty. This is a legitimate approach because, according to Sušanj (2005, 121), "composition of (organizational) climate and culture together explain 35 percent of job satisfaction." Consequently, it can be concluded that the higher the level of satisfaction with interpersonal relations the higher the level of satisfaction with organizational culture. So, are members of the faculty satisfied with interpersonal relations? The most accurate answer is that they are moderately satisfied, being least satisfied with their relationship with colleges at the Faculty level (3.49). They are more satisfied with the relationship with colleges at the department level (3.57),[8] and they are most satisfied with their relationship with students (3.72).

CONCLUSION

Results of this investigation do not offer much surprise. Lecturers are moderately satisfied with interpersonal relationship, with selection of new employees, with the opportunity for professional promotion and with the ceremonies at the Faculty. However, that what was not expected at the beginning of investigation is a relatively low level of satisfaction with the value system. It seems that lecturers would

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[5] For example, both lecturers and students usually wear suits ore costumes, vice dean gives speech after defense of final thesis, students are offered with champagne at the end of the ceremony, etc.

[6] Article 129 says that students' behavior should be in accordance with the University's ethical code.

[7] According to Vecchio (2000, 345), "a strong (versus weak) culture is distinguished by whether the organization's values and norms are intensely held and widely endorsed."

[8] In a similar investigation Kovač (2006, 187) found a relatively low level satisfaction with governance practice on the level of faculty (2.84) but a higher level of satisfaction with governance practice on the level of departments (3.23).

prefer a higher level of commercialization of the Faculty. Furthermore, it was not expected that such a high percentage of members of faculty think that clear rules of behavior for students should be established. Obviously, Faculty's organizational culture cannot be considered as a strong one because it misses some important norms (see page 2, and note 7). Finally, having in mind that this is the first investigation of organizational culture of the Faculty of civil engineering, it is important to specify issues that should be investigated in the future. Authors of this research suggest that it is important to compare the results above with the results for other Faculties at the University of Zagreb and with the results for other Faculties of civil engineering in Croatia and abroad. In addition it would be interesting to compare students' perception of organizational culture with the perception of lecturers at the Faculty. With this type or research it would be possible to have a better assessment of the quality of organizational culture of the Faculty.

Appendix

QUESTIONNARIE[9]

Interpersonal relations

Please, answer the first nine questions on the basis of your personal assessment (1 – very dissatisfied, 2 – dissatisfied, 3 – neither satisfied, nor dissatisfied, 4 – satisfied, 5 – very satisfied).

1) How satisfied are you with interpersonal relations at the Faculty of civil engineering (1-5)?
2) How satisfied are you with interpersonal relations at your department (1-5)?
3) How satisfied are you with relations between lecturers and students (1-5)?

Human resources management

4) How satisfied are you with the way how new employees are selected (1-5)?
5) How satisfied are you with the opportunities for promotion at the Faculty (1-5)?

Ceremonies and rites

6) How satisfied are you with the rites of passage (1-5)?
7) How satisfied are you with the rites of enhancement (1-5)?
8) How satisfied are you with the rites of integration (1-5)?
9) How satisfied are you with the rites of promotion for students (1-5)?

Values

10) Sort values from the most important to the least important ones (teaching quality, scientific excellence, profit, or something else)!
11) How satisfied are you with the hierarchy of values at the Faculty (from 1-5)?

[9] Questions in this survey are composed on the basis of Nachmias (2000, 233-43).

Other elements of organizational culture

12) Do you think that the Faculty should have set of rules about students' behavior (Yes or No)?
13) Do you think that Faculty should have dress code for students (Yes or No)?
14) Do you think that Faculty should have dress code for lecturers (Yes or No)?
15) Do you have any comment on questionnaire?

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INSURANCE

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Abstract

The paper describes insurance whose purpose is to transfer the damages from an insured person on the insurer. The basic principle of contemporary insurance is the compensation, respectively the principle of an insurable interest.

The paper analyses the issues of insurance of buildings under construction, of liability insurance and of contractual liability insurance.

Keywords: insurance, buildings, construction

INSURANCE

1. General

The purpose of insurance is transferring the possible risk of liability from the insured person onto the insurer. The insured person, upon paying the premium, transfers his/her risk on the insurer who will, in case of a harmful event, entirely or partly cover the damages. In this manner the insured person protects himself/herself and his/her business, transferring the risk of possible liability onto the insurer. Particularly exposed to possible liability are people in particular trades who, by performing an activity, may either cause damage to a large number of people or extensive damage. The extent of a damage arising from a specific harmful event may be of such an extent that the injurer cannot independently cover the damages without considerable financial problems. The peril of possible extensive damage is particularly high in construction industry with extremely huge capital invested and where, due to the manner of construction work and the buildings, damages can reach disastrous proportions. Therefore, the insurance industry has developed a series of „products", a series of various types of insurances offered to the contractors and construction industry generally. These are, in the first place, so called building under construction insurance, liability insurance and contractual liability insurance.

Generally speaking, an insurance contract is a contract whereby one party (the insurer) by charging a fee (premium) is obliged to their contracting partner (insurance contractor) to cover the damages to a person (the insured person) up to a defined level (insurance compensations) suffered by people and things (subject of a contract) arising from an covered risk.[1] Therefore, essential elements of the insurance contract are as follows: the subject of insurance, covered risk, insurance premium and insurance compensation. The period of insurance is not an essential element in an insurance contract, but only one of the elements of individualised risk.

The basic principle of contemporary insurance is the principle of damages, that is, the principle of insurable interest. Pursuant to this principle, the insured person can be only a person with an insurable interest, therefore the person that will suffer damage arising from an covered risk. The second important principle of contemporary insurance is the principle of aleatory moment (randomness). The aleatory moment (randomness) of the contract means that at the time of making the contract, it is not known whether the harmful even will occur. In this respect, pursuant to article 922, par.2, LO, the insured peril must be a future one, aleatory (uncertain) and independent of the exclusive will of the insurance contractor or the insured person. If the covered risk occurs at the moment of making an insurance contract or is occurring or is certain to occur or the possibility of its occurrence has expired, the insurance contract is null and void.[2]

The contracting parties in an insurance contract are the insurer, the insurance contractor and the insured person. An insurer must be a legal entity with headquarters in the Republic of Croatia, authorised for insurance activities by a supervisory body.[3] An insurance contractor is a person that makes the insurance contract with the insurer and pays for a contracted premium, and an insured person is a person that is entitled to claim compensation from the

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[1] See: article 921 of the Law on Obligations (hereinafter: LO), Official Gazette (hereinafter: OG) No. 35/05, 41/08)
[2] See: article 922, para. 3 LO
[3] See: article 6 of the Law on Insurance (OG 151/05)

insurer. An insurance contractor and an insured person may and may not be the same persons. If an insurance contract does not explicitly state that the contract is made on behalf of third party, it is presumed that the insurance contractor is an insured person.

Insurance of buildings under construction

This type of insurance provides insurance at all the phases of construction, from design, preliminary works, construction to warranty term. It protects from destruction, damage or disappearance of damaged matter, and the subject of insurance may be buildings under construction (new buildings, reconstructions, repairs, annexes), and installation works, installation material, building equipment and improvised buildings, including neighbouring buildings. The insurance protects from a series of risks, for instance, fires and thunderbolts, explosions, storms, hail, moving ice, demonstrations, aircraft crashes, spilling waters, sinking soil, frost, unforeseeable atmospheric precipitation, vehicle collision, fall of insured objects, hit or crash of objects on the insured objects, unforeseeable construction accidents, clumsiness, carelessness or negligence of workers or third parties, burglary or theft, floods and torrents, high water, underwater, landslides. In Croatian insurance practice insurers state individual covered risks perils word for word. However, there is an increased number of insurance policies under international CAR (Contractors' All Risks) conditions, which cover all risks save the ones excluded under CAR conditions. Insurance policies made pursuant to CAR conditions often give protection from damage arising from construction, default, faulty or delayed fulfilment suffered by third parties. To that effect the insurance policy for a building under construction frequently offers liability insurance and contract liability insurance.

This insurance policy is issued in the amount of an individual harmful event which is regularly a portion of the total construction contract fee (e.g. 100%, 70%, 50%, 10% of the total construction contract fee). In so doing, the insured amount depends primarily on the estimate of the insured person for the possible damage in an individual harmful event. The insurance premium will, evidently, depend on the insured amount, and on the risk estimated by the insurer. The estimate of risk is separately made for every single insured person.

Since the damages arising from risks covered by the insurance are suffered both by constructors and their clients, it can be made both by constructors and their clients. It is usual that constructors make the insurance policy, since, being persons in charge of the building and works, they are obliged to be liable for the risks on the building or activities under their control. In the same manner, being exposed to an insured risk, clients often demand that the insurance policy has vinculation, namely, that the right to compensation is transferred into their name.

1.2 **Liability insurance**

Liability insurance refers to the insurance which offers the insured person a protection from the risks arising from his professional activities, that is, by which he/she is protected from non-contractual liability he/she can cause to the third parties in the course of his profession. Therefore, this is the third party liability insurance. Within this insurance, the insurer is obliged to compensate for the damages arising from bodily injury of the injured party or from the damage or destruction of their possessions. If specifically stipulated, this insurance also covers so called pure economic loss, thereby the damage not arising from bodily injury or from damage of destruction of the possessions of the injured party. This insurance covers all the damages caused by the insurer to the persons he/she does not have contractual relationship with. For instance, this insurance would cover the damages suffered by third parties during construction work, as well as the damages caused by the death or injury of innocent bystanders during construction work, damages caused by destruction or damage of neighbouring buildings and so forth. If specifically stipulated, this insurance can cover the damages suffered by the insured person's employees, who have suffered a particular damage during construction work. As a rule, excluded from this insurance are intentional damages, damages suffered directly by the insured person, damages caused by war and similar armed interventions.

This insurance covers only the damages arising from harmful event which occurred during policy period. If the harmful event was caused by the reasons occurring before the policy period, the damages caused by these harmful events will be covered only on condition that the insurer was not informed about the causes of the harmful event prior to the moment the policy was made.

1.2 **Contractual liability insurance**

A contractor can cause damage to the client by failure to perform construction work from the contract, by delayed performance of construction work or by defective performance of construction work. Bearing in mind that construction industry involves considerable capital, possible damages suffered by the client, caused by failure or delay to perform construction work, can be very high. Compensation for damages might endanger the financial stability or even the existence of the constructor. For this reason, a constructor can make a contractual liability insurance policy and thus transfer the risk onto the insurer. This type of insurance does not cover third parties, so that it covers only damages caused to the person who have a contractual relationship with the insured person.

This insurance covers the risk of contract breach (failure to perform construction work from the contract), delayed performance of construction work (failure to perform work within contractual term) and defective performance of contractual work (construction work performed unprofessionally and of inappropriate quality). This insurance covers so called pure economic loss, thereby financial losses suffered by the client due to the breach of contract by the insured person. This insurance, as a rule, will not cover intentional damages. This insurance will neither cover the damages to the fellow contractor of the insured person arising from other legal basis, and not on the basis of breach of contract. Thus, for instance, this insurance will not cover damages on the possessions of the fellow contractor caused during construction works.

The amount of insurance for an individual harmful event is contracted on individual basis, depending on the estimated risk to the insured person and estimated damages a fellow contractor might suffer.

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LIABILITY FOR DEFECTIVE PRODUCTS ZAGREB

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Abstract

The paper describes liability for defective products as a non-contractual, strict liability which is stipulated by provision of the Law of Obligations patterned after Council Directive 85/374/EEC of 25 July 1985 on liability for defective products, amended by Directive 1999/34-EEC.
The paper analyzes the concepts of product, defectiveness, injurer and the injured party, damage, burden of proof, release of liability and expiration of liability.

Keywords: liability, defective products

LIABILITY FOR DEFECTIVE PRODUCTS

1. General

Liability for defective products is a non-contractual, strict liability. This form of liability is stipulated by provisions in articles 1073 to 1080 of the Law of Obligations (hereinafter: LO),[1] patterned after the Council Directive 85/374/EEC of 25 July 1985 on liability for defective products, amended by Directive 1999/34-EEC. Since it is a non-contractual liability, the injurer is liable regardless of the existence of the contractual relationship between the injurer and the injured party. In the same manner, as it is strict liability, the injurer is held responsible regardless of his fault. In other words, even if he is not at fault for the damage that occurred, the injurer will be liable for the damage suffered by the injured person caused by the defects of the product. In this process, a contract cannot stipulate in advance an exemption or limitation of objective liability.[2] Strict liability requires the following: an injurer and an injured person, a harmful act, damage, causality and illegality of a harmful act.

A defective product

According to the regulations concerning liability for damages, the producer is liable for the damage caused by the defectiveness of his product. In order to apply these regulations it is essential to define a product and a defective product.

Concept of a product

Pursuant to the provision of article 1074, LO, products are movables, whether or not incorporated into another movable or into an immovable. In other words, products are also movables which have been incorporated into other products as parts, raw materials or incorporated materials. Within the context of liability for defective products in construction industry, a building cannot be viewed as a product. Namely, by provision of article 1074, LO, a product is defined as a movable. Whereas, based on the principle *superficies solo cedit*, a building, with the land on which it has been constructed, represents one immovable property,[3] it is evident that the regulations regarding a defective product cannot be applied to a constructor who has built a particular property.

It must be noted, however, that a building becomes an inseparable part of a property and thus stops being a movable only if it is relatively permanently connected to the land where it has been built.[4] In this respect, the buildings constructed on a land which are not accrued to the property do not become its part if they have been built on the land for temporary purposes, respectively the buildings which can be removed from the property, like various kiosks, containers and so forth.

It is also important to know that liability for defective product includes a product incorporated into a property as raw material or other incorporated material. In these terms, liability for a defective product includes raw materials, building elements, appliances and equipment incorporated into a building. For instance, liability includes cement, concrete, iron

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[1] Official Gazette (OG), 35/05,, 41/08.
[2] See: article 1079, Law of Obligations (LO).
[3] See: article 2, par. 3 and article 9, par. 3, Property and Rights in Rem Law (hereafter PRRL) (OG 91/96, 68/98, 137/99, 22/00, 72/00, 114/01, 79/06, 141/06).
[4] See: article 9, par.3, PRRL.

reinforcements, paints, varnishes and other raw materials incorporated into a building, on condition that the court has ruled that they are defective. Moreover, liability includes elevators, boilers and other appliances incorporated into a building. Finally, liability includes woodwork, electrical fittings and other equipment incorporated into a building.

Liability for a defective product only includes the damage arising from product defects and not the damage arising from "defectiveness", i.e. unreliability of services. In this respect, the regulations on this type of liability for damages do not include the contractors, designers and other persons whose services have contributed to the construction of a building, even if damage has been caused by inadequate service.

1.1.2. **Defectiveness**

Pursuant to provisions of article 1075, LO, a product is defective if, taking into consideration all the circumstances of the case, and particularly the manner in which a product has been presented, reasonably foreseeable purposes for which a product can be used, and the time when a product was put into circulation, it does not offer safety which a person is entitled to expect. However, it must be emphasized that a product shall not be considered as defective solely because it is not in conformity with the contract. Namely, some products can have certain (material) shortcomings, which do not challenge their safety. Namely, there are different criteria for defining nonconformity with the contract (material shortcomings) an object and its defectiveness. While a product is not in conformity with the contract on condition it does not serve its purpose, a product is defective if it does not have expected safety, that is, if there is a high possibility of its damage for people. For instance, if woodwork incorporated in a building leaks or is not air tight, it will not be in conformity with the contract since it does not serve its purpose. However, the woodwork shall not be considered as defective since, due to its shortcomings it does not increase danger for people's lives and health, or it does not endanger their assets.

The defectiveness of a product can consist of the manufacturing defect, design defect and information defect. Manufacturing defect exists if a product is not identical to other products of the same series, which results in increased danger for safety of people and their assets. Design defect exists when the formula, design or construction of a product is defective which results with an entire series of products by the same producer having the identical type of defect which makes these products excessively dangerous. Information defect exists when the users haven't been given complete and accurate information on the safe use of the product by its producer which results in the product's increased danger.

Within the context of product defectiveness, it is important to note the necessity of respecting the safety standards stipulated by regulations of technical legislation and norms. Namely, if a product meets the safety standards stipulated by technical legislation, that is, if in the absence of these standards, it meets the requirements or relevant norms, then it is refutably presumed that the product is safe. [5] To this effect, if the safety of a product is doubtful, the producer could argue that, when constructing, manufacturing and labeling the product, he/she had acted in accordance with the relevant safety standards or norms to prove that the product is safe. However, since the compliance of the product with the regulations of technical legislation is only a refutable presumption of the safety of the product, an injured person might, in a concrete case, argue that the product, in spite of proved compliance, is still defective.

[5] See: article 4, par.2, Law on Product Safety (OG 158/03, 107/07).

Injurer and injured person

Pursuant to the rules on liability for defective product an injurer is the producer of a defective product. Within the context of liability for defective product the concept of a producer largely differs from the everyday, common concept of a producer. Pursuant to the provision of article 1076, LO, a producer is a person who has manufactured a final product, a person who has manufactured a component part or a raw material incorporated in the final product, an importer of the defective product and any other person who identifies him/herself as the producer by putting their name, trade mark or other distinguishing mark on the product.

If it is impossible to identify the producer, any person putting the product into circulation will be considered the producer, unless, within a reasonable period he/she informs the injured party which person the product originates from.[6] According to this rule in many cases builders might be held liable for a defective product. Namely, if the court finds that the damage was caused by defective raw materials or building products incorporated into the building, then, as a rule, the injured persons are not informed about the producers of these raw materials or building products and the builder will be held liable, because he has put these products into circulation by incorporating them into the building. For instance, if it has been found that the injuries of certain persons caused by a falling building were caused by a defective iron reinforcements incorporated in that building, the injured persons, as a rule, do not know the producer of iron. Therefore, they will sue the builder who put that iron into circulation, that is, who has put the third parties at risk of damage by incorporating the iron into the building. However, the builder can be released from liability if he/she identifies the person who manufactured the iron used, namely, if he/she identifies the person from which the purchase of iron was made.

If a number of persons are liable for damages caused by a defective product, they have joint liability for damages.[7] It specifically means that the injured person could claim for damages from any person liable for damages. For instance, if the damage was caused by a defective reinforcement grid incorporated into a building manufactured by one person, and imported to Croatia by another, both the manufacturer and the importer are liable for damages and the injured person could claim for damages from both persons.

The injured persons can be any persons suffering a defective product damage which falls into the category of liability pursuant to these rules. In principle, they can be buyers of a building (e.g. apartments), third parties (e.g. persons who were accidentally in front of the building whose parts fell onto the street) or builder’s employees who suffered damage caused by a defective product (e.g. an employee who was injured when a building under construction fell).

Damage

According to the rules on liability for defective product a person is not liable for the whole damage. Pursuant to the provision of article 1073, LO, persons are liable only for material damages caused by a death or physical injury of the injured person and for material damages caused by destruction or damage of the objects belonging to the injured person but only under a presumption that these objects are for personal usage and if the injured party mostly used them for this purpose and if the value of the damage is higher than 500 Euros worth in kunas.

[6] See: article 1076, par.3, LO
[7] See: article 1077, LO

Pursuant to the above provision of LO, under the rules on liability for a defective product, persons are not held liable for non-material damages and material damages caused by destruction or damage of the objects used for business purposes. For instance, if a building falls because of a defective building product, and destroys a building machine owned by a subcontractor, the producer of a defective building product is not to be held liable for that damage because the destroyed thing had a business and not a personal purpose.

Burden of proof

Pursuant to provision of article 1073, par.8, LO, the injured party is obliged to prove the defectiveness of the product, the damage and the causality between the defective product and the damage. It is usually extremely difficult to prove the defectiveness of a product. Namely, to prove that a product is defective would mean that it is possible to prove that the product was defective when manufactured, that it was designed as defective or that the information with the product was insufficient. In any event, the process of proving the defectiveness of a product requires a highly sophisticated expertise which has to establish whether the product in question contained any defects. For instance, if there is damage caused by the defectiveness of concrete incorporated into a building which resulted in building's falling, it will be necessary to prove that the concrete used was not of relevant composition or that the raw materials used in making the concrete were not appropriate, which resulted in the building's falling and caused damage.

Exemption of liability

The producer of a defective product has at his disposal a wide range of reasons for being exempt from liability. Thus a producer will be exempt from liability if he/she proves:

- that he/she did not put the product into circulation,
- that the circumstances of the case indicate that the defectiveness, and its cause, did not exist at the time when he/she put the product into circulation,
- that the product was not manufactured to be sold, leased or for any other business purpose, neither was it manufactured or put into circulation within the scope of his business
- if the defectiveness is the result of applying mandatory provisions which were in force at the time when he/she put the product into circulation
- that the state of science or technical knowledge at the time of putting the product into circulation did not make possible to discover the defect,
- that the damage was caused solely by the injured party or a person for which he is responsible, respectively, by the activity of the third party which the producer could not foresee or whose consequences he could not have avoided or eliminated.[8]

If the injured person or a person he/she is responsible for has partly contributed to the damage, the producer will be partly exempt from liability while if a third party has partly contributed to the damage, the producer will have joint liability with this person.[9]

[8] See: article 1078, par.1, LO.
[9] See: article 1078, par. 2 and 3, LO.

Expiration of liability

The injured person has three years within which to seek compensation. This period starts from the date on which the plaintiff became aware of the damage, the defect and the identity of the producer.

The producer's liability expires at the end of a period of ten years from the date on which the producer put the product into circulation, unless in that period proceedings against the producer were started at court or other competent body.[10]

No contractual clause may allow the producer to limit his liability in relation to the injured person.

[10] See: article 1080 LO

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ENERGY CERTIFICATION OF BUILDINGS. TRAINING OF EXPERTS.

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Abstract

According to the Action plan of the Ministry of Environmental Protection, Physical Planning and Construction, the engagement of the implementation of the Directive 2002/91/EC to the Croatian legislation has to be completed in 2009. The final goal of the Directive is the achievement of energy efficiency in buildings, with emphasis on design of building and building elements, heating and cooling systems and use of renewable energy sources. The presentation of energy performances of the building should be visible in energy label that will classify the building in comparison to energy consumption and must be submitted while buying, selling or renting the building. For the realization of energy certification of the building it is required to provide training for wide number of experts. The production of professional basis is ongoing, where besides the building classification and modification or production of correspondingly technical regulations, are determining the conditions and standards for persons who should provide the certification, as well the method of providing.

Keywords: buildings, energy consumption, certification, training of experts

Introduction

A large number of countries and organisations launched worldwide programs and network of activities for promotion and education as well as for the implementation of energy efficiency measures in order to ensure high level of environmental protection and sustainable development. Energy production and consumption are the indicators of economic and technological development level but are also the most significant factor in environmental pollution. The constant increase in energy prices prompts the expeditious implementation of measures for energy use reduction as well as the finding and the exploitation of alternative energy sources.

Energy Consumption in Building Construction

The substantial improvement of living standard and life style changes leads to higher energy consumption due to the wide-spread use of air conditioning for space cooling. The use of air conditioning causes considerable environmental pollution exacerbating, thus, already intense global warming which, on the other hand, has a significant impact on further increased energy consumption in order to maintain the acquired standard of living. Buildings consume significant amounts of energy participating in the total annual energy consumption with almost 40%.

The possibilities of energy saving are the largest in the building construction sector. The present measures for heat loss reduction through building components and their related joints resulted in the considerable progress in energy efficiency but not all possibilities have yet been exhausted. The biggest share in current energy consumption goes to space heating (52% in non-residential sector and 54% in residential sector). The energy consumption shares for lighting installations and hot water supply must not also be overlooked.
The present calculation method focused on the heat necessary for space heating in buildings was based solely on the construction part of the building without taking into consideration the efficiency impact of heating, air-conditioning and ventilation systems and does not present the actual energy consumption. Extraordinary energy savings potential lies in the building sector i.e., up 22% by 2010, especially in heating installations, hot water supply, air conditioning and lighting installation.

European Initiatives
Promoting energy efficiency in buildings in the European Union has gained prominence recently with the adoption of several documents i.e., directives to build on and develop the policy framework in this complex area (Council Directives 89/106/EEC, 93/76/EEC, 2002/91/EC and 2006/32/EC). Council Directive 89/106/EEC of 21 December 1988 refers to the approximation of laws, regulations and administrative provisions of the Member States relating to construction products.
The provisions of Council Directive 93/76/EEC of 13 September 1993 limit carbon dioxide emissions by improving energy efficiency (SAVE). The EU Directive on the Energy Performance of Buildings (EPBD) contains a range of provisions aimed at improving energy performance of buildings, while the provisions of the Directive 2006/32/EC promote the energy end-use efficiency and energy services.

The most important document currently in implementation in all EU Member States is Directive 2002/91/EC on the energy performance of buildings passed by the European Parliament and of the Council on 16 December 2002. The four key points of the Directive are a common methodology for calculating the integrated energy performance of buildings; minimum standards on the energy performance of new buildings and existing buildings that are subject to major renovation; systems for the energy certification of new and existing buildings and, for public buildings; energy performance certification, inspection and assessment of heating installations and central air-conditioning systems in buildings.

According to Article 3 of the Directive the methodology of calculation of energy performances of buildings shall include at least the following aspects: thermal characteristics of the building (shell and internal partitions, etc.), heating installation and hot water supply, air-conditioning installation, ventilation, built-in lighting installation, position and orientation of buildings, including outdoor climate, passive solar systems and solar protection, natural ventilation and indoor climatic conditions. The positive influence of the renewable energy sources shall, where relevant in this calculation, be also taken into account.

For the purpose of this calculation buildings should be adequately classified into categories such as single-family houses of different types; apartment blocks; offices; education buildings; hospitals; hotels and restaurants; sports facilities; wholesale and retail trade services buildings; other types of energy-consuming buildings.

The deadline for the transposition of Directive 2002/91/EC by EU Member States was January 4, 2006 but the implementation was in practice postponed for up to three years (January 4, 2009) and almost all Member States took advantage of this opportunity to delay its implementation.
Due to the upcoming expiry of the EPBD implementation deadline which has been postponed for three years the final preparations for full implementation of the legislative framework regarding energy efficiency in buildings are well underway.

EPBD implementation process is an extremely complex and multidisciplinary task which poses significant challenges for the Member States and requires the engagement of numerous accredited institutions and experts in its realisation. In order to facilitate the implementation of the Directive several international initiatives were launched. One of the main initiatives for promoting dialogue between the Members States is the Concerted Action (CA) in which Croatia also participates, has two main objectives: enhance and structure sharing of information and experience from national implementation as well as promote good practice in activities required of Member States for implementation of the Energy Performance of Buildings Directive (EPBD). The first Concerted Action (CA I) initiative and its continuation (CA II) assist in addressing the issues in implementation of Directive provisions and finding the most suitable methodology. The exchange of information during the project duration shows full cooperation between the participants and mutual readiness for professional assistance.

Energy Efficiency Legislation in Croatia

Even though the mentioned Energy Performance of Buildings Directive has not been fully transposed in Croatian, the preparatory activities have been underway for several years in Croatia and energy efficiency standards have been included in a series of laws, ordinances and regulations. In the area of thermal protection and energy saving in buildings numerous European standards were accepted which are the integral parts of methods for thermal performance calculations for buildings. A number of national technical regulations refer to the calculation methodology according to European standardization system accepted also in Croatia.

The Republic of Croatia is interested to remove the barriers to efficient energy use, the cogeneration implementation and the use of renewable energy sources which is clearly visible in its strategic documents such as the Energy Development Strategy (OG No. 38/02) and the National Environmental Strategy (OG No. 46/02) as well as the Energy Act (OG No. 68/01 and OG No.177/04).

There are several acts, regulations and ordinances that have been already enacted and are partly connected with the EU Directives such as the Construction Act (OG No. 175/03 and 100/04) with provisions setting the requirement for thermal energy saving and thermal protection which was taken from the Construction Products Directive 89/106/EEC. Pursuant to this act Technical Regulation on Thermal Energy Saving and Thermal Protection of Buildings (OG No. 79/05, 155/05 and 74/06) and Technical Regulation on Systems for Ventilation, Partial Air Conditioning and Air Conditioning of Buildings (OG No. 03/07) as well as the Technical Regulation for Door and Windows (OG No. 69/06) and the Ordinance on Conformity Assessment, Conformity Certificates and Marking of Construction products (OG No. 1/05).

Technical Regulation on Thermal Energy Savings and Thermal Protection of Buildings (OG No. 79/05, 155/05 and 74/06), which took effect in 2005, introduced new calculation method for energy performance denoted as Q_h or the annual thermal heat demand necessary for the heating of the building (in kWh/m^2 for residential buildings or in kWh/m^3 for non-residential buildings). In order to successfully apply this calculation method the experts developed some supporting computer programmes. In the past three years all initial difficulties in the implementation of this regulation have been completely overcome creating, thus, the basis for the regulation emendation according to European trends and successful increase of energy efficiency.

Transposition of EPBD in Croatian Legislation

The Ministry of Environmental Protection, Physical Planning and Construction and the Ministry of economy, Labour and Entrepreneurship are the government bodies in charge of the transposition of the Directive 2002/91/EC in Croatian legislation and its full implementation.

In early 2007 the Commission for implementation of European Directive 2002/91/EC has been founded within the Ministry of Environmental Protection, Physical Planning and Construction. Its members are the experts from various ministries, faculties, institutes and economy. The task of the Commission was to develop the action plan for the implementation of Directive. In March 2008 Croatian Government adopted the EPBD Implementation Plan which anticipates the following activities:

- transposition into laws and sub-law acts which regulate the construction as well as energy and energy efficiency sectors,
- implementation through sub-law acts by taking over all relevant standards, procedure development, certification of new and existing buildings, education programs for accredited energy experts,
- other technical measures essential for development: implementation assessment of alternative energy supply systems, energy efficiency of boilers, heating and air conditioning systems, system audit, setting up of administrative framework, making of national data base, promotion of energy efficiency in building construction and marketing.

At the moment the analyses of the EPBD implementation experience in European legislation are underway and the expert base studies are being prepared to facilitate the making of draft versions of regulations and ordinances which will regulate the Croatian legislation framework in the area of energy efficiency according to new methodology.

Until the end of 2008 the following regulations will be enacted:

- Technical Regulation on Heating and Cooling of Buildings,
- Revised Technical Regulation on Thermal Energy Saving and Thermal Protection of Buildings,
- Ordinance on Classification of Buildings, Buildings with Obligatory Energy Performance Certificate Display and Certification Process,
- Ordinance on Terms and Criteria for Selection of Energy Experts

It is anticipated that the drafting of the suggestions for energy inspections for both new and existing buildings, reference books and computer software necessary for certification process and the revision of computer programmes for calculation of energy performance of the building according to adopted methodology will be completed in 2009.

Energy Performance Certificate for Buildings

Pursuant to Article 7 of the Directive the energy performance certificate must be issued for all buildings displaying the data on energy characteristics and the energy efficiency scale of the each building. The energy performance certificate for buildings shall include reference values such as current legal standards and benchmarks in order to make it possible for consumers to compare and assess the energy performance of the building. The objective of the certificates shall be limited to the provision of information and any effects of these certificates in terms of legal proceedings or otherwise shall be decided in accordance with national rules.

The provision of the energy performance certificate will be obligatory for all new buildings, major renovations of existing buildings and for the existing buildings when sold or rented out. The validity of the certificate must not exceed 10 years. The energy performance certificate for buildings with a total useful floor area over 1000 m^2, occupied by public authorities and by institutions providing public services to a large number of persons and therefore frequently visited by these persons, must be placed in a prominent place clearly visible to the public.

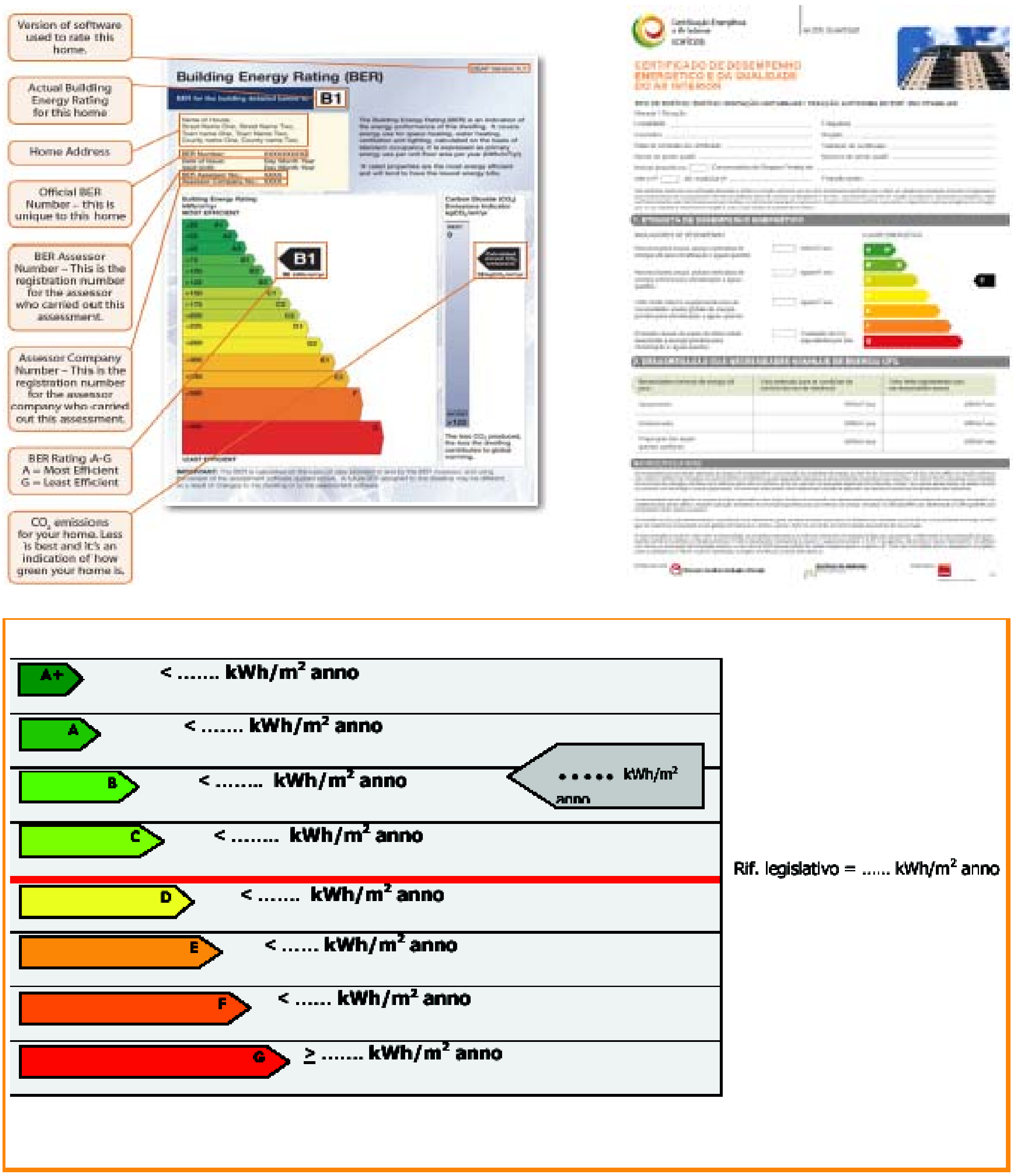

Fig. 1. Examples of the Energy Performance Certificate for Buildings (Ireland, Portugal and Italy)

Energy performance certificates will significantly influence both the real estate market and the status of dwellings their owners want to sell or lease.
The prospective sellers or landlords will have to provide the certificate on energy performance scale (A to G) for its real estates and made it available to the prospective buyer or tenant, as the case might be. The Energy performance Certificate will bring more transparency to the real estate market and raise consciousness of all market participants about the energy performance. A higher energy rating should make a better rated building more marketable than one with a lower rating. The owners will, therefore, be motivated to point that out as an extra positive selling factor. This should encourage the owners whose real estate has lover energy rating to make necessary improvements in order to achieve higher energy efficiency rating.
It is expected that the investment in energy efficiency of buildings will be cost-effective both for the owners and the tenants in the form of the provided comfort, lower running costs and increased market value of the property. The market trends and behaviour of market participants will change in time which will, undoubtedly, improve the energy efficiency of national housing stock in general. The mentioned market changes will considerably contribute to the environment protection through CO_2 reduction in national housing stock.

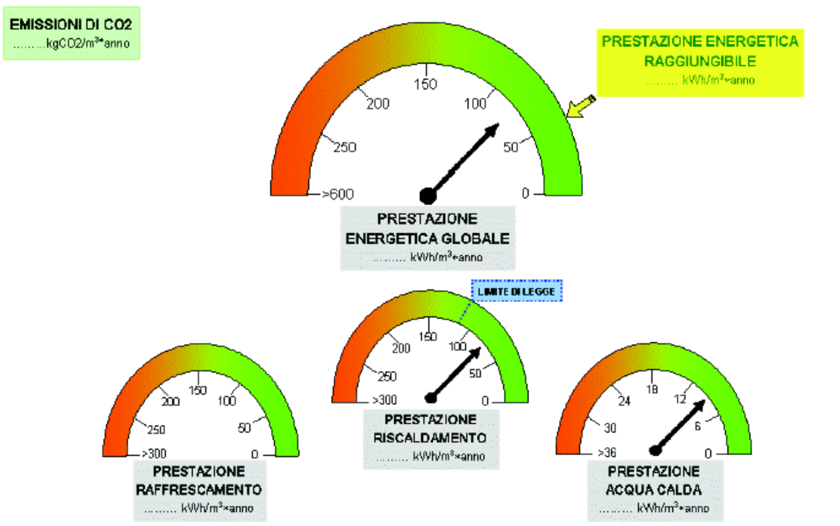

Fig. 2. The Energy Performance Certificate for Buildings (Italy)

Fig. 3. The energy rater

Training of Energy Experts and Inspectors

Large number of accredited experts and inspectors must be trained for assessment of energy performance of buildings and issuing of energy performance certificates. The energy performance certificate for new buildings can be made as a part of technical documentation on the basis of the project data and the assessment of the building components performance as well as the properties of built-in devices. The certification for the existing buildings will be based on the analysis of the building components, built-in devices and the building's geometry. It is necessary, thus, to conceive and conduct adequate professional training courses.
During their training courses the energy experts will acquire a variety of information about the EPBD provisions, building rating, demands, methods of energy assessment, the measurements of the building's dimensions, calculations: the U-value, heat and ventilation losses; energy assessments of heating and cooling systems as well as the systems for hot water supply; lighting installations, renewable energy sources, carbon dioxide emission calculations.

In order to be able to use the computer programmes the experts must be also computer literate.

The experiences in the conducting of the training courses for energy experts and inspectors in the Member States of European Union show that the continuity is very important in order to train sufficient number of adequately trained experts as soon as possible. The training courses in Ireland show the complexity of the task and the scope of activities that are still impending in Croatia. In Ireland weekly training courses are conducted at 26 locations (May – June 2008 data). The workshop-type training course for maximum 10 participants lasts five days (40 hours). Its registration and participation fee is 1,800 Euros. The training courses are followed by exams on national level. For a successful energy performance certification of almost 170,000 buildings, there will be a need for up to 2,000 independent experts and inspectors to deal with the demand. In Denmark the energy experts must renew their licences on annual basis. In addition to that, all experts and inspectors have to follow a yearly one-day training course on experience from the quality control, reported energy labelling and technical research and development.

Conclusion

The emendation in technical regulations in the area of energy efficiency has a considerable influence on building design. The architects must take into consideration all aspects of energy saving regarding the heating, cooling, ventilation, lighting and other energy flows. New dimension has, thus, been added to the preparation of technical documentation for energy efficiency while the cooperation with the experts in the area of building physics, mechanical engineering and electrical engineering is indispensable and very important. The energy performance certificate will provide energy ratings for buildings according to their energy consumption which will also be an important indicator of the building's utilisation expenses. This document will significantly change the relations towards the real estate value, particularly with regard to the existing residential buildings, because higher energy rating will also be a positive factor when selling the building. The efforts of Croatian professional builders in implementation of energy performance certification will be rewarded with the setting up of energy efficiency in building construction as an essential determinant of sustainable development.

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CLASSIFICATION PART OF THE INDIRECT COSTS IN CONSTRUCTION PROJECTS

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Abstract

This paper shortly describes classification part of the indirect costs in construction projects whose goal is to uniformly approach analysis of constructions costs and standardization in making bills of quantities. Analysis of the construction sites indirect costs is based and harmonized with the Principles of Measurement International (POMI) which is compatible with the international system FIDIC for contracting construction works. According POMI, these indirect costs of construction sites are analyzed and shown as individual positions in bill off quantities, while indirect construction company costs don't show individually, but they are distributed in standard bills off quantities positions. This paper also describes methodology of construction cost calculation where whole indirect costs (construction sites costs and company costs) distribute in standard bills off quantities positions. This approach gives basis for successful project costs management.

Keywords: indirect costs, construction cost calculation, project cost management, Principles of Measurement International (POMI)

1. Introduction

International associations dealing with projects management (PMI - Project Management Institute, IPMA – International Project Management Association, PRINCE2 - Projects IN Controlled Environments, etc), in goal of standardization in projects management, define the project management knowledge areas (project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communication management, project risk management, project procurement management) whose combination achieves complete projects management.

Project cost management includes all processes which ensure realisation of project in accord with planned budget. Different projects participants have different views on cost and control cost methodologies in specific phases of project implementation. This paper describes classification of construction projects costs from view of contractor and business system (construction company) dealt with construction.

The key to successful use of the bills off quantities as most commonly used way of contracting building works, is a clear understanding by all parties included or excluded in contract, and their measurements. Because of that requests occur for clear definition of standard measurement methods for building works. One of those methods is SMM7 (Standard Method of Measurement of Building Works) which provide uniformly basis for measurement and determinate accurately quantities and quality of building works.

In the international systems for contracting construction works the most commonly used are Principles of Measurement International (POMI) which are published from Royal Institution of Chartered Surveyors (RICS). These principles require a detailed technical specification and drawings to be provided.

2. Traditional model of construction calculation

In the technical specification of construction project, quantities of irrecoverable resources consumption (materials, labour, and equipment) are unambiguous assigned, and they are only one part of construction project costs. They are called direct costs and they specify according to standard normative or own internal normative. Besides direct costs there are indirect costs so as to realise construction project. These indirect costs are second part of construction project costs, and they are costs of construction sites and construction company. They don't have attribute of irrecoverable consumption, but they are element of whole construction work price.

Construction costs and construction work price are calculated in construction cost calculation in phases of definition and construction projects based on bills off quantities. Positions (items) of bills off quantities are forming from standard work process. Implementing usual construction cost calculation, whole construction work price is sum of product quantity and unit cost of all individual items in bills off quantities.

$$C_p = \sum_{i=1}^{n} k_i \times C_i \quad (1)$$

Where are:

- C_p - construction work price,
- k_i - quantity of "i" individual items bills off quantities,
- C_i - unit cost of "i" individual items bills off quantities.

Unit cost of "i" individual items bills off quantities is sum of part direct and indirect costs.

$$C_i = (D_{tri} + I_{tri}) = (D_{tri} + I_{tri1} + I_{tri2}) \quad (2)$$

D_{tri} is direct cost of "i" individual items bills off quantities and it is a sum of consumption of resources for unit of "i" individual items bills off quantities.

$$D_{tri} = (p_{pi} + m_{pi} + u_{pi} + a_{pi}) \quad (3)$$

Where are:

p_{pi} - brut labour costs for unit of "i" individual items bills off quantities,
m_{pi} - materials costs for unit of "i" individual items bills off quantities,
u_{pi} - subcontractor costs for unit of "i" individual items bills off quantities,
a_{pi} - amortization equipment costs for unit of "i" individual items bills off quantities.

I_{tri} is indirect cost of "i" individual items bills off quantities, and it can be divide as show below:

I_{tri1} - indirect construction sites costs of "i" individual items bills off quantities,
I_{tri2} - indirect construction company costs of "i" individual items bills off quantities.

Whole construction work price can be showed as follows:

$$C_p = \sum_{i=1}^{n} k_i \, x \left(D_{tri} + I_{tri1} + I_{tri2}\right) = \sum_{i=1}^{n} k_i \, x \, D_{tri} + \sum_{i=1}^{n} k_i \, x \, I_{tri1} + \sum_{i=1}^{n} k_i \, x \, I_{tri2} \quad (4)$$

3. Analyses of indirect costs

Ambitions of business system are expressed through mission or reason of existence. The mission can be implemented if business management can conceive future desired position or vision of business system. Respecting interest of all key projects participants, and mission and vision, it is necessary to define strategy for business system success.

In the processes of strategic planning, business management is bringing: prices policy, framework plans for manufacture volume, plans for all processes and activities of business system, decisions of planned profit and risk assessment so as to define measurable business goals for planned period.

Strategic management through displayed flow from mission to the measurable goals, which stated gathering business processes who are fundamental for business success, called Balanced Scorecard (BSC). BSC are expressed through common goals or processes performance, which are banked inside financial, customers, internal processes and employees perspectives. All management subsystem, used own functions, plan, organise, lead and control business processes how to accomplish positive measurable business goals by all areas.

In the phase of project preparation and making bid and planning, the parts of business system (construction company) who work on construction calculation together with top management determine next elements of calculation:

- processes of management project,
- processes of management construction site,
- processes of installation and deinstallation construction site,
- processes of value risk analyses.

Placing measurable project goals who are expressed gathering settings (performance, attribute) project processes and essential for project success, called Project Scorecard (PSC).

One of the key methods for allocating measurable project goals is bidding calculation. Constructual calculation is done after getting contract and after finishing construction works is doing additional calculation that is base for assessment project efficiency or achievement PSC. That PSC is used for periodical assessment business system efficiency or achievement BSC.

According POMI all works are divided in 16 sections. Section General principles define basis principles of measurement which provide a uniform basis for measuring works in making bills off quantities and measuring accomplished works. The objects of bills off quantities are to assist in the accurate preparation of tenders by providing uniformly measurement quantities and give a basis for the financial control of a project in accordance with the conditions of contract. These principles define methods for measurement all individual items of bills off quantities.

It is necessary take all possible costs (labour and all associated costs, materials, equipment costs, temporary works, all indirect costs and profit) in making costs calculation. It is possible in bills off quantities specific costs for unforeseen works. Do not require restrictions for coding and forming bills off quantities, any construction company can make independently do it. The principles of measurement international do not require that all indirect costs analyze and show as individual items in bills off quantities.

In the section General requirements are defined costs which are resulted from conditions of contract. Those General requirements specify indirect construction site costs and they unambiguous mark on connection between contract, drawings and all individual items of bills off quantities.

Recommendation is that General requirements inevitable specify next costs groups:

- Restrictions. Those are costs that can include access to and possession on the site, limitations of working space or working hours, and the maintenance of existing services on under or over the site and items of a like nature.
- Contractor's administrative arrangements. Those are costs that can include site administration, supervision, security, safety, health and welfare of workpeople, transport of workpeople.
- Constructional plant. That are costs that can include small plant and tools, scaffolding, cranes and lifting plant, site transport, plant required for specific trades.
- Employer's facilities. Those are costs that can include temporary accommodation (offices, laboratories), telephones (including costs of calls), vehicles, equipment and any other facilities for the employer's representatives.
- Contractor's facilities. Those are costs that can include accommodation and buildings (offices, laboratories, mess rooms, living accommodation), temporary fencing, temporary roads, water for the works, lighting and power for the works, temporary telephones.
- Temporary Works. Those are costs that can include traffic diversion, access roads, bridges, pumping, de-watering, compressed air for tunnelling.

- Sundry Items. Those are costs that can include testing of materials, testing of the works, protecting the works, removing rubbish, traffic regulations, maintenance of public and private roads, control of noise and pollution, all statutory obligations.

From the contractor's view construction sites costs can be more elaborated and supplemented so as to comprehensive consider this very important costs areas. It gives proposal of classification the indirect construction sites costs (I_{tr1}):

1. General requirements:

1. restrictions,
2. contractor's administrative arrangements,
3. constructional plant,
4. employer's facilities,
5. contractor's facilities,
6. temporary works,
7. sundry works.

2. Technical support

3. Project management:

1. top project management – project's team,
2. construction site management.

4. Profit
5. Management value
6. Project risks
7. Project financing

All indirect costs (construction site costs (I_{tr1}) and construction company costs (I_{tr2})) can be showed as follows:

$$\begin{aligned} I_{tr1} &= T_{ot} + T_{tp} + T_{pu} + T_{ugr} + U_{vp} + D_p + R_{iskp} + T_{finp} \\ I_{tr2} &= (C_{pp} / U_p) x (T_{pv} + T_{io} + O_k + R_p + O_{sig}) \end{aligned} \quad (5)$$

T_{ot} - general requirements costs,
T_{tp} – technical support costs,
T_{pu} - project's team costs,
T_{ugr} – construction site management costs,
D_p – profit,
U_{vp} – management value,
R_{riskp} – project risks costs,
T_{finp} – project financing costs,
U_p – scheduled annual revenue of business system (construction company),
C_{pp} – preliminary construction work price,
T_{pv} – scheduled annual costs of representatives owner business system,
T_{io} – scheduled annual costs of management administration business system,
O_k – working capital,
O_{sig} – assurance costs,
R_p – risk business costs.

Scheduled annual revenue of business system (U_p) estimate on basis currently contracting business affairs, potential business conditions, market research, estimation of business system competitions, situation of available resources etc.

Preliminary construction work price (C_{pp}) estimate with some method for estimating construction work price.

Scheduled annual profit (D_p) represents increase potential business system and estimate based on invested owner's capital, agreements dividend, prices capital on market, etc.

Scheduled annual costs (T_{pv}) of representatives owner business system estimate based on situation for similar previous years as framework value.

Scheduled annual costs (T_{io}) of management administration business system estimate based on resources situation and total revenue of business system for similar previous years as framework value.

Mentioned business system costs in whole construction work price often estimate preliminary and they assign with certain ratio percent between preliminary construction work price and total revenue of business system for planned period. It is necessary to consider possible deviations because different complex projects require different business system engagement however they are equal according total construction work price.

Whole construction work price can be showed as follows:

$$C_p = D_{tr} + (C_{pp}/U_p)x(T_{pv} + T_{io} + O_k + R_p + O_{sig}) + T_{ot} + T_{tp} + T_{pu} + T_{ugr} + U_{vp} + D_p + R_{iskp} + T_{finp} \quad (6)$$

4. Models of construction calculation

According recommendation of POMI all indirect construction site costs (I_{tr1}) show as individual items in bills off quantities. Indirect construction company costs (I_{tr2}) assign with certain percent in bills off quantities. If whole indirect costs are not show as individual items in bills off quantities then they are distributed in bills off quantities according certain models of construction calculation.

Most often models of distribution indirect costs in unit cost of any individual items bills off quantities in effect are:

a) If whole indirect costs (I_{tr}) distribute through labour works costs of standard work processes of all individual items bills off quantities, then any unit cost of "i" individual items bills off quantities is:

$$C_i = p_{pi} \times F1 + m_{pi} + u_{pi} + a_{pi} \quad (7)$$

$$F1 = \left(1 + \frac{I_{tr}}{\sum_{i=1}^{n} k_i \times p_{pi}} \right)$$

F_1 is multiplier factor labour works costs of standard work processes of "i" individual items bills off quantities for covering indirect costs (I_{tr}).

b) If whole indirect costs (I_{tr}) distribute through whole direct costs of all individual items bills off quantities, then any unit cost of "i" individual items bills off quantities is:

$$C_i = (p_{pi} + m_{pi} + u_{pi} + a_{pi}) \times F_2 \quad (8)$$

$$F_2 = \left(1 + \frac{I_{tr}}{\sum_{i=1}^{n} k_i \times (p_{pi} + m_{pi} + u_{pi} + a_{pi})} \right)$$

F_2 is multiplier factor whole direct costs of "i" individual items bills off quantities for covering indirect costs (I_{tr}).

c) If indirect construction site costs (I_{tr1}) distribute through labour works costs of standard work processes of all individual items bills off quantities and indirect construction company costs (I_{tr2}) distribute through whole costs of all individual items bills off quantities, then any unit cost of "i" individual items bills off quantities is:

$$C_i = (p_{pi} \times F_1' + m_{pi} + u_{pi} + a_{pi}) \times F_2' \quad (9)$$

$$F_1' = \left(1 + \frac{I_{tr1}}{\sum_{i=1}^{n} k_i \times p_{pi}} \right); F_2' = \left(1 + \frac{I_{tr2}}{I_{tr1} + \sum_{i=1}^{n} k_i \times (p_{pi} + m_{pi} + u_{pi} + a_{pi})} \right)$$

F_1' is multiplier factor labour works costs of standard work processes of "i" individual items bills off quantities for covering indirect construction site costs (I_{tr1}) and F_2' is multiplier factor whole costs of "i" individual items bills off quantities for covering indirect construction company costs (I_{tr2}).

d) If indirect construction site costs (I_{tr1}) and indirect construction company costs (I_{tr2}) distribute through whole direct costs of all individual items bills off quantities, then any unit cost of "i" individual items bills off quantities is:

$$C_i = (p_{pi} + m_{pi} + u_{pi} + a_{pi}) \times (1 + F_1'' + F_2'') \quad (10)$$

$$F_1'' = \frac{I_{tr1}}{\sum_{i=1}^{n} k_i \times (p_{pi} + m_{pi} + u_{pi} + a_{pi})}; F_2'' = \frac{I_{tr2}}{\sum_{i=1}^{n} k_i \times (p_{pi} + m_{pi} + u_{pi} + a_{pi})}$$

F_1'' and F_2'' are multiplier factors direct costs of "i" individual items bills off quantities for covering construction site costs (I_{tr1}) and construction company costs (I_{tr2}).

Presented models of cost calculation direct and indirect costs through items bills off quantities is usual by most calculation softwares although on different primary bases give similar logical models. Also they give similar kind of report results and analysis quality.

5. Conclusion

In this paper presented classification part of the indirect costs in construction projects which goal is uniformly approach analysis constructions costs and standardization in making bills of quantities. This classification represent appendix to other methodologies for monitoring and project costs management. According POMI, those indirect costs of construction sites, analyze and show as individual in items bills off quantities that make easy distribution project costs because only small part of indirect costs (construction company costs, risk, profit) distribute through multiplier factor in individual items bills off quantities. This approach unsure costs optimisation and entire costs management transparency.

In order to provide basis for uniformly measurement and determinate accurately quantities and quality of building works, because that occur requests for clear definition of standard method of measurement for building works like SMM7 method (Standard Method of Measurement of Building Works).

This classification's indirect costs and use of standard methods of measurement for building works make easy placing measurable project goals for Project Scorecard (PSC). One of the key methods for allocating measurable project goals is bidding calculation where business system (construction company) through presented whole classification indirect costs in construction projects calculate construction work price. After finishing construction works is doing additional calculation which is base for assessment project efficiency or achievement PSC. That PSC use for periodical assessment business system efficiency. This approach gives base for successful project costs management.

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PRILOG SAGLEDAVANJU FUNKCIJA VODITELJA PROJEKTA

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Sažetak

U radu se analiziraju pojedine funkcije voditelja projekta u procesu upravljanja projektima. Znanstveni pristup nam omogućava da kroz jasne pojmove znanstvenim metodama pomoću načela koja daju okvir nekom području i povezuju ga u cjelinu, dođemo do teorije kao sustavnog grupiranja pojmova. Proces upravljanja projektima možemo raščlaniti na šest osnovnih funkcija voditelja projekta, a to su; vođenje, organiziranje, kadrovsko popunjavanje, planiranje, kontroliranje i koordiniranje. Sve navedene funkcije su vrlo važne za uspješno vođenje projekata.

KLJUČNE RIJEČI: upravljanje projektima, znanstveni pristup, funkcije voditelja projekta.

CONTRIBUTION TO UNDERSTANDING FUNCTIONS OF PROJECT MANAGERS'

Abstract

Individual functions of project mangers in the project management process are analyzed. A scientific approach is used to formulate an appropriate theory, or a systematic grouping of relevant terms, based on appropriate scientific methods and using principles that provide framework to the area under study, and shape it into a logical whole. The project management process can be divided into six basic project managers' functions: leading, organizing, staffing, planning, controlling and coordinating. All these functions are highly significant for the successful management of projects.

KEY WORDS: project management, scientific approach, project managers' functions.

1. UVOD

Proučavanje upravljanja projektima možemo raščlaniti na funkcije oko kojih možemo organizirati znanje koje je osnova tim funkcijama, a uz pomoć pojmova, načela i teorija grupirati oko osnovnih funkcija. Većina autora se slaže da se osnovne funkcije vežu uz menadžera odnosno voditelja projekta kao realizatora projekta, a to su; vođenje, organiziranje, kadrovsko popunjavanje, planiranje, kontroliranje i koordiniranje.

Pored navedenih funkcija, voditelji projekata moraju poznavati i određene vještine kao što su; tehnička vještina (metode, procesi i postupci), vještina rada sa ljudima (npr. sposobnost za timski rad) i vještina donošenja zaključaka. Pored navedenog, voditelj mora pokazati sposobnost rješavanja problema na način koji će koristiti cijelom projektu kroz praktično rješavanje problema u okviru realnosti.

Među autorima koji se bave upravljanjem postoje različiti načini organiziranja znanja, ali većina je usvojila sličan okvir nakon povremenog korištenja alternativnih načina strukturiranja znanja. Dakle, upravljanje se prvenstveno bavi obavljanjem zadataka koji se provode unutar organizacije i cilj im je oblikovati unutarnje okruženje. Međutim, ne smije se zaboraviti da upravljanje mora obuhvatiti i djelovanje u vanjskom okruženju. Mnogi elementi iz vanjskog okruženja, kao što su; tehnološki, ekonomski, društveni i politički, utječu na područja njihova djelovanja. Iz tih razloga voditelj projekta je dužan poduzimati akcije koje će omogućiti da pojedinci pridonesu najviše što mogu zadaćama cijele skupine.

Prema definiciji, upravljanje je umijeće što znači da je upravljanje kao praksa umijeće, odnosno organizirano znanje na kojem se zasniva ta praksa koju možemo nazvati znanošću. U tom se kontekstu znanost i umijeće međusobno ne isključuju, već se nadopunjuju. Naravno, znanost na kojoj se zasniva upravljanje prilično je gruba i neprecizna, jer su mnoge varijable izrazito složene, no usprkos tome, to znanje svakako može unaprijediti praksu upravljanja.

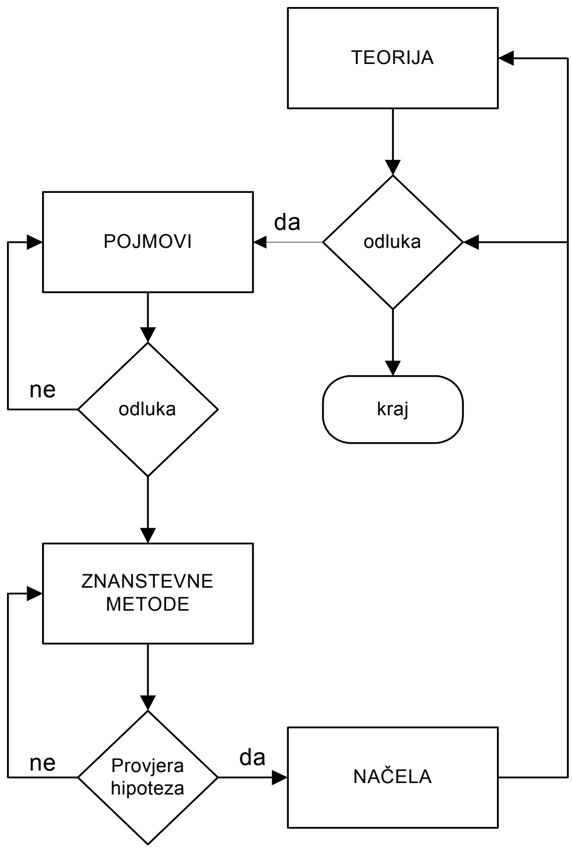
2. ZNANSTVENI PRISTUP

Razvijanje znanja primjenom znanstvenih metoda osnovno je obilježje bilo koje znanosti. Iz tih razloga znanost se bazira na teoriji, pojmovima, načelima, znanjima razvijenog iz pretpostavki (hipoteza), eksperimenata i analiza. Znanstveni pristup (slika 2.1), kod stvaranja teorija, zahtijeva jasne pojmove, znanstvene metode kojim utvrđujemo činjenice putem promatranja, te načela koja objašnjavaju odnose između dvaju ili više skupova varijabli.

Znanstvena metoda je po definiciji skup različitih postupaka kojima se znanstvenik koristi u svom radu da bi istražio i izložio rezultate istraživanja u određenom području ili disciplini. Znanstvenom metodom naziva se i svaki način znanstvenog istraživanja koji osigurava sigurno, sređeno, sustavno, precizno i točno znanje. Nakon što smo činjenice klasificirali i analizirali, pomoću znanstvenih metoda tražimo kauzalne odnose.

Provjerom hipoteza i kada one odražavaju i tumače stvarnost, nazivamo ih načelima. Vrijednost provjerenih hipoteza je u predviđanju što bi se moglo dogoditi u sličnim okolnostima. Sama *načela* nisu uvijek potpuno i nepromjenjivo istinita, ali ih se smatra dovoljno valjanima da bi ih se koristilo za predviđanje.

Prema definiciji, *teorija je sustavno grupiranje međusobno ovisnih pojmova i načela koji daju okvir nekom značajnom području znanosti i povezuju ga u cjelinu.* [2] Uloga teorije na području upravljanja je sustavno klasificiranje značajnog i relevantnog znanja u različitim područjima kao što je formiranje i oblikovanje organizacijske strukture, načelo delegiranja na osnovi očekivanih rezultata, načelo jednakosti ovlasti i odgovornosti.



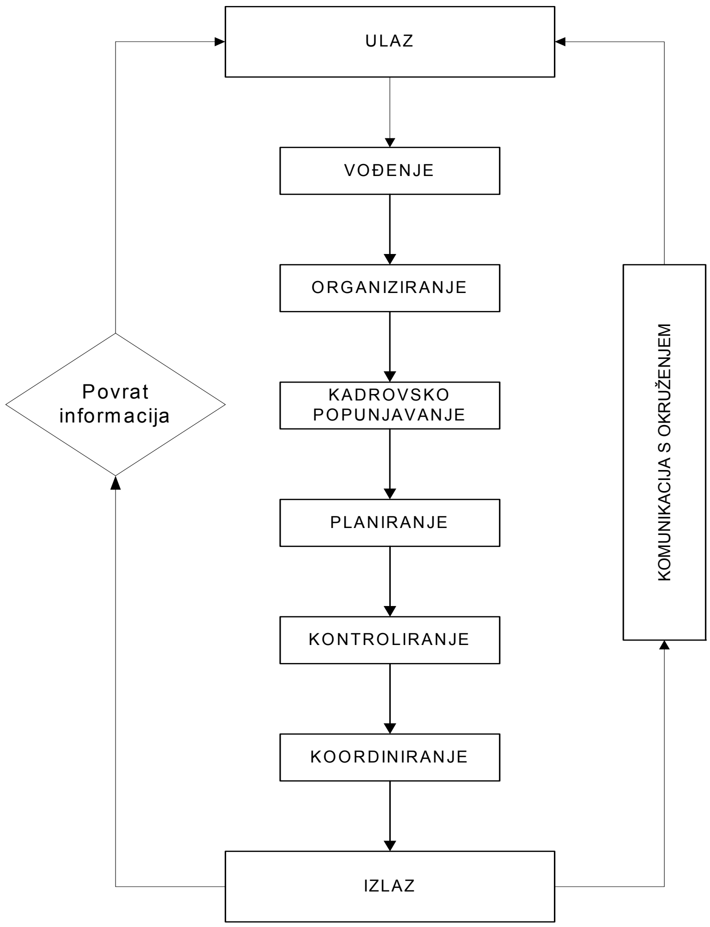
Slika 2.1 Dijagram toka znanstvenog pristupa

U upravljanju, kao i na bilo kojem drugom polju, ukoliko se praktičari ne bi prepustili učenju putem pokušaja i pogrešaka, jedino je mjesto gdje se mogu obratiti za smislene upute upravljanja, gdje je akumulirano znanje u stvari njihovo područje prakse. Znanstveni pristup je omogućio razvoj raznih tehnika i alata koje su u osnovi načini činjenja stvari, metode postizanja određenih rezultata. Najznačajnije među njima su gantogram, mrežno planiranje i kontrolne tehnike poput tehnike prikazivanja i valorizacije programa (PERT), metoda kritičnog puta (CPM), koji su danas dio novih softverskih alata za upravljanje projektima kao što su; *Primavera*, *MS Project*, *CA Super Project*, *PlanView Enterprise*, *Pacific Edge Mariner*, *Open Plan*, i td.

Kako smo već u uvodu napomenuli, znanstvenim pristupom stvorena je praksa sa smislenim uputama koja definiraju osnovne funkcije voditelja projekta u procesu upravljanja projektima, a to su; vođenje, organiziranje, kadrovsko popunjavanje, planiranje, kontroliranje i koordiniranje.

3. FUNKCIJE VODITELJA PROJEKTA

Funkcije voditelja projekta sadrže korisnu strukturu u smislu organiziranja znanja o upravljanju projektima (Slika 3.1). U proteklom vremenu nije bilo značajnijih novih rezultata istraživanja iz područja upravljanja projektima, koje se ne bi moglo odmah uključiti u klasifikaciju; vođenja, organiziranja, kadrovskog popunjavanja, planiranja, kontroliranja i koordiniranja.



Slika 3.1 Funkcije voditelja projekta (*menadžera*[2])

Iz slike 3.1 je vidljivo, da je funkcija menadžera ili voditelja projekta *vođenje* zapravo najvažnija, jer uspješan vođa tima će postaviti takovu *organizacijsku* shemu, koja će mu omogućiti da nakon *pažljivog odabira članova tima*, *planski* razradi put do postavljenog cilj, te uz stalnu *kontrolu* izvršenja postavljenih zadataka i *koordinaciju*, komunicirajući sa *okruženjem*, uspješno privede cijeli projekt zadanom cilju.

3.1 Vođenje projekta

Vođenje projekta znači imati utjecaja na ljude kako bi pridonijeli samoj organizaciji i zajedničkim ciljevima. Prema nekim autorima, voditelj projekta se bavi pretežno međuljudskim aspektima vođenja projekata. Nadalje, sva mišljenja idu u prilog tezi da najvažniji problemi dolaze od ljudi, njihovih želja i stavova, njihovog ponašanja kao pojedinca ili člana tima, te da vrstan voditelj projekta mora biti i vrstan vođa.

Vođenje ili vodstvo je *sposobnost utjecaja na skupinu u smislu postizanja ciljeva*[1]. Po definiciji podrazumijeva sljedbeništvo, a ljudi teže slijeđenju onih koji im nude načine zadovoljenja njihovih vlastitih potreba i ideja. Iz tih razloga je razumljivo da vođenje uključuje određenu motivaciju, načine vođenja i pristupe, te funkcionalnu organizaciju i komunikaciju.

Najpoznatije teorije vođenja su; teorija karakternih crta, behaviorističke teorije, teorije kontingencije (contingency models) i suvremena teorija karakternih crta karizmatsko vođenje. U posljednje vrijeme sve više je prisutna teorija karizmatsko vođenje sa pet karakteristika vrsnog vođe, a to su; samopuzdanje, vizija, snažno uvjerenje u viziju, ponašanje izvan normalnih okvira (nekonvencionalno i suprotno normama) i kreator radikalnih promjena.

3.2 Organiziranje

Organiziranje podrazumijeva, da članovi tima koji rade zajedno da bi postigli neke ciljeve moraju imati definirane uloge ili zadatke koje izvršavaju. Pojam *zadatak* znači da ono što članovi tima rade ima točno utvrđenu svrhu i cilj, da se uklapa u rad tima, te da imaju potrebne informacije, ovlaštenja i opremu da obave zadatak.

Organiziranje je dio upravljanja koji definira i uspostavlja strukturu zadataka za članove tima unutar organizacije. Drugim riječima, znači da su svi zadaci neophodni za ispunjenje ciljeva dodijeljeni, i da su ih dobili ljudi koji ih mogu najbolje ispuniti. Organizacijska struktura je ipak samo sredstvo koje treba stvoriti okruženje u kojem će se odvijati određena djelatnost i nije cilj sama po sebi.

Tradicionalne organizacijske strukture su linijska, funkcionalna, i linijsko-štabna. Birokratski model je specifičan strogo hijerarhijski model (primjenjuje se u državnoj upravi, vojsci, i td.), i pogodan je za rutinske procese. Suvremene organizacijske strukture su funkcionalna (timska), projektna i matrična.

3.3 Kadrovsko popunjavanje

Funkcija kadrovsko popunjavanje se definira kao *popunjavanje i održavanje popunjenima mjesta u organizacijskoj strukturi*. [2] Da bismo mogli utvrditi potrebu za kadrovima u odabranoj organizacijskoj strukturi nekog projekta, potreban je sustavan pristup, a prvi korak je izrada detaljnih opisa poslova koje svako radno mjesto treba obaviti. Taj prvi korak je vrlo važan, jer iz njega slijede svi ostali zahtjevi prema određenom radnom mjestu, kao što su stručna sprema, potrebno iskustvo, poznavanje tehnika i alata, i td.

Drugi korak je jednako važan, a to je izbor osoba za pojedina radna mjesta. Izbor je moguće obaviti unutar postojeće organizacije ako raspolaže sa potrebnim kadrom, što je povoljnije ili putem natječaja što iziskuje puno više vremena i rizika.

U procesu trajanja projekta, često se događa da su ljudi na pojedinim funkcijama precijenili svoje mogućnosti ili su nezadovoljni ili jednostavno žele promijeniti sredinu. Tada dolazi do izražaja sustavan pristup i sposobnost održavanja popunjenosti mjesta u organizacijskoj strukturi.

Sustavan pristup znači imati pregled dostupnih ljudi za pojedina radna mjesta iz okruženja ili odabirom, postavljanjem, unapređivanjem, te obučavanjem ili na drugi način razvijanjem kandidata i onih koji su već zaposleni, kako bi se zadaci obavljali učinkovito.

3.4 Planiranje

Planiranje je po definiciji odabiranje zadataka, ciljeva i načina po kojima bi se oni postigli, te zahtijeva donošenje odluka i odabira između mogućih alternativa. Postoje različiti tipovi planova, od globalnih svrha i ciljeva do detaljnih akcija koje treba poduzeti. Pravi plan ne postoji dok nije donesena odluka o ulaganju ljudskih ili materijalnih resursa.

Sve planove prije odluke možemo nazvati planskim studijama ili analizama. Samo planiranje bez kontrole neće dati adekvatne rezultate pa je logično da je kontrola u stvari nastavak planiranja.

Najpoznatiji softverski alati, koji se danas najčešće koriste u upravljanju projektima u području planiranja i praćenja, zasnovani na bazi podataka i web tehnici su *Primavera Project Planer* i *MS Office Project*. *Primavera Project Planer* (P3) je softverski paket za upravljanje vrlo složenim projektima, a u sebi sadrži planiranje vremena i resursa, kontrolu troškova i grafičke prikaze. Program podržava gantograme, CPM, PERT i PDM metode planiranja vremena i ima WBS strukturu podjele poslova.

MS Project je vodeći softverski alat za upravljanje projektima za pojedinačne korisnike, za male i srednje projekte. Program omogućuje; planiranje aktivnosti i njihovo trajanje; upravljanje resursima i troškovima; praćenje projekta kroz razne oblike prikaza (tabela aktivnosti, troškova i vremena), gantogram, PERT dijagram, kalendarski prikaz, i td.; te različito izvještavanje.

3.5 Kontroliranje

Kontroliranje je najkraće rečeno, vrednovanje uspješnosti nečijeg rada s obzirom na planove, te olakšava ispunjenje istih. Aktivnosti kontrole su fokusirane na praćenje i mjerenje postignutog uobličene u različite vrste izvještaja za različite pokazatelje, kao što je kontrola vremena, resursa, rokova, budžeta projekta, izvješća o izgubljenim radnim satima, inspekcijski zapisnici i td.

Svaki od tih izvještaja pokazuje da li se planovi ispunjavaju ili kolika su odstupanja od planova. Ako se odstupanja nastave, potrebno je događaje usmjeriti na uklapanje u planove što znači ustanoviti koja je osoba odgovorna za odstupanja od planiranog, te poduzeti potrebne korake. Na taj način se rezultati rada osoba ili grupa prate kroz kontrolu onoga što su napravili. Mora se napomenuti, da su za zakašnjenja najčešće odgovorni ljudi ili grupe ljudi koji nisu na vrijeme obavili određeni zadatak.

Temeljni sustav kontrole obuhvaća četiri koraka, a to su; postavljanje pokazatelja, mjerenje učinkovitosti pomoću pokazatelja, izvještavanje o učinjenom, te otklanjanje odstupanja od planova.

3.6 Koordiniranje

Koordiniranje je pored vođenja najvažnija funkcija voditelja projekta sa svrhom postizanje sklada između pojedinačnih napora članova tima kako bi se postigli zadani ciljevi cijelog tima. Obavljanje svake od prethodno navedenih funkcija bitno pridonosi koordiniranju. Razlog je što članovi tima nerijetko tumače slične interese na različite načine, pa se njihovi napori prema zajedničkim ciljevima ne uklapaju automatski u napore ostalih. Iz tih razloga osnovni je zadatak voditelja projekta uskladiti različitosti u pristupu, te kontrolirati i uskladiti pojedinačne ciljeve kako bi pridonijeli ukupnom cilju organizacije.

4. ZAKLJUČAK

Upravljanje projektima može biti uspješno samo ako se proces upravljanja oslanja na sve navedene funkcije glavnog menadžera ili voditelja projekta. Svaka od funkcija ima svoju ulogu oslanjajući se na stečenu praksu, na umijeće u provođenju pojedinih funkcija i znanstveni pristup. Pored navedenog u procesu se treba služiti i svim dostupnim tehnikama i alatima, koji pomažu da se zadani ciljevi ostvare u planiranim okvirima.

5. LITERATURA

[1] Robbins, P. S.; *Bitni elementi organizacijskog ponašanja*, Mate, Zagreb, 1995.
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CONSTRUCTION CONCEPT OF PRODUCTION AND CONTRACT RELATION

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Abstract

The contemporary construction production paradigm is based on three complementary integrated concepts: the concept of transforming the input parameters into the output ones with decomposition due to minimizing the costs and increasing the efficiency *(“Transformation concept of production”),* the flow concept based on the queuing theory and minimizing of the variability as the key flow determinant *(“Flow concept of production”)* and the customer value achievement concept which is based on the quality matrix and value insufficiency elimination *(“Value generation concept of production”).* When explaining the construction production concept two approaches are of importance: the deductively oriented one which is based on interpreting the production concept and the inductively oriented one which interprets its generic characteristics. The sub-system which is specially analyzed in the paper is the relation between the customer and the client which is formalized by a construction contract. The paper offers review of causal mechanisms which cause this interaction.

Keywords:

Concept of production, Transformation concept of production, Flow concept of production, Customer value achievement concept, Contract practice.

1. Introduction

Two approaches are required when the construction concept of production is explained: the deductively oriented one which is based on explaining the production concepts and the inductively oriented one which explains its generic characteristics. The first approach is insufficient in its theoretical structure, while the other concentrates exclusively on qualitative observation of specific phenomena. The combination of both offers a better basis for explaining the behavior of specific sub-concepts of the construction concept of production. The sub-concept which is analyzed in this paper relates to the relationship between the customer and the client which is formalized by a construction contract. The very construction contract and the contract practice which is based on it are analyzed as a formal part of the construction concept of production. Since the contract relationship comprises the functional sum of components which are themselves parts of other concepts of the environment (technical-technological knowledge concept, effects of legal concepts, effects of marketing concepts), its exposure and susceptibility to dynamics of production requirements in specific construction conditions. The paper offers a survey of causal mechanisms which cause this interaction.

2. Concepts of production

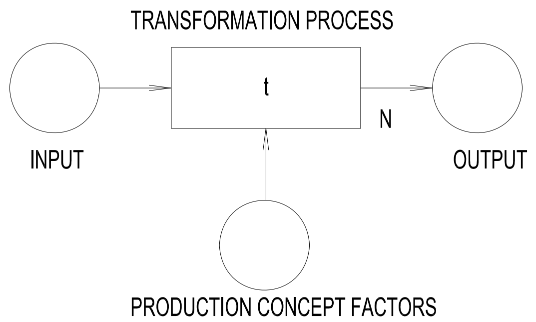
The knowledge about the specific production situation such as construction only partly rely on the production doctrine – Wortman, (1992), Samuelson and Nordhaus, (1985), Cook, Gill, (1993). Contemporary authors Koskela (1992), base the production patterns of construction upon three complementary integrated concepts: the concept of transforming the input parameters into the output ones with decomposition due to cost minimizing and efficiency increase ("Transformation concept of production"), the concept of the flow based upon the queueing theory and variability minimizing as the key determinant of the flow ("Flow concept of production") and the concept of value effectuation for the customer which is based upon the matrix of the effectuated value for the customer and elimination of the value flaws ("Value generation concept of production").

2.1. Transformation concept

The transformation concept is a historical, a fundamental and an economical one. The production process comes down to the conditioned "input-output" system within which the very process of technological transformation (also called transition by some authors) is not analyzed separately (as shown in figure 1). In order to illustrate it, the continuation offers a typical economic formulation by authors Samuelson and Nordhaus (1985): "The production function is the technical relationship between the maximum amount of output that can be produced by each and every set of specified inputs or factors of production. It is defined for a given state of technical knowledge". The transformation process has three main determinants: the first is that it can be decomposed into tasks which retain characteristics of transformation processes. This is performed in order to manage the processes more easily, following the western tradition of analytical reductionism Taylor (1913) also relies on. He puts the scientific management and its practical component – "Task management" into relation. By doing so he point out the following: "… Perhaps the most prominent single element in modern scientific management is the task idea,…Scientific management consists very largely of preparing for and carrying out these tasks". The second determinant of the transformation process is that the minimizing of the entire process costs can be achieved by minimizing the costs of every single (independent) task. The minimizing relies on applying the adequate technology as well as on recognizing the activities which provide the largest cost / income contribution. The third determinant is the relation to the effects of the environment where the process effect is ensured and optimized by establishing the system of physical and organization buffers.

The mass production (which replaced the handicraft low-series production) being the most important result of transformation concept application was accepted only partially in construction production concept. The transformation concept is recognizable in project management and planning practice ("Task Management", "Working Brake Structures"), account-keeping ("Material Requirement Planning") and organization regulation ("Organizational Responsibility Chart"). The institutionalized separating of roles and job distribution can also be seen in contract practice: it can be said that the traditional separation of project preparation contracting from construction contracting is the consequence of the specialization concept immanent for the handicraft production which remained an important component of construction production practice despite the mass production based on the transformation concept. It is therefore transparent that in no industry is the product conception so remote from its production. In this matter, the entire contracted practice is based on supply procedure which, as a rule, is motivated by obtaining the lowest price (of design, construction, production). The consequence of such heterogeneousness is a fragmented control and sequential project realization.

Figure 1.
Review of transformation concept by Petri – net analysis



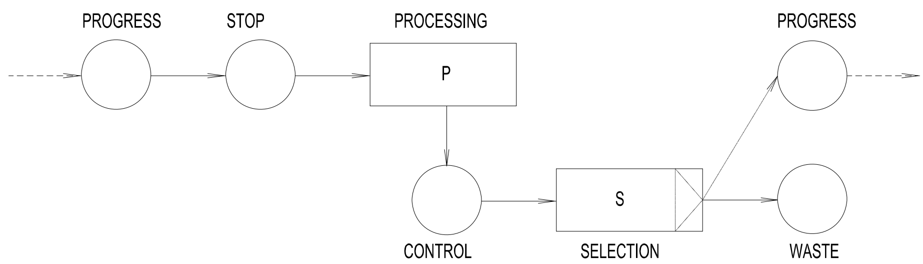
2.2.Concept of the flow

The concept of the flow is a result of critics and reactions to the traditional transformation concept in itself. It was promoted by scientists of the so called “Just in Time” concept Shingo (1988). Different from the transformation concept which claims that the processes and specific tasks are on the same axis (so that the improvement of different operations leads to improvement of the entire process), the concept of the flow claims that the very flow is situated on the ordinate and shows the change of production object place, while the abscissa shows operations representing the production subject. Such decomposition of the transformation flow leads to the conclusion about existence of value-added and non-value-added activities. Figure 2. shows the general situation of transformation flow where the sole processing represents the value-added activity with additional value. This all leads to conclusion that the cost minimizing can be achieved by reconfiguration and compression of value-added activities and elimination of non-value-added waste activities. While doing so, in order for activities to be performed timely, time is added as a new resource and is analyzed in a way different from the one of the transformation concept. This fact was used by Hopp, Spearman, Wallace (1996) so by using the queueing theory the production model is shown as a physical one unlike the transformation economical model.

The flow concept theses pointed out the variability as the main blocker of the system efficiency. The system variability has two main manifestations: the first relates to the variability which is a result of the time needed for processing different activities (natural variability) which is influenced by time needed for system adjustment, time for mistake correction and possible repeated processing and time for activity operator reaction. The second manifestation relates to the flow variability which depends on production situation logistics. It was observed that the variability of the early stage of the flow has a significantly larger destabilization effect than the variability of later stages. The application of heuristic principles (such as system simplification, transparency and flexibility) was of great importance for overcoming the variability. However, it must also be observed that the flow concept in determining the variability is limited exclusively to the narrow range of circumstances connected to the immediate process development, while the variability caused by the environment of the very production process is not taken into consideration. This is satisfying within the organized stationary production conditions but not when analyzing the construction production in a wider range.

Therefore, the flow concept was accepted as a production planning method and even as management practice (“Lean Production”, “Just in Time”, “Time Based Competition”, “Continuous Improvement”, “Business Process Redesign”;), but its practical application, unlike other industries (especially the car production industry) was a poor one. The reflections of this concept on the construction contract practice were of indirect character and related to the understanding and minimizing the variability using the quality control system establishment which resulted in more precise definition of customer requests through the contract intention. The system optimization concept based on eliminating the non-value-added activities which occurred due to lack of quality had reflections on contract practice through terms of formal establishing of monitoring and controlling. The same also relates to the formalization of communication between the contract parties in order to minimize the system variability which can be observed through three essential theses: the demonstration of a satisfying communication level by which the contractual obligation acceptance is confirmed, the communication which must meet legally required form and the legal form of communication which lasts during the period of contractual obligation.

Figure 2.
Review of the flow concept by Petri – net analysis



2.3. Customer value achievement concept

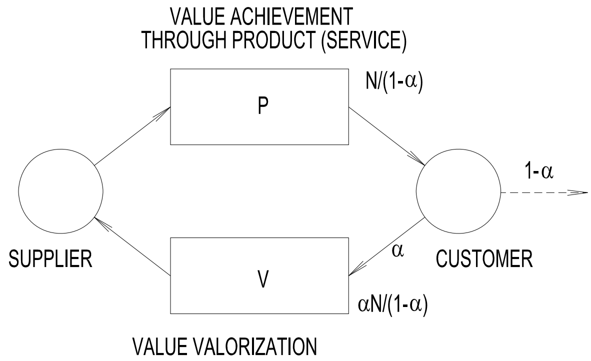
The customer value achievement concept is also a reaction to the traditional transformation concept which occurs simultaneously with promoting the flow concept. The meaning of the reaction was perfectly sublimed by Drucker (1989) [9]: “Finally the most important single thing to remember about any enterprise is that results exist only on the outside. The result of a business is a satisfied customer…Inside an enterprise there are only costs.”

What does this conceptualization of customer and supplier bring? The input represents the totality of data which depend on the customer and the output represents the product achieved by a production process at the supplier's. The Petri – net analysis (figure 3) shows that, in achieving the value, the relation between the purchaser and the supplier has iteration character which supposes creation of a satisfying communication infrastructure the entire efficiency of the system depends on. Therefore, there are two sub-systems on the supplier's side: the sub-system of product design which is connected to the sub-system of direct production by a production order. In the purchaser value achievement concept the product design is in the forefront ("Product Development and Design"). It is controlled by production specifications which are basically generated by the purchaser, while the very production process is designed by a project in relation to value (of the product to the customer). The very concept of the value can be defined in different ways: since the product / service price is an arbitrated category, the value is expressed as a relation profit / price by Barnard (1995). The value loss question also arises: Taguchi (1993). The author correctly observes that the value loss can have a broader horizon than the single user so he introduces the concept of value loss for the broader environment, which is an important contribution to understanding of the public interests.

The customer value achievement concept has strongly contributed to the development of quality management concept ("Total Quality Management – TQM") being the production paradigm. It has also been accepted as the general manager concept – Deming, (1982). The orientation towards the customer contributed to development of marketing methods and approaches which solves the variability problems generated by the customer and marketing conditions which is the main missing element in flow concept variability. Therefore those two concepts are extremely complementary.

The special significance is also reflected in the repositioning of the product design which is put into the supplier's domain and therefore integrated with the production processes. In their studies Bennett and others (1996) [13] and Konchar and Sanvido (1998) analyzed the achievements of Desing-Built contract forms (here after "DB") in relation to the other contract forms. Besides the stated facts it also significantly influenced the development of the contract practice through development of specific contract forms and risk distribution. The referent contract practice FIDIC 99 also accentuates the risk allocation depending on who designs the structure (unlike previous editions which were organized according to variety of works), primarily focusing on the risk allocation consequences which were the result of design bearer role. There is a certain closing in on the contract concept DB in performing the hydrotechnical technological assemblies based on the contract form "New Yellow Book" FIDIC 99 and "Silver Book – EPC / Turnkey Projects" FIDIC 99 in Build – Lease – Transfer financial arrangements.

Figure 3.
Review of the customer value achievement by Petri net



3. Generic characteristics of construction production system

The generally known differentiating category by which the construction is separated from the other economic activities is usually articulated by economic observation about the product static quality and dynamic quality of production forces (working force, work conditions and tools). Civil engineering is defined as a project industry type. Numerous authors analyze qualitative determiners of fundamental and generic characteristics of construction production. Groak (1992) points out the following aspects: long production time, high initial costs, product usage longevity. Nam and Tatum (1988) point out the large social importance of construction, the complexity and immobility, while Carassus (1998) points out the significance of construction production, construction as a production of prototypes, incontrollability of the construction process, presence of informal management system. Warszawski (1990) points out the low standardization level, the high manual and handicraft production level, share of authority among customers, designers, contractors, subcontractors and stakeholders from the project environment, mobility of work site of single work groups. The mentioned characterization can be sorted out into three broader causative areas: production uniformity, non-stationary production and temporary organization.

3.1. Production uniformity

Three causes condition the production uniformity: different request and priorities of the customer, repeated difference in locations and conditions of construction and difference in project solutions. The difference in project solutions intensifies the “prototype” production. Wortman (1992) points out the significance of design as an integral part of the production process and neuralgic issue which causes uncertainty due to customer’s reaction. On the supplier’s side there is a larger continuity of repetitive components, skills and technologies which he uses so that the uniformity characteristics of the production mostly do not reach the extreme level. Understandably, the contract relation must determine the relations between the involved parties and the place of risk as well as their distribution.

3.2. Non-stationary production

The term non-stationary production is connected to the fact that the construction is performed at construction sites and therefore the production forces must be spatially mobile (unlike the stationary industrial production where only the flow of production material is mobile). This characteristic is repeated at every single construction site on the level of different work processes where work groups are moved to different work sites. This leads to discontinuity and fragmentary circumstances at completion, whose consequence is activity in sub-optimal circumstances. The construction conditions create a series of specific risks which are the consequence of work process exposure to weather conditions, influence of local conditions (work force and material) and conditions and circumstances of the location which require specific technical solutions. Undoubtedly, such circumstances significantly increase the insecurity and risks in relation to the stationary industrial production and complicate the risk division within the contract relationship (customer – supplier – designer). It must be noted that the construction site is not only a necessary input, but also a resource susceptible to a complex transaction process in which the risk bearers (customer – supplier – customer) are multiply changed under (contract) conditioned circumstances. The entire process is performed on the broader spatial horizon than the construction one where there is site logistics and the time horizon which is significantly longer than the immediate construction process. Both flows of material and flows of information significantly broaden the project field logistics in time and space. Non-stationary production is significantly more complex than the stationary one and represents the most significant generator of variability. Within this category the aspect of connection between the customer and the location can also be pointed out. The location for the customer has a large and often determinative importance as a rule and largely influences shaping of the enterprise. The relation between the customer and the location has also an emotional connotation, which contributes to variability in shaping the customer's requests.

3.3. Temporary organization

Independent from the accentuated project design, the temporary organization is not an exclusive apartness of construction industry. It is a generally accepted organization form of many industries. However, in construction industry, the temporary organization is a result of economic requests and marketing circumstances. It represents an organization answer to risks which result from general instabilities in amount of work, seasonal instabilities, spatial and marketing instabilities and, finally, production instabilities relating to construction non-stationary production. The temporary organization is unique in uniformity measure of each project. This circumstance presumes the participation of selected subcontractors who posses knowledge about specific technologies, or subcontractors who meet the economic requirements of the project, mostly by employing local workers. It is a fact that the interaction of numerous project participants is performed under circumstances of communication between parties who do not posses experience of previous contacts and most probably posses their own communication habits and / or procedures, which generates specific risks which must be accepted within the contract relation. The contract relation determines the communication levels, information and communication channels, consistency in communication, communication culture, manners and behavior. Insisting on communication culture is of extreme importance: commitment to explicit discussions, readiness to share information and express intentions and plans and constant tendency and effort in order to improve the relations are the basic premises of productive relations among the contracted parties. Formalization of communication processes significantly prevents occurrence of informal structures and routines to which the temporary organization is more significantly exposed than the permanent organization forms.

By summarizing the observations about the production concepts and generic characteristics of construction production system, it can be concluded that there are two key phenomena which are significant differential categories in relation to the production situations of other industries: the fragmentary quality and variability. According to Brousseau and Rallet (1995), the fragmentary quality is the consequence of local character of the market and technical complexity of the production which also supposes inclusion into the heterogeneous supply market. The fragmentary quality of the production system is generated in causative areas of production uniformity, non-stationary production and temporary organization. By analyzing the transformation concept it was pointed out that the traditional approach of separating design from the production as well as supply oriented towards obtaining the lowest possible price contributes to the fragmentary quality through sequential and heterogeneous production. As it was mentioned in discussion about the temporary organization, the variability is the result of general and local instabilities in work amount and production instabilities relating to construction non-stationary production. While the process variability is explained by the flow concept and the technological complexity of the production process and customer value concept, exactly the customer is recognized as the main generator of the variability. The most significant symptom of fragmentary quality and production system variability occurrence is the occurrence of informal forms of organization behavior.

This phenomenon (besides the previously mentioned Brousseau and Ralet) was analyzed by numerous authors and institutions. All of them confirm the occurrence of informal systems and behavior patterns, explaining it by inability of the system to react to consequences of variability, fragmentary quality and complex inter-dependence within the production system. Even if operative problems of effectuation can be, as a palliative measure, solved by informal systems, the general insecurity arises due to occurrence of specific crisis inter-dependences and opportunistic behavior of stakeholders in informal system. Under such circumstances, a self-enhancing dichotomic effect arises, which eventually results in decreasing the efficiency of the production system. In this relation, the observation of Applebaum [21] is interesting because it will be confirmed by most practitians of construction management. The author comments on operative dichotomy of the management in the following way: "… we have virtually two separate organizations: one for the management function and one for getting the work done. The two organizations do not coordinate their work, and they are characterized by different goals and viewpoints."

The rigid formal systems which are part of the production system are most easily deformed into informal systems. The example for that are quality maintenance programs which are easily deformed under influence of realization coercion into informal forms. The systems of supply, planning, controlling, design and, by all means, the contract relation as part of the production system also belong to this category.

4. Construction contract – formal system behavior

The construction contract is a typical representative of the formal system. It is named, strictly formal, double-side obligatory and based on the administrative-law regulation of the mandatory character. The formal system, when exposed to the influence of realization coercion and unable to react adequately, spontaneously shows a tendency toward informal behavior forms. It is manifested in the segment of contract documentation management as a spontaneous role share, informal substitution of procedures of starting and finishing the contract, disregard and non-sanctioning of contracted and communication procedures, informal ways of changing the contract documentation, claim procedures which can not be met and are not documented. The tendency of the formal system to continuity of functioning, increase of efficiency and continuity of efficiency increase under the conditions of variability, insecurity and inter-dependency represents the ability to retain the effective operability of the formal system. It is analogue to the ability of retaining the sense and operational level of the contract relation, with a claim for the coincident flexibility in accepting the variability of the production system and reliable rigidness in maintaining the contractual intent.

It is definitely to be examined whether the satisfactory effective operability can be sustained only by a constant adding to complexity of contract forms under growing requests. An example for such tendency is the practice New Engineering Contract (NEC) which describes procedures of avoiding conflict in detail (Perry (1995) and Broome & Perry (1995)). However, contemporary production concepts, especially the customer value achievement concept opened space for different approaches such as “Long term partnering”, Dorre (1996) and “Project wise partnering”, Loraine (1994). The partnering concept has been developing since middle 1980s in the UK and USA and, related to it, there is a professional practice of measurable achievements which is accompanied by a corresponding contract practice. The realization of this concept for public placers of orders is by all means conditioned by the regulations of public supply law. Unlike the municipal administrations of developed EU countries, the Croatian practice has not yet accepted such a tendency.

“Performance concept” by Becker (1996) represents a practical complement of customer value achievement concept. The customer defines the criteria and the expected level of performance, while the supplier transfers those quality requests into technical specifications by creating design documentation based on which he offers work which will meet the customer’s expectations. For improving such a concept “post occupancy” evaluation and benchmarking analysis Preiser (1988) are offered. This concept was accepted through development of technical specifications and standards and is applied in practice in the developed countries of the EU and the world.

5. Conclusion

By summarizing the stated, it can generally be concluded that both the production concepts and the generic characteristics of the construction production system explain the occurrence of causative areas in which connected and complex causal mechanisms occur. The inductive approach which is based on the production concept theory is adequate for explaining the development of the contract practice: it explains the transformation separation of design and production and integration of product design and production by customer value achievement concept. The deductive approach which concentrates on the analysis of generic characteristics of the construction production system explains the phenomena of fragmentary quality and variability. Therefore, the introductory thesis about the necessity of both inductive and deductive approaches was justified.

The contract relation, being the part of the production system, aims for a more pragmatic and elastic informal response due to absence of the adequate response to production coercion. Under circumstances of increasing complexity of construction production system, the customer value achievement concept offers solutions which are not based on adding complexity to the contract forms, but on horizontal and vertical integration of the process and the involved parties based on partnering concept ("Long term partnering" and "Project wise partnering"), which creates new requirements in determining the supply procedure and contract practice. By noting that the very customer is one of the main generators of fragmentary quality, the systems which support the customer request determination ("Performance concept"), mostly due to inability of realizing and adequately articulating value attitudes on time and on whole. This new concept is accompanied by corresponding contract forms, contract practice and (public) supply practice.

The Croatian practice does not show any tendency towards the customer value achievement concept, although there is a contemporary legal framework which is adapted to the EU instructions in good measure. In addition, the state demand (with public cost share of almost the half of gross national product) is continuously high on the national market, so the customers – registrants of the public supply are the main factor of determining the value of products / services and therefore also the main generator of variability and fragmentary quality. What is evident is the existence of an opportunistic practice which does not measure, evaluate or publish accomplishments of public works, so there is no real interest of public placers of orders to improve the production and contract practice factors. According to the theses stated in the paper, this phenomenon can be explained as a form of an informal behavior caused by inability of the formal system to respond to the requirements of maintaining the public interest and marketing democracy.

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SHORING THE STEEL CONSTRUCTION ON UHMP

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Abstract

Central Institute for Emergency Medicine („Ustanova za Hitnu Medicinsku pomoć, UHMP") has been built in Zagreb, in Heinzlova street with the investment of 125 million Kn. Steel construction on about 5.500 m^2 includes Communications Office, Maintenance Service, ambulance, Center for Emergencies, Education Center and Administration Office. There are also garages on the area of the same size for ambulance cars and other functions of the Central Institute for Emergency Medicine. All these will ensure reorganizatio of the emergency service functioning, and about 350 employees will finally work in adequate conditions. The building of Central Institute for Emergency Medicine presents a steel construction. In this paper the neceessary shoring of the construction and the alternatives to it are described as well.

1 Introduction

Construction of Central Institute for Emergency Medicine is a framed structure with steel columns and beams, including composite floor slabs. Some information on construction and static model should be given to understand the necessary shoring of it. Construction system is built of a composite slab with steel beams to stabilize horizontally the rigid girder. Almost all columns have articulated joints on the both ends (rocker posts). The only exceptions are columns in axis 6' in the ground floor, which are coupled and fixed to the floor girder. The reason is that in this axis there are no vertical coupled elements. The static model calculation includes floor slabs as continuous elements through all fields, being studied as rigid frame on the particular floor. Global stability on horizontal load in the both directions is reached by vertical coupled elements in two orthogonal planes that are arranged possibilities of architectural design. Vertical coupled elements are, with regarding to free dimensions, designed as "K", "X" and "V" truss. Under the -0.29 elevation there is no concrete core or a wall for horizontal stabilization; instead of it all horizontal loads are transfered exclusively by coupled steel elements. All details are solved by bolted connections, and welding is allowed only in special cases for which a contractor assures that they don't cause possible negative consequences on bearing capacity and stability of the construction as well. It is necessary in this cases that the contractor also proves that it is technically impossible to solve the detail of the bolted connection.

2 Construction shoring

There are three main types of shoring on UHMP construction:

- Shoring the floor slab in the basement storey
- Support construction during the steel construction assembling
- Shoring the floor super elevation on construction floors

Shoring the floor slab in the basement is necessary because of supporting construction in the ground floor. Supporting construction is ensuring stability in the phases of assembling steel construction in ground floor, until complete bearing capacity is achieved.

Shoring the beams is necessary because of their super elevation. This shoring does not present classical and simple shoring of the assembling construction. There are large forces in question in comparison to classical shoring. Every floor from the upper to the lower one transfers forces. On the bottom floor there are large forces from the whole construction above. Concrete composite floor is constructed to take the whole load.

3 Shoring system

a) <u>Super elevation of construction floors</u>

   If we consider classical shoring system of steel construction and adopt it to UHMP construction, there is a raster of every 3x3 m to impose classical strut frame. Technically, it causes problems of transportation and manipulations through such a dense network of vertical elements.

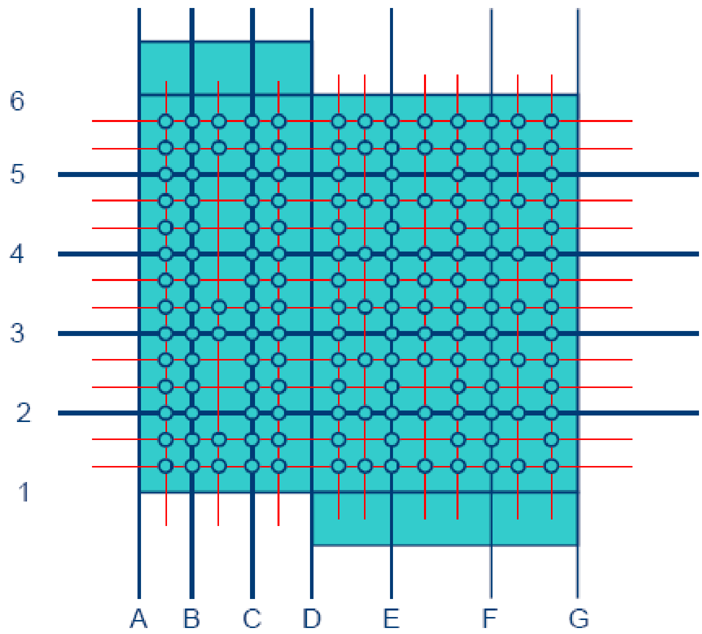

Figure 1. Classical shoring

In the Figure 2-5 the shoring plan in some of the characteristic axes are shown:

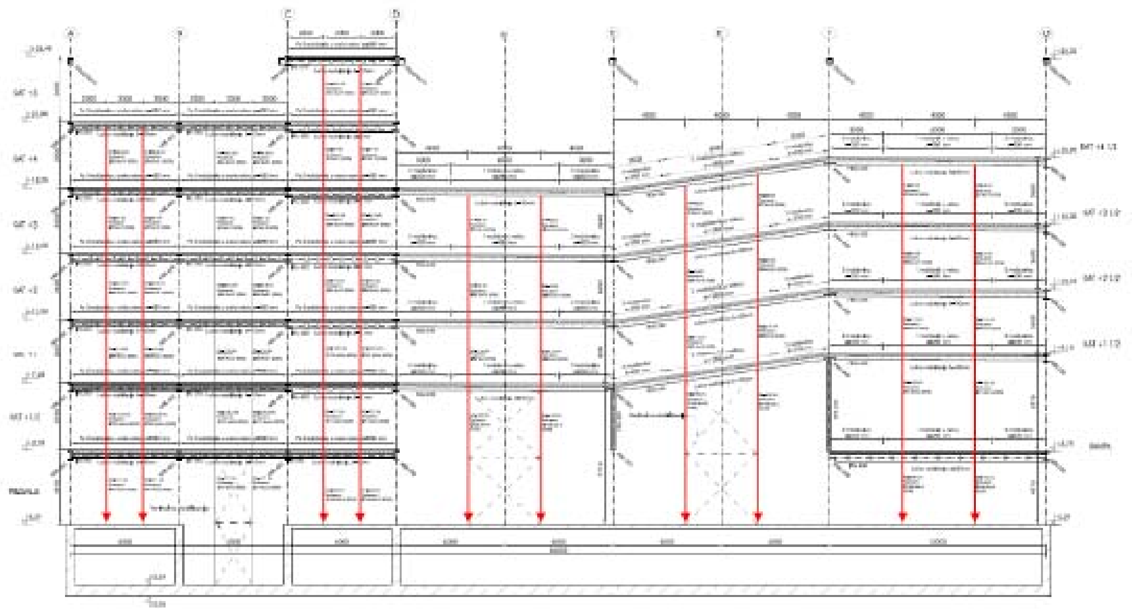

Figure 2. Shoring in axis 1'-1'

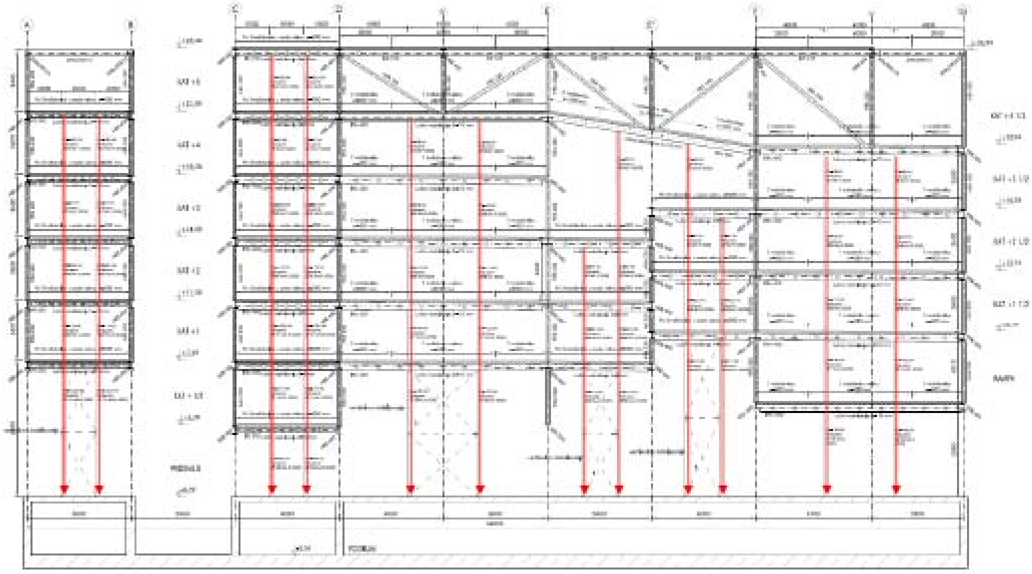

Figure 3. Shoring in axis 4-4

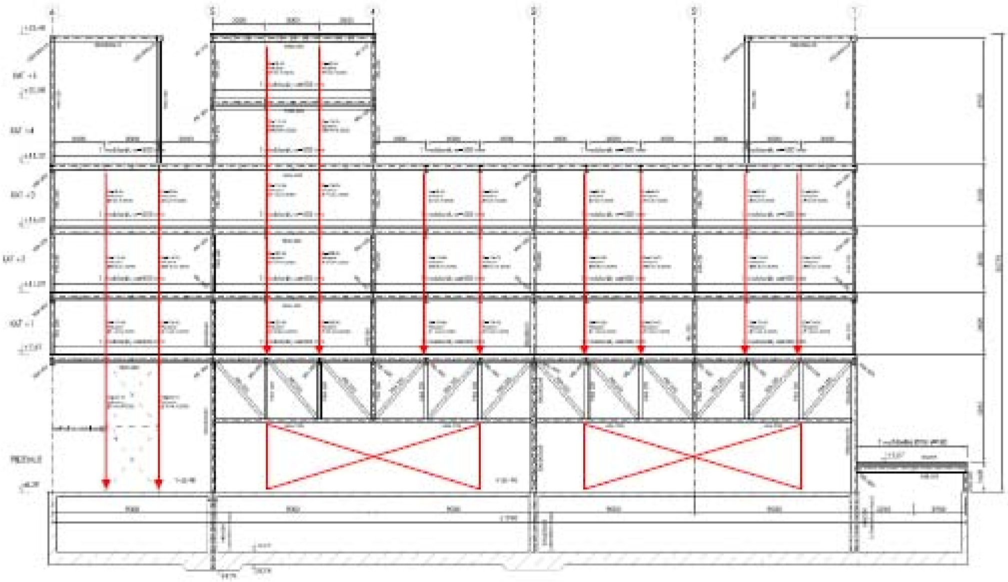

Figure 4. Shoring in axis E-E

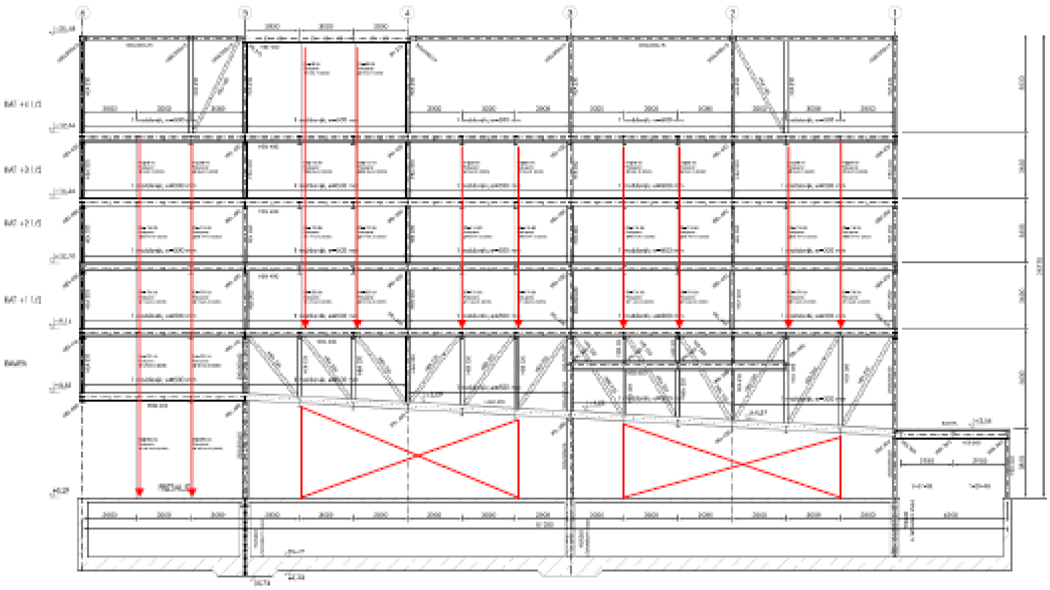

Figure5. Shoring in axis F-F

Contractor decided to analyse alternatives for such a shoring system and tried to make it more rational for construction technology. In Figure 6. the chosen alternative of the shoring system is shown. Vertical forces are transferred to the lateral side of the construction. Although this caused some delays and financial recalculations of shoring system, it appears as the better and more acceptable solution.

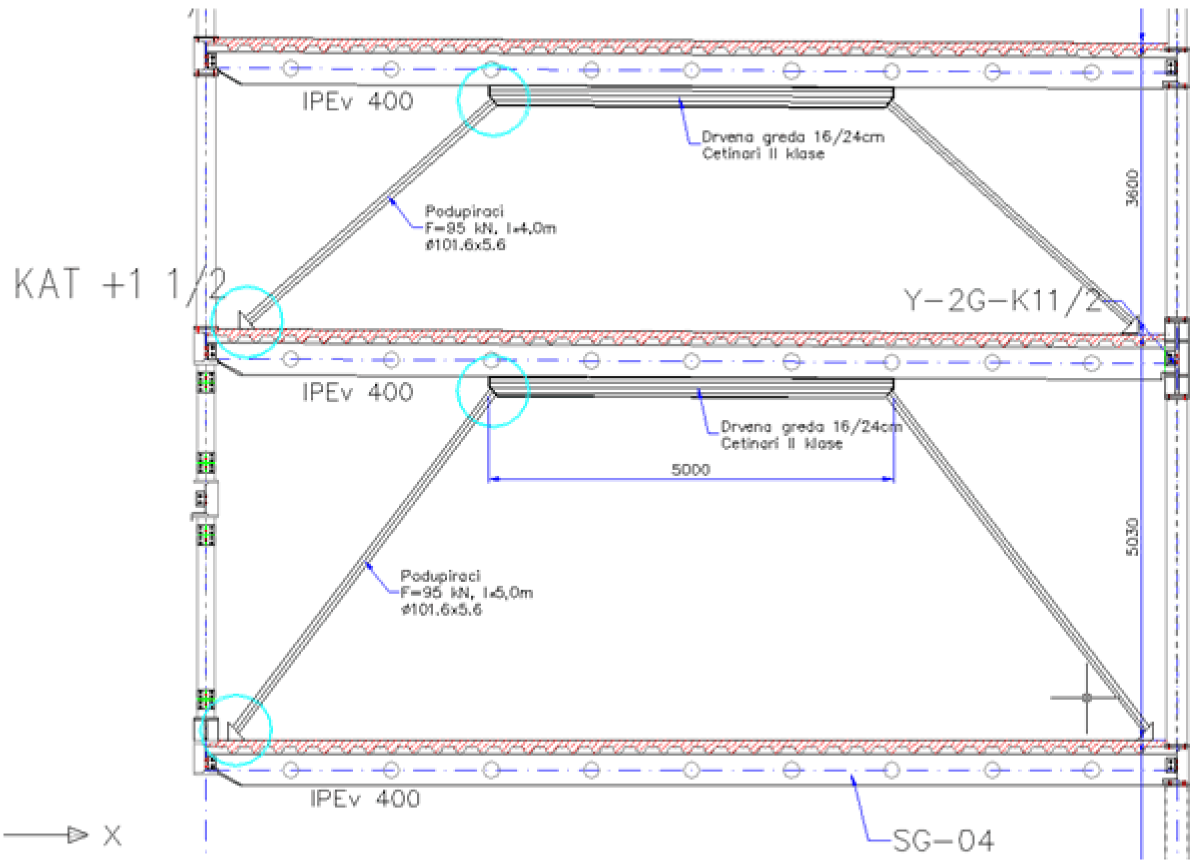

Figure 6. Shoring of superelevation of construction floors

b) <u>Support construction in the ground floor and shoring of the floor slab in the basement storey</u>

In the phases of assembling the steel construction it is necessary to support construction as long as the whole system receives designed load. Figure 7 and Figure 8 show forces that support construction has to receive. There is a large force in axis D-

D (1540 KN) that requires special analyse of shoring in the basement storey. (See Figure 10.)

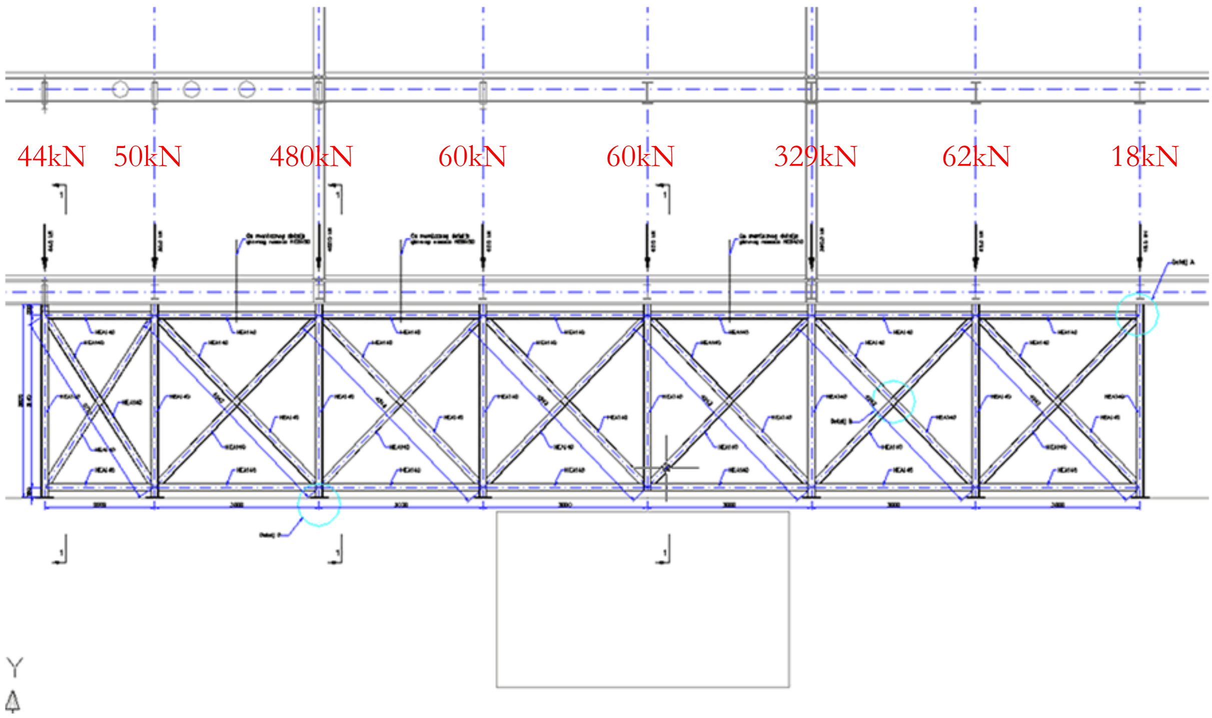

Figure 7. Supporting construction in axis C-C

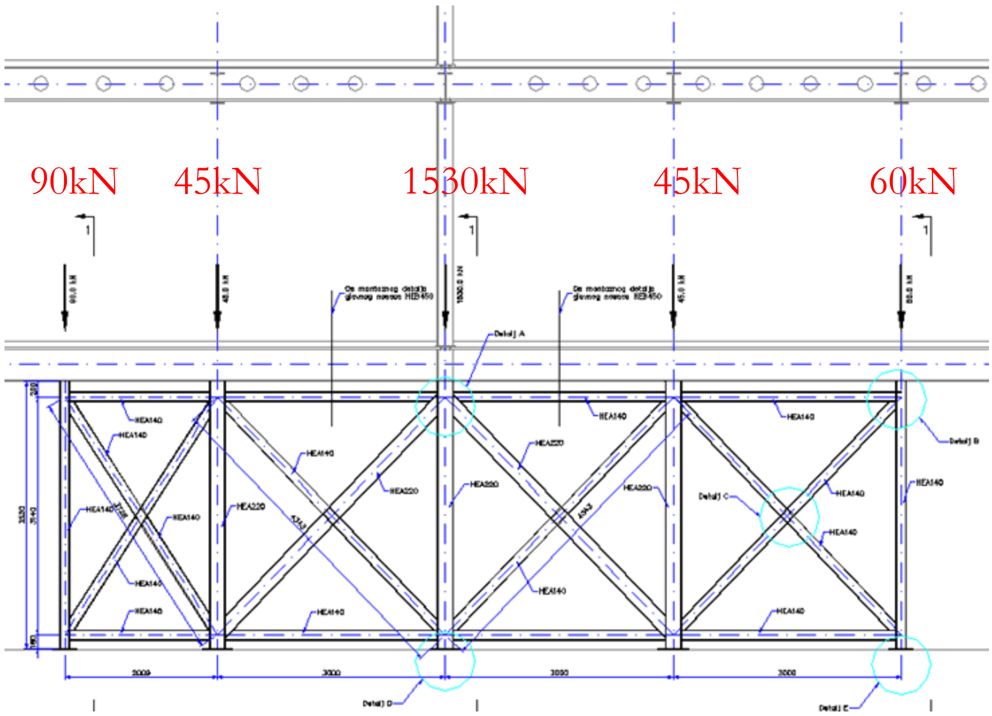

Figure 8. Supporting construction in axis D-D

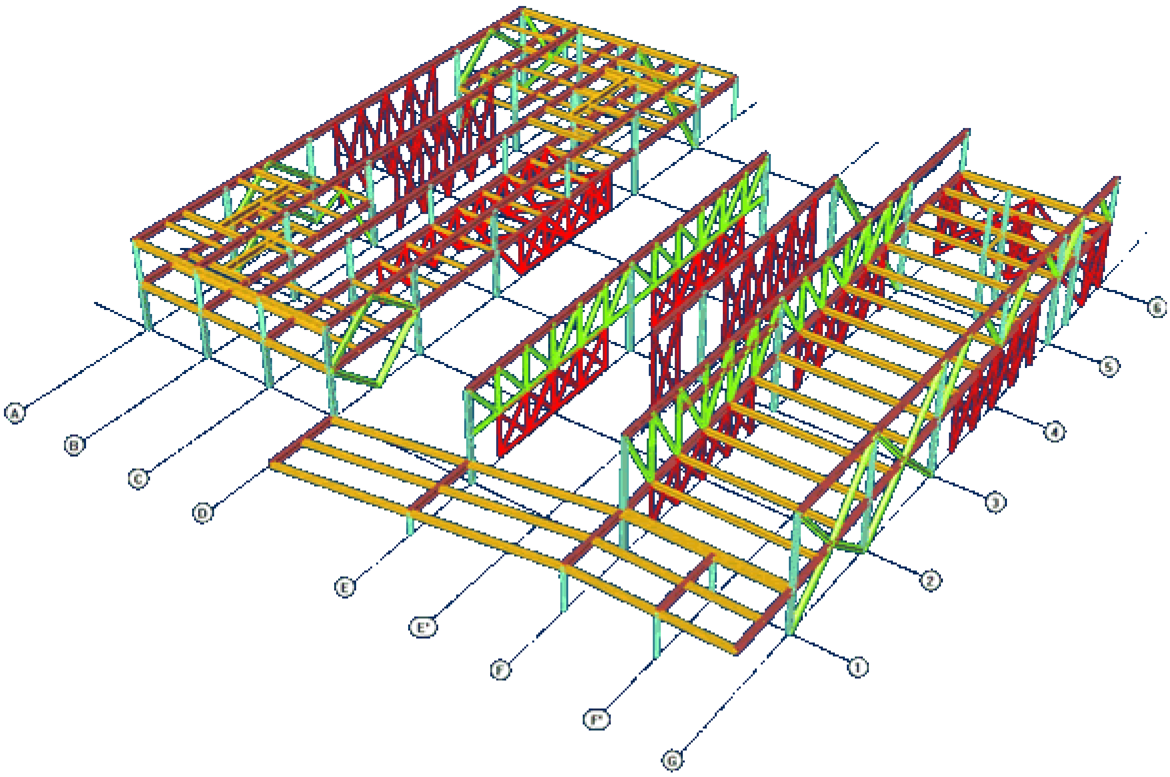

Figure 9. Supporting construction model (red)

Figure 10. Shoring the supporting construction in the basement storey

4 Conclusion

Complex constructions such as UHMP involve lots of interdependent elements in the phase of details' elaboration. Technology and organization of construction site usually looks for the alternative solutions, even drafting of new static systems and redesigning of the whole projects. In the UHMP construction the classic shoring elements were scheduled and it was obvious that they couldn't be applied. Necessary changes caused some time delay and some extra money but constructability justifies their implementation.

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SITE AND PROJECT MANAGERS ROLES IN CONSTRUCTION PROJECTS IN SERBIA: PAST, PRESENT AND FUTURE

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Abstract

International business environment fostered changes of site and project manager roles in Serbian construction projects.

In the near future great investment activity is planned in Serbia. Many large construction projects are now funded by international financial institutions and private investors, and constructed and supervised by international companies. International business environment fostered changes of site and project manager roles in construction projects. For better implementation of new project organisational structures it is important to research and explain the way these roles have been changed in construction, design and build, and lump sum contracts. New roles results in greater need for engineers which could enter industry with a broader educational perspective that includes influences from economics, marketing, management, and computing. Advanced scheduling techniques, alternative procurement, computer aided cost planning and control, international law, concurrent engineering, supply chain management, risk and value management, TQM and HR management, are some of the additional knowledge and skills necessary for successfull management of complex construction projects with short duration and strict quality requirements.

Keywords: construction, project management, site management, organisational structures

1. Introduction

Great number of big investments is presented in the last few years on the market of Eastern Europe, and in Serbia also. Project financing from financial institutions, public sector and private funds requires project realisation within previously defined budget and time. The most important phases are design, procurement and construction, and it is very important to employ consultants on the project to proceed with tender procedures and implement the appropriate contracts on the project.

Generally, today project passes through feasibility planning after project concept stage and when the pre tender estimate is completed project go through scheme and detailed design, procurement, construction and handover. Roles of site and project managers changed through market development after more than decade of crisis, and today market seek managers with strong technical, organisational and commercial skills.

2. Roles of site managers, project managers, investors and developers

Generally, permitting process (location studies, land permit, building permit and operating permit) which has the great influence on procurement process and projects realisation is very slow, unpredictable and risky on the Serbian market. Procedure for obtaining the necessary documentation for construction of building / facilities and usage of building / facilities includes 5 segments:

1. Preliminary issues,
2. Obtaining of the building permit,
3. Construction of buildings/facilities,
4. Obtaining of the inspection certificate,
5. Obtaining of the operating permit.

Site managers are responsible for operation on site, generally organise and supervise works to be done according to Serbian law, coordinate works of all subcontractors, check their progress etc. Site manager should be licensed from Engineering chamber of Serbia and there are responsible for all operations on site.

Project managers have the great role on the modern construction projects and generally they are responsible to realise project within budget and in time (Meredith and Mantel 2000). They are very often regulatory managers as well, and generally in Serbia they are with strong engineering background. As the movement on the market mostly they need commercial and law education and skills as well as engineering and construction experience.

Today consultant services in construction industry are very different and specialised and all Investors (either bid or small) generally should use their best practice. Concept and project brief should be prepared by Investor together with lead consultant and all other actions should be based on decisions made by Investor after consultant’s analysis of all risks and potential problems and recommendation preparation.

Developers provide full support during the feasibility stages and their main activities are: site analysis, town planning strategy, site investigation and remediation, market comparisons, consultant and advisor selections, strategic programming, cost and value analysis, project definition and briefing and logistics and construction consultancy.

3. Role of site and project managers in construction projects in Serbia: past, present and future

3.1. Past role of site and project managers

Before 90s on Serbian construction market was presented mostly big firms. They had good organised technical and commercial department as support for building sites. Project managers coordinated works on site, delegated to site managers, and had very strong support from technical and commercial department. All decisions they made together with head office. Past Project Manager and Site Manager Roles are shown on Figure 1.

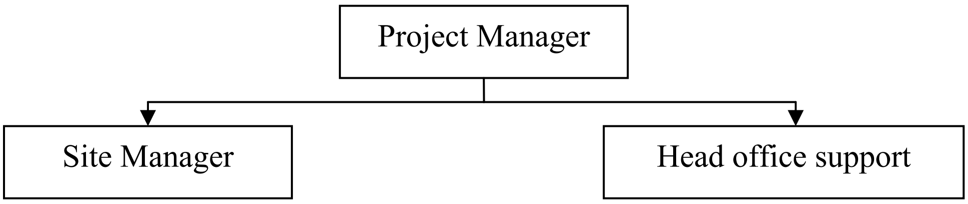

Figure 1: Past Project Manager and Site Manager Roles

3.2. Current role of site and project managers

Today on Serbian market mostly is present small and middle construction companies. The level of investments significantly increased during the last few years, so project managers need better support for successful coordination and management of projects. As project managers mostly have good technical skills they can cover some roles as the project is not specific and demanding. On some construction management projects emphasis is on the commercial and planning roles, and usage of project management tools helps the projects to be planned and controlled properly. Current Project Manager and Site Manager roles are shown on Figure 2.

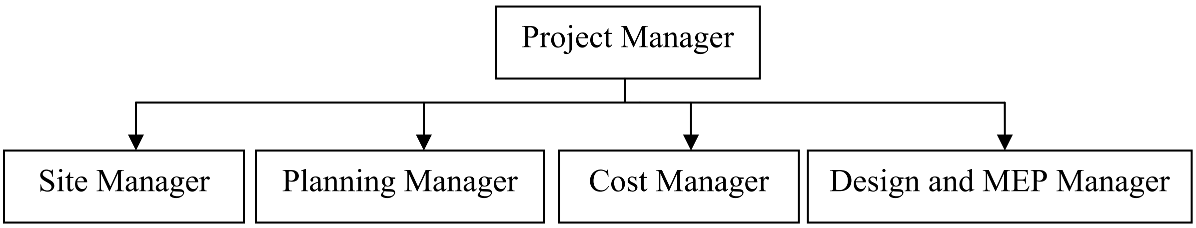

Figure 2: Current Project Manager and Site Manager Roles

3.3. Future role of site and project managers

As the Serbian market is limited size, private companies will have limited growth, so in near future we can expect mostly middle companies to be active. Matrix organisational structure is optimal and can enable maximum profit, so good project manager is possible to be specialist to manage few site managers and to use support from technical and commercial specialists. Future Project Manager and Site Manager Roles are shown on Figure 3.

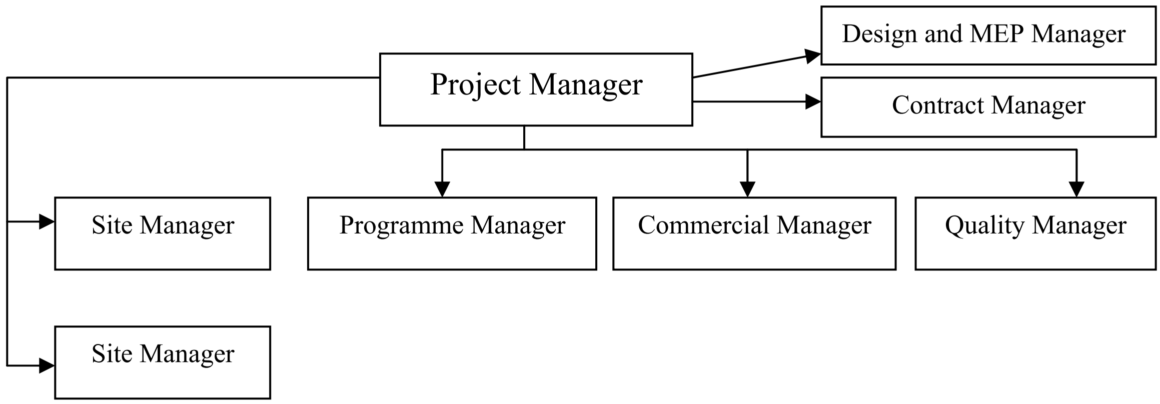

Figure 3: Future Project Manager and Site Manager Roles

3.4. Case study 1 – Contract for construction for building and engineering works designed by the employer

3.4.1. Measurement contract

The common practice on Serbian market was measurement contracts. Bidders prepare offers after bill of quantity and full specifications are prepared, and all interim and final payment is done based on quantities measured and approved by supervisor on site.

That type of contracts is not acceptable in current practice for investors as the price is not defined before contract is signed and it is very difficult to apply for the loan without guaranteed maximum price. Also, that traditional approach is very slow as there is no overlapping of design and procurement phases.

3.4.2. Lump Sum contract

General practice is to use lump sum contracts for small jobs when there is no enough time for bill of quantities preparation and contractor prepare offer based on specification, drawings and method statements. Project manager role on thet type of contract is to manage works to be done in accordance with specified quality and in time. Contractors project manager should be experienced to overview size of project and cost in advance.

3.4.3. Project organisational structure

Project organisational structure for Lump Sum Contract is shown on Figure 4.

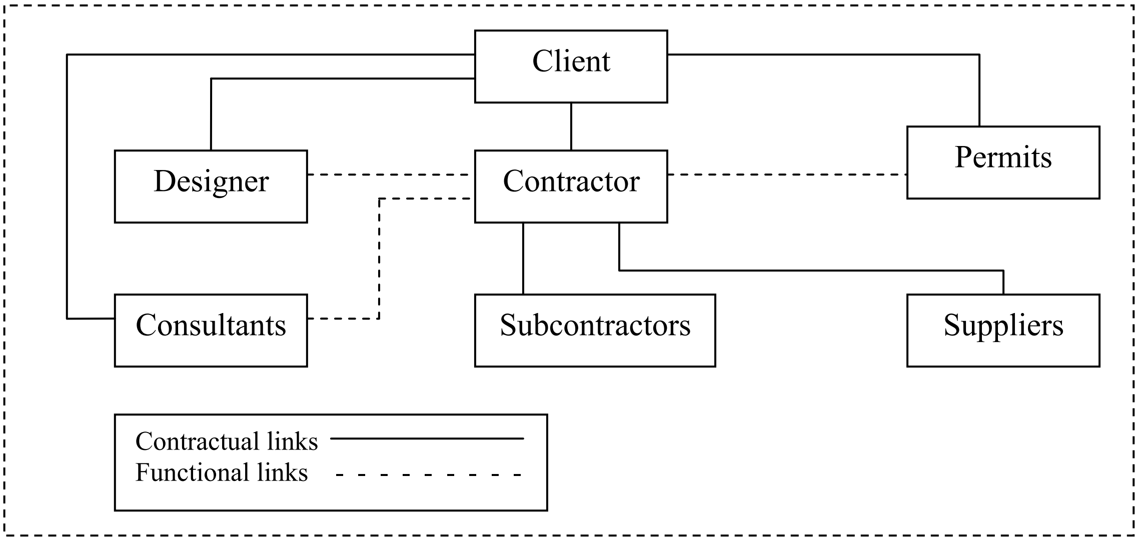

Figure 4: Project organisational structure – Lump Sum Contract

3.5. Case study 2 – Design and build contract

Permitting process in Serbia is very slow, so design and build route is good procurement approach to speed up the process executing design, construction and obtaining the land, building and operation permit simultaneously. The Contractor carries out all design work and then constructs the required building for a fixed price, all within a time limit set by the Client (Ashworth and Hogg 2007). This we will call the "pure" form of Design and Build, as it was originally created - one in which all design detail and construction responsibility is left to the Main Contractor.

In recent years there has been a tendency for Clients to make their design briefs / requirements increasingly detailed and in some cases even novating their Architect over to the Main Contractor, in which case the Client maintains much of the say as to the designs as they proceed.

The risks in the design and build route are - the contractor in this case is responsible for the design of the building, and so the Client can send his project out to tender as soon as he has finalised the Performance Specification (usually produced with the advice and help of an Architect and/or other specialists). Once the Contractor has stated a time and cost for completing the works these should not change, as the responsibility for these is entirely the contractor's. It is thought that the factor which could suffer in the case of a Design and Build approach is that of quality. It must be said, however that the opposite may be true, and design could benefit.

The Contractor, through his own design team, may in fact come up with an innovative, exciting design. In more recent times, a number of clients have entrusted some quite prestigious developments to Design and Build contractors, who have come up with very fine results.

3.5.1. Project organisational structure

Project organisational structure for Design and Build Contract is shown on Fig. 5.

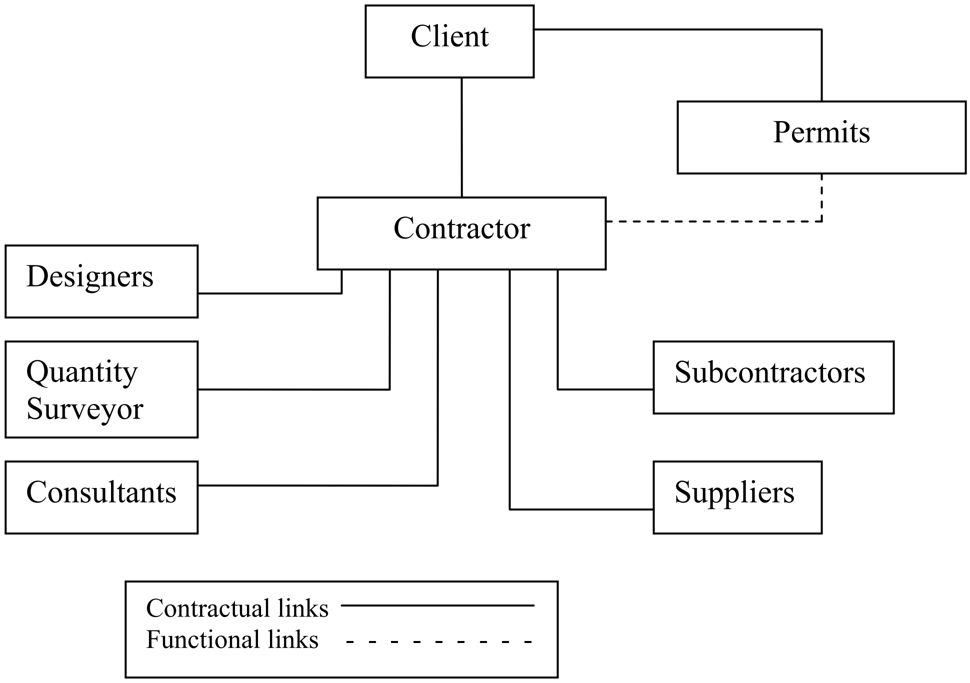

Figure 5: Project organisational structure – Design and Build Contract (Ashworth and Hogg 2007)

3.6. Case study 3 – Management contracting

This procurement route covers possible contractual / control situations, but in all cases the Client appoints an individual or organisation to manage construction operations for him, in return for a lump sum fee or a percentage of the Contract Sum. In Management Contracting the lead contractor provides expertise in management and in buildability, and does not take on the work or employ any of the labour or plant themselves (Oberlender 2000). They will let the work as a series of packages, usually by competitive tender (though sometimes on some other basis) One advantage of this is the capacity for the Client to engage the management contractor at an early point in the design stage, thus drawing on the latter's expertise in putting the whole thing together. In this case, contracts for the works packages will be between the Management Contractor and the works package contractors (Ivković and Popović 2006). Construction Management operates similarly, but here, whilst the Project Manager (again, an individual, firm or contracting organisation) has the same co-ordinating role as that above, the contracts for the work packages are directly between the Client and the works package contractors.

Risks to the Client under Management Contracts

The Client, through their project manager or through the management contractor can determine the quality of the works (through rigorous specifications, drawn details etc.) and can set an overall programme for the works, which it should be possible to enforce. It is thought that the factor which could suffer most in the case of Management approach is cost (Bower 2003). This is because this procurement route gains its speed by the letting of works packages as the project proceeds. Since design may only be finalised in time for the letting of the package, there can be no actual certainty as to cost until the tender sum has been agreed for the last work package to be agreed and issued (Oberlender 2000).

Management of change in the Management Routes

The processes and consequences for the Client in this case will be much the same as for either of the above traditional or design and build routes, depending upon how a particular package has been let.

3.6.1. Project organisational structure

Project organisational structure for Management contracting with contractual and functional links is shown on Figure 6.

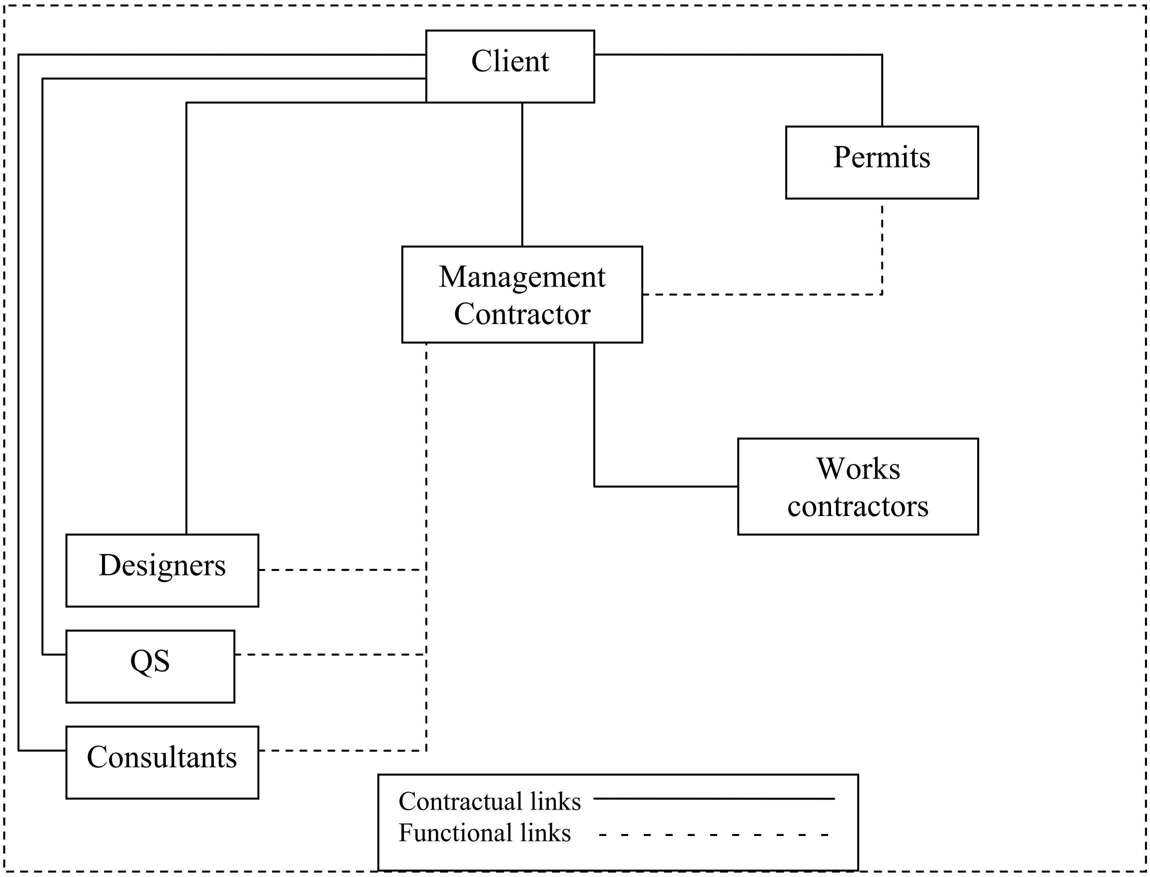

Figure 6: Project organisational structure - Management contracting (Ashworth and Hogg 2007)

4. Discussion – Importance of project managers role

Today construction practice need project management as the investors strictly insist projects to be completed within budget and in time. Very important is to define what standard project management procedures are, what phases different projects should pass to be delivered successfully (Bower 2003). Definitely, project manager is specialist who produces project documents and minimise risks on the project (Lock 2000). Risk analysis and management is very important technique and must be standardised. Also legal system in Serbia should be changed to allow better implementation of modern procurement routes.

5. Conclusions

Project management is new approach to the Serbian construction market, generally transferred from western practices and initiated with bank credits and loans. Specialists present on that market have started to get new skills mostly commercial as the projects are mostly financed by financial institutions, private funds and public sector. New project and construction management departments should be opened on existing universities, and also some new quantity surveying, real estate, development management courses as well, and specialists from abroad should be involved on current projects and transfer of knowledge should be permanent practice. Also, current legal system and permitting process which is generally very slow and unpredictable should be changed, and to define project manager role projects together with designers, contractors and supervisors. All that changed should be appropriate to Serbian market with very strong tradition and all their specificities.

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MANAGEMENT AND ECONOMICS EDUCATION PROGRAMMES QUALITY ENHACEMENT STRATEGY

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Abstract

Quality assurance of construction management and economics education programmes are expected to include regular feedback from employers, labour representatives and relevant organisations. In the final analyses the aim of education program is to prepare learners for an active and positive role in construction industry. The use of learning outcomes represents a shift in thinking from a stuff-based input-oriented system to a student-centred output-oriented approach. It is very important for higher educational institutions to develop and implement a strategy for the continuous enhancement of quality of their programmes and awards. Integrated databases and knowledge base is suggested as an IT support for programme development, monitoring and renewal. In order to become a mirror industry image educational programs have to respond to industry requirements for broaden management and economics competencies. Outcomes analysis can provide very useful information about developments, trends, good practice and areas of persistent difficulty of CME programme and can become useful tools for quality enhancement.

Keywords: construction management and economics, education, quality, knowledge base

1. INTRODUCTION

In the near future great investment activity is planned in South-East of Europe. Many large construction projects are now funded by international financial institutions and private investors, and constructed and supervised by international companies. That is why engineers employed in construction companies need additional knowledge and skills in project and corporate management to successfully manage complex construction projects with short duration and strict quality requirements. In this dynamical situation it is clear that construction companies are strongly oriented toward employing educated, skilled and experienced engineers.

Important research phase is development and implementation of Integrated Education Programme Database and Education Programme Knowledge Base, as an IT support for education programme development, monitoring and renewal.

The next generation of civil engineering professional is similarly witnessing the emergence of knowledge-based tasks as a central focus of organization operations (Chinowsky and Guensler 1998, Drucker 1993). The industry is slowly adopting concept of learning organizations (Cayes 1998), and still has not come any closer to arriving at a consensus on education requirements appropriate for new managerial challenges (Chinowski 2000). The challenge to organization leaders is to develop knowledge dissemination mechanisms that retain a focus on individual enhancement while enhancing distribution to the overall organization (Stata 1989).

It is very important for higher educational institutions to carefully examine the educational needs and opportunities within construction companies and set the education objectives required to create a innovation corporate culture and civil engineering learning organization. The new civil engineer combined university education with professional experience and are entering the engineering industry with a broader educational perspective that includes influences from economics, marketing, management, and computing (Grant 1996).

In an attempt to respond to industry requirements for specific educational skills, university programs have slowly emerged as a mirror image of construction industry (Long 1997, Singh 1992, Lowe 1991, Wadlim 1985, Hancher 1985, Grinter 1955). University programs have followed project management tradition as they have prepared each succeeding generation of industry managers (Oglesby 1990, Betts and Wood-Harper 1994). According to results of many researches in this field (Chinowsky and Paul 1997, National Academy of Sciences 1995, National Science Foundation 1996), management education is a critical issue for the long-term success of the civil engineering industry.

2. EDUCATIONAL PROGRAMME QUALITY ENHANCEMENT STRATEGY RESEARCH

If Europe is to achieve its aspiration to be the most dramatic and knowledge-based economy in the world (Lisbon strategy), then European higher education will need to demonstrate a policy and associated procedures for the assurance of the quality and standards of their programmes and awards. In order to develop a quality enhancement strategy and formal mechanism for the approval, periodic review and monitoring of higher educational programmes and awards, educational research is based on the following framework:

- Definition and analyses of all phases of CME education program life-cycle
- Industry influence in education programmes development, monitoring and renewal
- System for Regular Industry Feedback (cyclical monitoring and periodic review by employers, labour representatives and professional organisation) of competences and learning outcomes of CME Department graduates
- Development of Education Programmes Information System – IS which can be considered as a IT support in programme development, monitoring and renewal
- Data and information from all phases of education programme life-cycle could be stored in an Integrated Educational Programme Database – IEPDB
- IEPDB could form a Construction Industry Education Programmes Knowledge Base, as a subsystem of Construction Industry Knowledge Base
- Education Programmes Knowledge Base could be used in programmes development
- it is possible to apply principles of life-long learning – LLL in field of CME
- development and dissemination of CME knowledge and skills could foster innovation corporate culture, integrated innovation processes and organizational improvement
- managing the integrated innovation processes could foster industry development

External quality assurance of institutions and programmes should be undertaken on a cyclical basis. Life-cycle of the education programme is shown on Fig. 1.

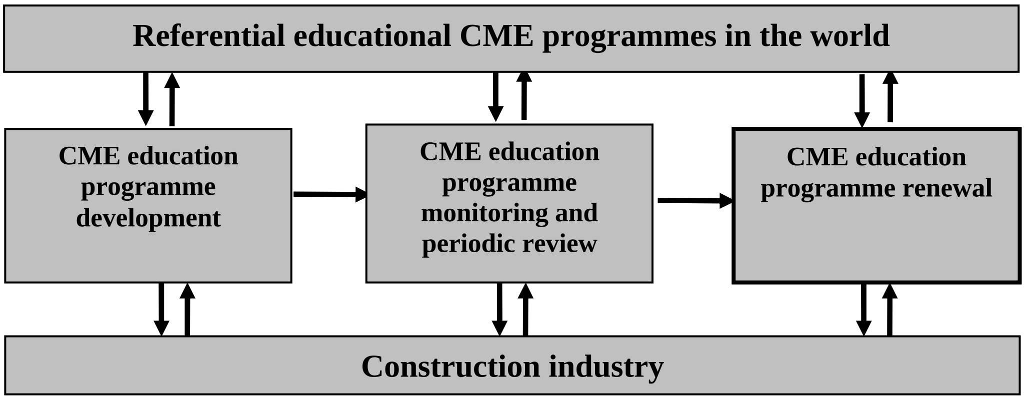

Figure 1: Life-cycle of CME education programme

The confidence of students in higher education is more likely to be established and maintained through effective quality assurance activities which ensure that programmes are well-designed, regularly monitored and periodically reviewed. Quality assurance of programmes and awards are expected to include regular feedback from employers, labour representatives and relevant organisations. Learning outcomes are sets of competences, expressing what the student of department will know, understand or be able to do after the completion of a process of learning, whether long or short. In the final analyses the aim of education program is to prepare learners for an active and positive role in construction industry (DGEC 2005).

The use of learning outcomes represents a shift in thinking from a stuff-based input-oriented system to a student-centred output-oriented approach. Learning outcomes are expressed in terms of competences. Competences represent a dynamic combination of attributes, abilities and attitudes, and can be subject specific or generic. Programme monitoring and periodic review is shown in Figure 2.

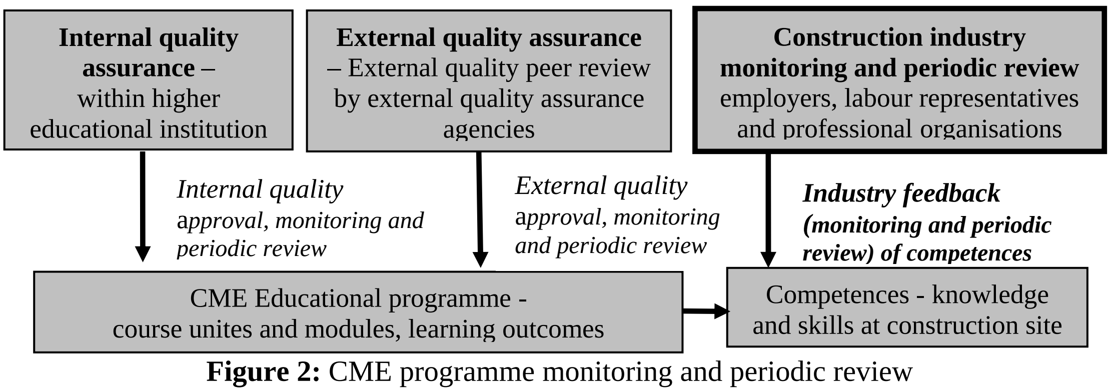

Figure 2: CME programme monitoring and periodic review

CME educational programmes quality assurance is not a static but a dynamic process. It should be continuous and not "once in a life-time". Outcomes analysis can provide very useful information about developments, trends, good practice and areas of persistent difficulty of CME programme and can become useful tools for quality enhancement.

3. IT SUPPORT IN EDUCATION PROGRAMME DEVELOPMENT, MONITORING AND RENEWAL

The higher education institutions in field of CME should collect, analyse and use relevant information for the effective management of their programmes of study and other activities. The quality-related education programme 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. Integrated education programme database IEPDB is integrated database containing data from design, operational and renewal phases of education programme life cycle (Fig. 3).

EDUCATION PROGRAMME INFORMATION SYSTEM

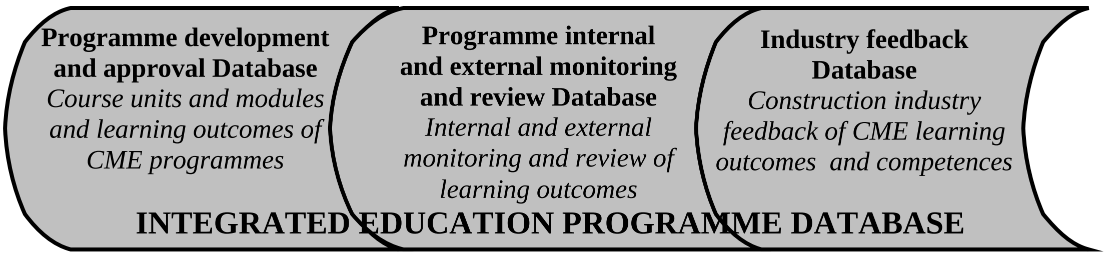

Figure 3: Integrated CME programme Database

In order to preserve, spread and manage the knowledge accumulated in previously realized CME education programmes, all IEPDB can be gathered and stored in a newly created Education Programmes Knowledge Base – EPKB. Knowledge Based Systems-KBS should preserve developed and rare knowledge in such form that can be efficiency distributed to anyone who needs it (Dutton *et al.* 1996). EPKB, as a subsystem of industry knowledge base, is shown in Fig 4.

CONSTRUCTION INDUSTRY KNOWLEDGE BASE

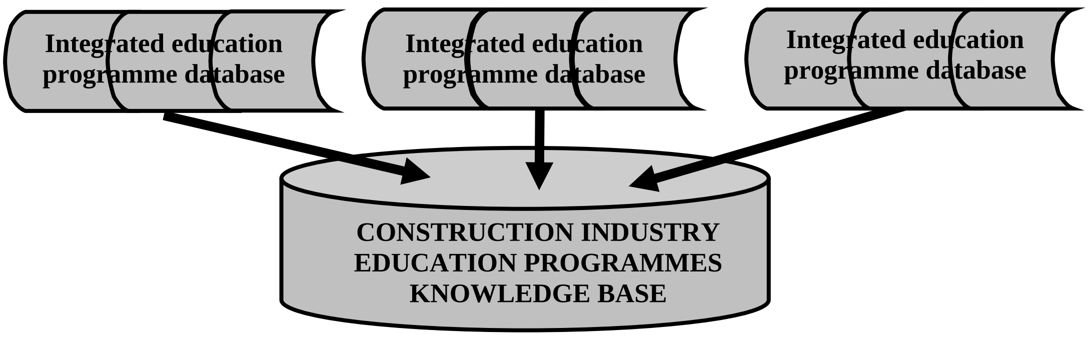

Figure 4: Construction Industry Education Programmes Knowledge Base

4. LIFE-LONG LEARNING, INTEGRATED INNOVATION PROCESSES AND INDUSTRY DEVELOPMENT

The successful construction companies are increasingly facing the need to establish Life-Long Learning – LLL as a centrepiece of strategic management. Updating core engineering knowledge or expanding skills to areas such as management and technology, education is the emerging avenue to organization improvement (Chinowski 2000).

LLL comprises all types of learning and training within any type of institution, company or outside in the field, i.e. formal, non-formal and informal learning. Where formal learning takes place in CME education and training institutions and leads to recognised CME diplomas and other types of documented qualifications, non-formal learning occurs outside mainstream education and training and does aim at formalized certificates. Informal learning is natural sequence of everyday life. CME life-long learning as a organization improvement and industry development support is shown in Fig. 5.

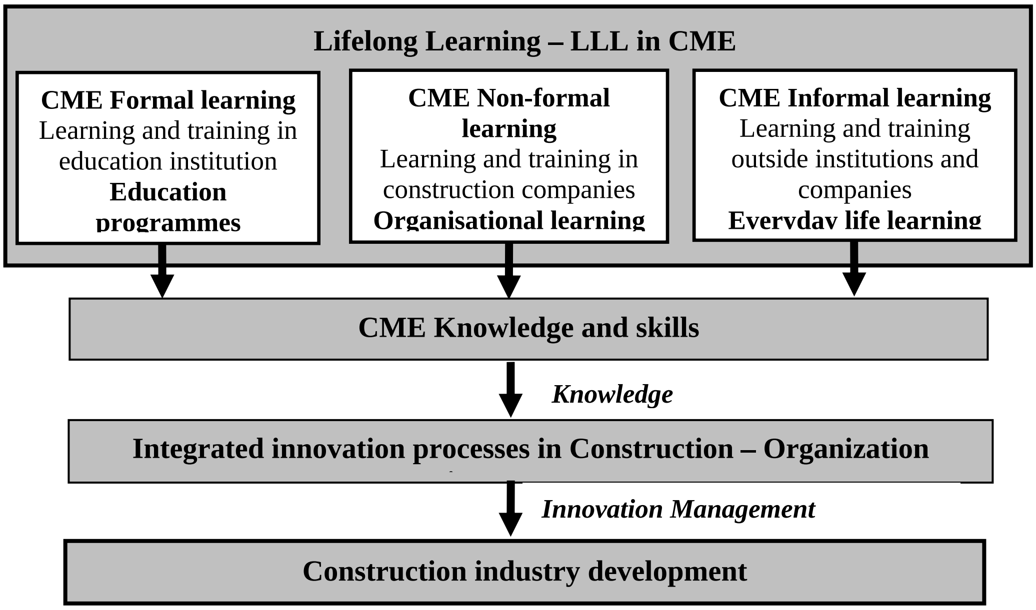

Figure 5: LLL as a support for organizational improvement and industry development

Construction companies face many challenges due to the changed technical, economic and social conditions inside and outside the sector. Raised environmental demands can be identified as challenges for a change. As soon as such a change is an economically successful novelty for the company, it can be considered to be an innovation. However, in order to innovate successfully, it is necessary to create efficient innovation processes. Organisational learning – OL is one of the mechanisms that facilitating Innovation.

The chief aim of innovations is to contribute to meeting the needs of the clients, providing for the quality of the services offered and gaining advantages in competition. Using the available knowledge is one of the main components of the innovative strategy. It is possible to group justification for life-long education of civil engineering organizations into four categories (Chinowski 2000): bridging the management knowledge, enhancing career advancement opportunities, enhancing personnel and professional development and ensuring competency in discipline knowledge. With the focus of long term benefit, a strong organization knowledge base is a foundation to retain competitive advantages.

5. RESEARCH METHOD AND METHODOLOGY

The main goal of the first part of educational research is to find which CME competences (as a learning outcome of education process) leading construction companies at the market consider most important for competitiveness and future industry development. The need to introduce new education opportunities to address emerging business environments is a significant challenge. Once organization establishes the need for a professional education program, the next issue that arise is what topics should be studied. This research explores the essential CME knowledge and skills that the successful project and corporate manager in the industry should possess.

CME competencies as a learning outcomes of education processes	**(%)**
1) **Project Management** (scheduling techniques, alternative procurement, WBS, CAP)	100
2) **Cost Engineering** (techniques, modelling, planning, control, estimating and tendering)	100
3) **Construction Law** (contract low, claims, forms, alternative dispute resolution, mediation)	100
4) **Production management** (concurrent eng., lean production, supply chain management)	100
5) **International construction** (market entry, growth, profitability and survival, local government and regulatory bodies, market trends)	100
6) **Risk and Value Management** (risk identification and quantitative approaches, integrated value and risk engineering and management)	100
7) **Development and Investment** (valuation, NPV, rate of return, discounted cash flow)	100
8) **TQM** (TQM, sustainable construction, built environment, ISO 9000 and 14000)	88,88
9) **Accounting and Financial analysis** (balance sheets, profit measurement, cash flow, profit and loss, financial ratios, budgeting)	88,88
10) **Business Management** (organizational structures and culture, leadership, marketing, taxation, processes improvement, partnering)	77,77
11) **Human Resources Management** (organizational behaviour, innovation, market, recruiting, performances, learning)	55,55
12) **Strategic Management** (planning, diversification, competitiveness, markets, portfolio)	55,55

Table 1: Results of round two - relative importance of competences

First seven competencies are project oriented, following industry project management orientation and tradition, and last five are business and corporate oriented, with broader educational perspective in field of business management, economics, finance and investment.

Industry needs for project management competencies are in accordance with project management oriented educational programs (analysed by Oglesby (1990) and Betts and Wood-Harper (1994)) and educational research studies (Long 1997, Singh 1992, Lowe 1991, Wadlim 1985, Hancher 1985, Grinter 1955) which have shown strong industry and educational institutions belief that project management knowledge and skills and successful project execution is the fundamental key to corporate success.

Industry requirements for specific business management and economics competencies beyond a project management level is in accordance with many educational research studies (Chinowsky and Paul 1997, National Academy of Sciences 1995, National Science Foundation 1996), which have considered management knowledge and skills as a critical issue for the long-term corporate and sustainable industry success.

6. CONCLUSIONS

Educational research in field of programme quality enhancement strategies, IT support for programme development and monitoring, and adaptation of educational programmes to the construction industry needs, are important activities for programmes developers and educational researchers.

Research results have shown industry requirements for broaden construction management and economics competencies. In order to successfully respond to industry requirements management and economics educational programs have to become a mirror image of construction industry needs.

Considering the latest dynamical changes in contemporary business methods, and bearing in mind that life-long learning is in the heart of contemporary educational process, educating engineers to successfully manage their projects and companies could foster integrated innovation processes, organizational improvement and sustainable industry development.

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APPLYING ANALYTICAL HIERARCHICAL PROCESS (AHP) TO BUILDING MAINTENANCE MANAGEMENT

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Abstract

The Analytical hierarchy process is a systematic procedure for representing the elements of any problem hierarchically. It organises the basic rationality by breaking down a problem into smaller and smaller constiuent parts and help decision makers to make decision through a series pairwaise comparisons. the Analytical hierarchy process is a very useful tool for setting priorities. In this paper the Analytical hierarchy process is used for setting priorities in maintenance of the main administration building of port of Ploče which is located on the E coast of the Adriatic Sea and sheltered by Peljesac peninsula.
Setting list of priorities of maintenance work will help the investor to provide funds for maintenance and repair. As a support for decisions the authors apply Expert Choice software which is based on the Analytical hierarchy process .

Keywords: Analytical hierarchy process , Maintenance, Buildings

Sažetak:
Analitički hijerarhijski proces je procedura rastavljanja složenih problema na hijerarhijske razine. Donošenje odluka je temeljeno na seriji odluka kroz usporedno poredjenje hijerarhijskih razina medjusobno u odnosu na postavljeni cilj. Analitički hijerarhijski proces je vrlo koristan za donošenje odluka o prioritetima. U radu je prikazan primjer uporabe Analitičkog hijerarhijskog modela na određivanju prioriteta u održavanju na objektu u Luci Ploče. Luka Ploče se nalazi na Jadranskom moru u okrilju poluotoka Pelješac. Određivanje liste prioriteta će pomoći investitoru u osiguravanju fonda za održavanje i popravke objekta. Kao podrška za određivanje liste prioriteta korišten je Expert Choice kompjutorski program koji u sebi ima inkorporiran analitički hijerarhijski proces

Ključne riječi: Analitički hijerarhijski proces, Održavanje, Objekt

INTRUDUCTION

The problem of maintenance has been actual subject for many years. Maintenance problems differ from country to country, but there is one common thing to all and this is that structural changes in investment go in hand to hand with economic development and business advances. The level of investment in the construction of new structural projects is constantly decreasing and the level of assets invested in the maintenance of existing buildings rising. This will be aslo the case with the Republic of Croatia. Currently, there are a number of investment into a new buildings and infrastructure projects, but it is predictable that in the future the investment in maintenance of these buidlings will take a great part of total investement in the conctruction sector.

Making decisions in the prioritisation process for the maintenance of buildings is becoming the important subject, resulting in a number of priorities setting models applicable today. The task of the model for prioritisation in building maintenance is to rank as consistently as possible the defined maintenance works by their overall significance. All models are based on a consistent and unbiased weighing valuation of planned works, applying the said criteria, and on the formation of a cumulative index defining priorities in maintenance.

Setting the priorities in the building maintenance should enable the prolonged life of a building, avoiding the situation where certain works must be undertaken inevitably and immediately.

ANALYTHICAL HIERARCHICAL PROCESS (AHP)

AHP was developed by Saaty (1992) to assist managers in decision making. By incorporating subjective estimates and objective facts into a logical hierarchical framework, AHP enables an intuitive and common-sense approach to quantifying the significance of each element through the process of mutual comparison. This process assists the decision makers to reduce a complex problem to a hierarchical form that has several levels. Globally, the hierarchy has at least three levels: the goal, criteria, and options. Criteria may have sub-criteria (Figure 1).

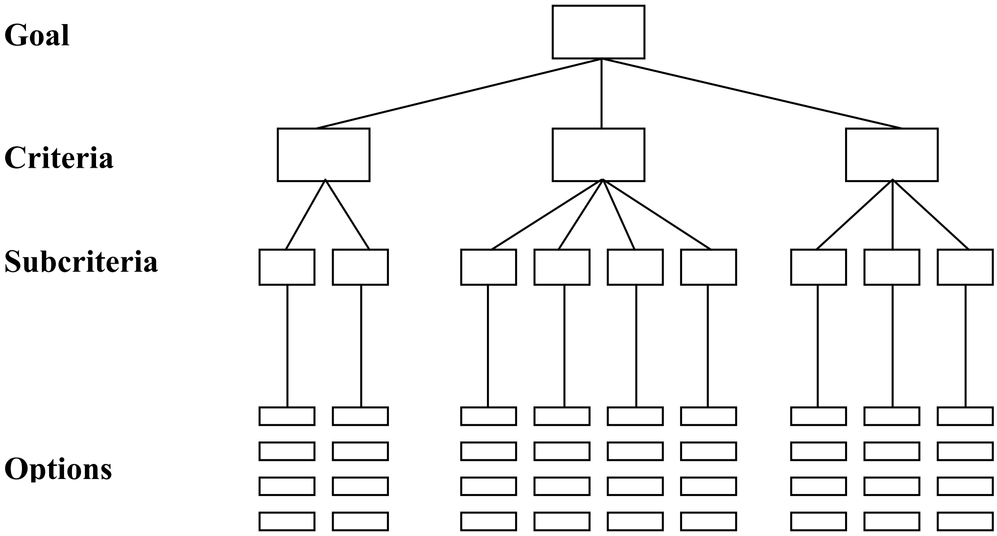


Figure 1: Hierarchical structure of the model

The process begins by determining the relative significance of individual options in relation to criteria, or sub-criteria. Then, criteria are compared relative to the goal. Finally, the results of these two analyses are synthesised in order to calculate the relative significance of options in relation to achieving the goal.

The comparing process is represented by forming a comparison matrix. If there are *n* options available, or criteria which form the comparison matrix, $n(n-1)/2$ comparisons need to be made.

Eigen vector of each comparison matrix represents the ranking list of priorities, while the eigen value gives the consistency measure with which the comparison was made. Synthesised eigen vector represents the global ranking of criteria in relation to reaching the goal. A global consistency coefficient less than 0.10 is acceptable, otherwise the judgements made should be revised.

In order to determine the eigen vector and the maximum eigen value of the comparison matrix, the general problem of eigen values, expressed in the following form, requires to be solved:

$AW = \lambda_{max}W$

where:

A – comparison matrix,

$W = (W_1, W_2, W_3, W_4, W_5)^T$ – eigen vector, and

λ_{max} – the highest eigen value.

As previously stated, AHP is most usable for multi-criteria problems where the precise quantification of the influence of options on decision making is not possible. Therefore, AHP is particularly suitable for defining priorities in maintenance.

APPLICATION OF AHP FOR DEFINING PRIORITIES IN BUILDING MAINTENANCE – CASE

In this paper the AHP is used for setting priorities in maintenance of the main administration building of Port of Ploče which is located on the East coast of the Adriatic Sea and sheltered by Peljesac peninsula.

Structure of the model

The structure consists of several levels. The goal is the highest level on the hierarchical scale. Then follow the criteria, sub-criteria and activities.

The *goal* is the prioritisation in maintenance work of the administration building in Ploce.

To define priorities in planned building maintenance, decision makers have to analyze the condition of the building from various aspects. Different aspects this gives criteria that are weighted and evaluated in order to define maintenance priorities. A larger number of criteria gives a larger weight to the decision made. The authors Spedding and Holmes (1995) offered several major criteria.

These criteria are used in this example. They are as follows:

Criteria:

1. Status of structure
2. Physical Condition
3. Importance for usage
4. Impact on users
5. Impact on structure

Activities are works that are intended to be executed as part of the maintenance of the structure.

The activities are (Marevic, 2008):

- Repair facade
- Repair roof
- Repair gutters
- Repair walls and ceilings
- Repair floors in halls
- Replace lighting conductor
- Replace radiators
- Replace shutters
- Replace window boards
- Replace dilapidated carpentry, windows and doors
- Replace window sill
- Replace ceramic tiles
- Replace dilapidated sanitary fitting appliance
- Repair pergola
- Repair hanging ceilings
- Repair rack

Comparison Matrix formation

The most important and most sensitive step in the maintenance prioritisation model is the formation of comparison matrices. This is also the only subjective step and depends upon the expertise, experience and personal priorities that are defined by the decision maker. For each level, mutual comparison and valuation of elements at this level is to be executed in relation to each element at a higher level. requires to be executed in order to quantify this concurrent valuation. Saaty has proposed one such standardisation (see Shen, 1998).

Criteria comparison with respect to goal

Considering the determined goal, a series of judgements is made to compare the significance or weight value of each set criteria to the others. The comparison can be made in four different ways: verbally, graphically, by matrix and with questionnaire. The software will standardise each judgement, regardless of the input method, to the norms suggested by Saaty.

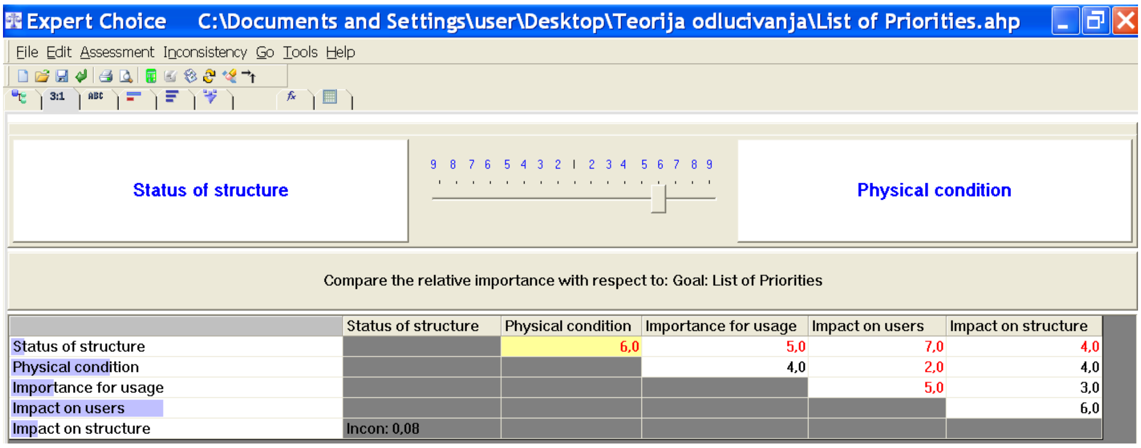
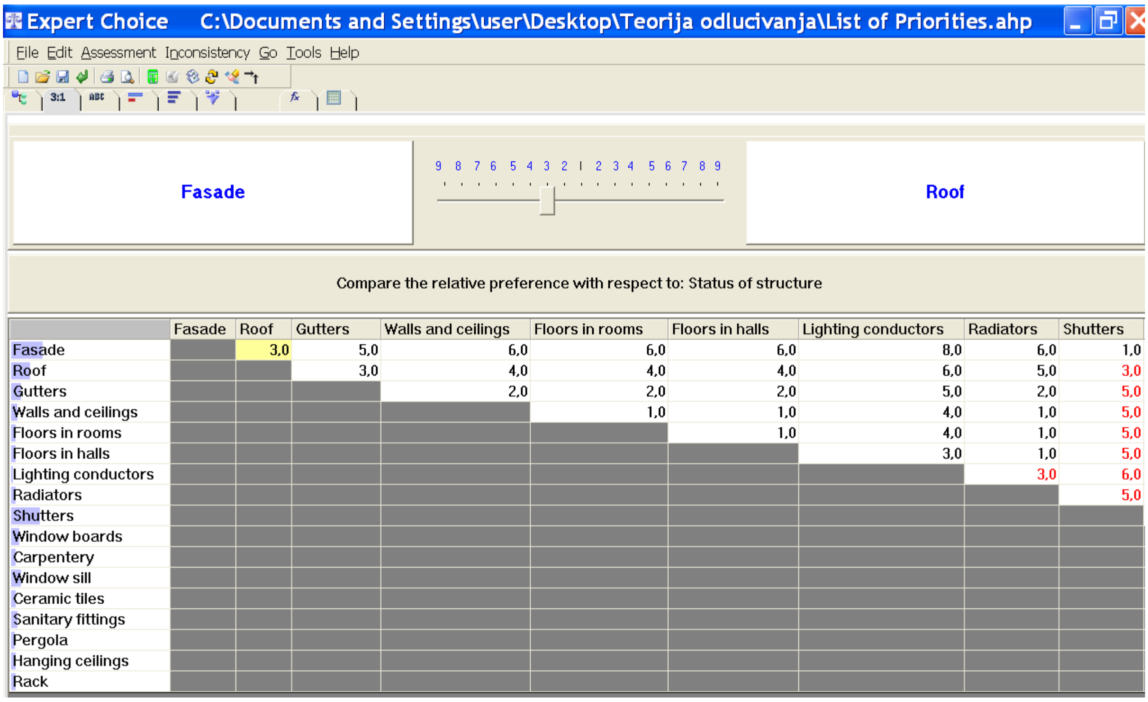


Figure 2. Matrix criteria comparison method with respect to goal

Figure 2. shows the matrix comparison method of *Status of structure* and *Physical conditions* criteria relative to the determined goal. All the criteria comparisons are formed by the direct input into comparison matrix with respect to the previously determined goal. In case when inconsistent determination occurs, the option [Best Fit] indicates inconsistent judgements and suggests corrections. In this example it is concluded that the *Status of structure* is sex times more important than the *Physical Condition*.

Activities comparison with respect to criteria

Considering each of the criteria, a series of judgements is made to compare the significance or weight value of each set activity to the others. Here, the comparison can be made also in four different ways: verbally, graphically, by matrix and with questionnaire.



	Fasade	Roof	Gutters	Walls and ceilings	Floors in rooms	Floors in halls	Lighting conductors	Radiators	Shutters
Fasade		3,0	5,0	6,0	6,0	6,0	8,0	6,0	1,0
Roof			3,0	4,0	4,0	4,0	6,0	5,0	3,0
Gutters				2,0	2,0	2,0	5,0	2,0	5,0
Walls and ceilings					1,0	1,0	4,0	1,0	5,0
Floors in rooms						1,0	4,0	1,0	5,0
Floors in halls							3,0	1,0	5,0
Lighting conductors								3,0	6,0
Radiators									5,0
Shutters									
Window boards									
Carpentery									
Window sill									
Ceramic tiles									
Sanitary fittings									
Pergola									
Hanging ceilings									
Rack									

Figure 3. Matrix of activity comparison method with respect to criteria

Figure 3. shows the matrix comparison method of activity *Façade* (Renovation of the façade and interior plaster) and *Roof* (Replacement of trussed rafter roof structure) with respect to *Status of structure*. Comparisons of all the activities are formed by the direct input into the comparison matrix with respect to the set criteria. In case when inconsistent determination occurs, the option [Best Fit] indicates inconsistent judgements and suggests corrections. In this example it is concluded that *Façade* is three times as important as *Roof* with respect to *Status of structure*.

Synthesis of comparison results and establishing the priorities

The data input into the software is completed when all comparisons on all the hierarchic levels are input. The software then calculates relative significance of all the criteria with respect to the goal, activities with respect to criteria, and activities with respect to goal, and shows the appropriate consistency coefficients for each level of decision making. In case when the consistency coefficient is greater than 0.1, it is necessary to repeat the comparison process to achieve the adequate consistency. Relative importance of the activity with respect to the goal is, at the same time, a list of maintenance priorities.

Figure 4. shows relative activity significance with respect to the goal. It shows the list of all the activities, diagram of analysis results, and consistency coefficient. The synthesis of the results shown here also represents a list of maintenance priorities. It is obvious that the biggest maintenance priority should be assigned to the reconstruction of the façade and internal plaster, and the lowest priority assigned to the replacement of central heating installation.

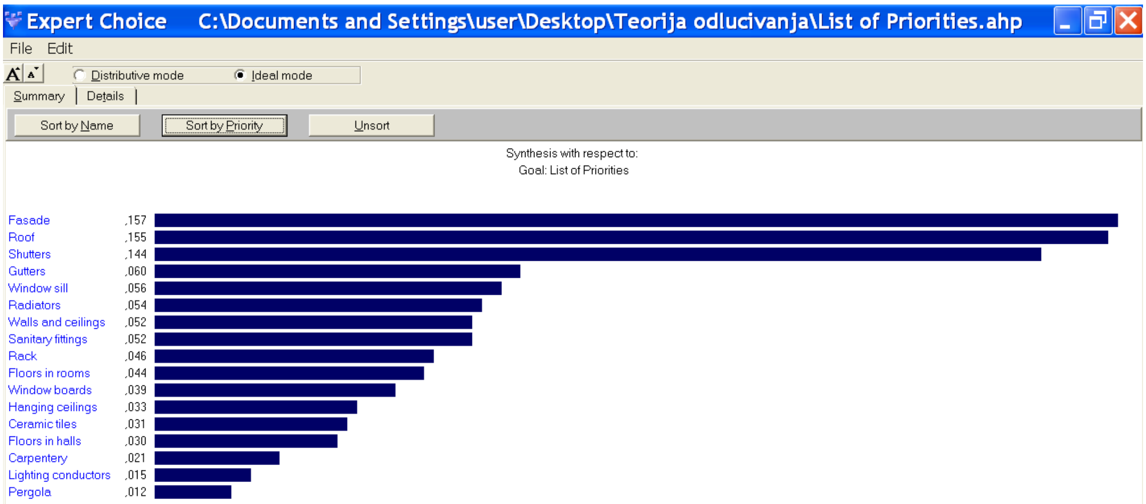


Figure 4. Relative weight of activities with respect to goal – list of maintenance priorities

CONCLUSION

Building maintenance play very important role in whole life- cycle of the buildings and should be considered in the context if the entire building process.

Planning of maintenance works and their funding, should be done during the building design phase.

The decision making process on the maintenance priorities is a base for an efficient and rational building management. Setting the priorities in the building maintenance should enable the prolonged life of a building, avoiding the situation where certain works must be undertaken inevitably and immediately.

Analytical hierarchical process is a mathematical model for decision makers and help them to organise the information and obtain all the information relevant for decision making process. In this paper the AHP is used for setting priorities in building maintenance.

The Expert Choice computer programme called Advanced Decision Support Software, ECPro ver. 11.0 of Expert Choice, inc. Pittsburgh, Pennsylvania, USA developed within the AHP mathematical model was support for structuring model for Port of Ploče and calculating all relevant parameters in order to get the priority list of maintenance work.

The results of application shows that AHP is a very good tool and applicable for setting priorities in building maintenance and can be applied widely, not only for commercial or residential buildings, but also for infrastructure projects.

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BUILDING CROSS-CULTURAL SKILLS – CROATIA CASE

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Abstract

In 1991 Croatia changed political and economic environment and like many other new independent Eastern European countries strives to implement a full market oriented economy.
At present time, very high level of investment in infrastructure projects in Croatia caused very favourable environment for construction companies. Foreign companies such as Bechtel, Strabag, Astaldi, Spie Batignolles, Bouygues and Kajima are being involved in construction projects in Croatia. There are some differences in the way organisations are structured within the different business culture. Management practices vary throughout the world. Therefore, there are differences between employees in one country and another despite their similar jobs in companies.
Interviews were conducted with the Croatian consultants who were hired as local consultants and the managers of foreign companies that are present in Croatia. This article shows the preliminary results of the research which refers to the experience of the Croatian companies working with foreign companies and vice versa.

Keywords: Culture, Organisation, Construction companies, Croatia

SAŽETAK:

1991. godine Hrvatska je promijenila političko i ekonomsko okruženje, te se kao mnoge novonastale države Istočne Europe orijentira na tržišnu ekonomiju. Trenutno se u Hrvatskoj dosta investira u infrastrukturne objekte i Hrvatska je kao takva privlačna stranim tvrtkama koje se žele uključiti u poslove vezane na građevinarstvo. Strane tvrtke kao što su Bechtel, Strabag, Astaldi, Spie Batignolles, Bouygues i Kajima su već prisutne na hrvatskom tržištu. Struktura organizacije tvrtki kao i organizacijske kulture su različite kako ovih tvrtki međusobno, tako i u poređenju s hrvatskim građevinskim tvrtkama. Menadžment tvrtki je različit i stoga postoje razlike među zaposlenicima tvrtki iako obavljaju slične ili iste poslove.
Članak prikazuje preliminarne rezultate intrvjua o iskustvima domaćih konzulatanta i stranih menadžera involviranim u zajedničke projekte u Hrvatskoj.

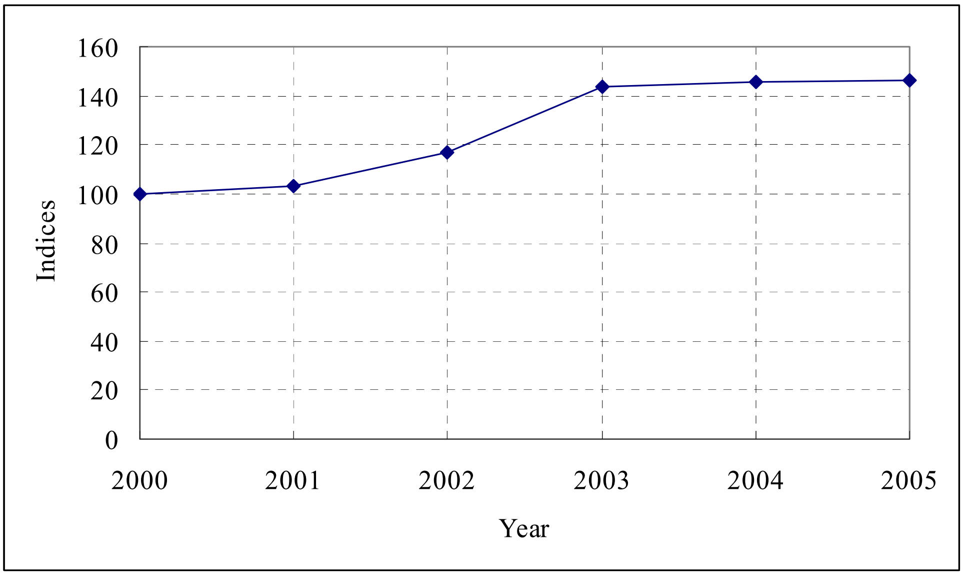
Ključne riječi: Kultura, Organizacija, Gradjevinske tvrtke, Hrvatska

(

INTRODUCTION

In 1991 Croatia changed political and economic environment. One of the results of such a change was that Croatia became an open market like many other Eastern European countries. Mostly the Croatian construction firms were owned by the state in the former socialist system and they got their business opportunities with little or no competition, whereas nowadays they have to compete against not only themselves but also against the foreign companies breaking onto the local market.

In 2004, the total number of workforce employed in the construction sector was 115 142 which makes about 10% of the entire number of employees in the Republic of Croatia. The building sector makes about 12 % of the total Croatian GDP. Statistics shows that there are no unemployed civil engineers. Construction work in 2005 compared to 2004 has increased 17.1% and in 2004 compared with 2003 increased 4.4%. The index rates of construction work show a constant growth. It can be said that the construction sector in Croatia at the moment experiencing its „golden period“ (see Graph 1).



Graph 1: Index rates of construction work (Croatian Central bureau of statistics, 2005)

By analyzing the structure of investment in construction work for the past ten years it is evident that two types of investments are predominant. One investment refers to the reconstruction of housing buildings that were devastated during the war and the second dominant investment regards investment in the infrastructure. Road construction is of special importance in the Republic of Croatia because of tourism, which is one of the main industrial branches. The government has decided to invest large capital in the construction of highways in order to properly connect the northern part of the country with its southern part. Croatia also has a significant geographical position because it forms the link between the East and the West.

AN OVERVIEW OF CROATIAN CONSTRUCTION MARKET

At present time, very high level of investment in infrastructure in Croatia caused very favourable environment for construction companies. There is a constant growth of the percentage of financial investing into highways and roads with regards to other construction work (see Table 1).

Year	Highways and roads [%]
1998	29.4
1999	37.8
2000	39.6
2001	41.1
2002	47.6
2003	51.3
2004	54.8

Table 1: A percentage of total investing into highways and roads (Croatian Central bureau of statistics, 2005)

The World Bank and the European Bank for Reconstruction and Development played and important role in providing financial support for infrastructure projects in Croatia. These institutions believe that the development of a region is the result of the development of the infrastructure (Kramer 2006) and therefore they supported Croatia strategic plans of infrastructure development. According to the information from 2001, the World Bank had until then financed 26 projects in the Republic of Croatia of which 62% of the total amount of financial support went towards the financing of infrastructure projects.

The expansion of construction work made Croatia an appealing market for foreign construction companies and they have already deeply penetrated into the Croatian market. Globalization is not exclusively a multi- national or big firm issue. Very few companies, even small to medium-sized enterprises (SMEs) and micro-firms, remain immune to the impacts of globalization-they may face competition from overseas competitors, may be involved in world-wide supply chains and/or are looking to expand their own market place internationally (Winch *et al.*,2006).

Foreign construction companies like Spie Batignolles, Bouygues, Strabag, Astaldi were involved in construction projects in Croatia. Among these European companies on the Croatian market there was also a joint venture of the U.S. contracting giant Bechtel Group Inc. and Turkish heavyweight Enka construction & Industry Co. Inc., and also the Japanese company Kajima. The arrival of foreign companies encourages the development of local companies and investment in their business knowledge for the purpose of creating better competition in realizing business opportunities. In general, partners [joint ventures] offer strategic benefits like new technologies, stable international finance, local market expertise, and availability of human resources (Elshamawi, 1998)

Mostly foreign companies were involved in the infrastructure projects and got their business contracts through international tenders. They hired domestic consultants and developed close business relationship working on a number of projects. Culture affects the way that people make decisions, think, feel and act in response to the opportunities and threats affecting the organization. (Thompson, 1993).

Because of the presence of so many foreign companies on the local market, which is another novelty in the Croatian construction sector, it was interesting to find out how the domestic consultants and companies were dealing in this new environment.

INTERVIEW SURVEY

Interviews were conducted with the Croatian consultants who were hired as local consultants and the managers of foreign companies that are present in Croatia. A total of 20 experts were interviewed. They were asked to stress the most important issues from their perspectives about working environment.

This is an exploatary research which is a type of research that is performed to "explore" survey participant response to the survey topic. Exploratory research is typically performed when the researcher does not have a hypothesis or does not have specific assumptions concerning the survey problem.

The preliminary results of the research which refers to the experience of the Croatian companies working with foreign companies and vice versa are as follows:

A: The main characteristics of the new business environment from the perspective of the Croatian consultants who were interviewed can be grouped as follows:

1. Differences in business communication

This problem does not refer to the language barrier, but rather to the ways of holding meetings. It has been observed that foreign representatives strictly adhere to the procedures, which are in most cases a part of the organizational structure of the company that they represent. They are more or less acting by the „handbook". This especially refers to American and British companies.

The Croatian companies do not have this type of „handbook"and rely mostly on improvisation when dealing with problems.

The representatives of foreign companies are more aware of the time factor than the local ones; therefore they arrive to meetings fully prepared and with the intention of achieving the set goals as fast as possible.

When working with a Japanese company it was recorded that a lot of time was wasted due to constant consultations with the head office in Japan.

2. Prejudice of foreign companies towards local Croatian companies

According to the interviews, there is some prejudice towards the knowledge of local companies. Croatian teams need a certain time period to demonstrate that they have good know-how knowledge and international experience. It was recorded in many cases that foreign companies do not send their good teams and the reason for this is again prejudice which causes problems because the lack of technical knowledge from the other side soon becomes apparent.

3. Transfer of knowledge and technology

Croatian consultants claim that working with foreign representatives brings new experience and knowledge about project management, construction law and human resources training.

It is often brought up the fact that the foreign representatives adhere strictly to the written procedures or steps in carrying out each task and believe that we should adopt this type of approach to project management.

4. Difference in adhering health and safety regulations

Problems occur because foreign companies adhere to health and safety regulations more than the local ones. It was recorded that the construction companies that come to Croatia are more sensitive to this issue. They often have their own internal health and safety regulations and they intend to implement them.

5. Business relationships

Business relationships in Croatia are more focused on long-term and on personal relationships than in foreign companies that have a tendency to focus on the profit and «the bottom line».

6. Decision making and risk taking

Foreign companies are ready to take risks more than Croatian ones, but mostly in cases when they are almost certain to realize an even greater profit. The decisions are brought on a hierarchical principle, which is similar to the principle in Croatia. There is a slight noticeable difference when dealing with Americans because they have greater decision making authority but also bigger responsibilities if they make the wrong decision.

7. Behavioral culture

In Croatia it is customary that the business relationships are also formed after the meeting, during lunches and dinners where conversations take place which do not have to be directly involved with business. Unlike the Croatians, those who were interviewed said that the relationship of the foreigners is less personal and often only involves business.

B: The main characteristics of the Croatian business environment from the perspective of the foreign representatives who were interviewed are the following:

1. Knowledge

Foreign representatives were surprised by the knowledge and experience of the local consultants. They did not expect that they would be working in this part of the world with people who are well educated, have vast experience in both their own country and abroad.

2. Skill and ability of Croatian construction sector

US construction officials applaud their Croatian counterparts for skill and ability: “One of the best kept secrets in this part of the world is the Croatian construction industry“- the State Dept. Project executive said while he was working at the US

Embassy in Zagreb: “I am impressed by the quality of the product that the local manufacturers are producing.

3. Impact of political changes to the construction project

Foreign representatives are more displeased by the influence of the political changes on the projects. They believe that there is a risk that if the government should change then in most cases changes in the contracts also occurs.

4. Bureaucracy

Foreign representatives stress the problem with the beaurocratic system but also the problem with the Croatian regulations.

5. Health and safety regulations

Foreign representatives mention the problem of very bad work safety. «Teaching safety is challenging», says one official from Bechtel. «The Croats have no history of safety.... We had to build safety into two cultures where it was nonexistent. »

6. Inefficiency

Inefficiency and unnecessary waste of time are another characteristic of Croatians, is what those who were interviewed said, but they believe this is due to the influence of the Mediterranean culture.

CONCLUSION

In the past ten years the Croatian government has invested a lot in construction, especially in the infrastructure projects that have an indirect influence on the development of tourism, which is one of the strategic branches of industry. When Croatia became independent, like many other eastern European countries it wanted to open up its market. This led to the influx of foreign capital into the country and the presence of foreign construction companies, which have already deeply, penetrate into the construction sector. Croatian construction sector is faced with cultural differences. The formation of multicultural teams is important for this part of Europe and this is something that the TRADE network does, which helps increase the cooperation of local and foreign companies. The TRADE Network is a regional cluster (network) of 26 non-profit business consultants in Bulgaria, Croatia, Hungary and Romania that provide expert business advice or training to SMEs in Southeast Europe.

Today foreign construction companies work together with local companies, which results in the multicultural factor which significantly influences the success factor of the project. The foreign companies hire local companies as sub-contractors of the project and local consultants. It is necessary to learn about the differences and similarities in the ways of handling business of different cultures that are nowadays present on the Croatian market.

This research was carried out in order to improve in the future the cross-cultural skills and increase the efficiency in local companies working with foreign companies. Local and foreign managers were interviewed and the preliminary results of the research were presented. The Croatians mostly answered about the communication, prejudice of foreign representatives towards the knowledge and experience of local companies, short-term business relationships of foreign companies, the differences in implementing health and safety regulations. The results of the interviews with the managers of foreign companies show that they are surprised by the knowledge and experience of domestic managers, unsatisfied with the influence of political changes on the contracts, they are not familiar with our regulations and are unsatisfied with so much bureaucracy in the country. They emphasize the problem of not adhering to the health and safety regulations.

This article shows the preliminary results of the research. The research shall be continued further by collecting and processing the information with the intention of passing on this information to all interested sides of both local and foreign companies already present in Croatia and those planning to come here. In the Croatian investment and development strategy of infrastructure projects the plan is to build another 700 km of new roads until the year 2011 but this also includes other investments in the construction sector; therefore there will definitely be potential companies who wish to make a profit. A lot of competition between local and foreign companies and working in a multicultural environment will help Croatian companies find their place better on foreign markets in the future. Therefore, this research might be useful for both side.

Acknowledgement:
Many thanks to all managers from Croatian and foreign companies present in Croatia who were interviewed and help the authors to conduct this research. Our gratitude also goes to the Ministry of Science of the Republic of Croatia who sponsored the project "Human resource management in Croatian Construction companies".

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METHODS IN THE DECISION-MAKING PROCESS OF OPTIMAL CONSTRUCTION PLANNING

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Abstract

In this paper formulation of problems has been presented and overview of methods and tools that support decision-making in the process of construction structures optimization has been given as well. The theory of decision-making in economies, politics, business and management, were established long time ago, but in construction industry decision-making is mainly connected with subjective evaluation. Taking into consideration that optimal design and construction are required in modern construction industry, often through more simultaneous parameters, a comprehensive preliminary analysis is needed for decision-making, i.e. for final determination of optimal solution. However, it is possible to incorporate the influence of designers' decisions while planning a model of decision-making. Such a model should persevere with impacts of time and costs of design, time and costs of erection and construction, with possibilities of making errors and corrections, costs of transportation, control and safety obtaining, as well as with estimated risk from mistakes and injuries at work.

Keywords: building constructions, optimization, decision-making, decision analysis, theory of decision-making

1. GENERAL ISSUES

Theories of decision-making were established in various aspects of economies, politics, business and management long time ago. Within the framework of jobs related to construction industry and civil engineering, project procedures are clearly defined, but during these procedures a lot of decisions should be made. Every construction should be: cheap, relatively rapidly built, qualitative, durable, functional, fitted into the environment in satisfactory ecological frameworks and certainly not monotonous. These problems are usually unique in their nature. However, through detailed analysis of a construction and its elements it is possible to create a conceptual framework for planning that is adjusted to the real state of our construction industry to make a successful building feasible.

Nowadays, when there are databases with all the data about earlier occurrences and realized structures, it happens that current conditions of the environment are not similar enough to be able to determine the probability of an occurrence. Also, conditions of the environment are so changeable that very quickly some of the data become inoperable. Continued research in these areas is needed as well as systematic collection of data, on which the optimization process is based. Therefore, while making decisions, the participants in a project often depend on subjective judgment.

Moreover, these problems can be included in the frameworks of some mathematical models subject to the axioms of probability theory and, more often, to the axioms of possibility theory. A process of optimal design should involve several stages: researching the subject of optimization, mathematical modeling of the problem, optimization process and implementation of optimal solution. Thus, firstly material and time saving is attained; secondly, energy saving during the production, fabrication and exploitation as well as saving of structure realization costs are accomplished. Furthermore, not only environment protection effects, but also protection and safety from construction failure are achieved.

It should be pointed out that costs of structure construction do not signify that optimal solution regarding this issue has been attained. Also, the process should always involve further maintenance costs including costs of possible repairs, as well as possible costs of demolition and perhaps displacement to some other location when speaking about constructions made of steel, wood or some other modern materials for dry construction. If the initial costs of a structure are low and maintenance costs high, it can be considered that the construction is not most economically designed. From an economic point of view, the ideal objective of structure cost optimization should be minimization of total costs during the construction life cycle.

Optimization of construction projects, in the terms of used materials adjustment to real needs for building, exploitation and possible utilization of a carrying construction after the need for structure has ceased, is certainly the way towards the improvement of contemporary construction industry.

Total construction costs are affected not only by technical and environment factors, but certainly by momentary market conditions. Costs of material, energy, maintenance and other costs must be anticipated at the very beginning of the project aimed at accomplishing a well designed construction that complied requirements of all participants in it. Various direct parameters, such as speed of building, selection of the foundation method, costs related to the natural control of structure interior (heating, ventilation, lighting), benefit or money refund from investment also participate in cumulative costs. There are also indirect parameters, such as local and global effects, local economy, use of natural resources and energy substances… The life of a structure is usually longer than expected, so that a construction should be prepared for the possible function re-purpose without disproportional cost increasing.

Method of building is also an essential factor in total cost analysis. Sometimes it is necessary to invest more in modernization of auxiliary scaffolding, tools and machines. On a more detailed level, standardization can lead to significant savings, especially at joint facilities of steel constructions, although it appears to be a loss, a “wastage” of material. It is also necessary to work out all the details during design, because a special elaboration of these details at the site can be more expensive and less elegant.

Several main factors that significantly affect costs of life cycle of a construction can be identified. They are:

a. costs of construction elements production
b. transportation costs
c. costs of elements built–in technology
d. the geographic location of the project site
e. purpose of a construction
f. the anticipated life of the structure
g. the discount rate of the currency
h. the use of the structure
i. significance of a construction

Structural designers usually do not have control over all factors that reduce the life cycle costs of a structure. Furthermore, additional burdens can occur in cost optimization of constructions while defining cost functions related to imprecision, fuzziness and uncertainty in determining cost parameters. Therefore, the formulation of cost function and the resultant solutions have been complicated [1].

2. GRAPHIC REPRESENTATION

Models of decision-making are usually graphically presented through algorithms. An algorithm in the form of decision tree [7] represents detailed structure in which, from the left to the right, different possible scenarios or decision steps are shown as branches. Influence diagrams [5] define general structure and models and present variables and their interdependence.

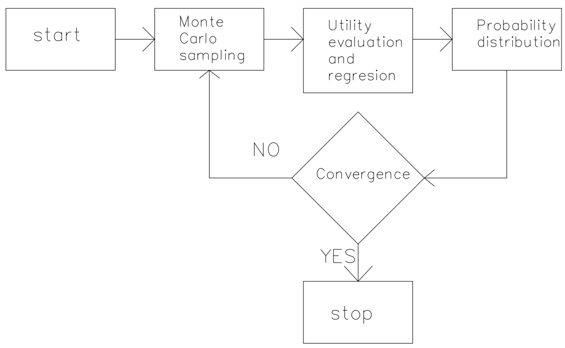

Figure 1 An example of an algorithm for problem solving

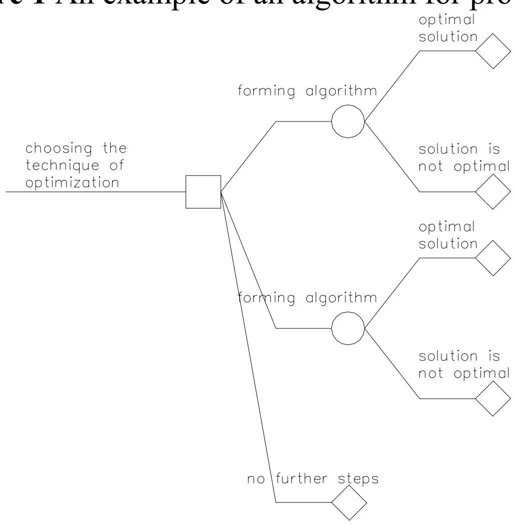

Figure 2 An example of a decision tree for problem solving

Although these two concepts of problems are easy, clear and detailed, problem arises when there are a lot of variables, i.e. a lot of decisions. In addition, all variables must be treated as discrete, even if they are continual.

3. EXPECTED VALUE

The expected value is a standard measure for the selection of the desired alternative in decision-making, including uncertainty in the process of decision-making. The expected value for an alternative *i* can be presented as follows [3]:

$$OV(i) = \sum_{i} P(j)\, O(i,j) \quad \text{and} \quad \sum_{i} P(j)=1 \qquad (1)$$

where P(j) is the independent probability of state *j*, and O(i,j) is the outcome state *j* for an alternative *i*.

The expected value can be presented as an average value that will result if a process is repeated several times.

4. UTILITY THEORY

According to this theory, utility is a measure of "desirability of consequences of courses of action under uncertain conditions" [6]. The main assumption is that decision-maker always chooses the alternative for which utility is maximized. To determine expected profit, the utility has to be assigned to every possible consequence of each alternative. Utility theory has been mathematically formulated even in the paper of Newmann and Morgenstern *"Theory of Games and Economic Behavior"* [8]. In their paper they present a set of necessary and sufficient axioms, as well as a model to measure utilities on the numeric scale.

This theory has been useful as a fundamental to many other theories, nowadays widely spread in the field of civil engineering as well (Multi-criteria Decision Making, Simple Multi-attribute Rating Techniques,...).

5. VARIANCES

Statistical analyses have also shown some other tools for expected values determination when the conditions of the environment are uncertain. Considering two options with the same expected value, the one with less value has smaller risk. In the case of random variable X, with expected value E[X], variance of X, defined as Var (X), can be expressed as [3]:

$$Var\,(X) = E[X^2] - (E[X])^2 \qquad (2)$$

The standard deviation is simply $\sqrt{(Var\,(X))}$. The variance of the sum for two random variables, X and Y is:

$$Var\,(X+Y) = Var\,(X) + 2Cov\,(X,Y) + Var\,(Y) \qquad (3)$$

where Cov (X, Y) is a product co-variance of variables X and Y. If two variables are independent, then Var(X,Y) =Var(X)+Var(Y).

The equation for standard deviation of the product of two independent variables X and Y is:

$$\sigma_{xy} = E[X]^2\sigma^2{}_y + E[Y]^2\sigma^2{}_X + \sigma^2{}_X\,\sigma^2{}_y \qquad (4)$$

The above-mentioned terms for sums and products of random variables can be used to create stochastic models for decision-making. For example, a bond of bolts with a steel element has the bolt with diameter A and teh hole with diameter B. The distance C between diameters is B-A. It is assumed that product dimensions of the bolt are random variables with normal distribution. The risk that the bolt will not fit the hole can be computed from the probability distribution for the variable C using the above-mentioned terms. For such simple stochastic models direct analytical method of stochastic analysis can be implemented. As the models become more complex, non-linear functions of dependence or similar ones are introduced and direct analytical methods soon become impossible. In such situations the desired approach is a simulation.

6. SIMULATION

Monte Carlo simulation is a numeric method for the solution of mathematical problems using random numbers. The method is ideal for problems including uncertainty factor, a large number of variables, or for the problems that cannot be solved analytically. However, due to many sources of uncertainty, which are inherent in structural design, there is the risk of unacceptable performance for structures, which is called failure. Monte Carlo simulation is the method of a sample, because inputs are randomly generated from the probability of distribution to simulate the process of taking sample from the current population. Simulation is an iterative process where taking samples is repeated until statistically significant distribution is achieved. In the case of the bolt defined in the previous chapter, Monte Carlo simulation can be used for value selection from probability distributions that define diameters of a bolt and a hole. Deviation is then computed for each pair of dimensions leading the distribution to clearly defined values. Simulation Monte Carlo requires relatively large number of models, so it is much more convenient for work on personal computers.

7. OPTIMIZATION

Numerous analytical and numerical techniques make it feasible to determine optimal joining of resources for minimal or maximal values of some aspects of a system. Techniques of optimization can be classified in different ways based on the type of variables and equations used in a mathematical model of the system. Systems can be modeled to be linear or non-linear, continual or discrete, deterministic or stochastic, constrained or not constrained. Techniques of optimization are global or local. The following Table, originally presented in literature [3], and modified by autors, describes optimization methods used in contemporary construction industry.

Table 1: Review of optimization methods

Linear Programming

- Simplex Method
- Revised Simplex Method
- Primal-Dual Simplex Method
- Dual Simplex Method
- Interior Point Methods
- Decomposition Method
- Sensitivity Analysis
- Parametric Programming
- Quadratic Programming

Nonlinear Programming

- Analytical Methods
    - Equality Constraints
        - Lagrange Multiplier Method
    - Inequality Constraints
        - Kuhn-Tucker Conditions
- One-Dimensional Minimization Methods
    - Elimination Methods
    - Unrestricted Search
    - Exhaustive or Simultaneous Search
    - Dichotomous Search
    - Fibonacci Method
    - Golden Section Method
- Interpolation Methods
    - Quadratic Interpolation
    - Cubic Interpolation
    - Newton's Method
    - Quasi-Newton Method
    - Secant Method
- Unconstrained Optimization Methods
    - Direct Methods
        - Random Search Method
        - Grid Search Method
        - Univariate Method
        - Pattern Search Methods
        - Powell's method
            - Hooke-Jeeves' Method
            - Rosenbrock's Method
        - Simplex (Polytope) Method
    - Descent Methods
        - Steepest Descent (Cauchy) Method
        - Fletcher-Reeves Method
        - Newton's Method
        - Marquardt Method
        - Quasi-Newton Methods
            - Davidon-Fletcher-Powell (DFP) Method
            - Broyden-Fletcher-Goldfarb-Shanno (BFGS) Method
- Constrained Optimization Techniques
    - Direct Methods
        - Random Search Methods
        - Heuristic Search Methods
        - Sequential Linear Programming Method
        - Sequential Quadratic Programming Method
        - Methods of Feasible Directions
            - Zoutendijk's Method
            - Rosen's Gradient Projection Method
        - Generalized Reduced Gradient Method
    - Indirect Methods
        - Transformation of Variables

            - Sequential Unconstrained Minimization
                - Interior Penalty Function Methods
                - Exterior Penalty Function Method
                - Exterior Interior Penalty Function Method
                - Penalty Function Method for Parametric Constraints
                - Augmented Lagrange Multiplier Method

Geometric Programming

Dynamic Programming

Integer Programming

- Cutting Plane Method
- Branch and Bound Method
- Balas Method
- Generalized Penalty Function Method
- Sequential Linear Discrete Programming Method

Stochastic Programming

Separable Programming

Multiobjective (Multicriteria, Multiparameter, Vector) Optimization

- Pareto Optimum Solution
    - Sequential optimization method
    - Linear weighting method
    - Min-max procedure
    - Constrained method
    - Compromise programming
    - Goal programming
    - Goal Attainment
    - The ξ-Constraint Method
    - Multi-attribute utility method
    - Contact Theorem
- Utility Function Method
- Global Criterion Method
- Lexicographic Method
- Goal Programming Method

Global Optimization

- Exact Methods
    - Naive Approaches
    - Enumerative Search Strategies
    - Homotopy (Parameter Continuation), Trajectory Methods, and Related Approaches
    - Successive Approximation (Relaxation) Methods
    - Branch and Bound Algorithms
    - Bayesian Search Algorithms
    - Adaptive Stochastic Search Algorithms
    - Interval Analysis Methods
- Heuristic Methods
    - Global Extensions of Local Search Methods
    - Monte Carlo Simulation
    - Collective Intelligence
    - Genetic Algorithms (GA)
        - GA with penalty function method for constraints
        - GA with the Augmented Lagrangian Method
        - Vector Evaluated Genetic Algorithm (VEGA)
        - Non-Generational Genetic Algorithm
        - Randomly Generated Weights and Elitism
        - Non-Dominated Sorting Genetic Algorithn
        - Niched Pareto GA
        - Gray coding
    - Evolutionary Strategies
    - Evolutionary Programming
    - Evolutionary Algorithms
        - Rank-Based Evolutionary Algorithm

o Simulated Annealing o Neural-Network-Based Methods o Fuzzy Systems o Rough sets o Tabu Search o Scatter Search o Approximate Convex Global Underestimation o Continuation Methods o Sequential Improvement of Local Optima o Parallel Computing
Meta-Heuristic Methods o Ant Colony Optimization o Artificial Intelligence

Some methods and techniques can be successfully combined with the aim to obtain better solutions by one or more optimization criteria (e.g. fuzzy genetic algorithms, etc.). Sometimes optimization is first carried out by one of the above-mentioned methods, and then the obtained solution/solutions is/are further optimized implementing some other methods.

8. FORECASTING

The forecasting is also an important activity for certain projects in virtual analyses. Tools of statistical analysis such as regression analysis and correlation models are used for historical data analysis to predict the forthcoming events.

9. CONCLUSION

Considering that optimal design and performing is required in contemporary construction industry, often through implementation of more simultaneous parameters or subjects of optimization, extensive preliminary analysis is needed for decision-making, i.e. for final determination of optimal solution. There is a great number of software on the market, from those that are complimentary, to large and protected ones, specially made for big companies that easily solve the problems of decision-making, simulation, or optimization. These software programs are composed of some of the methods mentioned in Table 1.

10. LITERATURE REVIEW

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LONGEST PATH PROBLEM IN NETWORKS WITH LOOPS AND TIME DEPENDENT EDGE LENGTHS

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Abstract

There are many generalizations of project scheduling in several fields of applications. One of these researching directions is applying time dependent edge lengths. In this case durations on edges can change according to its departure time. Most of papers present solution for logistic [1,2], telecommunication [3] or evacuate [4] models, which are shortest path problem. Moreover critical path scheduling is very important in construction management too, as it give the opportunity to using calendar. In this paper I demonstrate a solution for longest path problem in networks with loops and time dependent edge lengths. The algorithm is presented by an example at the end of the paper.

Keywords: time dependent edge length, critical path scheduling

Introduction

We often use networks for modelling projects. Nodes of the network represent occurrence, arcs represent real or virtual activities and connections. In engineering practice the activity times are not fixed, regularly depend on their departure time. Activity times depended on departure times creates a sequence. It is a natural assumption if the activity starts later then it cannot be finished earlier. For example if it starts on Monday and finishes on Friday then in case of starting Tuesday it should not finishes before Friday.

In networks we distinguish minimal and maximal limits for duration of activities. In case of the first one the arc directed to the node which occurs later and the activity time is positive. In case of the other one these properties are just the opposite of the first one.

There is an example on Figure 1. *A* is the start node and *B* the finish node. Between them the different can be minimum 5 and maximum 7 time units.

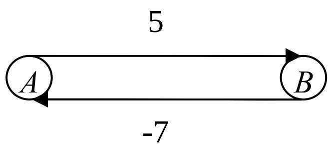

Figure 1

Using the maximal assumption we can create loops in the network. More such assumptions can create more loops with each other too. We do not constrain the possibility of this.

Our aim is to find the earliest lead time of the schedule in case of any starting time.

Model

Denote *[N,A]* a directed graph where *N* is a set of nodes and *A* is a set of arcs. There is only one starting node *s* and one end node *t* in it. Arcs are directed only outwards from *s*. Directed graph contains no parallel arcs and there is a path in the network from node *s* to node *t* by way of every other node in the network.
On the arcs of the digraph define $\tau_{ij}(\mu_i)$ $ij \in A$ discrete function. There are only integers in it. Its argument is the departure time of starting node of the arc. We assume that

$$\tau_{ij}(\mu_i + \delta) \geq \tau_{ij}(\mu_i) - \delta \quad \forall ij \in A, \delta \in N \tag{1}$$

The network defined in this way denote Time Dependent Scheduling (TDS) and indicate it *[N,A,τ(μ)]*.
If every $ij \in A$ $\tau_{ij}(\mu_i)$would be constant, then it were the same task like in [5].

The aim to find a μ - system, where the potential of *t* is the shortest while the potential of *s* is arbitrary and

$$\tau_{ij}(\mu_i) \leq \mu_j - \mu_i \quad \forall ij \in A \tag{2}$$

Primal problem. Given *[N,A, τ(μ)]* digraph. We look for μ_i, $\forall i \in N$, where it is true that

- *(2) true*
- $\mu_i \geq 0 \quad \forall i \in N$
- *and* $\mu_t \rightarrow$ *minimal.*

We can assign a dual task to this.

Dual problem. Given *[N,A, τ(μ)]* digraph. We look for a y- system, where y_{ij} integer for $\forall ij \in A$ and it is true that

- *if* $s \in N \qquad -\sum_{sj\in A} y_{sj} + \sum_{is\in A} y_{is} \leq -1$
- *if* $k \in N \setminus \{s,t\} \quad -\sum_{kj\in A} y_{kj} + \sum_{ik\in A} y_{ik} \leq 0$
- *if* $t \in N \qquad -\sum_{tj\in A} y_{tj} + \sum_{it\in A} y_{it} \leq 1$
- $y_{ij} \geq 0 \quad \forall ij \in A$
- *and* $\sum_{ij\in A} y_{ij} * \tau_{ij}(\mu_i) \rightarrow$ *maximal*

1. Remark. We can recognize the conditions of the maximal flow problem. After that y is a flow unit from *s* to *t*, so

$$y_{ij} = \begin{cases} 1, \text{ if } ij \in P(s,t) \in A \\ 0 \text{ otherwise} \end{cases}$$

, where $P(s,t) = \{s = x_0, \ldots, x_m = t\}$ a path from *s* to *t*

Consequently the arcs where $y_{ij} = 1$constitute a path from *s* to *t*. We can use another form.

$$\sum_{ij \in A} y_{ij} * \tau_{ij}(\mu_i) = \sum_{ij \in P} \tau_{ij}(\mu_i)$$

Indicate it $\tau(P(s,t))$ hereafter. So the goal function's form of the dual task:

$$\tau(P(s,t)) = \sum_{ij \in P} \tau_{ij}(\mu_i) \rightarrow maximal$$

The connection between the primal and dual task is defined in the next lemma.

1. LEMMA (BASIC LEMMA). Let be $\mu_k, \forall k \in N$ the length of any path from *s* to *k*. In his case $\mu_k - \mu_s, \forall k \in N$ is the longest path from *s* to k only if (2) true.

Proof

The proof is done in two sections like at the original task in [5].

1. If (2) is true then $\mu_k - \mu_s, \forall k \in N$ is the longest path from *s* to *k*.

Let be

$$\tau(P(s,k))$$

the length of any path from *s* to *k*.

Convert the form into summation and apply (2)

$$\tau(P(s,k)) = \sum_{ij \in P} \tau_{ij}(\mu_i) \le \sum_{ij \in P} (\mu_j - \mu_i)$$

By solving the summation the potentials drop out in couples.

$$\tau(P(s,k)) \le (\mu_{x_1} - \mu_s) + (\mu_{x_2} - \mu_{x_1}) + \ldots + (\mu_{k-1} - \mu_{k-2}) + (\mu_k - \mu_{k-1}) = \mu_k - \mu_s$$

Finally remain, that

$$\tau(P(s,k) \le \mu_k - \mu_s .$$

So there are no longer path from *s* to *k* like $\mu_k - \mu_s$. In other words, this is the longest path from *s* to *k*.

2. If $\mu_k - \mu_s, \forall k \in N$ is the longest path from *s* to *k*, then (2) is true.

We are applying indirect proof.

If (2) is not true, we can find a counterexample where $\mu_k - \mu_s$ is not the longest path from *s* to *k*. Look at the next example:

$$(x,y) \in P(s,k) \text{ where } \tau_{xy}(\mu_x) > \mu_y - \mu_x \text{ and}$$

$$\forall ij \in P(s,k) \setminus \{(x,y)\} \; \tau_{ij}(\mu_i) = \mu_j - \mu_i .$$

So there is an arc where (2) is not true, and on every other arc (2) is true by equality.

After transforming like former the length of *P(s,k)* is

$$\tau(P(s,k)) > \mu_k - \mu_s .$$

In this case $\mu_k - \mu_s$ is really not the longest path. Consequently assumption (2) is necessary in deed.

We have finished the proof with this.

As it seems the definitions of primal and dual task and the basic lemma are in analogy with the original task. But the solution based on linear programming is not possible because the variables depend on each other. It becomes an NP hard problem.

Further we examine the effects of loops in a network.

Loops in networks

Denote H a loop in the network where $N_H = \{h_1, h_2, ..., h_i, h_j, ..., h_r\}$ $N_H \subseteq N$ is a set of nodes and $A_H = \{(h_1, h_2);..;(h_i, h_j);..;(h_r, h_1)\}$ $A_H \subseteq A$ is a set of arcs. Let the potentials be $\mu_{h_1}, \mu_{h_2}, ..., \mu_{h_i}, \mu_{h_j}, ..., \mu_{h_r}$ appeared on nodes in order.

Nodes of the loop are also start and/or end nodes of outside arcs of the loop. In the course of calculation these incoming arcs define potentials on some nodes. Denote h_1 the start node of calculation round, selected arbitrary from them. Thanks to the property of loops the potentials of N_H refer to themselves by an indirect way. According to (2) we can define $\mu_{h_1}, \mu_{h_2}, ..., \mu_{h_i}, \mu_{h_j}, ..., \mu_{h_r}$ values. At the end we return to h_1 where we can define a newer (check) potential denoted $\hat{\mu}_{h_1}$. Thus we obtain the loop rate

$$\rho_H = \hat{\mu}_{h_1} - \mu_{h_1}$$

which determines the behaviour of the loop. It is known from the original task, if the loop rate is positive, there is no finite solution of the task. But in case of time dependent edge lengths the loop rate varies according to time activities. So there can be μ - systems where the loop rate is positive, while in other μ - systems it is not so. Because of this it is a reasonable method, if ρ_H is positive, then calculate round again with $\hat{\mu}_{h_1}$ and define a newer check value by the new $\hat{\mu}_{h_1}, \hat{\mu}_{h_2}, ..., \hat{\mu}_{h_i}, \hat{\mu}_{h_j}, ..., \hat{\mu}_{h_r}$ values. Let's take such iterations until the check value is not more as the start one.

This method suggests a question. Whether this iteration can skip such potentials, which would be feasible solution in the loop?

2. LEMMA. In case of any *[N,A,*$\tau(\mu)$*]* digraph the iteration above results the first feasible solution.

Proof

Let $\mu^*_{h_1}$ be any skipped potential, so

$$\mu_{h_1} < \mu^*_{h_1} < \hat{\mu}_{h_1}. \tag{2.1}$$

Further let $\hat{\mu}^*_{h_1}$ be the check potential after counting round with $\mu^*_{h_1}$. If it would be a feasible solution, then it was true that

$$\mu^*_{h_1} \geq \hat{\mu}^*_{h_1} \tag{2.2}$$

The aim of proof is to show that (2.1) and (2.2) cannot be true simultaneously.
Let be the correspondence between the two start potentials

$$\mu^*_{h_1} = \mu_{h_1} + \delta_1 \quad (\delta_1 > 0) \tag{2.3}$$

1. Examine the potentials of h_2 based on (2).

$$\mu_{h_2} \geq \mu_{h_1} + \tau_{h_1 h_2}(\mu_{h_1})$$
$$\mu^*_{h_2} \geq \mu^*_{h_1} + \tau_{h_1 h_2}(\mu^*_{h_1})$$

   Using (2.3) and after(1)

$$\mu^*_{h_2} \geq \mu_{h_1} + \delta_1 + \tau_{h_1 h_2}(\mu_{h_1} + \delta_1) \geq \mu_{h_1} + \tau_{h_1 h_2}(\mu_{h_1}) \tag{2.4}$$

Discussion

1. If

$$\mu_{h_2} = \mu_{h_1} + \tau_{h_1\,h_2}(\mu_{h_1})$$

then according to (2.4)

$$\mu^*_{h_2} \geq \mu_{h_2}$$

2. If

$$\mu_{h_2} > \mu_{h_1} + \tau_{h_1\,h_2}(\mu_{h_1})$$

then there is a $k \in N \setminus N_H$, for which

$$\mu_{h_2} = \mu_k + \tau_{k\,h_2}(\mu_k).$$

It comes from the goal function of primal task and the 1.lemma.

In this case there are two alternatives.

2.1. If

$$\mu^*_{h_1} + \tau_{h_1\,h_2}(\mu^*_{h_1}) \leq \ \mu_k + \tau_{k\,h_2}(\mu_k)$$

then

$$\mu^*_{h_2} = \mu_k + \tau_{k\,h_2}(\mu_k)$$

and

$$\mu^*_{h_2} = \mu_{h_2}$$

2.2. If

$$\mu^*_{h_1} + \tau_{h_1\,h_2}(\mu^*_{h_1}) \geq \ \mu_k + \tau_{k\,h_2}(\mu_k)$$

then

$$\mu^*_{h_2} = \mu^*_{h_1} + \tau_{h_1\,h_2}(\mu^*_{h_1})$$

and

$$\mu^*_{h_2} \geq \mu_{h_2}$$

So in every possible case $\mu^*_{h_2} \geq \mu_{h_2}$relation holds.

This examination can be applied on every node in the loop. Finally we can find out the correspondence between the check potentials on the start node.

$$\hat{\mu}^*_{h_1} \geq \hat{\mu}_{h_1}$$

Contrast it with (2.1).

$$\mu_{h_1} < \mu^*_{h_1} < \hat{\mu}_{h_1} \leq \hat{\mu}^*_{h_1}$$

So in case of the skipped potential

$$\mu^*_{h_1} < \hat{\mu}^*_{h_1}.$$

This relation is just the opposite of the condition (2.2).

With this we have showed that (2.1) and (2.2) cannot be true simultaneously.

This means that this iteration count results the first feasible solution.

We have finished the proof with this.

2. Remark. A special case of the task if the calendar is the same for every activities, so $\tau_{i,j}(\mu_i)$ functions alter in the same way. It results a much more simply problem which can be solved by algorithms in [5,6]

3. Remark. Another special case of the task if there is no loop in the network. In this case the algorithm in [6] is usable.

1. Consequence. There are two possible outcomes of the task:

1. There exists a finite solution. In practice we should define an upper limit for lead time since it cannot be forecasted because of the loops.

2. There is no finite solution, which occurs by an infinite iteration in a loop.

2. Consequence. According to the original task if we would like to count back the network and determine the latest dates of nodes, then we have to convert all the $\tau(\mu)$ functions. In this case they have to be determined by arrival times. At the end of counting back the start potential is not zero certainly.

3. Consequence. In case of iterations in loops if we find a finite solution it may has not critical path in traditionally way like in [7]. By increasing the number of loops the critical path may split in more and more parts. We can identify only critical activities. So we have to extend the definition of critical path.

1. ***Definition.*** Denote Θ_{ij} the waiting time on *(i,j)* arc.

$$\Theta_{ij} = \mu_j - \mu_i - \tau_{ij}(\mu_i)$$

2. ***Definition.*** Critical path is the result of shortest path in which we use the waiting times on arcs.

The algorithm

Input data

[N,A, $\tau(\mu)$*] and* μ_S

Maximal path – minimal potential algorithm

We can use the original algorithm [5] but we have to follow up the changes of values in $\tau_{ij}(\mu_i)$ functions. In this way every μ_i, $\forall i \in N$ can be determined.

Looking for the critical path

By means of μ_i, $\forall i \in N$ and $\tau_{ij}(\mu_i)$ values we can determine the waiting times on arcs. Applying the original shortest path algorithm for them we can find P critical path.

Output

Θ, μ and P

Example

Look at the digraph on Figure 2. It is a schedule, the vertical arcs represent the activities and the horizontal ones the connections among them. Activity times have minimal and maximal duration limits and only they depend on calendar, in which we do not allow work at weekends and holidays. The other values are constant. Values appeared on arcs are the necessary number of days of executing the activities (effective activity times). So these are the base rate of activity times and will be changed depend on the calendar, which we show in a table. Weekends and holidays are distinguished with grey background.

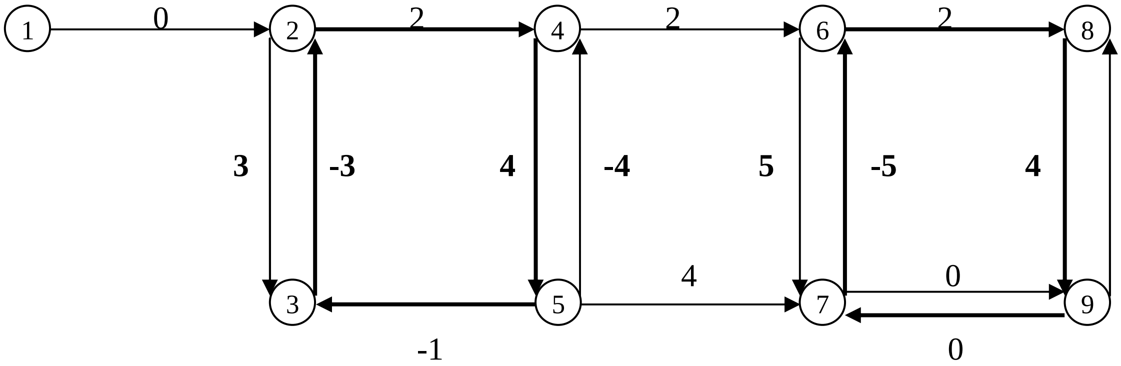

Figure 2

On Figure 2 we sign the changeable times with bold characters and the loops with thicker arcs.

arcs		start potentials																											
nodes	eff	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
2-3	3	3	3	3	6	6	6	5	4	3	3	5	5	5	4	3	3	3	5	5	6	5	4	4					
3-2	-3				-3	-3	-3	-4	-5	-6	-6	-6	-6	-3	-4	-5	-5	-5	-5	-3	-3	-4	-5	-5	-5	-6	-6	-4	-5
4-5	4	4	4	7	7	7	7	6	5	4	6	6	6	6	5	4	4	6	6	7	7	6	5						
5-4	-4					-4	-4	-5	-6	-7	-7	-7	-7	-7	-8	-9	-6	-6	-6	-6	-4	-5	-6	-6	-6	-7	-7	-7	-8
6-7	5	5	8	8	8	8	10	9	8	7	7	7	7	7	6	5	7	7	8	8									
7-6	-5						-5	-6	-7	-8	-8	-8	-8	-8	-9	-10	-10	-7	-7	-7	-7	-8	-9	-7	-7	-8	-8	-8	-9
8-9	4	4	4	7	7	7	7	6	5	4	6	6	6	6	5	4	4	6	6	7	7	6	5						
9-8	-4					-4	-4	-5	-6	-7	-7	-7	-7	-7	-8	-9	-6	-6	-6	-6	-4	-5	-6	-6	-6	-7	-7	-7	-8

Reading of minimal activity time (positive value): the minimal activity time in which the number of the work days equal to the effective activity time counted from the current starting day.
Reading of maximal activity time (negative value): the maximal activity time in which the number of the work days equal to the effective activity time counted from the current finishing day.
In case of counting back we have to convert the activity times according to potentials of the end nodes, so have to create another table, where the reading of the arc parameters are different. [2.Consequence]
Reading of minimal activity time (positive value): the minimal activity time in which the number of the work days equal to the effective activity time counted back from the current finishing day.
Reading of maximal activity time (negative value): the maximal activity time in which the number of the work days equal to the effective activity time counted back from the current starting day.

arcs		end potentials																											
nodes	eff	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
2-3	3				3	3	3	4	5	6	6	6	3	3	4	5	5	5	3	3	3	4	5	5	5	6	4	4	5
3-2	-3	-3	-3	-6	-6	-6	-6	-5	-4	-3	-5	-5	-5	-5	-4	-3	-3	-5	-5	-6	-6	-5	-4						
4-5	4					4	4	5	6	7	7	7	7	4	5	6	6	6	6	4	4	5	6	6	6	7	7	5	6
5-4	-4	-4	-4	-7	-7	-7	-9	-8	-7	-6	-6	-6	-6	-6	-5	-4	-6	-6	-7	-7									
6-7	5						5	6	7	8	8	8	8	8	9	10	7	7	7	7	5	6	7	7	7	8	8	8	9
7-6	-5	-8	-8	-8	-8	-10	-10	-9	-8	-7	-7	-7	-7	-9	-8	-7	-7	-8	-8										
8-9	4					4	4	5	6	7	7	7	7	4	5	6	6	6	6	4	4	5	6	6	6	7	7	5	6
9-8	-4	-4	-4	-7	-7	-7	-9	-8	-7	-6	-6	-6	-6	-6	-5	-4	-6	-6	-7	-7									

Using a MATLAB algorithm developed by the author, we get the solution appeared on Figure 3.

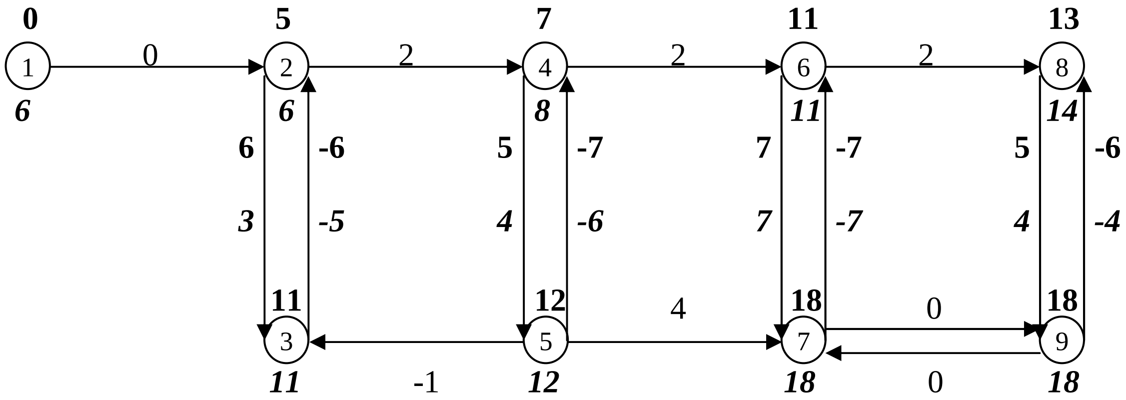

Figure 3

There are two values at every node and the activity arcs.

- The upper values are the earliest potentials and the current activity times accordingly to them. (Signed bold characters)
- The lower values are the latest potentials and the current activity times accordingly to them. (Signed bold italic characters)

On Figure 4 we sign only the counting of loops. Horizontally it shows the time, vertically the nodes. At spots we can see the potentials of nodes. The black ones are the effective values of potentials. It shows clearly how the iteration happens in the two loops.

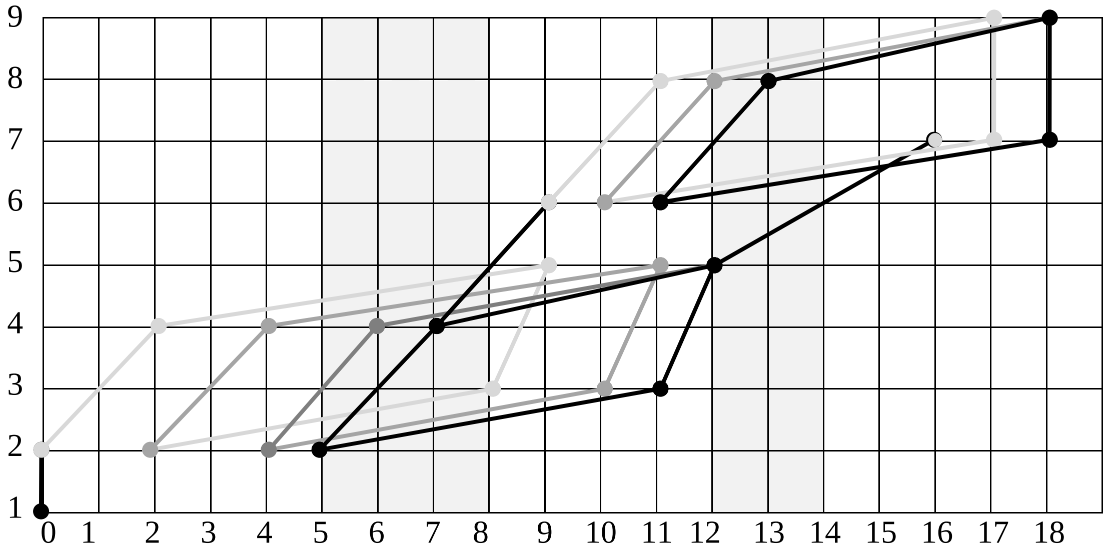

Figure 4

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INCORPORATING ENVIRONMENTAL COSTS AND BENEFITS INTO A PROJECT ECONOMIC ANALYSIS

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Abstract

Successful economic development depends on rational use of natural resources and on reducing adverse environmental impacts of development projects. EIA is a primary tool for achieving this objective, by inserting critical environmental information into the process of project preparation. Economic analysis is employed to determine if the overall economic benefits of a proposed project exceed its costs. Adverse environmental impacts are part of the costs of a project, and positive environmental impacts are part of its benefits. Consideration of environmental impacts, therefore, should be integrated with the other aspects of the project in the economic analysis to the extent possible.

The paper describes the process of incorporating environmental impacts identified in the EIA into the project analysis as a two-step process. It explains the problem of temporal and spatial boundaries, i.e. the problem of measuring the impacts of environmental changes in the future and beyond the boundaries of the project.

Keywords: Environmental Impact Assessment, cost benefit analysis, indirect methods

1 ECONOMIC VALUATION OF ENVIRONMENTAL IMPACT

To simplify the task of analysis, it is often useful to disaggregate any environmental impact into individual components of value. One approach to doing this is called the *Total Economic Value* (TEV) approach, whereby an impact is decomposed into a number of categories of value. The idea behind the TEV approach is that any good or service is composed of various attributes, some of which are concrete and easily measured, while others may be more difficult to quantify. The total value, however, is the sum of *all* of these components, not just those that can be easily measured. The breakdown and terminology for the components of TEV vary slightly from analyst to analyst, but generally include (i) direct use value; (ii) indirect use value; and (iii) non-use value.

1.1 Direct use value

Direct use value, also known as extractive, consumptive, or structural use value, derives from goods which can be extracted, consumed, or directly enjoyed. In the context of a forest, for example, extractive use value would be derived from timber, from harvest of minor forest products such as fruit, herbs, or mushrooms, and from hunting and fishing. In addition to these directly consumed goods, direct use values can also be non-consumptive. For example, people who enjoy hiking or camping in the same forest receive a direct use value, but do not actually “consume” any of the forest resource. Similarly, in a coral reef direct use values can include the harvesting of shells and catching of fish, or the non-consumptive use of the reef by scuba divers. All of these benefits are real, can be measured, and have values, even if the consumption by one individual does not reduce the consumption by another. Consumptive use is generally the easiest to value, since it usually involves observable quantities of products whose prices can usually also be observed. Non-consumptive use is often more difficult to value since both quantities and prices may not be observed.

1.2 Indirect use value

Indirect use value, also known as non-extractive use value or functional value derives from the *services* the environment provides. For example, wetlands often filter water, improving water quality for downstream users, and national parks provide opportunities for recreation. These services have value but do not require any good to be harvested, although they may require someone’s physical presence. Measuring indirect use value is often considerably more difficult than measuring direct use value. The “quantities” of the service being provided are often hard to measure. Moreover, many of these services often do not enter markets at all, so that their “price” is also extremely difficult to establish. The visual aesthetic benefits provided by a landscape, for example, are non-rival in consumption, meaning that they can be enjoyed by many people without detracting from the enjoyment of others. A special case of use value is the option value obtained from maintaining the option of taking advantage of something’s use value at a later date.

1.3 Non-use value

In contrast to use value, non-use value derives from the benefits the environment may provide which do not involve using it in any way, whether directly or indirectly. In many cases, the most important such benefit is existence value: the value that people derive from the knowledge that something exists, even if they never plan to use it. Thus, people place a value on the existence of blue whales, or of the panda, even if they have never seen one and probably never will; if blue whales became extinct, many people would feel a definite sense of loss. Non-use value is the most difficult type of value to estimate, since in most cases it is not, by definition, reflected in people's behavior and is thus wholly unobservable.

2 VALUING ENVIRONMENTAL IMPACT

Incorporating environmental impacts identified in the EA into the project analysis is a two-step process. First, one has to understand what the impacts are. This information is provided by a traditional EA. Second, one has to estimate the value of the impacts (where feasible and appropriate) in monetary terms to determine their relative economic importance, and assess the benefits and costs of various alternatives. This section focuses on *valuation techniques*, and their use in project analysis. [1] In most cases, the techniques have two parts: measuring the physical impact, and then assigning a value to that impact. A number of valuation techniques are potentially applicable to each category of value. For example, several techniques might be used to value the reduction in water quality; some are based on the cost of obtaining clean water by other means (replacement or relocation cost), while some are based on the consequences of reduced water quality (increased sickness or death). The specific choice of technique will depend on the situation and on data availability. Likewise, the loss of habitat could be valued in a number of ways, depending on the specific nature of the situation.

The choice of technique depends on the specific problem being studied. Except in very simple situations, however, it is likely that a variety of techniques will be necessary to estimate the full range of benefits. Moreover, where substantial investments are contemplated, it might be desirable to cross-check estimates by deriving them from multiple sources.

2.1 Direct Methods

2.1.1 Change in output of marketable goods

In many cases, the environmental effects of projects manifest themselves (at least in part) in changes in output of marketable goods. In cases such as these, the value of the unintended benefits and costs can be estimated by using the simple technique of valuing the change in output caused by the project. In Croatia, for example, reforestation activities under the Coastal Forest Reconstruction and Protection Project were estimated to result in increased wood production, which would be harvested at various intervals in the future. Using the increased wood output (in terms of both quantity and quality), the expected prices at time of harvest, and a discount rate of 10%, the present value of increased wood production was estimated at between 2.5US$/ha and 82US$/ha, depending on the site. Even when prices cannot be observed (for example, products harvested for home consumption), there are generally-accepted and reliable ways to estimate the value of the products (for example, by using the value of close substitutes or the cost of collection). The biggest difficulty in valuing such impacts generally arise from measuring the amounts of goods being produced and in predicting how these amounts will change with and without the project. However, once these estimates are in hand, valuing the changes is usually relatively simple.

2.1.2 Cost of human capital

Many environmental impacts, such as air and water pollution, have repercussions for human health. Valuing the cost of pollution-related morbidity (sickness) requires information on the underlying damage function (usually some form of a dose response relationship) which relates the level of pollution (exposure) to the degree of health effect as well as information on how the project will affect the level of pollution. The costs of an increase in morbidity due to increased pollution levels can then be estimated using information on various costs associated with the increase in morbidity: any loss of earnings resulting from illness, medical costs such as for doctors, hospital visits or stays, medication, and any other related out-of-pocket expenses. This approach is symmetric: the benefits of actions that reduce the level of pollution and hence of morbidity are estimated in the same way. Costs associated with pollution-related mortality (death), it is referred to as the *human-capital approach*. Because it reduces the value of life to the present value of an individual's future income stream, the human-capital approach is extremely controversial when applied to mortality. In general, estimating monetary values for mortality is a complicated, quite subjective process that has to be used with great caution and transparency.

2.1.3 Cost-based approaches

When the benefits of a given environmental impact cannot be estimated directly, information on costs can be used to produce valuable information. For example, an order of magnitude estimates of the potential costs (or savings) to society from a change in an environmental problem, can be obtained by using the cost of reducing or avoiding the impact, or the cost of replacing the services provided by the environmental resource. The major underlying assumptions of these approaches are (i) that the nature and extent of physical damage expected is predictable (there is an accurate damage function available), and (ii) that the costs to replace or restore damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that these costs can be used as a valid proxy for the cost of environmental damage. That is, the replacement or restoration costs are assumed not to exceed the economic value of the asset. These are strong assumptions and may not be valid in all cases. It simply may cost more to replace or restore an asset than it was worth in the first place.

2.1.4 Replacement cost

The replacement cost approach is often used as an estimate of the cost of pollution. This approach focuses on potential damage costs as measured by *ex ante* engineering or accounting estimates of the costs of replacement or restoration if damage from pollution were to occur. Note that this approach provides only a partial measure of damages caused by pollution. The replacement cost technique is particularly useful to assess the costs associated with damage to tangible assets, the repair and replacement costs of which are easily measurable. This information can then be used to decide if it is more efficient to allow the damage to occur and pay the replacement costs or to invest in preventing the pollution in the first place. The technique is less useful, however, for very unique assets, such as historical or cultural sites and unique natural areas, which cannot be replaced and cannot easily be restored, and about which restoration costs are uncertain. The *relocation cost approach* uses estimated costs of a forced relocation of a natural or physical asset due to environmental damage.

2.1.5 Opportunity cost

In some cases it is decided to protect a particular resource and forego other development options. The term *opportunity cost* refers to the value of these lost economic opportunities due to environmental protection. It is, therefore, a measure of the cost of environmental protection in terms of development benefits foregone. This is a very powerful technique, however, since it clearly identifies the expected economic cost of protection to society. In many cases, this amount is actually very small; in other cases, this information can be used to mobilize other sources of funds to compensate individuals or society for the opportunity cost of protection.

2.2 Indirect Methods

Often, the environmental good or service being valued is not traded per se in the market place. Examples of these amenity-type services include recreational sites and the preservation of biodiversity. A number of valuation techniques exist that can be used to place monetary values on these resources and this information, in turn, can be incorporated into a more conventional benefit-cost analysis.

2.2.1 Hedonic analysis

We know that environmental quality affects the price people are willing to pay for certain goods or services. Ocean front hotels, for example, charge different rates depending on the view (rooms with ocean views cost more than the same size room with a “garden” view —usually a nice way of saying the parking lot!). Hedonic models have been widely used to examine the contribution of different attributes to prices for housing and to wage levels, including the contribution of environmental quality. [2] As many observed this approach is of interest because many environmental dimensions are likely to be embodied in property values. Hedonic techniques allow this effect to be measured, holding other factors such as size and amenities constant. In essence, the technique estimates the implicit prices for various attributes, which together make up the sale price. In Croatia, for example, a hedonic analysis was used during preparation of the Coastal Forest Reconstruction and Protection Project to help estimate the landscape benefits of reforestation. Analysis of hotel room prices showed that rooms with views of forested landscapes cost, on average, about 3–6US$/day more than rooms in hotels in areas without such views. Hedonic methods require observations of the prices of goods and of the attributes of these goods. To enable the effect of the many different factors to be distinguished, large data sets are usually needed. Because of their data intensity and the need for open reporting of prices, the application of these techniques has had limited (but often successful) application in developing countries.

2.2.2 Travel cost

The travel cost (TC) method is an example of a technique that attempts to deduce value from observed behavior. [3] It uses information on visitors’ total expenditure to visit a site to derive their demand curve for the site’s services. The technique assumes that changes in total travel costs are equivalent to changes in admission fees. From this demand curve, the total benefit visitors obtain can be calculated. [4] The TC method was designed for and has been used extensively to value the benefits of recreation. The TC method depends on numerous assumptions, many of which are problematic in the context of international tourism. The basic technique generally assumes that travel cost is proportional to distance from the site and that people living at the same distance from the site have identical references. While these assumptions are often valid in the case of national tourism (tourism within a country), neither assumption may be valid in the case of international tourism. The technique also assumes a single-purpose trip and encounters difficulties when trips have multiple purposes.

2.2.3 Contingent valuation

Unlike techniques which use observed data, the Contingent Valuation (CV) technique relies on direct questioning of consumers (actual or potential) to determine their willingness-to-pay (WTP) to obtain an environmental good. [5] A detailed description of the good involved is provided, along with details about how it will be provided. The actual valuation can be obtained in a number of ways, such as asking respondents to name a figure, having them chose from a number of options, or asking them whether they would pay a specific amount (in which case, follow-up questions with higher or lower amounts are often used). CV can, in principle, be used to value *any* environmental benefit. Moreover, since it is not limited to deducing preferences from available data, it can be targeted quite accurately to ask about the specific changes in benefits that the proposed project would result in. This also means that, with appropriately-worded questions, CV can provide an all-encompassing estimate of the perceived costs and benefits of environmental changes, in contrast to other techniques which, as noted above, often only provide a partial estimate of environmental costs and benefits.

2.2.4 Benefits transfer

Benefits transfer is not a methodology *per se*, but rather refers to the use of estimates obtained (by whatever method) in one context to estimate values in a different context. [6] For example, an estimate of the benefit obtained by tourists viewing wildlife in one park might be used to estimate the benefit obtained from viewing wildlife in a different park. The main attraction of benefit transfer is that it provides a low-cost way of estimating values when time or resources do not allow fuller valuation studies, or when the good or service to be valued has not yet been created (for example, a new safari-tourism destination national park) so that there are no users to survey. This approach also has considerable risks, however. For many reasons, estimates derived in one situation can be inappropriate in another. As a result, benefits transfer has been the subject of considerable controversy in the economics literature. The estimates of the value of timber products produced by reforestation in Croatia cited previously indicate the limitations of benefits transfer techniques: even in a seemingly homogeneous area, environmental benefits can vary by an order of magnitude. The likelihood that benefits transferred from another area will be appropriate is, therefore, extremely low. The benefits transfer technique should be used with caution, therefore, and only when no site-specific measures are possible.

3 INCORPORATING ENVIRONMENTAL COSTS AND BENEFITS INTO ECONOMIC ANALYSIS

Once the various environmental impacts have been identified and the benefits and costs of various alternatives assessed, this information can be incorporated into the broader economic analysis of the project. This is usually done in a benefit-cost framework, whereby the streams of benefits and costs of a proposed project (including direct project inputs and outputs, as well as environmental impacts to the extent that they can be identified and monetized) are compared over some period of time. The three main decision criteria used in benefit-cost analysis are: *net present value* (NPV), *internal rate of return* (IRR) and *benefit-cost ratio* (BCR). All of these criteria rely on the concept of discounting a stream of benefits and costs which occur at different times over the duration of the project being evaluated. Discounting puts all of these costs and benefits into a common time frame to allow for more accurate comparison. Adding environmental costs and benefits does not change the method of analysis. However, several aspects of project analysis need particular attention when environmental problems are present. The impacts of many environmental changes, whether positive or negative, are often only felt in the future, long after the activity which caused the change has ceased. Similarly, effects are often felt far beyond the boundaries of the project itself. Special attention must be given, therefore, to the *temporal* and *spatial boundaries* of the analysis.

3.1 Temporal Boundaries

Since environmental impacts extend long beyond the normal life of the project, it is important to extend the time horizon of the analysis so as to include all the benefits and costs associated with environmental impacts, even if they go further into the future than the normal life of a project. The effective length of the time horizon of an analysis is determined by both the number of actual years included in the analysis and the discount rate used. Using too short a time horizon effectively ignores many environmental impacts, both positive and negative. For example, an activity that results in the permanent loss of a fishery should include in the analysis the present value of the entire future loss of that resource, even if the activity itself only lasts for a few years. The choice of the appropriate *discount rate* is also an important decision, since a high discount rate effectively reduces to zero the present value of benefits and costs that occur many years in the future. This *does not* imply that a different discount rate should be use when environmental impacts are important; in fact, it is always wrong to mix discount rates within one analysis. Given the importance of the discount rate, however, it is important to do sensitivity analysis using different discount rates. This can yield useful information to the decision maker when comparing alternatives that have very different time profiles of benefits and costs (including environmental ones). Two approaches are possible to incorporating long-term environmental effects. One approach is to extend the time horizon of the entire analysis to cover a period long enough to include all environmental effects (at least to the point where, given the discount rate, any additional environmental impact has no further effect on the analysis, typically after 50-100 years). Alternatively, the present value of the entire future stream of environmental impacts (benefits and costs) can be computed, and then incorporated in the normal project analysis framework in the same way that a residual value estimate for a long-lasting capital good would be.

3.2 Spatial Boundaries

When environmental effects are present, careful thought must also be given to the appropriate *spatial boundary* of the analysis. The analyst often has to look far beyond the geographical boundaries of the project itself, especially when water or air pollution is involved. In other cases, global aspects may be important and require a further expansion of the "accounting stance" of the analysis. With both spatial and temporal externalities, the important rule is to be transparent in the assumptions being made, and explicitly state the adjustments that have been used in defining the analytical boundaries for the project—both in space and over time. Whatever the actual techniques used to estimate the value of environmental benefits or damages, an important point that should be borne in mind is the likelihood of underestimation. Inevitably, some types of value will prove impossible to estimate using any of the available techniques, either because of lack of data or because of the difficulty of extracting the desired information from them. To this extent, any estimates of value will underestimate the total value; the estimates of project benefits will, therefore, be conservative, while estimates of costs will be optimistic. That some environmental benefits cannot be quantified, however, does not mean that they should be ignored. Rather, any un-quantified benefits should be described qualitatively to the extent possible. Table 3 illustrates how a mix of quantifiable and unquantifiable benefits might be presented in a table. Several of the benefits that were not quantified in this instance are in fact potentially quantifiable, using the techniques indicated, but data and budget constraints prevented this. Since the quantifiable benefits were large enough to justify the proposed investments by themselves, devoting additional resources to quantifying the remaining benefits was judged to be unnecessary.

3.3 Double-counting

Another potential problem which must always be considered is the risk of double-counting. The likelihood that total benefits will be underestimated because some benefits cannot be measured is well-recognized. Less well recognized is the opposite danger: that benefits (even if accurately measured) might be overestimated because some benefits are counted twice. An example will illustrate the problem. Suppose that the project aims to reduce air pollution at the site by relocating or shutting down polluting activities. The benefit of this reduction could be estimated by predicting the reduction in the prevalence of respiratory illnesses and valued using the reduction in treatment costs. At the same time, suppose that a hedonic technique is used to estimate the value of overall environmental quality. Since air pollution is part of environmental quality, treating these two estimates as though they described separate problems and adding the corresponding benefits together would be inaccurate.

4. CONCLUSION

EIA is an information-gathering and analytical process that helps avoid environmentally unsound development. It focuses on environmental externalities: unintended adverse effects of development projects on the environment. The impacts identified in the EIA process have not often been converted into monetary terms, because of the generally weak link between EIA and economic analysis.

EIA is a primary tool for identifying adverse impacts of development projects. Economic analysis, by comparison, is used to determine if the overall economic benefits of a proposed project exceed its costs, and to help design the project in a way that produces a solid economic rate of return. Consequently, adverse environmental impacts should be part of the costs of a project, and positive environmental impacts are part of its benefits. The environmental impacts, therefore, have to be integrated with the other aspects of the project in the economic analysis to the extent possible.

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RISKS IN IMPLEMENTAION PROCESS OF MANAGING BY PROJECTS IN CONSTRUCTION COMPANIES

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Abstract

For the last 10-years authors have been working on implementation of project management processes in engineering and especially construction companies. During those years they have collected practical knowledge about key risks that can occur in that process. Companies around the world are changing from traditional (functional) to more project oriented model. They are forced to change/adopt current organizational structure to pure project oriented or more often, some matrix form. Implementation of this change caries group of risks whose intensity and occurrence depends on key elements of implementation: number of projects inside the company, project manager's involvement in all phases of project, communication with stakeholders, using appropriate methodology and software support. Cultural aspects of doing business are put in correlation with world experience of author partner network.

Keywords: Risk, Project Management Process, Implementation, Organizational structure, Methodology

0. Introduction

During last ten years authors have been working on implementation of project management processes and have chosen twenty engineering companies as a referral cases for this purpose. Reference group includes 7 construction companies, 5 public administration/companies involved with construction, 3 maintenance & turnaround (energy) companies, 3 ICT companies, 1 financial company and 1 shipyard. Those companies had different organizational structure, mostly functional or some matrix form, or even pure project structure. Implementation mostly started on sponsor (high positioned person in company) initiative but in small number of cases intention came from project team members. Usually when intention came from project team members they were very motivated for implementation of project management processes, but when initiative came from sponsor team members were very indifferent and in some cases they have tried to ignore it. However, even with motivated project team, implementation project will fail without strong support of sponsor. This article will present most common risks that can occur during implementation of project management processes in private and public companies. The reason for referencing companies from other industries besides construction is in the fact that construction companies generally gain poorer results comparing to others. Finding reason for that fails far beyond the content of this article, but we strongly believe that risks defined here could show the way for further research.

1. Context of managing projects in construction industry of Croatia

Disappearance of big construction companies in Croatia caused disappearance of planning department which was unavoidable part of those companies. That department was in charge for planning and the other department was in charge for realization, so very often happened that realization never followed original plan and many working hours were lost for nothing. Today the planning is minimized and it is common that after the contract is signed project goes directly to realization without making a valid initial project plan which could be referenced in later stages. If some project manager decides to make initial project plan that usually ends with rough plan which is hanged on a wall and seldom updated. Main reason for such situation in our construction industry is because most projects are made by companies without formal project management methodology. In such companies project manager is usually, at the same time, site manager. Management is expecting from him to do the project plan with all other work in his job description without assistance. He is usually alone at the site, doesn't have knowledge to work in software for planning and often hasn't got project team to help him. Because of that he ignores the plan, relies on his experience and improvises to catch the deadline.

Nowadays management of Croatian construction companies realizes necessity for education of their employees in project management tools and techniques because they think that this will ensure them easier consolidation of all projects inside the company and easier visualization of company prosperity. Implementation of project management techniques requires reorganization of current organizational structure inside of the company. Most often companies have functional or week matrix organization which is not a good environment for project management. In such structures project manager has no authority over project because he has to ask all approvals for the project from his superiors. Very often different departments inside one company are responsible for completion of project phases (or their parts) but project manager doesn't have authority over department employees in a functional or week matrix organization and his role in such project is *project coordinator* which is another reason for change of current organizational structure.

Project manager is not involved in early phases of project (design, tender, negotiation,…) because that is the job of different departments inside the company. Reason for this is that mostly project manager in Croatian construction industry affiliates with site manager and by definition site manager is responsible only for construction phase which means that he doesn't participate in other phases of project. Making a more realistic position of project manager in Croatian construction industry and involving him in all phases ensures better project preparation for realization. He has to be able to influence a project from early phases and especially in defining Bill of Quantity (BoQ) together with designers. The correct structure of BoQ will simplify planning phase of project, since project manager will be able to make a project plan directly from BoQ and save a lot of his time which is he now spending on a distribution of BoQ items on a project activities. Today it is common that same works on all areas (like floors) are presented with one item.

Many companies don't have formal methodology for project management. Instead of that they use some sort of practical methodology which is written in a form of business procedures. Knowledge about successful project realization, of all things that went well and those that went wrong, are kept in project manager heads. So when one decides to leave company a lot of knowledge goes with him. Those situations have become big handicap for companies because there is a big fluctuation of employees. Because of that lot of companies have decided to collect experience from their employees and combine it with existing methodologies to get their own methodology. That methodology will short the time which is needed for adjustment of new employee on some project. Also all summary reports will be uniformed because nowadays each project manager has his own form for reporting about project realization. All Requests for Changes (RfC) will be integrated into project plan which will give costs projection at completion of project. That is very helpful because in functional and week matrix organizations each RfC has to go from applicant trough few officials to "Decision Maker" and all the way down to be approved. That is usually few days but sometimes can be few weeks which results with delays on a site because applicant will not start work till his RfC is not approved. Implementation of methodology combined with different organizational structure will give PM authority for making decisions and achieving project expectation.

2. Usage of Standard Best Practices coupled with technology solutions (SBP+T) for improvement of project management process

Primavera Systems, manufacturer of project management software, conducted a survey (390 online interviews) in late 2007 to examine the technology, business procedures and best practices in use by North American firms and owners in the Architecture, Engineering and Construction (AEC) industry. Analysis of the survey results show that companies which implemented standardized best practices coupled with technology solutions complete a higher percentage of projects on time and on budget, are better able to mitigate the impact of late and/or over budget projects on their organizations and have better knowledge about the causes of poor performance.

Analysis centered around three distinct groups of companies:

1. Companies who implemented Standardized Best Practices coupled with technology solutions (SBP+T);
2. Companies who report that they implemented Standardized Best Practices, but do not use technology solutions (SBP); and,
3. Companies that do neither ("neither").

Analysis of survey data shows that SBP+T companies are better at completing projects on time and on budget. Of all companies surveyed, these companies had a higher percentage than any other group, 47.3%, reporting that 90-100% of their projects are delivered early or on time. Similarly, they also had the highest percentage, 87.4%, reporting that more than half of their projects are delivered on budget. SBP+T companies are also better at mitigating negative impact from late and/or over budget projects. Of these companies, 41.8% complete late projects within one week to one month, more than any other group. The vast majority, 76.4%, also deliver over budget projects within 20%. This indicates that SBP+T companies are better able to limit the negative impact of late and/or over budget projects. The analysis also suggests that SBP+T companies have better visibility into the causes of late and/or over budget projects. All companies were asked about the main cause for poor performance. No more than 40% of SBP+T companies reported any one category as the main cause of late or over-budget projects. However, more than 50% of companies in both the SBP and the "neither" category reported owner and contractor change as the main reason. The data suggest that SBP+T companies are more accurate at assigning the major causes of poor project performance.

In Croatian construction industry similar surveys haven't been done because there are few companies that even have capabilities for implementation of SBP+T in project management. Usage of SBP in Croatian construction companies described in previous chapter is long way from United States construction companies. Implementation of technology solutions is so rare that authors refer to Primavera research conducted in United States. Primavera research is relevant because it is conducted on AEC industry which contain a great number of respectable construction companies and each of them have their own methodologies and project management procedures based on hundreds and thousands accomplished projects around the globe.

3. Experiences of implementation project management solutions

Authors experience in implementation of project management solutions starts with developing methodology for project management which is developed according to worldwide accepted project management standards and afterwards with implementation of IT platform (mostly Primavera). Usually customers perceive our solutions as IT based since they see software as a tangible result, while they are often not aware of all other changes that occur in this process and the necessity of methodology. This approach requires organizational change while on the other side more common practice by companies when implementing IT solution is to try to adopt and transfer existing praxis and processes into new system.

Authors have conducted implementation of project management processes on 20 companies, 12 of them were in construction industry (7 construction companies and 5 public-Ministries/Cities who work with construction projects). Management of those companies realized necessity for education of their employees and implementation of project management methodology. Most of methodologies are based on well known project management standards combined with specific requests of each company and industry. Most of companies have formed PMO – Project Management Office, or PMU – Project Management Unit (temporary unit for managing complex project including one or more persons which have project management education and IT support for project and contract management). In public administration projects, PMO officially doesn't exist but there is always one key person in each department which does everything (on a department level) what would be responsibility of PMO (on organization level). Of course, our intention is to change that, but for public administration even that is big success.

4. Risks factors in implementation processes

Company size

Size of the company has an influence on the success of the PM implementation. On larger company there is more possibility for successful implementation since it can commit more resources to the process.

Type of organization

We have classified here our references as functional, weak matrix, matrix, strong matrix and project organization. It's quite obvious that this order determines the chances for the implementation success as well – more functional organization is – more resistance there is against the changes and lower PM maturity is, as well.

Enterprise implementation / single project

If client recognizes implementation as a project and has an intention, by phased approach, to start implementation in representative set of projects, as a pilot, and then spread it out to the complete portfolio that represents the approach with more vision, more focused toward success than an ad-hoc try of implementation on a single project.

PMO/PMU

Existence of formal PMO/PMU is the main assumption for the implementation on enterprise level or for the complex engineering projects. It is the key risk if it is not present.

Formal project organization

It is important that project team members are dedicated to projects; that there is a formal position of project manager and formal project organization within functional. This is pointing to higher PM maturity and raise chances for the success.

Budget

Larger budgets force the organization to make more effort in the implementation process, the obvious reason is that fail would be quite an expensive (non)option.

Sponsor support

Strong sponsor support is definitely the key risk factor in implementation.

Executives support

This is management layer where implementation project could get a burst or could be extremely slugged. This layer is, also, most affected with organizational and cultural changes when, in most cases, project component of a company become stronger.

Team competence – agility

As it is in every project – without a good team with competent members working with high moral and agility every project will fail.

Formal PM education of project team, executives and key stakeholders

This is in correlation with team competence, but for sure one of the key assumptions for success implementation, therefore it's the key risk if this is omitted.

Certified in PMs/Team members

If client's sponsor/management is willing to get certification in PM competence for team members and other managers, it shows the vision of the sponsor and management which drives to the goal that project management is to be implemented and failure is not an option.

PM methodology

One of most important deliverables of PM implementation is tailored methodology framework for project management. In success cases it is result of joined efforts both of consultant and client team, and once it is accepted it becomes book of a rule for everyone included in projects.

Lifecycle PM

Another risk connected to PM maturity in a company. If project manager got his function/responsibility only in execution phase of the project, he can't be responsible for mistakes done in initiation and design phase. In that case there is no project control in early phases.

% of responsible persons included in planning

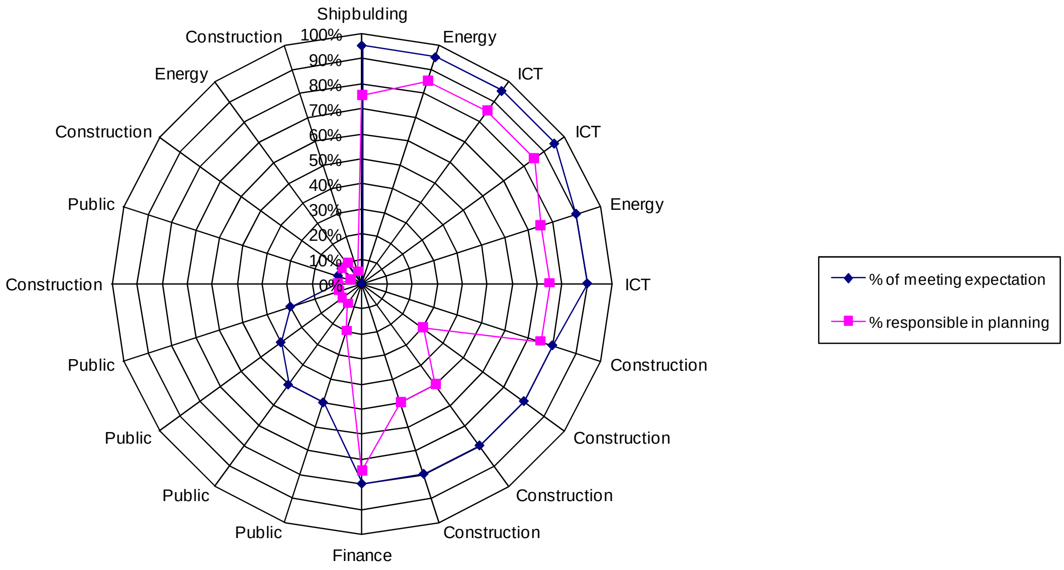
Project manager is responsible for project schedule, but all responsible persons in the project should contribute to the plan by planning their own parts of project that falls into their responsibility area. Without that, responsibility falls into gray zone.

Adequate BoQ

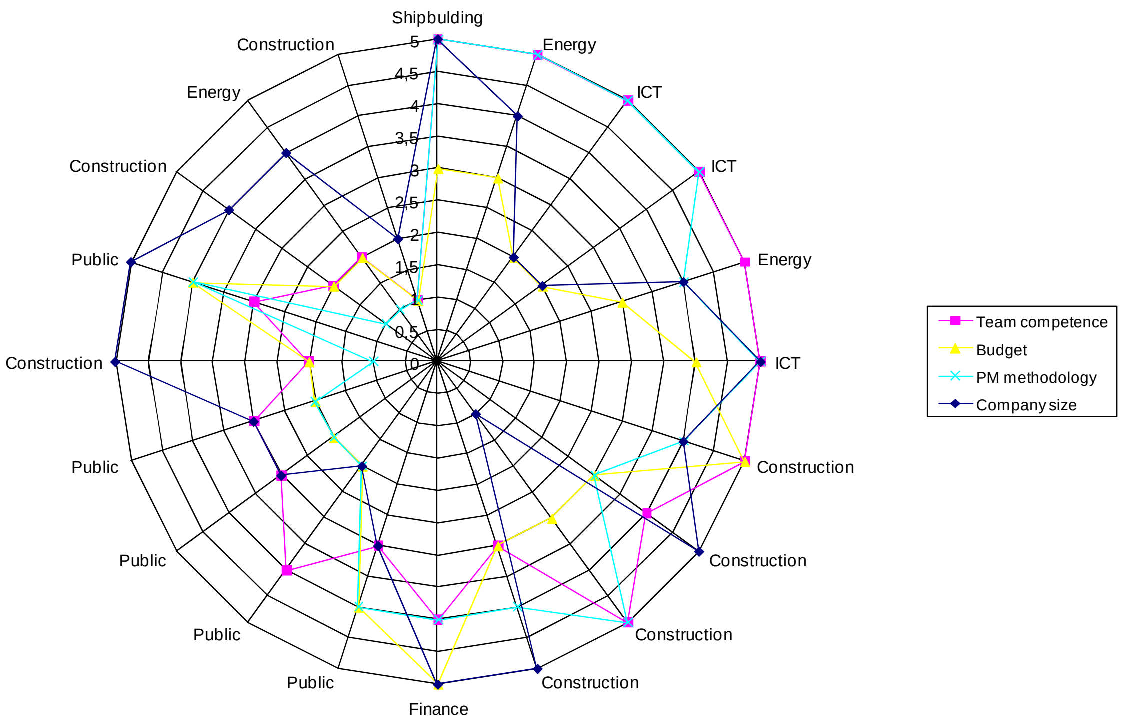
In construction projects it is important to have integrated project plan with time, money and responsibilities and this is the core of earned value measurement method – the most common method used for project planning and control. The best model for this is the case when all contractual items are linked to one or more activities. However, our present practice knows only summarized contractual items in Bill of Quantity so it is quite hard to distribute an item to more activities. This information, however, exists in designer drawings, but got lost in issued for the bid phase of design documentation. If this information of billed quantity is kept all the time with the place of the cost – we have a defined activity – we have better plan.

5. Findings

All risks described above are categorized and quantified for every particular company (here referred by its industry only). Measure of success is estimated by meeting expectation from implementation project in percentage. Measure of success was determined by our own evaluation of company result in this process.



Picture 1: Base diagram shows companies labeled by its industry with % of expectation of PM implementation started with Shipyard, one company from energy sector followed by two ICT companies which hit 100% of expectations.



Picture 2: Diagram shows 4 parameters for each company in a rank 1 to 5 (Team competence, PM methodology, Budget and Company size)

Team competence and PM methodology are ranked by marks 1 (lowest) to 5 (best) by authors estimate.

Budget is divided into 5 ranges:

1: < 10.000 EUR

2: < 30.000 EUR

3: < 70.000 EUR

4: < 150.000 EUR

5: > 150.000 EUR

Size of company id divided into 5 ranges by number of employees as follows:

1: < 10

2: < 50

3: < 150

4: < 500

5: > 500

	Industry	% of meeting expectation	Implementation project	Sponsor support	Executives support	Enterprise /Single project	PMO/ PMU	Organization	Formal PM education	Certified PM	Formal project organization	Adequate BOQ	Life Cycle PM
1	Shipbuilding	95%	YES	YES	YES	ENT.	PMO	MATRIX	YES	YES	YES	YES	YES
2	Energy	95%	YES	YES	YES	ENT.	PMO	S-MATRIX	YES	YES	YES	YES	YES
3	ICT	95%	YES	YES	YES	ENT.	PMO	V-MATRIX	YES	YES	YES	YES	YES
4	ICT	95%	YES	YES	YES	ENT.	PMO	S-MATRIX	YES	YES	YES	YES	YES
5	Energy	90%	YES	YES	YES	ENT.	PMO	MATRIX	YES	YES	N/A	YES	YES
6	ICT	90%	YES	YES	YES	ENT.	PMO	MATRIX	YES	YES	YES	YES	YES
7	Construction	80%	YES	YES	NO	ENT.	PMO	MATRIX	YES	YES	YES	PART	YES
8	Construction	80%	YES	YES	YES	ENT.	PMO	FUNCT.	YES	NO	NO	YES	PART
9	Construction	80%	YES	YES	NO	SINGLE	PMU	PROJECT	YES	YES	YES	NO	PART
10	Construction	80%	YES	YES	NO	SINGLE	PMU	V-MATRIX	YES	NO	YES	NO	YES
11	Finance	80%	YES	YES	YES	ENT.	PMO	MATRIX	YES	YES	YES	YES	YES
12	Public	50%	YES	YES	NO	ENT.	PMO	FUNCT.	NE	NO	NO	NO	NO
13	Public	50%	YES	YES	NO	ENT.	NO	FUNCT.	YES	NO	NO	NO	NO
14	Public	40%	NO	YES	NO	ENT.	NO	FUNCT.	YES	NO	NO	NO	NO
15	Public	30%	NO	NO	NO	ENT.	NO	FUNCT.	NO	NO	NO	NO	NO
16	Construction	10%	NO	NO	NO	SINGLE	NO	FUNCT.	YES	NO	NO	NO	NO
17	Public	10%	YES	DA	NO	Ent.	PMO/ PMU	MATRIX	YES	YES	YES	NO	YES
18	Construction	10%	YES	NO	NO	Ent.	NO	FUNCT.	NO	NO	NO	NO	NO
19	Energy	10%	NO	NO	NO	Single	NO	FUNCT.	NO	NO	NO	NO	NO
20	Construction	0%	NO	NO	NO	Ent.	NO	FUNCT.	YES	NO	NO	NO	NO

Table 1: Other risks by companies sorted by % of expectation accomplished.

6. Conclusion

From 20 referent companies 12 were connected with construction and in neither of them have accomplished more that 90% expectation of project management solution implementation, which has been accomplished in companies from Shipbuilding (1), Energy (2) and ICT (3) what shows that is possible to avoid all mentioned risks or have them under control. Group of 4 Construction companies (together with one from Finance sector) have achieved acceptable result 80% which shows lower grade of project management maturity which is connected to a conflict between functional and project organizational structure. Then follows group of 4 organization from public administration which have accomplished result 30-50% of expectations which is not much, but considering Croatian public administration (which is still the biggest investor in Croatia) it is hard for project organization to stand up to very strong functional organization. It is very hard to avoid or control most of risks in public construction projects, but results are accomplished thanks to big support of a sponsor, education and effort of a project team. At the end there are unsuccessful implementations, one Construction and one Government energy company where mentioned risks were not under control.

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SITE ESTABLISHMENT DYNAMICS DURING CONSTRUCTION OF EURODOM IN OSIJEK

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Abstract

The construction site of the Eurodom causes great attention of construction profession because of the fact that it is the biggest construction site in the city and its surroundings. The construction of Eurodom reached some of the significant construction achievements like the deepest sheet-pile wall with free end, the biggest ground anchors in sandy-clayey soil, one of the deepest excavation pits in Croatia, as well as the construction of drainage system with the aim of preventing water buoyancy on the foundation slab with its own pumping station. Because of the fact that the construction site is situated in an urban city environment with very high traffic intensity, there was a need of extensive and detailed preliminary works on construction site organization, along with ensuring access to the site and conducting demanding construction works under the condition that contact public and traffic areas stay untouched.

This paper presents the dynamics of these works in terms of changes in site establishment that were happening in line with the type and proportion of works on the site from the preliminary works, during excavations, till today, when the construction project of the future complex is in progress.

Keywords: site establishment, preliminary works, construction site organization, construction management

1. Introduction

At one of the most attractive locations in Osijek, in an ideal traffic position - the intersection of Vukovarska, Trpimirova and Istarska streets, work is in progress on the construction of the Business and Cultural Center Eurodom Osijek (*Figure 1*).

The investor of this significant project is the company Eurodom Ltd. established by the concern Agram, while the City of Osijek government is the sub investor in the project investing city land and existing communal infrastructure to this project. Value of the investment after the completion of works is estimated to one billion kunas.

Figure 1 - *Model of the future complex of the Eurodom*

The future complex of Eurodom, at 85000 m^2 will offer a variety of purposes: exclusive business and tourist areas, hotel capacities, cinemas and auditory for different cultural and artistic purposes.
Construction works on the Eurodom started at the end of 2004, and the plan is to finish by the beginning of 2009. During the preliminary works and earthworks the main contractor in charge of coordination and management of the project was the construction company Tehnika from Zagreb. In the second phase of the project, during the concrete works, construction companies Gradnja and Osijek-Koteks, with their subcontractors, took the leading role.

The most representative parts of the project are the two twelve-stores oval shaped business towers. The towers will dominate over the entire complex and it can be expected that they will become recognizable in the city skyline. Towers will be glazed to create the sensation of construction transparency.

Figure 2 – *Construction site of the Eurodom (May 2008)*

Four-storey building of a commercial center and a hotel will be built alongside Vukovarska and Istarska streets. Alongside Trpimirova Street the cultural center will be built offering 250 places for multipurpose hall visitors and in the extension of the same building, on 3000 m^2 there will be space for diverse cultural contents (*Figure 2*). Among three underground floors, two will be reserved for parking purposes with brand new robotic system and a capacity of 900 parking places. Communication between buildings will be established through underground floor and basement.

Pedestrian zone and the main square will connect all buildings into a complex and, according to the design, will be filled with green vegetation and water surfaces.

2. Site establishment

The construction site of the Eurodom causes great attention of construction profession because of the fact that it is the biggest construction site in the city and its surroundings.

The construction of Eurodom reached some of the significant construction achievements like the 28 meters deep sheet-pile wall with free end, the biggest ground anchors in sandy-clayey soil (25 meters long), one of the deepest excavation pits in Croatia (15.50 meters deep), as well as the construction of a drainage system with the aim of preventing water buoyancy on the foundation slab with its own pumping station.

Figure 3 - *View of foundation plate and sheet-pile wall*

Very important segment of this project is reinforced foundation plate 1.5 meters thick, total area of 10000 m^3 (*Figure 3*).

The amount of construction works, man-working hours, which include around 180000 m^3 of excavated material, and 80000 m^3 of concrete built in constructions together with a great amount of concrete steel, bring up a picture of a complex and demanding construction project.

Because of the fact that the construction site is situated in an urban city environment with very high traffic intensity, there was a need of extensive and detailed preliminary works on construction site organization.

Figure 4 - *Location of the construction site*

Proposed site establishment layout had to assure access to the site and conducting demanding construction works under the condition that contact public and traffic areas stay untouched (*Figure 4*). At the beginning of the project there were three entrances to the site. Entrances on Trpimirova and Istarska Street assured straightforward traffic on the site. At the third entrance, near to the Student center, offices of project manager, site managers, conference room and the closed space for workers were situated. After the earthworks were finished, the entrance on Istarska Street is closed.

3. Preliminary and exploratory works

Construction management of Eurodom calls for thorough knowledge, experience and creativity because of the complexity of the object and works, as some of the works are done for the first time in this region.

Preliminary works consisted of careful relocation of existing sewage, telecommunication and electrical installation so that the functioning of the infrastructure of that part of the city would not be questioned. During the preliminary works the whole construction site was fenced and the new regulation of pedestrian and public transportation was introduced. Pedestrian traffic along Trpimirova Street was shifted to communication between the building of the Employment Service and the Student Centre. One stop in the public transportation system was eliminated.

Figure 5 – *Shifting the Chapel of Stone Cross*

At the location of a former bus stop the characteristic site for placing concrete into the construction was planned. During the preliminary works, the Chapel of Stone Cross was moved from the location of the site. It will be put back after the project close out, at specially prepared site at the main square of the complex (*Figure 5*).

Before the construction works started geotechnical investigation works were conducted at the location of the future complex of Eurodom. Investigation works were carried out by the company Geoistraživanje Osijek. The results of investigation showed the soil was typically Slavonian, sandy-clayey. The level of underground water was detected at the depth of 6 m, so in 4 trial boreholes, from the specified 12, piezometers were placed to monitor the ground water level.

4. Construction of sheet-pile wall

Since the geotechnical laboratory testing confirmed that the soil is suitable for construction, the works on sheet-pile wall were started with the aim to protect the excavation pit.

Ground works in construction sheet-pile wall were performed by the company Crosco – geotechnical part of the company INA – with special grabs for drilling and excavation of ground material.

Works were conducted through sections 6 to 9 meters wide until the desirable depth.

Figure 6 - *Contractor-procedure*

After the trench was excavated up to the designed level, reinforcing barns were bedded and poured with concrete through so called contractor-procedure (*Figure 6*).

Concrete was poured through funnel at the top of the pipe that goes to the bottom of the trench and, at first, it almost touches the bottom. Due to the fact that the concrete is heavier then drilling mud it pushes it to the surface and fills the trench area. It was necessary to provide continuous concrete delivery so that embedding goes without breaks. Breaks cause damages with expensive and complex recovery or reparation.

Figure 7 - *Sheet-pile wall*

After concrete works were complete at certain section, they were connected with reinforced concrete beams. Constructed sheet-pile wall is 513 meters long, 28 meters deep and 0.8 meters wide.

5. Excavation pit

Excavation of the pit was conducted in layers together with the anchoring of the sheet-pile wall with ground anchors to assure stability of sheet-pile wall itself (*Figure 8*).

Excavation of the pit was carried out through several phases. The first phase consisted of the excavation to the level -2.00 m together with the working surface settlement and the slash excavation for the sheet-pile wall, as well as the construction of the sheet-pile wall. Excavation to the level -6.00 m followed, with the construction and prestressing the first line of anchors.

Figure 8 - *Excavation pit*

After that, excavation to the level -10.50 m followed with the construction and prestressing the second line of anchors. The third line of prestressed anchors were at the level -15.50 m. Together, 1135 ground anchors 25.0 m long are built into the construction. During the excavation around 180000 m^3 of ground was excavated and transported away from of the building site (*Figure 8*).

To provide the transport of such a huge amount of material, it was necessary to ensure the access for the construction machines and transport vehicles, which was done through the construction of entrance and approach ramp. After the earthworks were finished, entrance ramp was removed.

Figure 9 - *Entrance and approach ramp to the excavation pit*

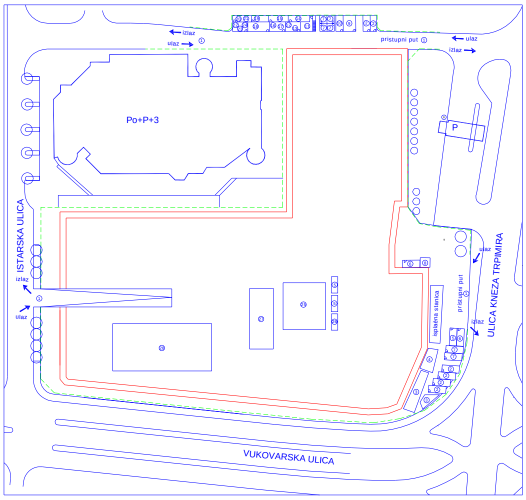

Figure 10 - *Site establishment layout during earthworks*

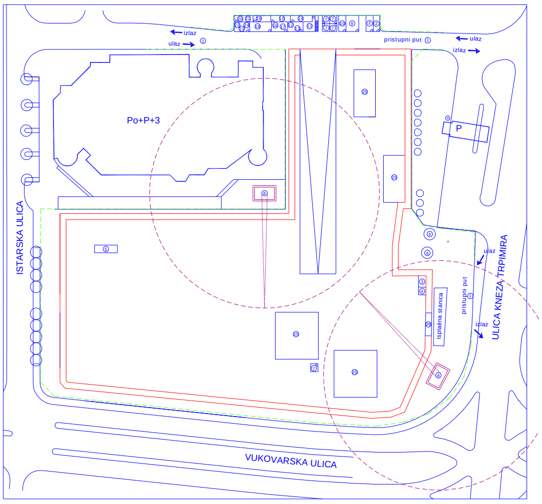

Figure 11 - *Site establishment layout construction of the pit*

Figure 12 – *View over construction site*

Figure 13 - *View over construction site during concrete works on the complex*

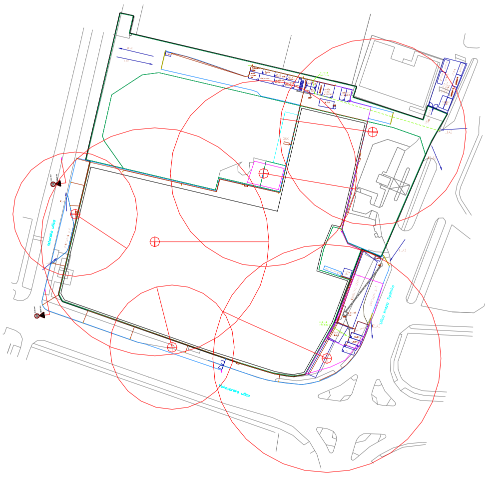

Figure 14 – *Site establishment layout during concrete works*

Due to the fact that four underground floors were planned, it was necessary to make an excavation pit that was 17 meters deep. Impact of underground water, soil settlement and damages on the surrounding buildings forced the design team to reduce the depth of the pit to the 15.50 meters, meaning that there is one underground floor less. Also, it was necessary to plant a drainage system with the aim of preventing water buoyancy on the foundation slab with its own pumping station. During the earthworks contractors came across a number of problems: from rainfall and underground water, to access to the excavation pit, more precisely the difficulties with transportation of the material over 15 meters long entrance ramp (*Figures 10, 11*).

Because of the fact that construction site is situated besides one of the most congested crossings in the town, it was necessary to provide conditions that would not disturb public traffic. All transport vehicles were properly washed with water to prevent deposition of ground material to the pavements. But still, there were still problems of different nature. Because of the intensive works on the site and the presence of numerous construction machines, tenants in surrounding buildings were constantly were complaining about noise. To solve this problem, additional sound filters were fitted to the majority of machines to decrease the noise level. Beside the noise, the settlement process started and damages at surrounding buildings occurred. Tenants warned the investor and the public about that. The investor will hire an independent company to evaluate possible damages. Ground works on the site were demanding and long lasting, causing extension of the works beyond the contract deadline. Investors and contractors believe that the delay will be caught up through more intensive work in the phase of concrete works.
Works continued with the assemblage of two tower cranes in the first phase, and later, the total of 6 cranes that exist at the site today were assembled.

For each phase of the construction works project manager together with contractor managers made a site establishment layout. This layout comprises all elements necessary for planning coordinated work of all the participants of this project. Layout enables unhindered application of designed technologies in construction. For the construction site of Eurodom there were layouts made for each phase of the project (*Figures 10, 11, 14*).

6. Conclusion

Site establishment is extensive and complex work and all project processes depend on it, as well as health and safety of workers on the construction site. Good site establishment scheme provides maximum usage of resources on site and full intensity of works.
Considering the type, volume and technologies applied for construction works, this site was intended, from the beginning, to be a training ground for carrying out the lectures of Construction Management Course at the Faculty of Civil Engineering in Osijek. For the third year in the role, students follow the works on the construction site and through direct contact with the participants of the project, they gather the necessary knowledge and experience in the field of organization and management in construction projects.

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EVALUATION OF OPPORTUNITIES OF BOT MODEL FOR INFRASTRUCTURE PROJECTS IN BiH

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Abstract

The utilisation of BOT model has a relatively short history across the world whilst it is only in the infancy stage of development in BiH. Sometimes the BOT model is not properly understood by the host government in developing countries such as BiH. One of key reasons is that infrastructure polices in these countries are pretty different from those in developed countries because of different modes of institutional setup and policy framework.

In its 'Policy Paper on Granting Concessions in Bosnia and Hercegovina' the BiH Council of Ministers admits that 'the BOT model is good for (infrastructure) financing' but it does not undertake enough for introducing the model into practice. The purpose of this article is to draw the attention to big and widening infrastructure gap and the necessity of improving the general framework conditions to make infrastructure projects more attractive to private investors and thus to reducing or eliminating that gap.

Keywords: BiH, infrastructure, BOT

Introduction

The link between infrastructure and growth is not clear. There is the problem of measuring the rate of return of specific infrastructural projects and particularly of comparing the rate of returns of various infrastructure projects and selecting the optimal mix of those projects. While it is necessary to link infrastructure investments and their expected impacts on growth, general understanding of how this linkage works is still weak and policy recommendations are accordingly not precise. There is growing evidence that infrastructure matters, but less clarity on how this could be translated into sectoral priorities (Estache, 2008).

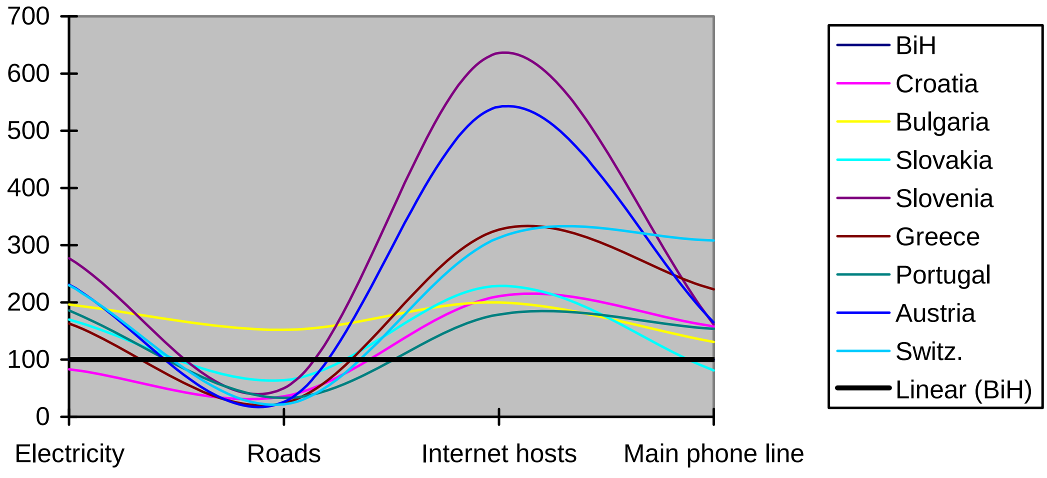
Among very important issues in infrastructure development is the necessity to strike the right balance between the role of private and public sector. The current consensus is that neither the public nor the private sector can exclusively deal with the infrastructure needs. In particular, there is no single solution fitting all sectors and all countries. It is broadly admitted that the public-private balance matters a lot. As the research clearly demonstrates, the private provision of infrastructure is not enough and adequate to fill the infrastructure gap. It is accordingly necessary to use combined financing models that mix public and private contributions in an appropriate manner.

A large proportion of infrastructure projects are still delivered mainly by the state in many countries, including among them even the Great Britain, worldwide known for

involving private investors in infrastructure development. The private sector has financed about 20-25 % of total infrastructure investments in developing and transition countries in recent years, and the trend is currently even declining. The public sector will undoubtedly remains in the foreseeable future as a key player.
In spite of having the relative presence of the private sector significantly increased in certain sectors, the public sector generally continues to finance and provide many infrastructural services. Many governments have tried due to fiscal constraints to attract the private sector to financing infrastructure projects, but not many of them were successful, and if succeeded in it, the results were mixed (Estache, 2008). In short, partnerships of public and private sectors will continue to be a rational option, the most challenging dimension of which will certainly be risk assessment or rather risk allocation between the private and the public sector.
Because of political and fiscal constraints, which prevent the BiH governments from developing increasingly expensive infrastructure of the country due to its optimisation at the sub-national levels, these partnerships, especially the BOT style ones, could be potentially very popular option as they minimise the impact of projects on capital budget, introduce increased efficiency into projects, encourage foreign investment and introduce new technology and know-how techniques.

1. Identification of Project Opportunities

In BiH, economic growth is obviously constrained by infrastructure bottlenecks. However, policy makers at all levels do not measure allocation of public resources between various sectors and its impact on economic development. In any case, the growth of the infrastructure sector in BiH has been relatively slow compared with the peer countries, particularly in the internet and telecommunications infrastructure (see picture 1). The lack of internet hosts particularly badly affects the country's economic development.



Picture 1: Infrastructure gaps in BiH

The BiH authorities have tried to promote infrastructure-led growth since recently (e.g. in the Operative Programme of the Government of Federation of BiH 2008-10) as they are aware of these bottlenecks, but they do not appear right in selecting priorities since they include among them building highways and hydro/thermo plants (or alternatively they could be right setting the telecommunication sector deliberately aside for privatisation and foreign investors; if so, privatisation proceeds would be less than potentially possible).

There are about 22,500 km of roads, 90 % of them being asphalted, but the country has only a 27 km-long stretch of highway and that existing roads are poorly maintained, what could qualify the road sector as a development and investment priority. There is widespread discontent among the population about the quality of local i.e. municipal and regional roads. Complaints about their low quality top the list among all public services not just infrastructure services – complaints being almost twice as high as the next problem, i.e. concerns about security, public transport, water supply and sanitation (World Bank, 2002). In addition, the estimated cost of clearing the maintenance backlogs on road network would amount to one per cent of GDP a year for five years (Izvorski and Kahkonen, 2008).

To underline once more, the link between infrastructure and growth is not clear, particularly in the country notorious for the lack of data and research in this area. Understandably, this prevents selecting right priorities and makes policy recommendations not firmly grounded. On the other hand, the better the appropriate infrastructure development priority and project identification, the higher the possibility of good impact of a sector/ project on economic growth would be.

Several recent articles try to estimate the minimum rate of return that private investors would like to achieve from a project in a given country. Setting aside the issue of strategic positioning that could be leading foreign investors toward a certain country, the returns required to undertake an infrastructure project in lower income countries have to be at least 2-3 percentage points higher than in richer developing countries and more than twice what is generally expected in projects in developed countries (Estache, 2008).

This implies that average tariffs/tolls necessary to generate the minimum required rate of return in a country such as BiH has to be higher than in many countries as it needs to cover a higher cost of capital. This is pretty difficult to hold, and few private investors are willing to do so. This explains why these days there is a lot of noise in BiH regarding the divestiture of the telecom and the energy sector. These are very attractive sectors in transition economies as economic returns on investment projects average 30-40 per cent for telecommunications and more than 40 per cent for electricity generations (Estache, 2008).

A favourable political, economic and social environment is crucial to attracting investment to the country, as unfavourable environment may preclude financing with private funds. The more stable the political, economic and social conditions, the better outcome the BOT projects will achieve (Qiao et al, 2001). For instance, the experience of transition countries clearly points to the importance of achieving public acceptance of BOT model. Issues that should be adequately addressed in BiH include public perceptions relating to environment issues, the relationship between tariff (toll etc.) levels and local standards and ability to pay, the “unfairness” of charging tolls/tariffs, and profits earned by investors. New initiative such are public hearings could be introduced and regularly held to discuss alternatives, in respect of EU directives.

2. Case Study

Despite being funded by private investors, a BOT project is a public project, with socio-economic value. That was not properly understood in a potentially first BOT project in BiH, started in November 2004 when a 30-year BOT concession for the Vrbas hydro-cascade was awarded. The authorities of the Republika Srpska (namely, the tender commission, the Government and the Parliament) awarded the contract to build, operate and transfer the HES Vrbas consortium led by Gradjevinar, based in Kraljevo in Serbia, which participates with 1 % in the capital, and the Slovene firm Vijadukt, that owns 99 % of the capital. The two enjoy the financial backing of Messerschmidt-Bölkow-Blohm (MBB), an affiliate of the DaimlerChrysler group, while Germany's Siemens is also involved in the consortium.

The cascade comprises two power stations, both on the Vrbas River: Banja Luka Niska HPP (37.2MW) and Krupa HPP (48.5MW). Expected average annual output is 186.94GWh and 140GWh respectively. Estimated project costs amount to 164,722,000 EUR. Five years of the 30 are expected to cover project development and construction, with the Consortium exploiting the resultant hydro-plants for the remaining 25 (Athens Process Newsletter, 2005).

However, even with the contract signed the construction of the cascade has not started by these days. An environmental study was to be carried out, but local ecological groups were against the project, as it was situated in an area that has been protected for the last half-century. At the end of 2005 the project came to a deadlock when the Government of Republika Srpska, obviously being aware of these protests, did not want to give its opinion on the initial design of the project, despite being obliged by the contract to do that. As a result, the Consortium ceased its activities on preparing the environmental study. Ever since there were no activities by August 2007 when the Government of Republika Srpska invited the Consortium to renegotiate. Its proposal for the Consortium was to carry out activities on just one hydro plant, namely on Krupa HPP, and delay activities on Banja Luka Niska HPP for sometime in the distant future.

In the case of one-side breach of contract, the Geneva court would be the place for resolving disputes. According to certain estimates, the Consortium the claiming damages from the Consortium could amount to130 million EUR.

3. Legal And Regulatory Frameworks

It is obvious from the aforementioned case that well-drafted policies, laws and regulations and their strict enforcement are necessary to support the successful implementation of BOT projects. However, in BiH, even a general policy framework for the private sector participation (PSP) has not been established yet. Some laws refer to policy framework documents, but these 'policy' documents cannot be identified, or rather they are mostly missing.

The BiH governments are committed to a sound concession program. They have enacted legislation to encourage concessions at the state and entity level. Further, there are concessions commissions established at the state and entity level that are tasked with passing bylaws. For instance, the Commission for Concessions of BiH adopted the Book of Rules on Request Submitting Procedure and Concession Granting Procedure July 11, 2006.

Policy papers on granting concessions have been adopted at the state and entity level. So, on July 2006, the Council of Ministers of BiH adopted 'Policy paper on granting concessions in Bosnia and Herzegovina'. According to the Paper, business environment in BiH has been significantly improved over last several but there are still many areas to be improved:

> 'This, first of all, refers to the adopting of the international standards and the developed practice of investing into concession projects through the participation of the private sector (PSP – the Private Sector Participation) and public private partnership (PPP – the Public Private Partnership), as well as the recommendations and guidelines of the EU in the field of concession investments.'

Further, in addition to the concession laws, there is need to define more precisely the granting of concessions in the laws for individual sectors (waters, forests, roads, rail traffic, postal traffic and telecommunications, energy supply, mining,…) as granting concessions varies from one sector to another, due to a series of specific features of each such sector (Policy Paper, 2006).

In short, it would be very useful for the BiH governments to draw up a policy regarding private sector investment in infrastructure projects, part of which could be a BOT Programme. Such a programme would identify whole spectrum of permissions under various laws (e.g. on zoning, acquiring land, protection of the environment, obtaining site development approvals, use of underground water reserves). The BOT programme would consider how to establish a consistent, overall and up-to-date legal framework to address all legal issues that arise when a BOT scheme applied. Legislation fit to cover such legal issues should include at least the following laws:

Table 1: Current Status of BOT Legislature

LEGAL ASPECTS	CURRENT STATUS
1. Concession	
concession laws	The laws regulating the issue of concessions are: • the Law on Concessions of BiH • the Law on Concessions of the Federation of BiH • the Law on Concessions of RS • the Law on Concessions of Brcko District and • Cantonal Laws on Concessions.
laws regulating granting concessions in specific sectors	There are the respective laws on waters, forests, roads, rail traffic, postal traffic and telecommunications, energy supply, mining with a specific regulation; these laws are dominantly at entity level
2. Contract	
contract	A civil code dealing inter alia with contracts, ownership, property rights, lease, competition, secured transactions, guarantees, including performance bonds, and other types of

	security instruments securing the proper fulfilment of obligations under the various agreements pertaining to the BOT model and other types of PPP, etc
property	Ownership is subject to environmental, zoning, building and similar rules which are aimed at protecting the public interest
intellectual property laws	These laws protect IP rights involved in a BOT project, protecting patents, know how, licenses, etc.
3. Special Purpose Vehicle	
company laws	There are companies laws at the entity level. They requires 12 procedures, takes 54 days, and costs 30.07 % Gross National Income per capita to start a business. BiH is ranked 150 overall for Starting a Business among 178 countries (World Bank, 2008)
bankruptcy laws	There are bakruptcy laws at the entity level. BiH is ranked 61 overall for closing a business among 178 countries (World Bank, 2008)
4. Public Procurement	
laws dealing with public procurement	The Law on Public Procurement for BiH, based on EU policies; a public tender for awarding contracts is open domestic and foreign entities, but foreign bidders face certain disadvantages for both procedural and substantive reasons (Bajramovic, 2008) e.g. obligatory preferential domestic treatment remains in force and is being phased out at a rate of 5% every two years until 2011, when it is due to be abolished. The electricity sector is excluded from this preferential domestic treatment in November 2006.
5. Foreign Investment	
foreign investment laws	The Law on Policy of Foreign Direct Investments in BiH tries to harmonise 'a labyrinth of formal and informal rules across the state, entity, cantons and municipal levels (EUTPP, 2007)
6. Taxation	
domestic taxation	• VAT at the country wide level • Corporate Income Tax and Personal Income Tax at the entity level • foreign investors are exempt from custom duties for capital goods
international taxation	23 ratified agreements on avoidance of double taxation aimed at eliminating the double taxation of income
7. Judicial and Business Disputes	
bilateral investment agreements	35 agreements on the promotion and protection of foreign investment
multilateral convention on investment	• Convention on Recognition on International Arbitration • Guidelines on the Treatment of FDI adopted by the World Bank

	• ICC Guidelines on Foreign Investments • United Nations Commission on International Trade Law (UNCITRAL) • Convention on Multilateral Investment Guaranteeing Agency (MIGA) • Convention on Solving Investments Disputes between States and Citizens of other States (ISCID) • Energy Charter Treaty (ECT), dealing with foreign investment within that sector
commercial mediation system	System was established in May 2007 in order to reduce the potential risks foreign investors are facing
a code of civil procedure	A code of civil procedure that lays down the rules for a fair trial
conflict of laws rules	Conflict of laws rules, according to which the applicable law is determined as well as the competent court, and the procedure for the recognition and enforcement of foreign court decisions and arbitration awards
8. Transactions	
laws on BOT transactions	There are no laws on PPP transactions at any level.
9. Building	
a law on construction	A law on construction providing for standards which constructors have to comply with
a law on zoning	• A law on construction providing for standards which constructors have to comply with • There is legislation on land use planning (zoning) at entity and cantonal level regulating land use
environmental legislation	Environmental issues are dealt with primarily at entity level. At State level, the Ministry of Foreign Trade and Economic Relations has the authority to deal with some issues concerning natural resources, including environmental protection. Further efforts are needed towards ratification of the relevant international conventions (the Espoo Convention, Montreal Protocol etc.) (CEC, 2007)

Conclusions

A great many of the infrastructure projects in BiH could be financed using the BOT model or one of its many variants. As the practice of BOT models has evolved in transition European countries as elsewhere in the world during the 1990's and 2000s, a firm ground for the BiH governments has been established. They can take a strategic and structured approach to the introduction of BOT models as a new and significant policy initiative for delivering infrastructure and related services across a range of sectors.

However, analyses of failed BOT projects in developing and transition countries suggest that these projects were unsuccessful because of poor legal and regulatory framework. Accordingly, it is advisable to consider the establishment of a BOT Centre in BiH with the responsibilities of (i) spelling out the manner in which private sector can participate in the infrastructure development and (ii) contributing to establishing rules for private sector participation in public infrastructure projects through BOT mechanisms. The Centre would provide technical assistance to various government agencies involved with private sector participation, and would not have regulatory role or real power outside that of suggestion.

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THE IMPACT OF CONSTRUCTION DYNAMICS ON PUBLIC BUILDING DESIGN ON THE EXAMPLE OF ELEMENTARY SCHOOL „SESVETSKA SOPNICA“

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Abstract:

The recent construction of public buildings use minimal time-limit (about 6-8 months).

Dynamism of the construction begs the question of the design of such buildings and using the materials that should reach the construction quality in such a short time.

The paper will describe in more detail the apprecciation which deals with this problem area by the example of the construction of the primary school „Sesvetska Sopnica“, finished last year, 2007.

Keywords: construction, school

1. INTRODUCTION

The design criteria for public buildings are directly dependant on and closely connected with complex social and political context of the building environment. The dynamics of project realisation is seldom the result of multiannual postponement of addressing such extensive problems which involve the shortage of public buildings in our society. Once the issues are recognised and their solution is initiated by announcing the invitation to tenders for construction of either school or kindergartens, it is already presumed that the project will be realised until the next academic year. These plans are sometimes foiled by unresolved complex ownership and cadastral issues regarding the plot itself, but in case when there are no hindrances, the municipal government *a priori* presupposes project's impending realisation by selecting the most acceptable solution.

The shortening of construction deadlines, among other things, is also dictated by practices of modern capitalist economy which is concerned only to secure high and speedy return on invested capital. The architectural practice, thus, ceases to be solely the ethical component of the building construction and must also address the complex issues of fast and high quality realisation of the project. When the construction process commences each error in planned realisation dynamic will mostly result in insufficiently deliberated on-the-spot solutions, which will directly undermine the building quality or, at least, have a considerable impact on its final shape.

2. DESIGN DOCUMENTATION

2.1. Preliminary design

In May 2006 the invitation to tender had been announced for the construction of an alternative building for elementary school in Sesvetska Sopnica.

In 1983 the prefabricated, ground floor elementary school building with boiler room was erected on the exceptionally small plot of only 14,076 m² (the no. of cadastral plot 2730/2 of cadastral municipality Sesvete). The project was made by a Zagreb-based company, INŽENJERING – PROJEKT, and the prefabricated building was manufactured in the company MARLES from Maribor, Slovenia. The existing prefabricated elementary school building was used for the activities and the needs of the 2nd Elementary School "Luka" branch and the "Leptir" kindergarten branch from Gajišće, Sesvete. On the north-western part of the plot the open, asphalt covered playground (basketball, handball/ mini soccer) with layout dimensions of about 33 x 55 m. The part of the plot that exits on Sopnička Street was arranged as a parking lot for passenger vehicles by the elementary school management. The rest of the plot is maintained as a grassed area with the regulated Sopnica brook on its south-western side.

The existing school building was situated almost at the very centre of the plot with the exceptionally irregular shape, while the larger part of the area was occupied by an open, asphalt-covered playground. The competition programme implied the construction of new school building of about 5.000m² with the preservation of the old building and the open playground during the construction period. Its concept, thus, was based on the two stages of the construction: the first stage included the annexing of the old school building while during the second stage the old school building would be demolished and the construction of the new building completed.

This competition entry, however, all necessary capacities of the new building entirely placed on the free part of the plot enabling, thus, the construction of new school building in just one stage while the demolition of the old building was planned only after the new building with all needed facilities is completed. This concept ensures the continuity of the teaching and learning process in the old building without the unnecessary construction works and connecting of the two buildings. It was the only competition entry that offered such original conceptual solution i.e., managed to meet the requirements of the project in just one stage, which largely influenced the selection of this solution for the construction of the new school (Fig.1). The identification of issues regarding the construction dynamics of public buildings and the necessity of their continuous utilisation also considerably influenced the deserved recognition of such approach.

Fig.1

2.2. Main project

The main project of this elementary school building was conceived in a manner which enables simple and speedy realisation dynamics.

The bearing structure of the building consists of east and west side structural expansions.

Eastside structural expansion consists of two levels: the ground floor and the first floor. The bearing structure is made of a skeleton framework with reinforced concrete columns (dia. 30cm) in regular grid (3.00m x 6.00m) which support 20 cm thick reinforced concrete slabs. Above the columns a grid of 20 cm wide, reinforced concrete beams is placed which support slanted, reinforced concrete roof slabs. Due to continuous and balanced load and the simplicity of construction process the strip footing foundation has been planned for this building.

Westside structural expansion consists of three levels: basement, ground floor and the first floor. The bearing structure is a combination of 20 cm thick reinforced concrete walls (in the basement and in one part of the ground floor and the first floor) which support 20 cm thick reinforced concrete slabs and spatial steel lattice structures over the areas of larger dimensions and which is reclined on the reinforced concrete wall structure in the basement over steel columns. The trapezoidal sheet roof is mounted above the steel greed. Due to larger spans of the main structure bearers and the stress to which the basement floor structure is exposed it was planned to make the foundations on the reinforced concrete bedplate (25 cm wide) with 50 cm thick strip reinforcements (Fig.2, Fig.3).

The exceptional regularity of the bearing structure concept brings to the significantly shortened construction process due to large number of repetitions.

The formative idea of this architectural solution originated from the rhythmic interpolation of two pitched surfaces whose permeation breaks down the total volume of the school building blending it, thus, with the style of the neighbouring buildings.

The formative idea has been realised by application of two materials which establish the character of lightweight, translucent membrane of building envelope: lining sheets of pitched roof surface, which retract and extend over the building envelope to the first floor level, and the envelope surfaces made of reflexive glass panels, in which the nearby greenery is reflected, dematerialise the total volume of the building creating, thus, the effect of floating sheet surfaces.

The applied materials require minimum intervention on the construction site because they are delivered and built in as final products.

The Kalzip® trapezoidal liner sheets used for roof covering were delivered to the construction site in rolls in order to facilitate the transport and were mechanically profiled on site in a very short time. The length of finished liner sheet can be identical to the sheet roll enabling, thus, quick and easy installation on the roof avoiding, thus, the lateral installation of the sheet strips. The lining sheets are longitudinally fixed to the substructure of the roof construction by means of extruded clips. The complete school building project was modulated according to Kalzip® lining sheet strips which are 400mm wide; the building was broken down into a number of elements which begin and end with the extruded clip, and their pattern also continuously extends from the roof over the envelope of the building.

Continuous glazing surface is made up of several modular frames (which are actually multiple 4000mm lining sheet modules).

The interior partition walls were made from gypsum boards and the process of their dry fitting was the crucial factor in the speedy realisation of this project.
In sanitary facilities the water resistant concrete panels with the washable coating were used for final panelling.
The use of all mentioned materials resulted in speedy settlement of relatively small number of repetitive details which largely influenced the construction process dynamics.

2. REALISATION

The applied approach enabled a simplified design process and the possibility of taking into consideration all parts of the building without the usual assistance of fellow co-workers.

During the project realisation process there was a serious injury risk to children who were attending their everyday classes and had to walk very close to the construction site but, fortunately, no such incident occurred. All previously contracted construction materials were timely delivered and used for the construction of new school building and the construction dynamics followed the planned deadlines.

The construction process was completed in a very short time. The construction site was opened in January 2008, the building was completed in August 2008 and in September 2008 the new academic year started in new school building (Fig.4, Fig.5).

3. CONCLUSION

The elaboration of the project with a series of modular and unified elements was one of the main reasons which enabled the completion of building in such short time. The role of the architect is extremely important in this case because, when involved in this type of project, he must take into consideration both the construction dynamics as well as all other elements which may endanger the project and its realisation.

Regardless of the dynamic of the project, due to the deliberations on materials and construction process, the structural quality of the building remains undisputed. The elementary school building project has been nominated for the „Viktor Kovačić" award as the most successful architectural accomplishment in 2007.

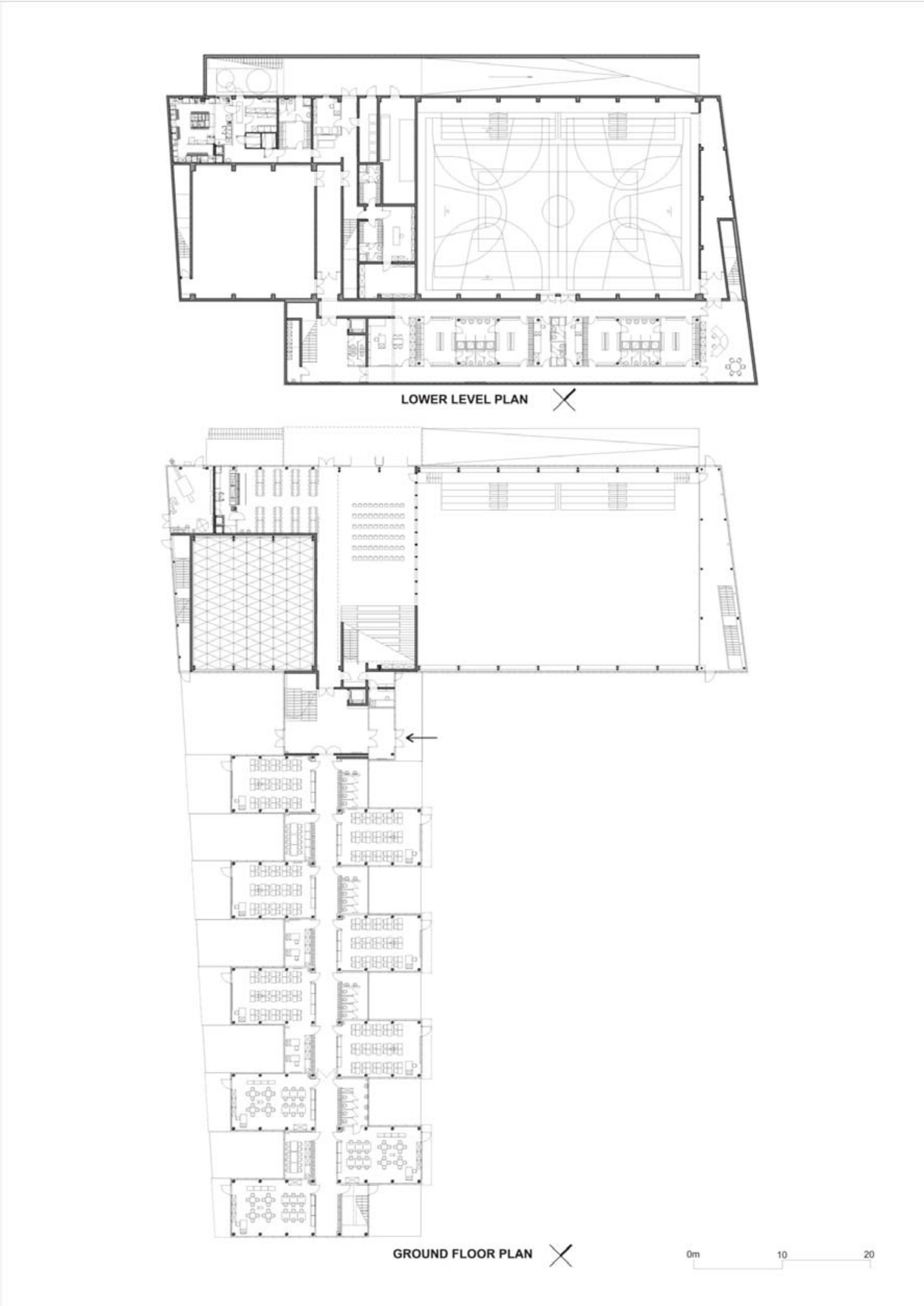

Fig.2

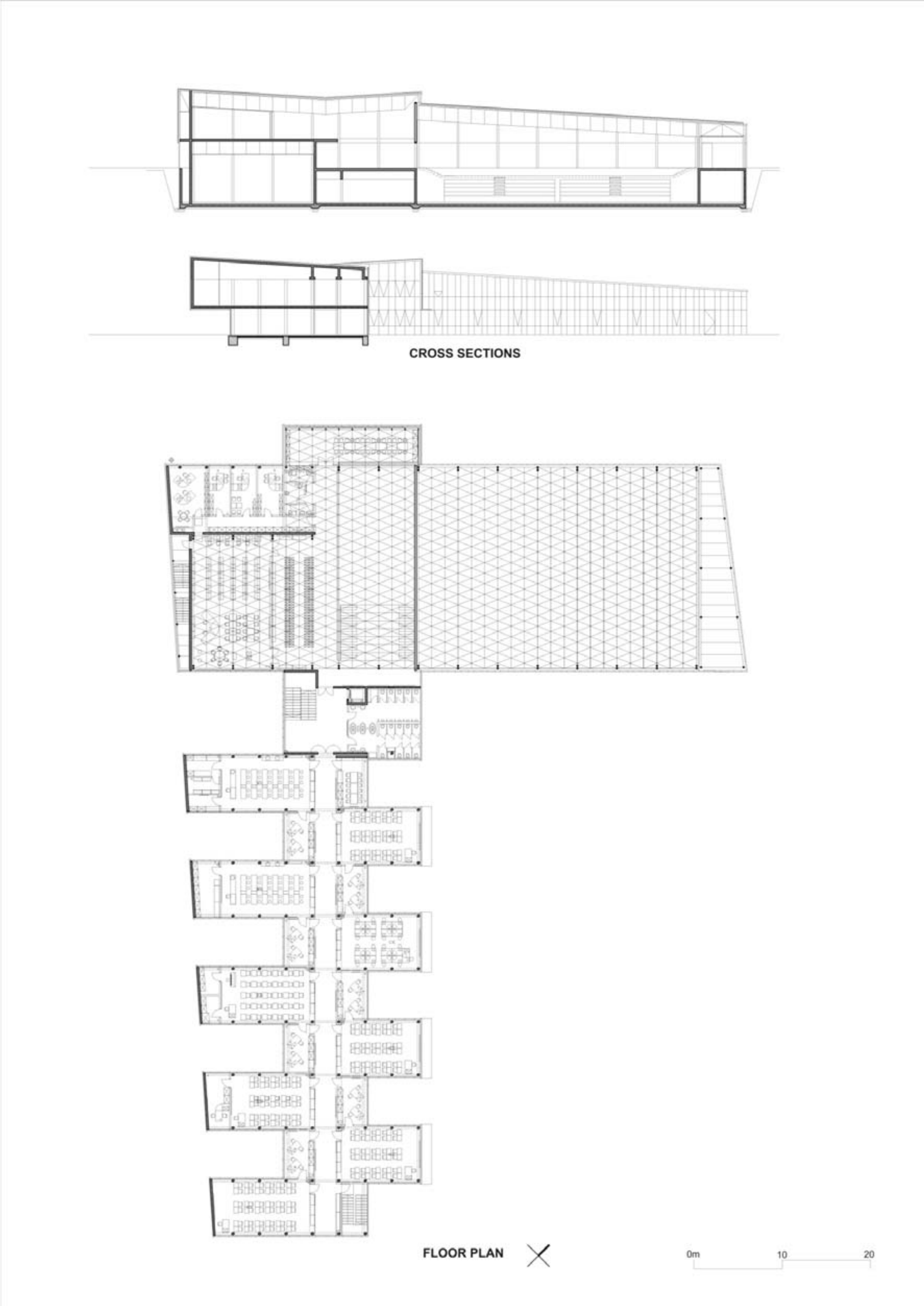

Fig.3


Fig.4

Fig.5

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SUPREVISING ENGINEER ROLE WITHIN THE CONSTRUCTION PROCESS

Ernest Ević[1], Hrvoje Anton[2], Dijana Čilić[3]

Summary

The supervising engineer role, along with other participants in the construction process, is being defined by legal regulations out of the sphere of construction. Depending on the sort of the project issue and the requests of the investor, the supervising engineer might have other obligations as well, which at most instances implicit the inclusion of the consulting services and project control throughout its financial part. By such obligations which are mainly defined by the contract with the investor, along with those which are imposed by the legal provision, the supervising engineer might also have significant impact to the organization of the construction site, processes performed during the construction, as well as to relations between the participants of the construction. In this document, there had been elaborated the supervising engineer activities on the construction site, which by their performance quality have impact to the weather conditions and financial aspects of the project, and are also partly presented through years of experience of the authors engaged on the expert supervision issue.

Key words:
supervising engineer, construction participants, investor, construction process, construction design management

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INTRODUCTION

Based upon Law on Spatial Arrangement and Construction, Article 177, there had been defined the participants within the construction procedure, i.e.: investor, designer, reviewer, contractor, supervising engineer.
All of the participants should, within the construction procedure, act in accordance with legal provisions and in pursuance with contracted obligations in order not to make any harm to the public interest, environment and private interests of other persons. All of them have the same goal to finalize the project or bring the construction itself in its narrower sense to its end, and as far as the time schedule, costs and quality issues are concerned, not to recede from the defined parameters stipulated by the contract documents.
Throughout this paper there shall be explicated the role of the supervising engineer, his rights and obligations, as well as his posture within the construction process of the structure on which he is supposed to perform the supervision, terms posed to the supervising engineer, documentation which should be followed during the construction works and reports, which at the moment of finalization of the works but prior to the technical inspection, should be presented to the commission in charge for the technical inspection.

SUPERVISING ENGINEER AS PER THE LAW ON SPATIAL ARRANGEMENT AND CONSTRUCTION

In Article 184 of the Law on Spatial Arrangement and Construction, there is being mentioned that the supervising engineer is a physical person who, according to a separate law, has the right of using the expert title - authorised architect or authorised engineer, who in the name of the investor performs the expert supervision of construction works, in case the same fulfils the terms regarding construction works in accordance with a separate law and provisions brought based upon such a law; in the same Article there is also being mentioned that the supervising engineer might not be an employee of the contractor engaged on the same construction.

In Article 185 of the said Law, there are stated supervising engineer obligations during the construction, and there are also being stated that during the expert supervision of the construction works, the supervising engineer is obliged to perform the following:

- supervision the constructions works so that they meet the concept regarding the terms of construction approved by the main design, i.e. by the construction permit, Law on Spatial Arrangement and Construction and special ordinances, too;
- determine weather the main design regarding horizontal and vertical dimensions and purpose of the constructions were performed in accordance with the conceptual design on construction terms, i.e. location permit in case of building constructions out of Article 205, paragraph 2 and 4 of this Law;
- determine weather the construction stakeout had been done by the person authorised for performing state measurements and land registry of real estates, all in accordance with a separate Law;
- determine weather the contractor fulfils conditions for performing construction activities prescribed by a separate Law;

- determine performance of check procedures regarding evaluation of pursuance, i.e. quality proof of certain parts of the construction which should be done by the authorised person who had not participated in procedures of issuing documents and proofs out of Article 182, paragraph 1, point 3 of this Law – for all construed parts of the structure and for works in procedure in cases where by this Law, by regulation brought based upon this Law by a separate regulation or by the design, there had been prescribed such an obligation;
- immediately inform the investor on all defects, namely, anomalies which he realises during the construction procedure, and to inform the investor as well as the construction inspection and other inspection bodies on measures that had been undertaken;
- work out the final report on performing the construction works.
- During the supervision of the construction works, and in case of necessity, the supervising engineer is obliged to determine the mode on which defects, i.e. anomalies of the construction of the structure, shall be eliminated, in case if:
- the contractor fails to ensure in the appropriate way the documents out of Article 182, paragraph 1, point 3 of this Law;
- by documents out of Article 182, paragraph 1, point 3 of the Law on Spatial Arrangement and Construction, there had not been proved the pursuance, i.e. in case there had not been proved the quality according to the requirements of this Law, prescriptions brought based upon this Law, separate regulations and the main design;
- contractor, i.e. responsible person in charge of the construction works out of the Law on Spatial Arrangement and Construction, fails to fulfil terms prescribed by the separate law;
- stakeout of the structure has not been done by the authorised person for performing state measurements and land registry of real estates in accordance with a separate law.
- The mode of defects, i.e. anomalies elimination out of the paragraph 2 of this Article, should be filed with the daily progress diary.

Terms for the main supervising engineer appointment as well as for participants in construction procedure responsible for the appointment of the same, are defined by the Article 187 of the Law on Spatial Arrangement and Construction.

According to the Law regarding structures on which several sorts of works are performed or comprehensive works, the expert supervision should be performed by more than one supervising engineers of appropriate expertise. The investor is obliged to appoint the main supervising engineer who should be responsible for the entirety and mutual harmony of the expert supervision on construction, and is obliged to work out the final report. Main supervising engineer might at the same time act as a supervising engineer for certain sorts of works.
On certain areas of construction or other expertise, there had been brought technical ordinances and norms, where aside of the afore mentioned obligations of the supervising engineer in pursuance to the Law on Spatial Arrangement and Construction, there had been regulated relations between all of the participants in construction, and had been clarified in details all preliminary actions of the supervising engineers for certain construction phases. So, for example, by a Technical regulation on concrete constructions, there had been defined a norm HRN ENV

13670-1, which defines relations regarding concrete and reinforced concrete structures.

CONDITIONS WHICH THE AUTHORISED ENGINEER SHOULD FULFILL WITH PERFORMING THE EXPERT SUPERVISION

For the purpose of performing tasks of the expert supervision, the engineer of a certain expertise should comply with the conditions prescribed by the Law on Croatian Chamber of Architects in construction, by which there had been defined the basic organization, scope, public authority and membership with the Croatian Chamber of Architects in construction. With a purpose of improvement of the members' work performance, within the frame of the Chamber there had been formed experts' grades which present a form of linking members of the expertise and their organizing between themselves and who are the performers of certain works; each member to the Chamber is at the same time a member to one of the experts' grades. Experts' grades are as follows: experts' grade of architects, experts' grade of civil engineers, experts' grade of land surveyors, experts' grade of machinery engineers and the experts' grade of electrical engineers.

Both, authorised architects and authorised engineers acquire their membership to the Chamber by registering with the Directory of Authorised Architects and Authorised Engineers. The right of being registered with the Directory of Authorised Architects and Authorised Engineers attains the person fulfilling the following conditions:

- be a Croatian citizen;
- be entirely business-like capable;
- be in health shape for performing tasks;
- be in possession of his Diploma with the appropriate Technical Faculty of the Republic of Croatia, who acquired the title of B.Sc. Engineer of a certain expertise;
- be a person who upon its study had worked at least three years under the supervision of the authorised architect and/or authorised engineer;
- be a person who passed the exam for performing works in construction the facilities, i.e. a different appropriate expert check exam on the knowledge of regulations out of the construction branch;
- be a person upon whom there not been raised investigation, i.e. that against the same there had not been raised criminal proceedings due to a criminal action led per the official duty;
- be a dignified person for performing architectural and engineering activities;
- be a person who does not perform activities not being linked with architectural nor engineering activities.

In case the person submitting the request for being registered with the Directory already passed the final exam abroad with a high education institution or any other worldwide acknowledged institution, it should be considered that the same complies with the conditions on membership, but such a person is being obliged to attain acknowledgement on his Certificate of Education, equivalency, all pursuant to a separate regulation.

Registration with the Directory of Authorised Architects, i.e. Authorised Engineers, might be approved to a foreigner even in instances the same does not comply with all of the mentioned conditions; and under the circumstance the same is a member of the Chamber of Architects or Engineers within the country of his citizenship, and under the condition of mutuality.
Exceptionally, the registry with the Directory of Authorised Architects, i.e. Authorised Engineers might be approved to a person who had not acquired the title of high graduated engineer, but if the same has a ten-year-experience in profession on jobs mentioned in Article 1, paragraph 2 of the Law of Croatian Chamber of Architects in Construction, and if the same person has proved its prominence throughout its work.
Conditions and criterion for registry with the Directory of Authorised Architects, i.e. Authorised Engineers of the persons who had, upon their studies, worked for at least three years under the supervision of the authorised architect and/or authorised engineer, should be brought by the Chamber's authorised body determined by its By-Laws.

Membership with the Croatian Chamber of Architects and Engineers in Construction, might not achieve the person sentenced for a criminal action against the Republic of Croatia, for criminal action against official duty, for criminal action made for self-interest and which make such a person indecent for performing architectural and engineering tasks according to a Code of ethics expertise.

TASKS OF THE SUPERVISION ENGINEER AND MAIN SUPERVISION ENGINEER ACCORDING TO CONTRACTUAL OBLIGATIONS

Legal person, who performs supervision, i.e. supervising engineer and main engineer, should be included into the design prior to the very beginning of the construction process. Beginning of supervision starts upon the supervision contract being concluded and ends at the moment of commissioning the facility.

Supervising engineer takes over from the investor the design documentation, contracts on construction accompanied by bill of charges and the document on appointment of the main supervising engineer, by which the legitimacy of the actions is being acquired.

Apart from the supervising engineer obligations during the construction phase and which is prescribed by the Law on Spatial Arrangement and Construction and legal prescriptions out of the area of construction, and which had been mentioned in previous chapters of this paper, there also exist obligations which are mainly stipulated by the contract with the investor or the ordering party.

Some of the obligations of the supervising engineer, and which are most frequently presented as integral part of the contract on submitting service of expert supervision, are as follows:

- performance of expert supervision in pursuance with Article 185 of the Law on Spatial Arrangement and Construction (National Gazette 76/07);

- studying the design documentation in order to determine eventual anomalies and presenting proposals for eliminating the same;
- in case of large volume anomalies within the design documentation, supervising engineer should submit written form objections;
- taking care that quality of the works, installed material, semi-products, products and equipment, are in pursuance with requirements of the bill of charges and that the quality had been proved by prescribed test methods and documents;
- continuous performing the control and signing the Time-book which is in charge of the contractor on the construction site;
- daily signing of the Daily Dairy on the construction site which is in charge of the contractor on the construction site, and filing into the same Dairy written form orders to contractor for performance of eventual subsequent works;
- controlling and verification in certain periods - and for the purpose of the contractor -temporary monthly based situations, performance of final calculation and organizing acceptance of the works and facilities;
- taking over from the contractor offers for subsequent and out of the bill of charges works accompanied with analysis of unit prices, and upon analysing the same, the supervising engineer approves the same;
- introduces to the contractor work procedure by submission of documentation and filing with the Daily Diary, and coordination of all of the participants involved in construction regarding tasks of realization;
- control of the construction time schedule and financial plan of realization; submission of consent, and submitting the Ordering party regular reports comprising proposals on how to come up with eventual delayed issues and sorting the works within the frames of planned time schedule;
- participating in work out of analyses of finalized works by checking few or more actions as well as subsequent and out of the bill of charges works;
- control of the start date of the works, interim time programme of certain phases and the completion date;
- participation in work out of feasibility study for entering into eventual additional contracts;
- organizing the work inspection by authorised expert institutions for the purpose of obtaining certificates and opinions on specific works and equipment;
- organizing technical inspection and preparing and completing documentation necessary for technical inspection of the facility;
- ensuring temporary or permanent expert collaborators for performing a portion of expert supervision, and such persons should have appropriate expert qualifications and authorisations for performing their portion of expert supervision;
- checking the existing situation of adjacent buildings and other structures for the purpose of eventual disputes in case of accrued damages during performance of the construction works;
- during construction works, taking photos on a daily base of all phases of the works, and upon the works finalization, such material should be submitted to the investor in an appropriate media (electronic one).

Out of above contractual obligations it might be evident that supervising engineer, apart from performing classic mode of supervision of the works performance, also performs a certain part of tasks regarding design management and follows up the realization of the works. Owing to this fact, investors do engage in designs more and

more frequently other participants too, like consulting engineer and site design engineer. There exist no legal provisions that would govern their tasks and obligations, since the same are selected by the investor himself based upon his own needs, and the investor is the one who defines in the contract the volume of services and responsibilities on time schedule, costs and quality.
In case the investor enters the agreement on consulting with a legal person and a contract on supervision, it might happen that the very one physical person plays double role – site design engineer and supervising engineer, too. With smaller-scale investments and structures, this is preferable due to easier communication between participants in construction. With large scale investments and projects, it is better to separate these two roles so that supervising engineer takes care of the construction site and the site design engineer controls the performance of the contract itself, controls the costs, manages the risks and informs the investor on all such issues.
It should be mentioned here that the supervising engineer might bear legal penalties for performance of his job, while on the other side - the site design engineer is responsible to the Ordering party only – i.e. to the investor.
It might happen that one very person is the designer and supervising engineer at the same time. It has its advantage since supervising engineer is acquainted with all segments of design documentation thus not spending additional time on it, but as a disadvantage would be that eventual mistakes in designs might creep in, in lack of additional control.

The mode upon which the supervising service shall be organized depends also on the issue weather the investor of the structure had obtained one or more building permits and weather the work performance he contracted with one or more contractors. It appears to be the simplest where, for the structure there exists one building permit and one contractor under the contract. The most complicated organization of supervision is where there exist few building permits and few contractors under the contract per one building permit. Such a situation very frequently happens at occasions of building up of lengthy road sections or motorways.

Relation and communication between the supervising engineer and other participants within the construction is being lawfully prescribed, and by contracted issues as well. The relationship between supervision and contractor is a specific one, since the investor and contractor have opposite interests. The contractor wishes to achieve as higher price of the facility building up as possible since the same presents its income, while, on the other side, the investor wishes to achieve as lower price as possible due to the fact that the same presents its costs. At this instance, supervision should be an independent institution, which, for the account of the investor controls the contractor in all segments of the design. There exist different opinions that between supervision and contractor there should be a relationship which confine with a conflict, all up to the opinion which imposes that the same should be friendly based, all functioning for the purpose of a common interest regarding as better realization of the design as possible. Based upon long lasting experience, the authors are proposing this relationship to be like two hedgehogs living in a common winter burrow – meaning, to be close enough to each other sharing a warm space, but being apart enough not to stab each other.

NECESSARY KNOWLEDGE AND SKILLS FOR PERFORMING EXPERT SUPERVISION TASKS

It is prescribed by the law, that the engineer who acquired his Diploma with the appropriate Technical Faculty, has a three-year-period of services under the supervision of the authorised architect and/or authorised engineer and passed his vocational ability exam, and complies with the code of his expert ethics, might perform expert supervision tasks. Owing to the complexity of the process itself, there is being imposed a question weather the aforementioned would be sufficient.

Civil engineer studies or any other studies of technical issue are primary oriented on creating the experts who would be capable - in the capacity of supervising engineer, person in charge of the construction site, design expert or performer of a certain structure – to practically apply their acquired knowledge. But, during the studies, the students do not have too many contacts with direct construction practice and which might pose negative impact to their future work, especially because of the reasons that they in their future practical work they would be compelled to solve the problems which belong out of their narrower field of specialization. This especially refers to the problems regarding management and interpersonal relations which do not present an integer part of the civil engineering expertise – in a narrower sense – but the same do present an unavoidable segment within the supervising engineer's work, since civil engineering like any other activity exploits manpower *en masse.* And also, supervising engineers coordinate and direct the operation of a certain number of people of verified profiles, aspirations and mentalities – all of these under many different circumstances. As far as professional subjects are concerned in their narrower sense, the study of civil engineering gives theoretical knowledge which at further instance makes possible solving the problems in practice. As for communication knowledge and management of the humans, the supervising engineer should act exclusively as "a man of practice" and to acquire its knowledge on interpersonal relations based upon the methods of endeavours and mistakes. In other words – supervising engineer has to have certain basic theoretical knowledge out of the area of social science which would enable him a better ingenuity in practice.

Supervising engineers' task is mostly referred to the construction site and the construction process itself. Construction site frequently happens to be located outside settlements and outside of the place of living, and the works take place in diversified weather circumstances. Closer construction sites located out of the places of living might be reached daily, but lots of time and energy resources are used for travelling. Construction sites located further give the opportunity of dwelling and periodical leave home, but in such circumstances the private life - family of all involved, suffer. In any case, there exist a possibility of stress situations to happen and which might lead to breach of the work discipline, vindicated absences, and conflicts with contractors and collaborators, too. This means that skilled supervising engineer should be a responsible, physically stable and a strong-character-person having a high level of self control and good organizational capabilities; should be adoptable to various different situations he happens to be in.

In case the supervising engineer – for example being civil engineer - is at the same time the main supervising engineer, than the same is supposed to coordinate the team consisting of several supervising engineers of appropriate expertise. Owing to the fact that the same are responsible for entireness and mutual harmonization of the expert supervision of construction works, the main supervising engineer should bring high quality and timely decisions for which he should have elementary knowledge out of electronics science, machinery, geodetics and architecture. Except mentioned expertise, for proper judgement forming, such a person should necessarily have basic knowledge out of the economy branch, law, art history, informatics and other branches. Process of judgement forming comprises lots of other components, too, which are mutually entangled: intuition, visual idea, analogy, and experience, and theoretical knowledge, knowledge on customary procedures, proposals and regulations, as well as previous solutions of similar problems.

In past ten years, there had happened the expansion of new technologies and materials applied in the civil engineering. According to certain investigations, it is considered that in civil engineering there is being used some 1.500 different products. Each of these has the issue, like: its own name, mode of application, place where it might be used and technology mode.

As it is not possible acquiring knowledge of all of the mentioned during their studies with Faculties, supervising engineers find themselves in a position of following new trends through fairs, magazines and specialised literature, and should participate in comprehensive education issues. Except to all of the mentioned, they should be well acquainted with laws, standards and ordinances, which at the period of adaptability to the EU legislation are changing - practically- daily.

CONCLUSION

Tasks of the supervising engineer, especially the one who acts as a main supervising engineer too, present a series of generally linked activities that had been defined by laws and/or on a contractual base with the investor. In order to properly perform its duties, the supervising engineer should have certain knowledge and skills, which are mostly gained through the studying and partially through practical work. As it appears that by its work, supervising engineer gets in contact with all of the segments regarding construction site issues, the same might by its activities and abilities have significant impact to the organization of the construction site, terms of work performance, and process during the construction procedure, and relationship between all of the participants engaged in the construction works.

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INTEGRATED MANAGEMENT SYSTEM -THE WAY TO INCREASE THE EFFECTIVENESS OF CONSTRUCTION COMPANY

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Abstract

An Integrated Management System (IMS) for construction firms consists of three key subsystems: Quality Management System according to ISO 9001:2000, Environmental Management System according to ISO 14000:2004 and Health Protection and Safety Management System according to OHSAS 18001:2007. There is described in my contribution model of IMS and basic principles and processes concerning the development and implementation of this integrated system. Implementation of IMS leads to quality production improving, safety of all employees of construction firm, application of all national and international standards concerning the environmental aspects and finally to customer satisfaction.

Keywords: Integrated Management System, Construction, Quality, Environment, Safety

1 Introduction

The quality and reliability of buildings, health and safety of all employees and keeping of all environment regulations on national and international level must be one of the most important factor of each construction company, which plans to be successful on world market.
The development and success implementation of IMS is not easy role, especially in bigger companies. The key role has director of the company. This person must have before IMS development basic information about this process and must constitute the representative of its company (Manager of IMS), who will be responsible for IMS development, implementation and improving. This role can plays in cooperation with professional advisor.
More and more construction companies in Slovakia have interest to work at IMS. IMS consists of three management systems (Figure 1): Quality Management System (QMS) according to ISO 9001:2000, Environment Management System (EMS) according to ISO 14001: 2004, Health and Safety Management System (HSMS) according to OHSAS (Occupational Health Safety Assessment Series) 18001:2007.
The model, structure and basic processes and activities of IMS are shown in table 1.

2 Company IMS policy

The director of construction company is responsible for IMS vision and policy, which consists of:

- quality policy,
- environmental policy,
- health and safety policy.

IMS policy must involve commitment of construction company top management to:

- satisfy customer requirements and continuously increase the effectiveness of IMS,
- implement preventive principles in quality, environment, health protection and safety area,
- keep the legislation requirements in quality, environment, health protection and safety area,
- increase education and awareness of all employees in quality, environment, health protection and safety area by periodical training process,
- inform public, state administration and local government about the company activities concerning the quality, environment, health protection and safety,
- create for company employees work conditions with aim to prevent creation of non-conforming quality of products, negative influence to human organism during the work activities and damage the health of all employees,
- active involve of all company partners and sub-contractors to IMS.

All employees of construction company must be inform about IMS policy and try to keep it in practice.

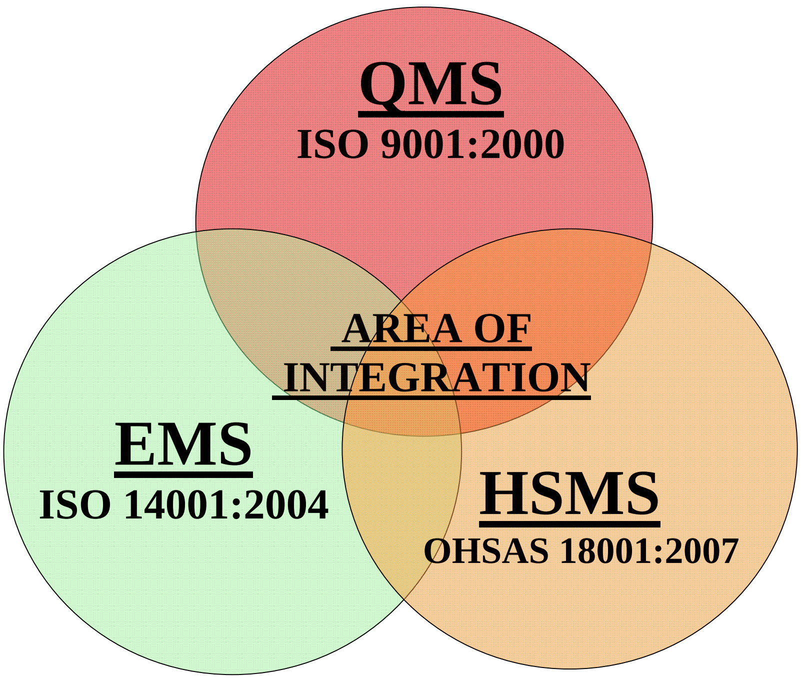

Figure 1. Integrated Management System

Table 1. Model of IMS

Step	Basic processes of IMS	SUBPROCESSES		
		QMS (ISO 9001:2000)	**EMS** (ISO 14001:2004)	**HSMS** (OHSAS 18001:2007)
01.	**Company vision**	Quality Policy	Environmental Policy	Health and safety Policy
02.	**IMS Planning**	1. QMS processes analysis 2. Interaction of QMS processes 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 program	1. Identification of dangers and threatens 2. Registration of law and other requirements 3. Risk evaluation 4. Health and safety objectives and targets 5. Health and safety program
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

3 IMS planning and key documents

During the process of IMS planning is useful start with QMS and to analyze of all processes according to ISO 9001 [1], create interaction of these processes, approve quality documents and forms of future records. One of the most important document on building site is Project Quality Plan (PQP), and its part Inspection and Test Plans (ITP) [2,3]. The content of these documents is in Figure 2.

PROJECT QUALITY PLAN
Content

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

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 program, how to meet environmental targets.

The most important steps concerning the development of HSMS are:

- 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 program, how to health and safety targets fulfill.

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 2,

C - consequence to environment and to health of employees –see table 3

On the value of risks we can define risk categorization and management –see table 4.

Table 2. Probability „P“ of incidence of environmental aspect and impact or dangers and threatens

Probability	P (points)
low	1
middle	3
high	9

The basic document of integrated management system is manual of IMS, 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,

Table 3. Consequence „C“ to environment and to health of employees

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 4. Risk categorization and management

Index	Risk „R“ (points)	CATEGORIZATION OF RISK	MANAGEMENT
I.	1-14	Insignificant risk	Not required
II.	15-80	Plumbles risk	Is required
III.	81-135	Seriously risk	Is necessary

corrective and preventive actions, can be implemented for all management systems.

For EMS are useful except of IMS manual procedures concerning the environmental aspects related to building processes and site conditions and for HSMS is useful health and safety building manual, in which are described necessary health and safety preventive actions for building employees.

4 IMS implementation, monitoring and audit

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. The requirement of EMS and HSMS is to prepare employees of company to possible emergency situation.
The basic documents concerning the quality, environment, health and safety monitoring on building is *inspection and test plans,* 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.
After some time of IMS implementation and operating (min. 3 months) is necessary 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.

5 Conclusion

Development, implementation and improvement of 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 include all employees of company and each person must try to find the way to customer satisfaction, safety work and environment protection during the building process

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APPLICATION OF A FUZZY LINGUISTIC APPROACH IN MAKING A BID/NO-BID DECISION FOR CONSTRUCTION PROJECTS

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Abstract

Bidding process is one of the most important stages related to construction projects. Making the right bid/no-bid decision is of great importance for a company doing business in the open market. A basis for a successful bidding strategy of company's products or services is a concentration of effort in the preparation of winning proposals that will assist in meeting company's objectives. There are various methods that can assist managers in making better bid/no-bid decisions by concentrating on the preparation of proposals that will, if successful, facilitate meeting the company's objectives. Given the fact that criteria for making a bid/no-bid decision cannot always be quantitatively determined, the paper proposes a fuzzy linguistic method that enables making a decision on the basis of qualitative criteria and linguistic terms that are being evaluated by various experts. The method is suitable for interpretation in case of uncertain or approximate thinking that involves human intuition, taking into consideration evaluator's uncertainty in assessing each of the evaluation criteria, thus maintaining the multiplicity of meanings in order to provide an overall merit or attractiveness of a new business opportunity. Individuals express their assessments through linguistic variables, whereas perception and assessment of criteria is based upon intuition, knowledge and experience of evaluators.

Keywords: Strategy, Bid/No-bid Decision, Bidding, Fuzzy Linguistic Method

1. Introduction

The preparation and development of proposals within the bidding process takes time and can be costly. Bidders are often faced with unnecessary waste of time and money. In the end, for a contractor, success consists in winning the contract and not merely in submitting a proposal for a particular project. Submitting several sequential non-winning proposals can damage a bidders i.e. a contractor's reputation.[15] Less desirable project can be rejected or bid for with reduced effort, affording the company with the resources to address more attractive request for proposals (RFP). With regard to preventing an organization from dissipating its energies in preparing a losing proposal, the bid/no-bid decision must be made within the context of the organization's strategic framework. [19]

Therefore, the development of successful bidding strategies, in the function of the overall company's strategy is a key factor to the survival of a company offering its services in the market and especially for a contracting company. The basis of a successful strategy is to concentrate proposal efforts on bid opportunities that, when successful, assist in satisfying the objectives of the organization.

Much research has been dedicated to the problem of effective bid/no-bid evaluation, and many methods have been developed that can be useful to managers in their efforts to concentrate proposal efforts on bid opportunities that, if successful, assist in achieving the set objectives of the organization. Here we wish to stress the quantitative method which can be used with the acceptable reliability, to interpret and evaluate the linguistic expression of experts when making the bid/ no-bid decision. This method is the most favourable for making bid/no-bid decision by companies where such a decision constitutes a critical activity and where relative engineering experience and knowledge represent very important elements for making such decision and for improving the evaluation of bidding strategies.

2. Making the bid/no-bid decision

The principal aim of the dilemma i.e. of the bid/no-bid decision making process is to obtain a rational, business consensus within the company whether or not a proposal shall be developed for a particular project.

The costs that occur as a consequence of the wrong evaluation of bid opportunities can be very high. Concentrating on real business opportunities helps company to preserve human resources, time and money for business opportunities that are deemed to earn the company its winning position.

Bidding in itself is a complex and unpredictable process that implies conditions in which the situation is evaluated based on a number of criteria.

First of all, when making such decision it is necessary to determine the overall value of the project for the organization.[3] On the other hand, it is necessary to evaluate whether or not the organization is qualified to win the project involved. The technical nature of the current market situation is such that the organization has to bid in a specialised field of industry. Although very often about 10 to 15 organizations bid for a certain project, only a few of them are serious competitors qualified to perform the proposed project. The others only waste time and money. Therefore, companies should concentrate their efforts in the area that supports their success by creating opportunities for satisfying the objectives of the company. The final bid price will represent the best judgement of the decision maker who has taken into account all relevant factors. The focus is not only on the fact what price will win the competition but in the value of the project for the bidder.

If, when making a bid/no-bid decision certain tools are used, it is important to examine the situation and to accept the tools as a support in making decisions and not as tools for making decisions. In doing this, it is important that company views the data used in the application of these tools as realistic and the situation as it really is, and not as the one certain decision makers would want it to be. In other words, it is not simple to reduce the competition relations in business to a form required by most tools owing to the complexity of such situations and the lack of information that is relevant for the outcome of these strategies and possible actions of the competitors.

Whether or not a company is developing a proposal depends on the organization's self-made decision. The approach to the criteria that shall be considered in making such decision shall be very serious. The criteria primarily depend on internal factors in the organization but also on the market environment. Based on information on the company, employer, competition and the market conditions the criteria are made that are analysed in order to determine the value of the subject project for the organization such as the nature of the project, bidding conditions, the value of the proposed project, the value of the resources etc.

Bidding is a complex and unpredictable process, whereas the criteria that are present in bid/no bid assessments are often not sufficiently defined. Due to a human capability to analyse the unknown and indistinct events which are not easily incorporated into the rigidly defined analytical methods, judgements of experts represent vital elements in evaluating certain criteria.

The fuzzy sets theory is a branch of modern mathematics that was formulated by the scientist L. A. Zadeh for modelling uncertainties i.e. ambiguities that have been attributed to human cognitive processes. It has been used ever since for solving ill-defined and complex problems implying insufficient and fuzzy information typical of the real-world systems. As such it is suitable for interpretation in uncertain and fuzzy thinking that includes human intuition. The fuzzy sets theory uses linguistic variables and membership functions of different degrees for modelling uncertainties inherent in natural human expression.[1]

The fuzzy linguistic method is a qualitative method which is based on the assumption that most factors and criteria elements affecting the bidding strategy are related to the uncertainty of human evaluation. Relative engineering experience and knowledge are very important elements for the evaluation of bidding strategies of companies in the market. This method is based on the assumption that evaluators are qualified for measuring/ weighing particular factors based on the suggested scale.

The evaluation methods that are based on linguistic expressions of experts encounter the problem of interpretation and assessment.

Hereinafter the procedure and the principle of application of fuzzy linguistic in making the bid/no-bid decision is described. The approach is presented that takes into consideration the ambiguity and multiplicity of meanings of evaluation criteria while (in the process of) considering the overall picture.

3. The application of fuzzy linguistic method when making the bid/no-bid decision

In this approach, a weights' relative importance and the merit ratings of different criteria assigned by decision-makers are expressed in linguistic terms. Then, appropriate fuzzy numbers are used to present linguistic terms and a simple fuzzy arithmetical operation is employed to aggregate these fuzzy numbers into a fuzzy number, which is called the fuzzy attractiveness rating. Finally, the fuzzy attractiveness rating is translated back into linguistics and the suggestion for a bid/no-bid decision is expressed in linguistic terms. [9]

This approach takes into account the multiplicity and ambiguity of the evaluation criteria in the aggregation process to ensure a more convincing and reliable decision.

The assessment framework is composed of two major parts: the first part measures criteria and aggregates them to a fuzzy attractiveness rating of a bid opportunity; the second part matches the fuzzy attractiveness rating with an appropriate linguistic level, thereby enabling the suggestion for the bid/no-bid decision.

This process is shown in the following Figure.

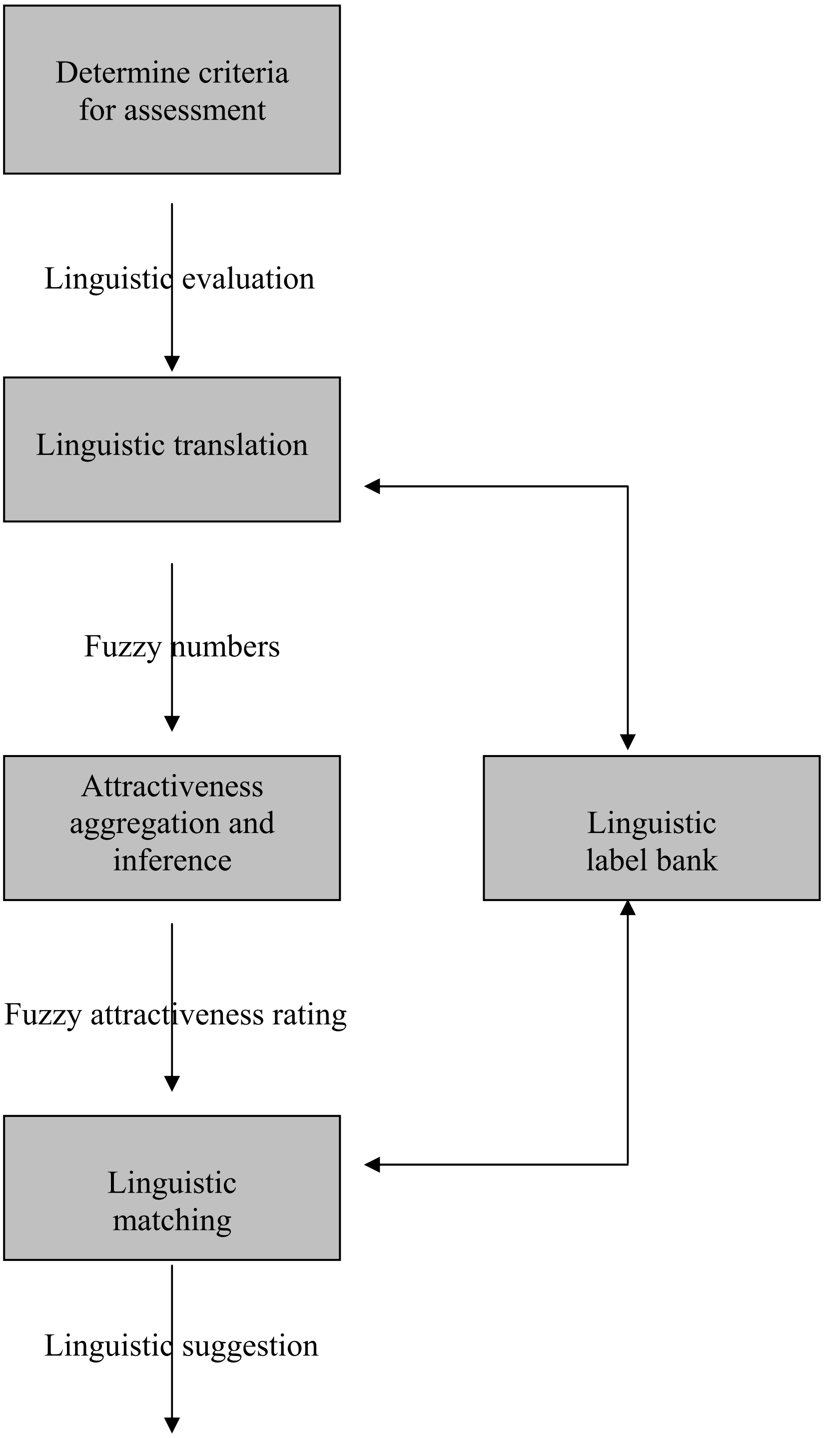

Fig. 1: The process of fuzzy linguistic assessment in bid/no-bid decision-making[9]

Owing to the high risk and cost of bidding for a large project, bid opportunities are evaluated and filtered by a bid/no-bid committee. The structure of the bid/no-bid committee is such that several managers, each with a different perspective on the business, influence the ultimate decision on whether or not to bid.[9] Members of the committee are chosen depending on the subject matter of the project and organisational units covering the purposes of the project. Once the committee has been assembled the selection of criteria for the assessment of a particular project takes place. In a concrete situation criteria are formed depending on the project, industry and market characteristics. The authors Lin and Chen[9] have made a rough classification into two categories, as follows:

1. Company factors which include company's resources, reputation, and mission.
2. Bid opportunity's factors which include the probability of project go-ahead, project risk and competition for the bid opportunity.

The evaluation as per the selected criteria in accordance with the linguistic scale follows. Those linguistic variables can attain different values such as very high, high, fair, low and very low which makes fuzzy sets (membership functions) and represents the decision-maker's perception of the meaning of each criterion. The concept of linguistic variables lies in the core of the fuzzy set theory since the basis of the fuzzy set theory is the manipulation of linguistic expressions and not numbers.

The fuzzy set is a set whose elements have various degrees of membership. The membership degrees of an element are expressed by the membership function. The membership functions in the fuzzy sets theory play a role similar to the one played by the probability distribution functions in the probability theory. Membership functions are used to represent uncertainty. The membership function is the function that maps the statistical mass of objects, X, in the unit interval [0, 1]. The statistical mass of objects represents the set elements, and the interval matches the set of degrees. The membership degrees in fuzzy sets may fall anywhere within the interval [0, 1]. The degree 0 (zero) means that an element is not a member of the set. The degree 1 (one) represents full membership. Contrary to the „pure sets“ that have only one function, fuzzy sets have a large number of membership functions.[1]

The linguistic terms of the ratings and weights of the sub-criteria and the weights of main criteria were approximated by fuzzy numbers in a fuzzy set. Then aggregation of fuzzy numbers follows to obtain the fuzzy attractiveness rating.

Since the average operation is the most commonly used aggregation method, the mean operator is used here to pool decision-makers' opinions. The fuzzy attractiveness rating (FAR) consolidates fuzzy ratings and fuzzy weights of all the factors that will influence on whether or not to bid for an opportunity. FAR represents the overall merit or attractiveness of a new business opportunity. The higher a bid opportunity's FAR is, the stronger the preference for this bid opportunity. Thus, the FAR membership function will be used to determine the bid/no-bid decision for a potential project.

Let Rj and Wj, j= 1,2,...,«, respectively, be the fuzzy rating and fuzzy weighting given to factor j by the evaluating committee. According to the standard fuzzy operation, the fuzzy attractiveness rating is obtained as: [9]

$$\text{FAR} = \sum_{j=1}^{n} (Wj \otimes Rj) \,/\, \sum_{j=1}^{n} Wj \qquad (1)$$

Once the fuzzy attractiveness rating of a bid opportunity has been obtained, one can further approximate a linguistic label whose meaning is the same as (or closest to) the FAR meaning from the natural language expression set of attractiveness level (AL). If we use the Euclidean distance method and if we suppose the natural language expression set for the attractiveness level, then the distance from FAR to each of the members in the set AL can be calculated as follows: [9]

$$d(FAR, AL_i) = \left\{ \sum_{x \in p} (f_{FAR}(x) - f_{AL\,i}(x))^2 \right\}^{1/2} \qquad (2)$$

where $p = \{x_o, x_1, \ldots\ldots, x_m\} \subset [0,1]$ such that $0 = x_o < x_l < \cdots < x_m = 1$.

The attractiveness rating generated by the fuzzy logic approach is expressed in terms of ranges of value. This rating can provide an overall picture of the pertinent possibility and give decision-makers flexibility for deciding. This thereby ensures that the decision made in the subsequent selection process is not biased.

The previous research has demonstrated the usefulness of the fuzzy linguistic approach as an extension to multi-criteria decision making in bid/no-bid decision. The research shows that it is possible for a company to use combination of the Analytic hierarchy process (AHP) and the fuzzy logic approach. In this case the attributes of the making decision alternatives as per AHP method would be presented in linguistic terms.

In this, everything depends on the characteristics of a particular proposal and on evaluators that use the method. The research has demonstrated that there is still no generally accepted method used by managers when making the bid/no-bid decision. Some managers ascertain that obtaining data that are required in quantitative methods is time consuming and very complicated. Furthermore, many managers note that traditional models tend to ignore human behaviour in the organizational setting.[9]

Assuming the fact that the bidding process is complex and uncertain and that the human judgement is a very important factor, the purpose of this paper is to show that the fuzzy-logic approach enables one to effectively and efficiently quantify imprecise information and make decisions based on vague and incomplete data. The approach concentrates on the application of linguistic approximation and develops fuzzy arithmetic as a help when making the bid/no-bid decision. This is a problem that business entities often encounter within the framework of their business activities.

4. Conclusions

Strategies for achieving the set objectives vary from company to company.
The strategy of a company actually implies compliance and aggregation of the organization with its present and future environment. In this sense, the strategy represents tendency for provisional monopole of the organisation in the market.

Bidding strategy as a basis for making the bid/no-bid decision is merely a part of the overall business strategy of a company. The main objective of all and therefore of contracting companies as well is to expand their business by successful bidding in the market. The bidding process is one of the most important stages in construction projects. It is therefore necessary to make the right decision as to whether or not a company will bid for a project.

For a company to be able to adopt a position regarding bidding for a particular project it has to have defined objectives and criteria that shall be met in order to achieve the set goals.

Many quantitative and qualitative methods have been developed that can help managers when making multi-criteria and complex decisions. The paper proposes the method wherein the fuzzy linguistic is applied in making decisions in case of insufficiently and vaguely defined criteria present when assessing the bid opportunities.

In this approach, a natural framework for representation of the problem in a situation with incomplete data and vague environments is constituted. The fuzzy sets theory uses linguistic variables and membership functions of various degrees for modelling uncertainty which is inherent of natural human expression. Managers assess criteria using a set of linguistic terms. Term values are then approximated by their membership functions; and by using fuzzy logic arithmetic; values from different evaluation assessors can be aggregated under different criteria. Thus, these imprecise criteria for bid/no-bid decision are allowed to assume exact values.

Fuzzy set theory provides a useful tool to deal with decisions in which the phenomena are imprecise and vague. It tolerates the blurred boundary of definitions. This brings the hope of incorporating qualitative factors into decision-making since it is often vaguely defined or has unclear boundaries. Fuzzy-logic in general enables one to effectively and efficiently quantify imprecise information, to reason and make decisions based on vague and incomplete data.[9] Furthermore, such concepts have been applied to management decision problems where the decision-makers had to deal with the critical issue of integrating and balancing different criteria.

The greatest advantage of this approach is that it gives the analyst more convincing and reliable results then in case of quantitative assessment of criteria. The experts experience and assessment is more easily expressed by subjective than by mathematical criteria.

And finally, we have to say that every organization will adjust and set algorithm to suit its needs and classify it into computer calculation to save time and reduce the possibility of errors.

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PDM LEAST COST SCHEDULING: A GENERALIZED PROBLEM

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Abstract

The history of modern project management practically has begun with the invention of the network scheduling techniques. One of the pioneers was the CPM (Critical Path Method) which originally was a least cost scheduling algorithm. An early development of CPM leads to the PDM (Precedence Diagramming Method). In this paper a generalization of the original PDM Least Cost Scheduling Problem will be presented. The following extensions will be discussed on the basis of the original problem: activities van be both splittable and non-splittable, both minimal and maximal type of precedence relationships are allowed in the network, earlier accomplishments of milestones are rewarded, later accomplishments are penalized.
The applied algorithm is traced back to the solution of minimal cost flow problem.

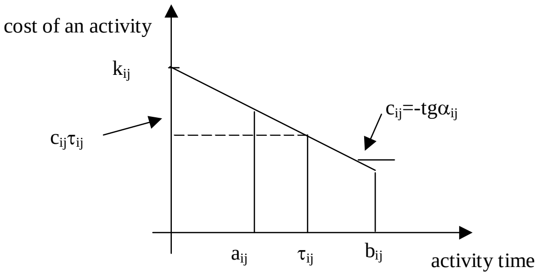
Keywords: Least cost scheduling, PDM time-cost trade-off, minimum cost flow, maximum flow.

1. Introduction

The first solution of the least cost scheduling problem originates from James E. Kelly and Morgan Walker [4], [5] from 1959, when they developed an LP based algorithm for an activity on arrow based network. They have called their method as CPM network technique, in our time we call it CPM/cost problem to make a clear distinction from the CPM technique used in practice, where pure time analysis is used only. A network flows based algorithm was published by Ray Fulkerson in 1961 [2].
A different network flow algorithm was developed directly on MPM/cost problem in Hajdu-Klafszky [3]. Assuming only non-splittable activities this problem is solved by Mályusz [7].

2. MPM/PDM least cost scheduling problem as an engineering problem

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 rush activity time and normal activity time. Assign to each activity a cost to complete the activity at the normal duration K_b and a cost – greater than normal cost to complete at the minimum duration K_a. 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 non-positive 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.
Mathematically the sum of $K_{bij} + (b_{ij} - \tau_{ij})c_{ij} + (\mu_i - e_i)d_i$ should be minimized.

1.1. The mathematical model

Let's 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 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 $a_{ij} \leq \tau_{ij} \leq b_{ij}$ for all $ij \in \mathrm{A}$ and signa_{ij} =signb_{ij} for all $ij \in \mathrm{A}$, moreover given $c_{ij} \geq 0$ 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 $c_{ij} = 0$.
Given d_i integer value for all $i \in N$ associated with each network's node that epresents the daily penalty/benefit for delayed delivery. 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 rush and normal. Denote k_{ij} the cost of activity *ij* for all $ij \in \mathrm{A}$ and *p* the project duration time.

Find to each node a $\mu_i, \forall i \in N$ value. An obviously natural condition that $\tau_{ij} \leq \mu_j - \mu_i$ $\forall ij \in \mathrm{A}$. The duration time of the network is *p*, where $p \geq \mu_t - \mu_s$. Let $\mu_s = 0$. Moreover given $e_i \geq 0, \forall i \in N$ and $d_i, \forall i \in N$ integer numbers. 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 and μ systems that

$$\sum_{ij \in A} K_{bij} + \left(b_{ij} - \tau_{ij}\right)c_{ij} + \sum_{i \in N} \left(\mu_i - e_i\right)d_i \text{ be minimal.}$$

Least cost scheduling problem leads to the following mathematical model.

Primal problem.
Given a directed network [N,A] with a_{ij}, b_{ij}, c_{ij} integer values where $c_{ij} \ge 0$ 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

$$\tau_{ij} \le \mu_j - \mu_i \quad \forall ij \in \mathrm{A} \qquad (1)$$

$$\tau_{ij} \le b_{ij} \quad \forall ij \in \mathrm{A} \qquad (2)$$

$$\tau_{ij} \ge a_{ij} \quad \forall ij \in \mathrm{A} \qquad (3)$$

$$\mu_s = 0 \qquad (4)$$

$$-p \le \mu_s - \mu_t \qquad (5)$$

$$\sum_{ij \in A} K_{bij} + \left(b_{ij} - \tau_{ij}\right)c_{ij} + \sum_{i \in N} \left(\mu_i - e_i\right)d_i \text{ should be minimized that is}$$

$$\left\{ \sum_{ij \in A} c_{ij}\tau_{ij} - \sum_{i \in N} d_i \mu_i \right\} \text{ should be maximized.}$$

Corresponding to the primal problem a dual problem is established here. Let us consider [N,A,k] network where $k_{ij} = \infty$, if $ij \in \mathrm{A}$ and 0 otherwise.

Dual problem.
Find a flow f_{ij} for all $ij \in \mathrm{A}$ on network [N,A,k], that

Minimize $\sum_{\substack{ij \in A \\ f_{ij} < c_{ij}}} \left(c_{ij} - f_{ij}\right)b_{ij} - \sum_{\substack{ij \in A \\ f_{ij} > c_{ij}}} \left(f_{ij} - c_{ij}\right)a_{ij}$.

subject to

$$\sum_{ji \in A} f_{ji} - \sum_{ij \in A} f_{ij} = d_i, \forall i \in N \qquad (6).$$

Relationship between primal and dual problems is shown in next lemma.

Lemma. *For any feasible solution* $\boldsymbol{\mu}$ *and* $\boldsymbol{\tau}$ *of primal problem (i.e.* $\boldsymbol{\mu}$ *and* $\boldsymbol{\tau}$ *fulfill (1),(2),(3),(4), (5), and feasible solution* $\boldsymbol{f}$*, of dual problem (i.e.* $\boldsymbol{f}$ *fulfill (6)), following inequality is fulfilled.*

$$\sum_{ij\in A} c_{ij}\tau_{ij} - \sum_{i\in N} d_i\mu_i \le \sum_{\substack{ij\in A\\ f_{ij}<c_{ij}}} \left(c_{ij} - f_{ij}\right) b_{ij} - \sum_{\substack{ij\in A\\ f_{ij}>c_{ij}}} \left(f_{ij} - c_{ij}\right) a_{ij} \tag{7}$$

where ν is the value of **f** flow (i.e. flow that network sends from node s to node t per unit time).

Proof.

$$\sum_{ij\in A} c_{ij}\tau_{ij} - \sum_{i\in N} d_i\mu_i = \sum_{\substack{ij\in A\\ f_{ij}\le c_{ij}}} \left(f_{ij} + c_{ij} - f_{ij}\right)\tau_{ij} + \sum_{\substack{ij\in A\\ f_{ij}\ge c_{ij}}} \left(f_{ij} - \left(f_{ij} - c_{ij}\right)\right)\tau_{ij} - \sum_{i\in N} d_i\mu_i =$$

$$\sum_{ij\in A} f_{ij}\tau_{ij} - \sum_{i\in N} d_i\mu_i + \sum_{\substack{ij\in A\\ f_{ij}<c_{ij}}} \left(c_{ij} - f_{ij}\right)\tau_{ij} - \sum_{\substack{ij\in A\\ f_{ij}>c_{ij}}} \left(f_{ij} - c_{ij}\right)\tau_{ij} \le$$

$$\le \sum_{ij\in A} f_{ij}\left(\mu_j - \mu_i\right) - \sum_{i\in N} d_i\mu_i + \sum_{\substack{ij\in A\\ f_{ij}<c_{ij}}} \left(c_{ij} - f_{ij}\right) b_{ij} - \sum_{\substack{ij\in A\\ f_{ij}>c_{ij}}} \left(f_{ij} - c_{ij}\right) a_{ij}$$

where

$$\sum_{ij\in A} f_{ij}\left(\mu_j - \mu_i\right) - \sum_{i\in N} \mu_i d_i = \sum_{j\in N} \mu_j \sum_{\substack{i\in N\\ ij\in A}} \left(f_{ij} - f_{ji} - d_i\right) = 0$$

Thus the lemma is proofed. ∗

The following optimality criteria comes from the proof of the Lemma.

Optimality criteria:

If $\boldsymbol{\mu}$ and $\boldsymbol{\tau}$ fulfill (1),(2),(3),(4), (5), and $\boldsymbol{f}$ fulfills (6), a sufficient condition of optimality is: exist such a flow for which:

1^0	If $\tau_{ij} < \mu_j - \mu_i$	then $f_{ij} = 0$
2^0	If $\tau_{ij} < b_{ij}$	then $f_{ij} \ge c_{ij}$
3^0	If $\tau_{ij} > a_{ij}$	then $f_{ij} \le c_{ij}$

Corollary: *If in (7) equality is fulfilled objective functions are optimal.*

If we know an optimal solution for a given project duration time p based on Klafszky [6] we have to solve only a series of maximum flow problems to get minimal solutions for all possible duration time p. In special cases – and in the practice is it frequently occur – there exist a trivial optimal solution.

Remarks.

1. An activity is called critical activity if $\tau_{ij} = \mu_j - \mu_i$ where $ij \in$ A. Flow can be goes only on these kind of activities.

2. If $b_{ij} > 0$ then $\tau_{ij} = \min\lfloor \mu_j - \mu_i, b_{ij} \rfloor$, if $a_{ij} < 0$ then $\tau_{ij} = \max\lfloor \mu_j - \mu_i, a_{ij} \rfloor$. If this network contains no positive cycle then let $f_{ij} = 0$ for all $ij \in$ A. If this system feasible it is an optimal initial solution for a *p* project duration time. If this network contains positive cycle (i.e., a directed cycle of positive length) we have to find an optimal initial solution using a minimum cost flow algorithm.

3. If $d_i = 0$, $\forall i \in N$ and there is no cycle in directed graph then $\tau_{ij} = b_{ij}$, $f_{ij} = 0, \forall ij \in A$ an optimal solution. This is the original CMP/cost problem see Kelley-Walker [4], Fulkerson [2], Klafszky [6].

4. If $d_i = 0$, $\forall i \in N$ there are cycles only with zero length then $\tau_{ij} = b_{ij}$, $f_{ij} = 0, \forall ij \in A$ is an optimal solution. This is the PDM/cost problem with minimum types of relationships. Solution of this problem is in Hajdu [3].

5. If $d_i = 0$, $\forall i \in N$ and there can be directed cycle with negative lengths it is an MPM/cost problem with minimal and maximal relationships. This problem can be to the minimum cost flow problem. See for instance Ahuja [1], Klafszky [6], Mályusz [7].

6. Primal problem of the least cost scheduling problem is the dual problem of minimum cost flow problem. If there is now trivial initial solution of the problem we have to solve a minimum cost flow problem to get an initial solution.

Depending on which conditions are satisfied for a certain $ij \in$ A in an optimal solution following classes can be set up for arcs.

A_I:	1^0 satisfied, (and/or 3^0 as well),	$\tau_{ij} < \mu_j - \mu_i$,	$f_{ij} = 0$.
A_{II}:	2^0 and 3^0 satisfied,	$a_{ij} < \tau_{ij} < b_{ij}, \tau_{ij} = \mu_j - \mu_i$,	$f_{ij} = c_{ij}$.
A_{III}:	only 2^0 satisfied,	$\tau_{ij} < b_{ij}, \tau_{ij} = \mu_j - \mu_i = a_{ij}$,	$f_{ij} \geq c_{ij}$.
A_{IV}:	only 3^0 satisfied,	$a_{ij} < \tau_{ij}, \tau_{ij} = \mu_j - \mu_i = b_{ij}$,	$f_{ij} \leq c_{ij}$.
A_V:	none of them is satisfied,	$\tau_{ij} = a_{ij} = b_{ij} = \mu_j - \mu_i$,	$f_{ij} \geq 0$.

These classes are necessary for the proof of next Theorem. This Theorem gives the skeleton of an algorithm for MPM/PDM least cost scheduling problem.

Theorem. *If for any p there exist an optimal* $\boldsymbol{\mu}, \boldsymbol{\tau}, \mathbf{f}$ *then either exist p*<p for which exist* $\boldsymbol{\mu}^*, \boldsymbol{\tau}^*, \mathbf{f}^*$ *optimal solutions or p is the least value for which problem is solvable.*

Proof. Proof is constructive, because it gives an algorithm that find an optimal solution μ^*, τ^*, f* if μ, τ, **f** are known, and p*<p. It consists of three main steps.

I. Create a residual network.
II. Find a maximum flow g and minimum (ST) cut on A.
III. Modify system μ τ, p decreasing μ in set T by δ.

I. Let us prepare the following [N,A',r] residual network, where A' is an expansion of A where if $ij \in A$ but $ji \notin A$ then let $ji \in A'$ and $r_{ji} = 0$. Residual network is used only to find maximum flow form *s* to *t* in A. It consists incremental flows of A see [1]. Capacities are chosen in such a way that $\mathbf{f}^*$ be dual optimal solution, because $\mathbf{f}^*$ satisfies optimality condition.

Classes	Capacity on ij∈A	Capacity on ji
ij∈A_I	$r_{ij} = 0$,	$r_{ji} = 0$
ij∈A_{II}	$r_{ij} = 0$,	$r_{ji} = 0$
ij∈A_{III}	$r_{ij} = \infty$,	$r_{ji} = f_{ij} - c_{ij}$
ij∈A_{IV}	$r_{ji} = c_{ij} - f_{ij}$,	$r_{ji} = f_{ij}$
ij∈A_V	$r_{ij} = \infty$,	$r_{ji} = f_{ij}$

Find maximum flow from *s* to *t* in A. Let maximum flow ***g*** and minimum cut is (S,T). (**g** can be 0). Capacity of nodes is saturated by the initial optimal solution.
If $ij \in A_q$ and $ji \in A_l$, where $q,l \in (I,II,III,IV,V)$ then $r_{ij} = r_{ij}^q + r_{ji}^l$.
Let $f^* = g + f$. Residual capacities guarantee that **f*** is an optimal solution of dual problem.
If **g** is infinite, then there is a path from node *s* to node *t*, where all activities are either in class A_{III} or A_V. It implies that in the path $\tau_{ij} = a_{ij}$, so *p* is the least value of project duration for which problem is solvable.
If **g** is finite, then all arcs in minimum (ST) cut are saturated, so either $f_{ij}^* = 0$ or $f_{ij}^* = c_{ij}$ $ij \in (S,T)$. Only arcs form classes A_I, A_{II}, A_{IV} can be in minimum (ST) cut because their capacity is finite. Backward in minimum (ST) cut there can be activities from all classes. Let us find minimum value of δ in such a way that optimality conditions remain fulfilled. System μ will be decreased in set T by δ.

Arcs in minimum (ST) cut $i \in S, j \in T$. If flow on arc is 0 for an ij $i \in S, j \in T$.
A_I $\delta_1 = \min_{\substack{i\in S, j\in T\\ ij\in A_I}} (\mu_j - \mu_i - b_{ij})$,

where δ_1 is the maximum value wherewith μ_j is reducible in arc A_I. Bigger decreasing means the optimality condition will not be fulfilled.
A_{II}, **A_{IV}** $\delta_2 = \delta_4 = \min_{\substack{i\in S, j\in T\\ ij\in A_{II}}} (\mu_j - \mu_i - a_{ij})$

where δ_2 and δ_4 are maximum values wherewith μ_j is reducible in arc A_{II}. Bigger decreasing means the optimality condition will not be fulfilled.

Arcs backward in minimum (ST) cut.
A_I, **A_{IV}**, **A_V**, $\delta_{b1} = \delta_{b4} = \delta_{b5} = \infty$
A_{II}, **A_{III}** $\delta_{b2} = \delta_{b3} = \min_{\substack{i\in T, j\in S\\ ij\in A_{II}}} (b_{ij} - \mu_j^* + \mu_i)$

where δ_{b1} δ_{b2} δ_{b3} δ_{b4} δ_{b5} are the maximum values wherewith μ_i is reducible in arc A_I A_{II} A_{III} A_{IV} A_V respectively. Bigger decreasing means the optimality condition will not be fulfilled.
$\delta := \min(\delta_1, \delta_2, \delta_4, \delta_{v2}, \delta_{v3})$, where δ is surely positive.

Let us define new optimal solution.

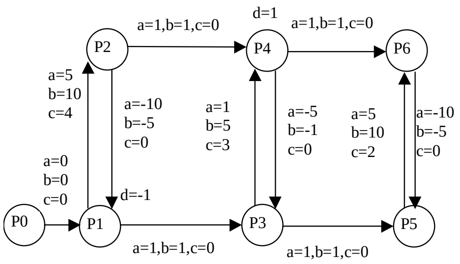
$\mu_i^* = \mu_i$, if i∈S, $\mu_i^* = \mu_i - \lambda$, if i∈T,

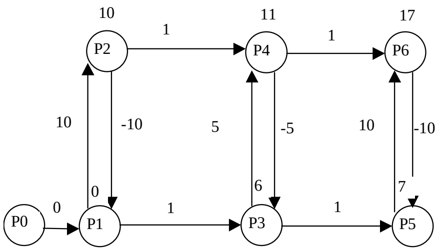
where $\lambda = 0,1,2,...,\delta$

and $\tau_{ij}^* := \min[\mu_j - \mu_i, b_{ij}]$.

System μ^*, τ^*, f^* are optimal solution for p*=p-λ. ∗

Example. Determine the least cost scheduling on next network for all possible project duration time.





Initial optimal solution:

$f_{12} = f_{24} = 1$, otherwise f=0.

Value of primal objective function:

$$\sum_{ij \in A} c_{ij}\tau_{ij} = c_{12}\tau_{12} + c_{34}\tau_{34} + c_{56}\tau_{56} + d_1\mu_1 - d_4\mu_4 = 40 + 15 + 20 + 0 - 11 = 64.$$

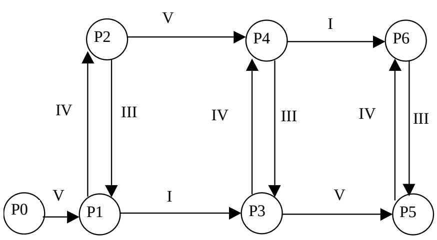
Value of dual objective function:

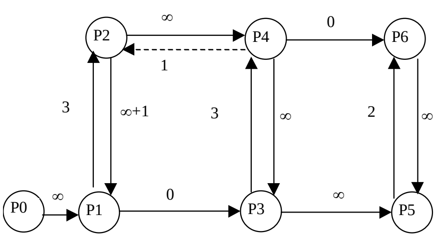
$$-(f_{ts} - c_{ts})a_{ts} + (c_{12} - f_{12})b_{12} + (c_{34} - f_{34})b_{34} + (c_{56} - f_{56})b_{56} = 0 + 30 + 14 + 20 = 64.$$

Remark. Arrow *(t,s)* is an $\mathbf{A_{III}}$ class arc in the cut (S,T) backward. The maximum possible decreasing: $b_{ts} - \mu_s + \mu_t = 0 - 0 + p, \quad a_{ts} = -p$. For the sake of simplicity it is eliminated from the diagram.

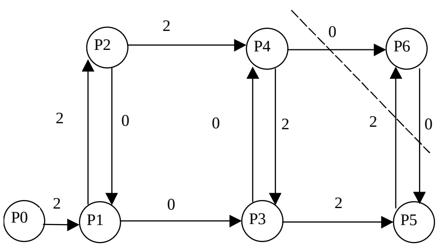
1. iteration step

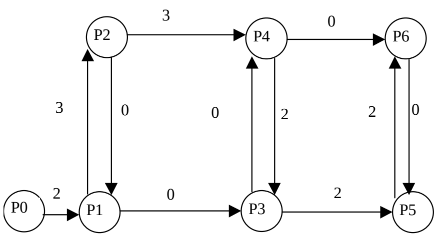
Classification of arcs. Residual network





Maximum flow g, and minimum cut (ST), f* flow.





Determination of δ in minimum (ST) cut.

$\delta_{46} = 17 - 11 - 1 = 5$

$\delta_{56} = 17 - 7 - 5 = 5$

Backward in minimum (ST) cut.

$\delta_{65} = -5 - 7 + 17 = 5$

$\delta = 5$

Second and third iteration step can be carried out in a similar way.

Since maximum flow is infinite in the third iteration 7 day is the attainable minimum project duration time.

Optimal $\boldsymbol{\mu}$ and $\boldsymbol{\tau}$ in each iteration step are summarized in the following table.

.

p0	p1	p2	p3	p4	p5	p6	01	12	21	13	24	34	43	35	45	56	65	ov
0	0	10	6	11	7	17	0	10	-10	1	1	5	-5	1	1	10	-10	64
0	0	10	6	11	7	12	0	10	-10	1	1	5	-5	1	1	5	-5	54
0	0	5	1	6	2	7	0	5	-5	1	1	5	-5	1	1	5	-5	39

Where p0, p1,… denotes the points, 01, 12… are the indexes of arcs and *ov* denotes the optimal value of the objective functions in each iteration step

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FLOOD LOSSES ON BUILDINGS AND RELATED INSURANCE ASPECTS

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Abstract

Catastrophic floods (from 1997 and 2002) caused immense damages on the property. Big amount of paid out insurance benefits evocated changes in Czech insurance field.

Czech insurance companies changed their approach to flood risk mainly during years 2002 and 2003. Flood risk is valuated meticulously and separately from other elemental risks as fire, windstorm, hailstorm or landslide. Flood losses can be extremely high, flood can even destroy whole building. Real property owners should be interested in financing future possible losses. Insurance is one type of possible financial backings. Main goal of this paper is: to show the way how to insure certain building within certain conditions against flood and other elemental risks to the best advantage with stress on self-insurance.

Keywords: flood, insurance, loss, building, financing.

Introduction

Catastrophic floods (from 1997 and 2002) caused immense damages on the property. Big amount of paid out insurance benefits evocated changes in Czech insurance field. Czech insurance companies changed their approach to flood risk mainly during years 2002 and 2003. Flood risk is valuated meticulously and separately from other elemental risks as fire, windstorm, hailstorm or landslide. Flood losses can be extremely high, flood can even destroy whole building. Real property owners should be interested in financing future possible losses. Insurance is one type of possible financial backings. Main goal of this paper is: to show the way how to insure certain building within certain conditions against flood and other elemental risks to the best advantage with stress on self-insurance from owner's point of view (owner is also called insurance policy holder in this paper).

Financial backings used to cover flood losses

There are several types of financial backing which can be used to cover flood losses. Those financial backings can be distributed among:

- Public (state budget, specific funds, funds from EU, etc.)
- Private (savings, credits, insurance).

People have to take into account that they cannot rely on public money when flood will damage their property. Nobody has legal claim to obtain financial help from state budget or EU funds (this help is usually conditioned and limited). Man has to shift for oneself, i.e. to ensure private financial backing. Each type has its advantages and disadvantages.

Tab. 1: Comparison of savings, credits and insurance

Type	Advantages	Disadvantages
Savings	Low costs Interest in prevention	Big amount of disposable money (cannot be invested) Incidentalness of damage
Credits	Inutility of reserves (money can be invested)	Downgraded prevention High costs (credit interest) Bank will not give a credit
Insurance	Inutility of reserves Money are at disposal immediately	Insurance benefit limit Expensive premium Exclusions

Insurance should be the basic financial backing for natural bodies as well as for corporate bodies; it provides the most effective financial protection of property.

Basic Insurance Criterions and their Relation

Quality of insurance and costs of insurance are dependent on various criterions. Those criterions are:

- Anticipated insurance period (in years),
- Value of property (*VP*),
- Insured value *(IV)*,
- Flood zone,
- Insurance benefit limit,
- Extent of insurance coverage (insured hazards),
- Deductions from premium (e.g. fire-resistant materials),
- Additional premium (e.g. insufficient security against theft),
- Number of anticipated losses,
- Extent of particular losses,
- Self-insurance range.

Insured value can be lower than real value of property. Such situation is called "underinsurance". In this case: 1) premium is lower, but 2) insurance benefit is decreased by portion *IV/VP*. We assume that *IV = VP* in this paper.

Flood Zones

Insurance companies distinguish between four flood zones according to the level of flood risk in particular area. Practically there are three flood zones in Czech insurance field. They are named usually as:

- 1^{st} flood zone: non-flood zone
- 2^{nd} flood zone: dangerous flood zone
- 3^{rd} flood zone: risky flood zone
- 4^{th} flood zone: uninsurable

First flood zone is characterized by minimal level of flood risk. It is necessary to set frontier criterion to differentiate between 2^{nd} and 3^{rd} flood zone. Such criterion can be described e.g.

whether the property has been deluged during last 20 years or not. Buildings located in 4th flood zone are uninsurable against flood risk.

Insurance Rates

Calculation of insurance rates is made by insurance mathematic rules on the level of insurance companies. Such calculation takes into account various factors like average losses, loss courses, loss frequencies etc. The problem is that relevant data are not available on the market. Insurance companies consider these data as their business secret and part of their know-how.

Insurance rates can be stated by insurance market analysis from clients' point of view. Such approach is also difficult because certain insurance companies comprehend various extents of insurance risks into basic elemental insurance packet. Total insurance rate is calculated as the sum of partial insurance risks. Total insurance rate is calculated by following quotation:

$$IR = \sum_{1}^{n} IR_1 + IR_2 + ... + IR_i + ... + IR_n$$

where *IR* is total insurance rate as the sum of *n* partial insurance rates. Contemporary insurance practice distinguishes between basic insurance rate and flood insurance rate. As mentioned before, insurance companies examine flood risk separately from other elemental risks (e.g. fire, windstorm, hailstorm).

Insurance market analysis gives following results of insurance rates (those numbers are valid for family house).

Tab. 2: Insurance rates for family house

Flood zone	I.	II.	III.
Basic insurance rate (*BIR*)	0,89 ‰	0,89 ‰	0,89 ‰
Flood insurance rate (*FIR*)	0,18 ‰	0,72 ‰	1,26 ‰
Total insurance rate	1,07 ‰	1,61 ‰	2,15 ‰

Calculation of Premium

Final premium (in other words cost of insurance) is dependent of many criterions as mentioned before. Following formula was derived:

$$P = IV * (BIR + FIR) * \left(\frac{100 - DED}{100}\right) * \left(\frac{100 + ADD}{100}\right) * \left[1 - \frac{1}{720} * \{40{,}228 * \ln(x) - 158{,}58\}\right]$$

where:

IV insured value (EUR)
BIR basic insurance rate
FIR flood insurance rate
DED deduction from premium (%)
ADD additional premium (%)
x self-insurance (EUR)

Goal from Insurance Policy Holder's Point of View

Insurance policy holder wants to have good insurance coverage and save money paid for premium and loss cover at the same time.

Policy holder's costs *C* are represented by:

- Paid premium *P*,
- Loss cover over the insurance benefit limit *B*,
- Loss cover by self-insurance *S*.

How to find minimal costs? It is necessary to find optimal self-insurance range. This issue is demonstrated in following case study.
Note: Calculation is made with the aid of mathematic model created by author in MS Excel. Calculation is made on discontinuous function (by using basic values of self-insurance range).

Case Study
Man owns family house, he assumes to live there for 40 years and he anticipates 5 future losses on the building during mentioned period. Insurance policy contains insurance benefit limit, there is no deduction or additional premium.

Tab 3: Description of case study

Type of object	Family house
Anticipated period of ownership	40 years
Value of property	160.000 EUR
Flood zone	nr. 1
Insurance benefit limit	10.000 EUR
Deductions from premium	0 %
Additional premium	0 %
Anticipated loss nr. 1	12.800 EUR
Anticipated loss nr. 2	600 EUR
Anticipated loss nr. 3	20 EUR
Anticipated loss nr. 4	6 EUR
Anticipated loss nr. 5	2.400 EUR

Total anticipated loss is 15.826 EUR. Part of loss exceeding 10.000 EUR is not covered by insurance (in this case 1st flood). By comparing results for basic values of self-insurance range mathematic model gives optimal self-insurance range 200 EUR. It means: from each loss first 200 EUR is not covered by insurance. Results for 3 different self-insurance ranges are displayed in following table.

Tab. 4: Loss cover structure

Self-insurance range	80 EUR	200 EUR	320 EUR
Insurance benefit	12.840 EUR	12.600 EUR	12.360 EUR
Loss cover over the insurance benefit limit	2.720 EUR	2.600 EUR	2.480 EUR
Loss cover by self-insurance	266 EUR	626 EUR	986 EUR
Total	15.826 EUR	15.826 EUR	15.826 EUR

In each case total coverage must be equal (100% of anticipated losses). But insurance policy holder's costs are different; cost for insurance is paid premium. With lower self-insurance range premium is higher, with higher self-insurance range premium is lower.

Tab. 5: Insurance policy holder's costs

Self-insurance range	80 EUR	200 EUR	320 EUR
Premium	5.448 EUR	5.097 EUR	4.918 EUR
Loss cover over the insurance benefit limit	2.720 EUR	2.600 EUR	2.480 EUR
Loss cover by self-insurance	266 EUR	626 EUR	986 EUR
Total	8.434 EUR	8.323 EUR	8.384 EUR

Comparison: Insurance policy with self-insurance range 80 EUR vs. 200 EUR; policy holder will:

▪ pay less for loss cover by self-insurance, but	- 360 EUR
▪ pay more for cover over the insurance benefit limit and	+ 120 EUR
▪ mainly pay much more for premium.	+ 351 EUR
Such insurance policy is more expensive.	+ 111 EUR

Comparison: Insurance policy with self-insurance range 320 EUR vs. 200 EUR; policy holder will:

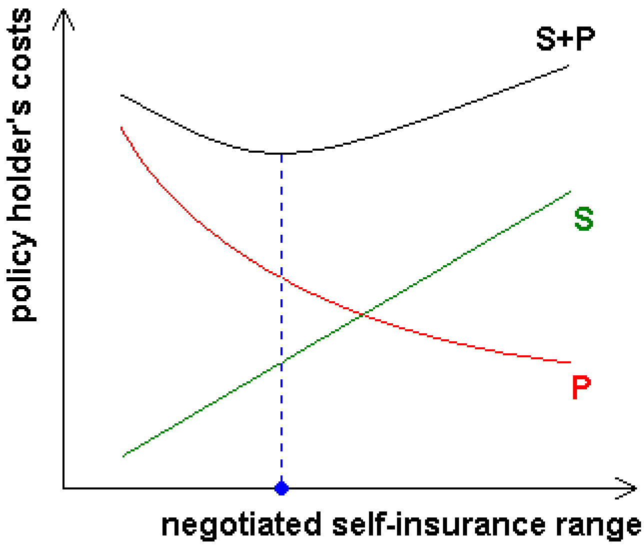
▪ pay more for loss cover by self-insurance, but	+ 360 EUR
▪ pay less for cover over the insurance benefit limit and	- 120 EUR
▪ less for premium.	- 179 EUR
Such insurance policy is more expensive.	+ 61 EUR

Conclusion

Good insurance is conditioned by many factors. Optimal level of self-insurance was solved in this paper. Self-insurance range does not affect quality of insurance (extent of insurance coverage is always the same). On the other hand it influences costs of insurance policy holder. Generally: With higher self-insurance range policy holder pays less for premium but his participation on loss cover is higher. Analogically, with lower self-insurance range insurance policy holder pays more for premium but his participation on loss cover is lower. Situation is more complicated if insurance benefit limit is negotiated.

Main goal is: to find the moment when marginal loss cover by self-insurance increment is equal to the marginal premium decrement.

Fig. 1: Relation self-insurance range and policy holder's costs



[Note: P … premium, S … loss cover by self-insurance; curve S can have different curvature]

Optimal self-insurance range depends mainly on quantity of anticipated future losses and also on the extent of particular losses. Low self-insurance range will be advantageous if we anticipate many small losses. High self-insurance range will be advantageous if we anticipate few big losses.

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Acknowledgment

This outcome has been achieved with the financial support of Czech Science Foundation grant project reg. nr. 103/05/0160: The procedures of support of the decision-making in the field of construction investment to assure the territory stability against flood.

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ECONOMIC EFFICIENCY AND POSSIBLE FINANCIAL ASSURANCE OF ANTI-FLOOD OPERATIONS' REALIZATION

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Abstract (12 pt bold)

Realization of anti-flood operations is very important activity in territories that were in past affected by flood or that are situated in the place, where the flood can be expected. However anti-flood operations' realization is usually very financially difficult. From this reason it is very important to consider the economic efficiency of these activities in connection with the possibility of their financing from particular available sources. The paper characterizes the area of the anti-flood operations financing from the aspect of the existence and availability of particular financial sources and also deals with the identification of approaches for economic valuation of supposed projects of the anti-flood operations realization.

Keywords: Anti-flood Operations, Economic Efficiency, Financial Assurance

Introduction

Floods belong esp. in the Czech Republic between the most frequent unexpected natural disasters of last ten years. It is very difficult or nearly impossible to avoid them. It is only possible to influence the process of the flooding with a help of well solved prevent preparative operations (e.g. establishment of flooding zones and degrees of flood activity), realized anti-flood operations and organizational assurance of the situation when the flood is coming.

Under the term anti-flood operation it is possible to include following technical solutions:

- realization and revitalization of polders, basins and dikes and assurance of their running including the maintenance and repairs,
- increasing of the flow capacity of watercourses, assurance of repairs, maintenance and running of connected objects and machinery,
- revitalization of ponds and increasing of their accumulative capacities

However it is not possible to leave the financial side of this theme out. It necessary not only the obtain in certain time, just in the time of the flood, a lot of financial sources that has to cover losses caused by the flood, but it is also necessary during the time to create “the fund” for the preventive anti-flood operations realization.

Only for the imagination about the amount of financial sources covering flood losses there is cited following table that presents amount of flood losses during last years in the Czech Republic.

Tab. 1) Flood losses in the Czech Republic in years 1997 – 2006 [1]

Flood situation [year]	Number of victims	Flood losses [mil. EUR]
1997	60	2 504
1998	10	72
2000	2	152
2001	0	40
2002	19	204
2006	9	240

The financial assurance of anti-flood operations

For the possibility of the financing of the anti-flood operations realization the sources from the state budget were detached in the frame of various programs. The most important programs are set in the following table:

Tab. 2) Overview of programs of the prevention against flood

Title of the program	Responsible subject
Prevention against floods	Ministry of agriculture
Operation program Environment	Ministry of environment

Realization of anti-flood operations is based on the Strategy of Protection against Floods in the Area of the Czech Republic from the year 2000 that was ratified by the government decree n. 382 from 19th April 2000. This strategy, including the suggestion of realization of operations in the Planes of drainage areas and Programs of operations in following 6 years, is developed in the Plan of main drainage areas of the Czech Republic ratified by the government decree n. 562 from 23rd May 2007.

Program Prevention against floods

Tab. 3) The program was divided into two phases. The mail objective of the first phase of this program that was solved in years 2002 - 2006 it is the improvement of the level of the flood protection by the realization of following operations in areas with higher threat of floods [3]:

- realization and revitalization of polders and basins intended for increasing of accumulative capacity of the drainage area,
- realization of protective dams in urban areas of cities and towns,
- increasing of the flow capacity of watercourses,
- elaboration of suggestions of manciples of watercourses for the assessment of missing flooding areas on all important watercourses.

Higher cited objectives will be achieved by realization of five partial program of the program Prevention against floods.

The main objective of the second phase is the next decreasing of the level of threat and flood risks in flooding areas of watercourses. For the fulfillment of this objective there were defined four partial programs [3]:

- Support of anti-flood operations with the retention
  (it is focused on the water basins, polders and construction objects intended for the spillages of floods)
- Support of anti-flood operations along watercourses
  (it is focused on the increasing of watercourses´ capacities, protective dams, lightening river-basins and tunnels, increasing of the flow capacity of weir plaints, reconstructions of dams, stabilization of watercourses)
- Support if increasing of safety of water constructions
- Support of determination of flooding areas and studies of drainage relationships

This program is for the period 2007 - 2012 grant aided by 420 mil. EUR.

Structural Funds of the European Union - Operation Program Environment

Risk of floods is in the frame of this operation program solved in the priority axe 1 - Improvement of the water utilization infrastructure and decreasing of the flood risk, support area 1.3 - Limitation of the flood risk [2] [3].

Supported activities in the area of realization of anti-flood operations can by for instance [2] [3]:

- information system of the prediction flood service and warning flood service
- investment support of elaboration of map groundwork about flood danger and flood risk
- realization of operations for the decreasing of the speed of the drainage from the drainage area and elimination of the flood flows in the form of the support of the polders or sets of retention basins realization
- realization of operations supporting natural suppressor spillage of floods in bottom lands
- increasing of the flow capacity of watercourses in towns

This supported area is for the period 2007 - 2013 grant aided by 100,165 mil EUR.

Basic steps for optimization of sources for financing

Very important step for optimization it is the identification of available sources for financing of investment projects in the area of protection against floods and the creation of the algorithm for valuation of the optimal structure of possible sources of financing fro the aspect of the investor.

During the decision making about the structure of sources it is possible to do following basic steps:

1. Mapping of the problem and the suggestion of possible technical assurance of the anti-flood protection
   - this partial step includes the suggestion of the specific technical solution of the anti-flood protection corresponding with the solved problem and locality

2. Assessment of investment costs connected with the technical solution
   - choice of the methodology for the investment costs of specific technical solution assessment
   - own calculation

3. Mapping of possible sources for financing of the chosen variant of the technical solution
   - identification of existing sources available for financing of the specific technical solution
   - valuation of availability of particular sources for financing

4. Assessment of the algorithm for the suggestion of optimal sources of possible financing of technical solutions
   - assessment of criterions pro the choice of the suitable source of financing
   - systematization of the procedure of the utilization of criterions for the valuation of the suitability of sources for financing with the focusing on their optimal structure

5. Suggestion of optimal structure of sources for financing
   - with the utilization of the defined algorithm will be chosen optimal structure of sources for financing

Basic principle of the economic efficiency of anti-flood operations realization calculation

In former times (esp. in the Czech Republic) it was many possibilities to see the amount of losses that can be caused by flood in urban areas. Potential losses threatening in risk areas can be to a certain extent reduced by a realization of suitable anti-flood operations discussed in previous chapters. However not in all cases the realization of effective anti-flood operation is easy and cheap matter, usually there exist more variant solutions, from that it is possible to choose. From this reason it is necessary just before own project realization to approve its potential benefit and expected costs for its realization and running for the area under the consideration, it is necessary to judge the project's economic efficiency. This chapter is focused on one of many possible approaches to the analysis of the economic efficiency of anti-flood operations in the territory threatened by the flood. During the valuation of the economic efficiency of the anti-flood operations realization there are compared investment costs for their realization and operating costs for assuring of their functionality with whole social and economic benefits that will be brought by the project's realization and running. Benefits of theses projects are defined usually in the form of the prevention or at least in the reduction of flood losses in the area under the consideration. With knowledge of the value of the property in the territory and expected rate of damage of the property by flood [9] it is possible to assign expected loss caused by the flood with expected intensity. Depending on the lifetime of realized anti-flood operations it is then possible, based on the prediction of the frequency of floods causing the loss, to predict the whole loss that will be avoided by the anti-flood operations realization. For the whole economic efficiency of the anti-flood operations realization assignment it is possible to use standard methods of the project efficiency valuation considering the time value of expected project's costs and benefits.

The basic principle of investment projects in anti-flood operation realization economic efficiency valuation it is the comparison of in finance unit expressed benefits and in finance units expressed costs of the project, considering the time value of theses cash flows. During investment projects economic efficiency valuation it is possible to proceed in following general steps [10]:

- Identification of benefits (benefits of anti-flood operations it is necessary to conceptualize mainly as a reduction of costs - losses connected with flood) and costs, whose amount will be influenced by the project's realization
- Description of the zero option (the project is not realized) and investment option (project is realized)
- Detailed description, quantification and evaluation of particular costs arising in the case of zero option and investment option
- Comparison of particular costs arising in the case of the zero option and the investment option as a difference between costs arising in the case of the zero option and costs arising in the case of investment option considering following conditions:
  - all costs it is necessary to use in positive values
  - to compare each other it is possible only costs and benefits arising in the same time period (year)
  - all cash flows arising in the frame of the project it is necessary to discount to one time point, usually to the start of the project

The result of the comparison and the main index of the investment project economic efficiency it is the Economic Net Present Value (NPV_E), which it is possible to calculate with the help of following relation [10]:

$$NPV_E = \sum_{i=1}^{n} \frac{1}{(1+r)^i} \left[\sum_{j=1}^{m} p_j \left(C_{ij}^0 - C_{ij}^I \right) \right] - IC \quad (1)$$

where:

NPV_E Economic Net Present Value

IC Investment costs

C_{0ij} **j** - kind of costs in zero option in **i** - time period

C_{Iij} **j** - kind of costs in investment option in **i** - time period

r Discount rate

n Life time of the investment project, event. duration of the valuated project's time period (in years)

m Number of costs identified in the frame of the projects

p_j Probability of **j** - cost, it must be $\Sigma p_j = 1$

Practical use of defined relation consists in the identification of particular states of the world characterized by certain intensity of the flood (and also by the loss that the flood causes), that can turn up during one year, and in assigning of probabilities of the occurrence of particular states of the world. This identification must be realized for particular years of the valuated period. The characteristic of particular states of the world and the identification of their probabilities must be realized regarding the local conditions of the solved territory. For the assessment of potential losses on the property in the territory caused by the flood it is possible to use e.g. Territorial Property Index characterizing an average value of the property per the square unit of the territory (e.g. m^2) and damage curves determining the rate of the damage of property representatives in the territory depending up the flood intensity. More detailed information about the Territorial Property Index assessment is available e.g. in [6], the way of the definition and the use of damage curves is available e.g. in [7] and [8].

Conclusion

The main objective of this paper is to introduce the possibilities available for the financing of various variants of solution of anti-flood protection. Paper solves the area of anti-flood protection in the form of various anti-flood operation and the possibilities of their financing from public sources. Attention is posed mainly on national sources (Ministry of Environment) and sources from Structural Funds of the European Union. The second part of the paper is focused on the suggestion of basic steps for optimization of the sources structure. At the end of the paper there is solved in basic principles the way of the economic efficiency of anti-flood operation realization assessment.

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This contribution has been written with the support of the grant project of the Czech Science Foundation (GA CR), project No. 103/05/0160 The procedures of Support of the Decision-making in the Field of Construction Investment to Assure the Territory Stability against Flood.

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DSS FOR URBAN INFRASTRUCTURE MANAGEMENT, PARKING GARAGES CASE STUDY

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Summary:

Problems of the urban infrastructure management could be found in the lack of systemic and comprehensive approach in problem solving at strategic level, as well as lack of data and procedures at operative level. Therefore, a generic model of a Decision Support System (DSS) for urban infrastructure management is proposed, which includes three decision and management levels (operative, tactical and strategic). In this paper the application of the DSS model is focused on the improvement of the part of urban infrastructure system that is parking garages. A case study deals with big parking garages project for a large urban area and how the DSS can be efficiently used for solving location and sub-project ranking problems, as well as for definition of an investment strategy. Two multicriteria models, AHP and PROMETHHE, in a combination with 0-1 programming are used. The main advantage of an application of multicriteria analysis is that all stakeholders could be objectively included into decision process.

Keywords: urban infrastructure management, Decision Support System, AHP, PROMETHEE methods

1. Introduction

Ever growing urban infrastructure systems, such as water supply system, traffic systems, sewage system 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 comes to the compromised and sustainable solutions that have to satisfy all stakeholders. Each long-term planning of an urban infrastructure is a complex, demanding project management task which should be enriched with decision support tools such as multicriteria methods and other operational research tools thus becoming more efficient.

Urban planning processes such as changing purposes of urban areas cause a generation of new transportation flows that result in new distribution of commutation ending points. Besides other problems, urban expansion as well as huge growth of vehicles on the roads raises the problem of development and maintenance of the parking places. Parking places and accompanied areas are become problems in the densely populated city centres and could endanger functionality of the certain urban space as well as endanger satisfaction of other population needs on the same area. Lots of authors research in the field of transportation management. In his work Bielli

(1992) presents urban traffic management as continuous decision process of coordination of all individual elements (traffic, signals, arterial roads, traffic, parking) and interrelated components (private cars, transit, pedestrians). He demonstrates DSS approach to urban traffic management. Its aim is the achievement of maximum efficiency and productivity for the whole system through the application of operating, pricing, regulatory and service policies. Cost and benefits evaluation aspect of potential infrastructure investments is also introduced in literature and several decision support models could be indicated. Two main goals of these papers mostly are selection of adequate model and model accessibility to users (Guisseppi, A., Forgionne, G.A, 2002.). All abovementioned leads to a conclusion that DSS development process is not intuitive and deterministic process, because today we are dealing with very complex problems. A reason for bigger complexity of the problems lies in inclusion of many stakeholders that are needed for reaching an appropriate solution which leads to ill-structured and semi-structured problems. Because of this characteristics many authors provide models for DSS design (Klashnera, R., Sabeta, S., 2007.). Today DSSs becomes very important even we could say a critical factor in modern organization. Their development and implementation is present in various books and research papers (Ahn, T., Grudnitski, G., 1985.; Alavi, M., Joachimsthaler, E., 1992.; Alter, S., 1994.; Sprague, R., Watson, H.J., 1996.; Steiger, D.M., 1998.; Turban, E., Aronson, J., 2000.). 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 perceived in publications of other authors (Afraim, T., Jaye, A., 1995.; Burstein, F., 1995.; Leclerc, G. et al., 2001.; Pomerol, J. et al., 1996.).

2. Generic model of DSS for urban infrastructure management

Urban infrastructure management system structure is based on the three decision levels concept: strategic, tactical, and operative (Figure 1). Integration of the system is realised through the relationships between three main DSS modules: data, dialog, models. Their interaction aims at support to the decision making process at all management levels. The architecture of the system implements the relationships at the adequate hierarchic level, as well as with information flows between the levels. The hierarchic levels serve as meeting point of adequate models and data. Inversely, according to available data sets at each level, an adequate model could be selected.
First management level supports decision-makers at lowest, operative decision level. It has two functions, support of decision making at the operative level and incubation of the data, information and demands for the decision making at higher levels: tactical and strategic. Likewise, second model level delivers tactical decisions and it creates basic information or concepts for further higher decision level. These decisions are based on the system state knowledge that is result of the first level data and models. At second level decision are made by experts and expert teams as well as employees from local political bodies and public companies that match to this management level and have certain responsibilities. The third level corresponds to strategic decision making process. 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 or urban plans for the city or region. These strategies are frameworks for lower decision and management levels thus ensuring continuity of decision making process throughout both decision and management system. Both

strategic and tactical level uses more complex techniques and knowledge then operative one. The most used methods are those for single or group decision making.

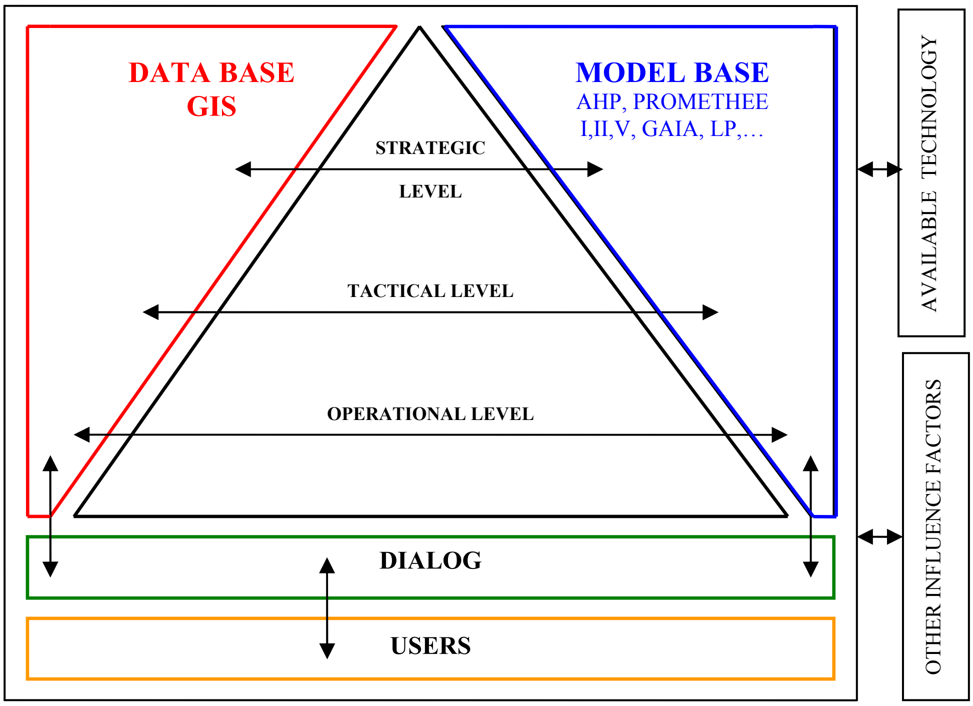

Figure 1: Architecture of the DSS for urban infrastructure management (Jajac, N., 2007).

Many outside factors may influence an urban infrastructure system as it may me seen at Figure 1. Technology influences the system at all levels through diverse appliances that are used at any level. The term "other factors" stands for the influence of local behaviour to the system, such as: established behavioural standards of a local community, actual and traditional styles of management and decision making, local mentality, etc.

3. The case study – Parking garages in the town of Split

3.1. DSS for transportation infrastructure system

According to the previously described DSS generic architecture a DSS for transportation infrastructure system is developed. The whole concept is tested on a problem of selection places for parking garages in town of Split. There were certain data at operative level so it was easily structured and passed to the tactical level. At the tactical level, because of ill-structured nature of the problem that emerges from incomparable data and conflict stakeholders' demands, adequate multicriteria models should be used. The whole procedure starts with goal analysis which end with structured hierarchic structure of the goals, a goal tree. The goal analysis is the basis for a criteria definition. The importance and/or relevance of the criteria for the certain problem are expressed by weights. Using multicriteria Analytic Hierarchic Processing (AHP) method (Saaty, T.L., 2001.) it is very easy to assign weights through group decision making process by interviewing experts as well as other stakeholders such as representatives of citizens or NGOs etc. Further analysis is based on PROMETHEE

methods (Brans, J.P., Vincke, Ph., 1984.) for multicriteria analysis and 0-1 programming, as well as GAIA method, a principal component based method for visual presentation of a multicriteria problem. The parking garage problem is quite complex, because there is an interaction between locations, because any selected location influence the attractiveness of the near-by one. Therefore, by construction of one garage the need for neighbouring garages will be changed. This is handled by applying 0-1 analysis (PROMETHEE V method, Brans, J.P., Mareschal, B., 1990) after multicriteria ranking, that helps to model the interactions between garages' locations.
Obtained solution, expressed in form of list of the highest ranked locations according to the criteria, as well as further selection of the locations, according to some additional elimination constraints, obtained by PROMETHEE V method are saved into a data base and they serve as possible strategic alternatives. The strategic decision level helped by experts selects the most convenient solution in accordance with current political orientation.

3.2. Analysis of the problem for the parking garages of the town of Split

The case study area is wider city centre with high concentration of public facilities and of pedestrian concentration. The area was surveyed in detail and as a result a demand for parking places is defined. At the same time, the optimal number parking places with potential location of garages (Cvitanić, 2005.). It was shown that 6800 parking places are missing in a wider city centre.

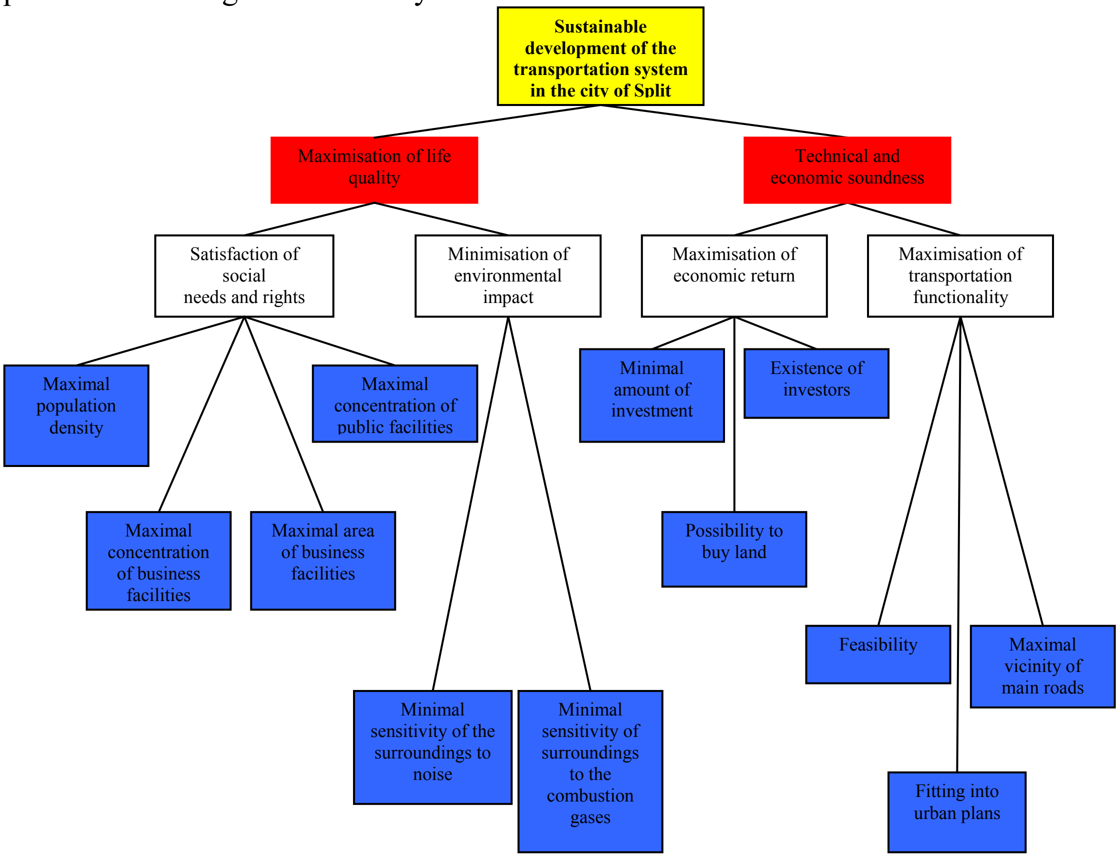

Figure 2: Hierarchy structure of the objectives as well as criteria for parking garage problem in town of Split (Jajac, N., 2007).

The Figure 2 shows the goal hierarchy for defined problem. As the main goal is Sustainable development of the transportation system in Split, the solution is based on the stepwise approach in a construction of the garages on the 29 potential locations. During the definition of the lower goals' levels all stakeholders were involved and the "wish list" was created. According to the "wish list" and to the priorities the whole objective tree was defined. As criteria for multicriteria analysis emerge form an objective tree, last hierarchic level of this particular tree derives the criteria set.

3.3. Multicriteria analysis

Weights for the criteria were defined by involving all stakeholders and with AHP method (Saaty, T.L., 2001.). According to the stakeholder group's main goal, three scenarios were developed (Table 1). The first scenario describes preferences of citizens, the second one of the transportation experts, and the third scenario represents how city authorities see the problem. The fourth scenario is an average value of them and stands for a compromised view to the problem.

Table 1: Criteria values and scenarios

Criterion	Description of criteria	Scenario 1	Scenario 2	Scenario 3	Average weight	%	MIN/MAX
C1	Population density	0,417	0,006	0,072	0,165	16,5	MAX
C2	Business facilities density	0,035	0,064	0,065	0,055	5,5	MAX
C3	Area of business facilities	0,049	0,013	0,214	0,092	9,2	MAX
C4	Concentration of public institutions	0,155	0,029	0,024	0,069	6,9	MAX
C5	Feasibility	0,006	0,104	0,103	0,071	7,1	MAX
C6	Fitting into urban plans	0,071	0,036	0,035	0,047	4,7	MAX
C7	Vicinity of main roads	0,017	0,305	0,300	0,207	20,7	MAX
C8	Investment	0,003	0,052	0,014	0,023	2,3	MIN
C9	Possibility to buy land	0,023	0,152	0,045	0,073	7,3	MAX
C10	Existence of investors	0,005	0,018	0,004	0,009	0,9	MAX
C11	Sensitivity of the surroundings to noise	0,073	0,111	0,042	0,075	7,5	MIN
C12	Sensitivity of surroundings to the combustion gases	0,146	0,111	0,083	0,113	11,3	MIN

Table 2 shows evaluated multicriteria model for ranking potential locations in the centre of the town of Split. Regarding expressed conflicts between the scenarios, compromised weights are found by simple average of scenarios' weights, thus giving equal importance for all groups of stakeholders. Therefore a new compromised scenario came out. Table 3 shows the final rank of all locations. If total flow Phi is considered as bonitet or worthiness of a location, the first location seems to prevail after all the rest. The following two locations have the same bonitet, and so on.

Table 2: Criteria values for the locations

ALTER-NATI-VES		CRITERIA											
		SOCIAL CRITERIA				TECHNICAL – URBAN CRITERIA			ECONOMIC CRITERIA			ECOLOGICAL CRITERIA	
NO	LOC	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1.	**3-1**	0.002055	0.0003	0.17706	8	5	1	0	104	1	0	0	0
2.	**3-2**	0.00411	0.0006	0.35412	9	3	0	0	91	1	1	2	2
3.	**4-1**	0.004044	0.00018	0.01497	6	3	1	0	144	1	0	4	4
4.	**4-2**	0.004044	0.00018	0.01497	3	3	1	0	60	1	0	0	0
5.	**4-3**	0.01348	0.0006	0.0499	4	1	0	0	28	0	0	0	0
6.	**4-4**	0.004044	0.00018	0.01497	1	5	1	0	21,6	0	0	10	10
7.	**5-1**	0.02229	0.0055	0.66213	6	5	1	0	84	1	1	0	0
8.	**6-1**	0.0168	0.0005	0.05763	10	1	1	1	75	1	1	2	2
9.	**6-2**	0.01008	0.0003	0.034578	7	3	0	1	30	0	0	0	0
10.	**7-1**	0.015912	0.00114	0.12762	2	3	0	1	15	1	0	8	9
11.	**9-1**	0.01087	0.00015	0.06638	1	5	1	0	11	0	0	4	5
12.	**9-2**	0.017392	0.00024	0.106208	1	3	0	0	20	1	0	8	9
13.	**10-1**	0.01729	0.0011	1,26413	2	3	1	1	76	1	0	0	0
14.	**11-1**	0.010512	0.00042	0.100974	1	3	1	1	27,8	1	0	0	0
15.	**11-2**	0.01752	0.0007	0.16829	6	1	0	1	30	1	0	6	7
16.	**12-1**	0.007587	0.00012	0.047148	1	3	1	0	90	1	0	3	4
17.	**12-2**	0.020232	0.00032	0.125728	1	3	0	0	12	1	0	2	2
18.	**12-3**	0.02529	0.0004	0.15716	2	5	0	0	37	1	0	4	5
19.	**12-4**	0.007587	0.00012	0.047148	4	5	0	1	35	0	0	4	5
20.	**13-1**	0.016566	0.00042	0.456036	2	3	1	0	27	1	0	8	9
21.	**13-2**	0.02761	0.0007	0.76006	8	5	1	0	61	1	1	8	8
22.	**13-3**	0.008283	0.00021	0.228018	3	5	1	1	55	0	1	0	0
23.	**18-1**	0.001416	0.00018	0.197526	2	5	1	1	45	1	1	0	0
24.	**18-2**	0.00236	0.0003	0.32921	3	5	1	1	31,2	0	0	4	4
25.	**19-1**	0.007401	0.00018	0.040554	1	3	0	1	10	1	0	4	5
26.	**19-2**	0.014802	0.00036	0.081108	2	3	1	1	20	0	0	0	0
27.	**20-1**	0.005709	0.00021	0.032202	2	3	1	0	15	1	0	4	4
28.	**20-2**	0.011418	0.00042	0.064404	1	3	1	0	18	0	0	4	5
29.	**20-3**	0.011418	0.00042	0.064404	4	3	0	1	24	1	0	0	0

Table 3: Preference flows and PROMETHEE II complete ranking for the compromised scenario

Ranking	Φ	Alternatives	**Ranking**	Φ	Alternatives	**Ranking**	Φ	Alternatives
1	0.3191	13	**11**	0.0584	15	**21**	-0.1281	20
2	0.2147	8	**12**	0.0408	24	**22**	-0.1418	27
3	0.2143	7	**13**	0.0182	10	**23**	-0.1428	16
4	0.1794	14	**14**	0.0167	25	**24**	-0.1454	3
5	0.1759	23	**15**	-0.0017	19	**25**	-0.1552	5
6	0.1583	29	**16**	-0.0070	1	**26**	-0.1639	11
7	0.1538	22	**17**	-0.0299	18	**27**	-0.1957	28
8	0.1389	26	**18**	-0.0558	17	**28**	-0.2067	12
9	0.0931	9	**19**	-0.0764	4	**29**	-0.3192	6
10	0.0697	21	**20**	-0.0818	2			

Graphical presentation of criteria using GAIA principal component analysis of total flows Phi shows that criteria stands in a positions that proves that the problem is ill-structured, and application of multicriteria analysis was appropriate.

3.4. Strategy selection by application of PROMETHEE V method

The intention is to build finite number of garages in accordance with available financial means. Therefore, using bonitet expressed by phi value as input data for 0-1 programming method - PROMETHEE V a final construction strategy can be defined. There exist certain interactions between garages, so by finishing one garage input values of others for multicriteria analysis change, namely the need of nearby garages. So additional constrains are implemented in the 0-1 model. The implemented seventeen constrains concern a limitation of the number of garages in one zone, and total amount of money for the investment.
Objective function presents locations attributed by phi values. Table 4 shows results from PROMETHEE V method obtained by Branch and Bound method implemented in WINQSB.

Table 4: The results obtained by PROMETHEE V method

No	**Location**		**Description**
1.	1	3-1	Zona 3 - Matejuška
2.	4	4-2	Zona 4 - Varoš
3.	7	5-1	Zona 5 - Grad
4.	8	6-1	Zona 6 - Manuš
5.	9	6-2	Zona 6 - Manuš
6.	10	7-1	Zona 7 – Lučac
7.	12	9-2	Zona 9 - Spinut jug
8.	14	11-1	Zona 11 - Bol zapad
9.	22	13-3	Zona 13 - Lovret sjever
10.	23	18-1	Zona 18 – Turska kula
11.	24	18-2	Zona 18 - Turska kula
12.	A29	203	Zona 20 - Gripe

4. Conclusion

For the problem of a garage construction priority ranking for the selected places in the town of Split, a DSS concept is applied. For the moment, a multicriteria analysis and 0-1 programming methods are used. Multicriteria analysis points out several methodological and socio-political advantages of this approach in resolving complex problems such as garage construction priority ranking, regardless of decision maker hierarchy level. Both problem complexity and decision making process become more complex as decision making process goes towards higher management levels. In that order selecting strategies for development, i.e. construction of infrastructure could be the difficult, tricky task. Multicriteria analysis process, if applied properly, requires involvement of all stakeholders. Participation of stakeholders in a selection process makes implementation and realisation of obtained results much easier and clears all mistrust and assumptions of bias existence during problem solving process. Stakeholders are directly involved in a decision making process by their opinions expressed by criteria weights, as well as by additional constrains implemented in the 0-1 programming. They were divided in three significantly different groups (citizens, transportation experts, city authorities). From methodological point of view multicriteria analysis implies system approach which represents most efficient and functional way of problem solving. An application of the combination of multicriteria analysis and 0-1 programming represents methodological framework for modelling decision makers' opinions. All abovementioned leads to a conclusion that concept of problem oriented DSS, such as DSS for urban infrastructure, may be successfully realised by application of both multicriteria methods and well defined goal analysis.

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ON COMPUTER MODELLING OF PROJECTS WITH UTILITY ASSESSMENT

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ABSTRACT

The paper describes the methodology of utility assessment of building and projects by use of computer modelling of the building process. A vector of 10 main aspects (criteria) for utility assessment was created with a common measure unit. The aspects were given a certain level of significance each. A database of construction processes was created including the aspects for utility assessment. On the base of the methodology of the construction technology design a method for modelling of realization of building and projects based on the construction technology network diagram with utility assessment was created and a computer system for this purpose was developed. This expert system is based on quick modelling of the building process, maintenance or reconstruction of different buildings and structures by use of typical network diagrams, which are prepared in advance, created by an original construction technology network diagram method. Models of the building process created in this way can be used easily for utility assessment of building and projects.

KEYWORDS

Construction technology, building process, network analysis, model, utility assessment

1. PRINCIPLES OF CONCEPT OF THE METHODOLOGY

When projects are to be undertaken it is necessary to visualize all the operations of the project, arrange these operations in their proper sequence, achieve confidence that every participant of the building process (the owner, the architect and the contractor) understands each of his tasks, acquires the know-how and means necessary to perform them and feels convinced that the method chosen for performing all tasks is the most progressive and economical. Thus all projects have to be efficiently planned at the investor's (owner's), architect's and contractor's sides. In the planning and design stage of the project several specific problems must be solved and many points of view have to be taken into this decision process. A lot of these questions can be efficiently solved by creating of a computer model of the building process of the structure. One of the most significant questions is the utility of the project.

The utility can be defined as the quality or condition of being useful; usefulness. It is a very general concept for the user to be able to evaluate the utility of a building or of a project on the base of this definition. Especially the architect and the investor should have a simple computer method to be able to assess the utility of the project he wants to undertake or design. The utility of the project is a very complex idea. It is a hard work to assess the utility - it is not possible to evaluate the utility only as one magnitude, as for different participants of the building process – the owner (final user), the architect and the contractor of the project the utility of the building or of the project means something very different. Different features of the utility can be defined from the point of view of the whole community. Therefore more aspects have to be taken into the method of the utility assessment and a vector of criteria of utility assessment must therefore be created, see e. g. Jain (2006). Naturally, all aspects do not have the same significance, so they must be allotted their weights (significances). It would be very advantageous if all utility assessments aspects could have the same exact measure unit and if they could behave as certain resources, so that they could be calculated mathematically. Then they could be put into a project computer modeling system as resources linked to building constructions and in this way the utility of a whole building or of a project which consists of several building constructions could be evaluated. For modeling of the building or of a project the methodology of construction technology design, see Jarský et al. (2003) can be very efficiently used. Therefore the CONTEC project preparation and management system which includes the database of building constructions with 20 resources each and a big set of typical network diagrams that enable very quick creation of the model of a building or of a project consisting of more facilities can be then used for the calculation. With the help of the system the user has the possibility to simulate the proposed composition of constructions and construction processes in the project and the time and resource flow of the building process of the project on a microcomputer even if the topical relevant data about the project in the planning stage are poor. The more precisely the task is determined; the better results can be obtained from the model. The utility assessment method of building and projects designed by the author is based on this concept and is briefly described below.

2. DESIGN AND SIGNIFICANCE OF THE UTILITY ASSESSMENT ASPECTS

During the design of the criteria for utility assessment of buildings and project three main areas for the evaluation were stated – the contractor, the investor (owner) and the community. About 15 aspects for all areas were identified and finally 10 main criteria were picked out for the definition of the utility assessment vector. The criteria of the utility assessment vector are as follows:

- for the contractor
    - realization technology
    - environmental impact during the building process
    - energy intensity during the construction
    - risk during the construction
- for the investor (owner)
    - lifetime and fire resistance
    - quality
    - operation energy intensity
- for the community
    - build-up of free area
    - noise, traffic, operation emissions
    - recycling of used materials

For all aspects a common measure unit was proposed – 1 finyar (fiňár in Czech), abbreviation 1 FIN. It is something like a special sort of currency and in this way all aspects can work as resources in the utility vector assessment calculation. The lesser the amount of finyars will be allotted for a certain criterion the better is the resulting assessment.

The significance of all aspects was evaluated by a group of four experts. The aspects were mutually compared one to each other and at every comparison the value 1 was divided into two parts according to the higher of lower significance of the two compared aspects. If the significance of both compared aspects was equal both of them got the value 0.5. If one aspect was more significant than the other, it got the value from 0.51 to 1.0, the other got the value of the complement to 1. One of the 4 calculations of the significance of all utility assessment aspects is illustrated in Table 1. The actual values of weights (significances) of all criteria were then calculated as the average of values defined by mentioned four experts. The weights are illustrated in Table 2.

Table 1. Utility assessment aspects and their weights evaluation

			Realization technology	Environmental impact in the building process	Energy intensity during the construction	Risk during the construction	Lifetime and fire resistance	Quality	Operation energy intensity	Build-up of free area	Noise, traffic, operation emission	Recycling of used materials	Sum	**Weigth of the aspect**
Code	Aspect	#	1	2	3	4	5	6	7	8	9	10		
U10	Realization technology	**1**	0.0	0.6	0.7	0.7	0.3	0.3	0.2	0.4	0.7	0.3	4.2	**0.0933**
U20	Environmental impact in the building process	**2**	0.4	0.0	0.5	0.4	0.3	0.2	0.3	0.3	0.5	0.4	3.3	**0.0733**
U30	Energy intensity during the construction	**3**	0.3	0.5	0.0	0.3	0.4	0.3	0.3	0.2	0.6	0.3	3.2	**0.0711**
U40	Risk during the construction	**4**	0.3	0.6	0.7	0.0	0.4	0.4	0.3	0.3	0.7	0.3	4.0	**0.0889**
U50	Lifetime and fire resistance	**5**	0.7	0.7	0.6	0.6	0.0	0.5	0.6	0.7	0.8	0.7	5.9	**0.1311**
U60	Quality	**6**	0.7	0.8	0.7	0.6	0.5	0.0	0.6	0.7	0.8	0.7	6.1	**0.1356**
U70	Operation energy intensity	**7**	0.8	0.7	0.7	0.7	0.4	0.4	0.0	0.7	0.8	0.6	5.8	**0.1289**
U80	Build-up of free area	**8**	0.6	0.7	0.8	0.7	0.3	0.3	0.3	0.0	0.4	0.4	4.5	**0.1000**
U90	Noise, traffic, operation emission	**9**	0.3	0.5	0.4	0.3	0.2	0.2	0.2	0.6	0.0	0.3	3.0	**0.0667**
U100	Recycling of used materials	**10**	0.7	0.6	0.7	0.7	0.3	0.3	0.4	0.6	0.7	0.0	5.0	**0.1111**
	Sum		4.8	5.7	5.8	5.0	3.1	2.9	3.2	4.5	6.0	4.0	45.0	1.0000

Table 2. Utility assessment aspects and their weights

Code	Aspect	#	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Average
U10	Realization technology	1	0.0933	0.0956	0.0533	0.1084	0.0876435917
U20	Environmental impact in the building process	2	0.0733	0.0822	0.0489	0.0790	0.0708628041
U30	Energy intensity during the construction	3	0.0711	0.0733	0.0489	0.0497	0.0607486832
U40	Risk during the construction	4	0.0889	0.0844	0.0467	0.0858	0.0764446953
U50	Lifetime and fire resistance	5	0.1311	0.1333	0.1689	0.1332	0.1416290444
U60	Quality	6	0.1356	0.1289	0.1533	0.1219	0.1349184851
U70	Operation energy intensity	7	0.1289	0.1289	0.1556	0.1219	0.1338073740
U80	Build-up of free area	8	0.1000	0.1022	0.1489	0.0903	0.1103511412
U90	Noise, traffic, operation emission	9	0.0667	0.0667	0.0489	0.0835	0.0664359167
U100	Recycling of used materials	10	0.1111	0.1044	0.1267	0.1264	0.1171582644
	Sum		1.0000	1.0000	1.0000	1.0000	1.0000000000

3. MEANS FOR MODELLING THE BUILDING AND THE BUILDING PROCESS

Three main means for quick modelling of a building that consists of constructions or of a building process which consists of construction processes were created. First, a database for the quick modelling of the building is available. This database consists of the main data about all constructions and construction processes at the technological structure of work gangs. It includes main facts about the time standard, productivity of labour, price of the product, number of workers, technological pause and other 20 economical and technological resources (material costs, wages, costs for machines, overheads, average profit, machines, materials, professions) and the utility aspects vector per measure unit of the construction. The values of the utility aspects are given in the interval <0 FIN/m. u.; 1000 FIN/m. u.>. The neutral value for each aspect is 500 FIN/m. u., the "good" values are lesser than 500 FIN/m. u., the "bad" values are greater than 500 FIN/m. u. The greater the value of FIN/m. u. of the aspect is the worse is the influence of the aspect on the utility. Nowadays, there are more than 500 building constructions and construction processes included in the database, see Figure 1.

Second, a set of typical network diagrams of certain types of facilities and their way of erecting based upon the construction technology network diagram method, see Jarský (2000), (2006), was created. The typical network diagram of a building process of a facility as a computer file contains the data about the sequence of the constructions and construction processes, and their linkage. The typical network diagrams can be easily modified according to the spatial structure of the actual building. The volume of production and costs and price of all constructions are included too. They are related to an adequate custom-made measure unit, usually m^3 of build-in space or m^2 of reconstructed area in case of a reconstruction. The typical construction technology network diagram can be modified according to the spatial structure of the building process by using the 3 main minimum working space indices.

Third, the CONTEC project preparation and management system, see Jarský (2000), was adapted so that it is capable to calculate and evaluate the utility vector including the weighted values in a certain tabular form.

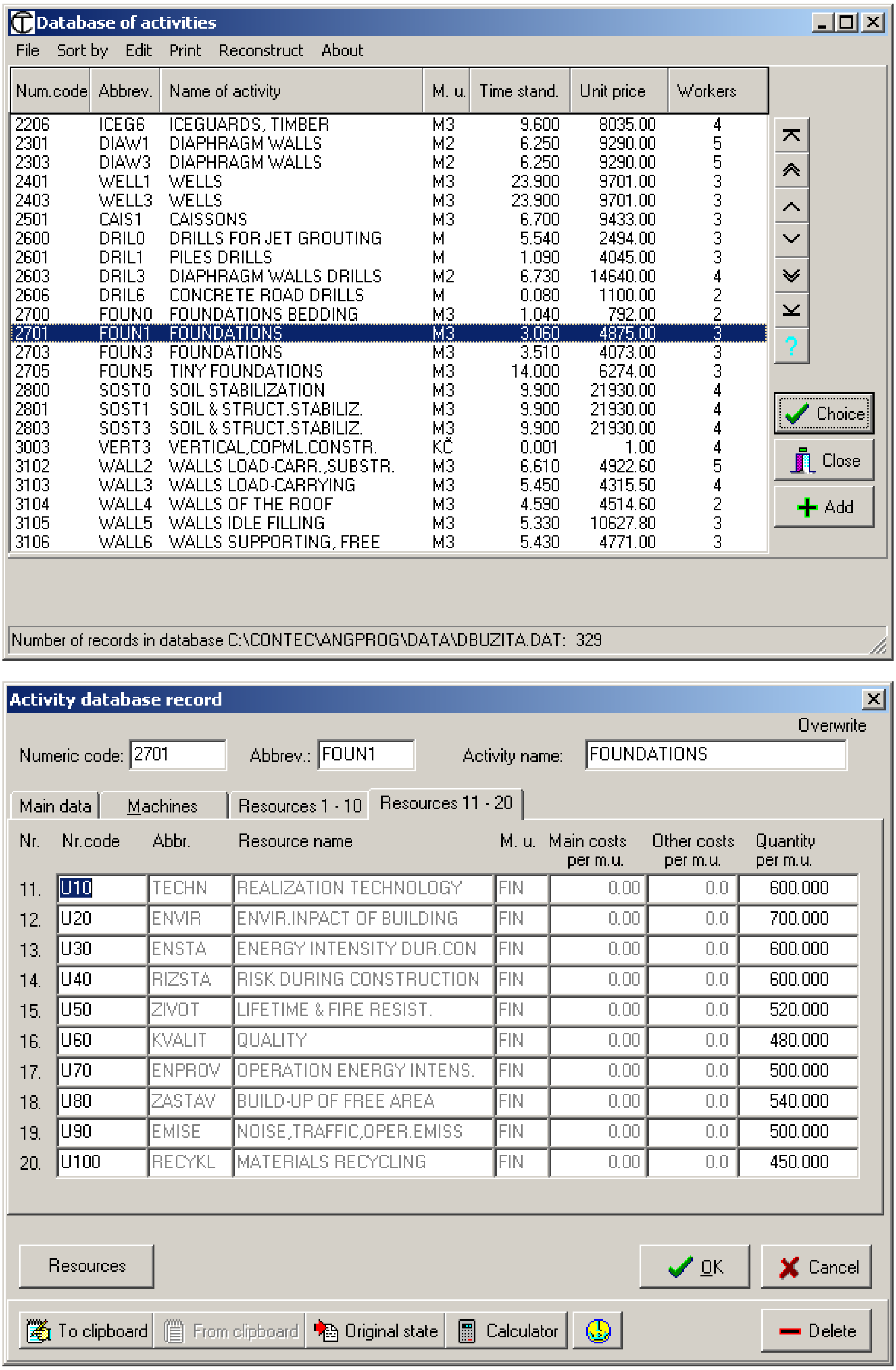


Figure 1. Part of the listing of the database of constructions and construction processes

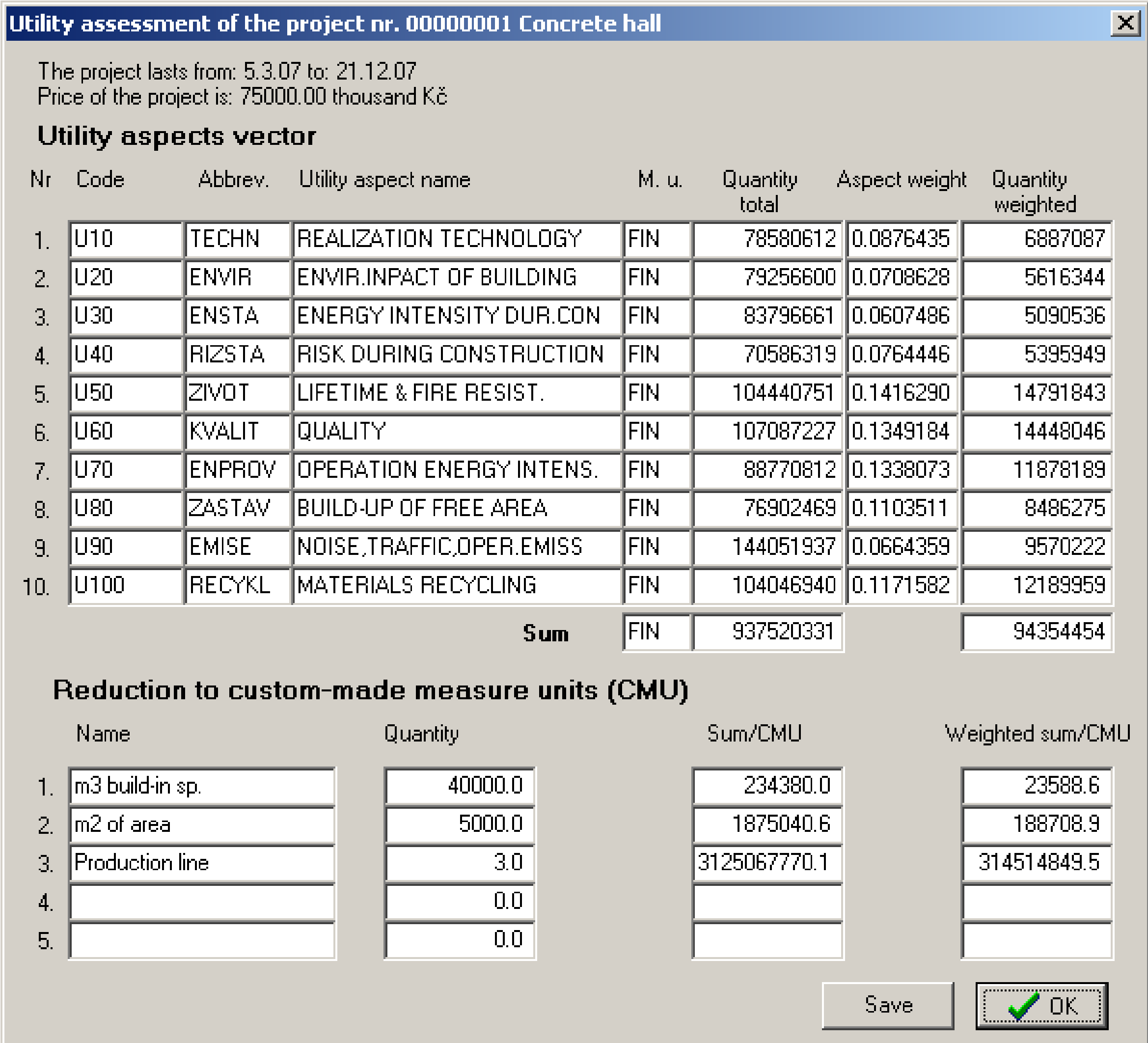
4. PRINCIPLES OF MODELLING THE BUILDING AND EVALUATING THE UTILITY VECTOR

When the user wants to simulate the facility or the building process, in the first stage he defines up to 5 custom-made measure units for the building or for the project. Then he calls up the typical network diagram of the certain type of facility, modifies it by stating the actual main working space indices and the computer generates the first draw of the model of the composition of the building, including the time and cost analysis data which are transferred from the database of constructions. Thus, the user can get the first model much quicker than by the use of classical project management systems that require creating the network diagram by adding relevant activities one after another and stating their duration, resources and links. The created model has to be defined with more precision according to the facts known about the building. It is known that 80 % of the price and costs is influenced by 25 - 30 % of activities only. Volumes of production of these significant constructions have to be stated according to the construction design, prices of the production, labour consumption and resources needed. If the exact bill of quantities is available its values can be automatically transferred into the model. After the calculation of the network diagram the user gets the early and late terms of starts and finishes of all activities. Constructions of all sorts (not only those from the database) can be included into the network. After making these models for all facilities that are included in the project it is possible to make a network diagram of the whole project by connecting the partial networks and linking them together with flow links in case of continuous work of specialised work gangs in linked buildings.

Thus, it is not necessary to create the network diagram individually from the very beginning for every project. The CONTEC system enables to build up the model of the building process of the project very quickly from prefabricated sections, typical network diagrams of different buildings, and to define it with more precision easily according to the facts gained from the investor's task. After creating the model of the project the user can transfer the data about the utility aspects for all activities from the database mentioned above. The system then calculates the whole utility vector in a table form, see Figure 2. The system enables to print the calculated network diagram in different forms of the construction technology design documents (technological analysis sheets, resource allocation overviews, bar charts, line-of-balance graphs (time-space graphs), resource allocation graphs of price, costs and cash flow, labour consumption, need of work force etc.), in Czech, English, Russian and Italian. Naturally all data included in the model can be interactively edited and recalculated.

All documents that are gained on the base of the construction technology network diagram can be easily edited and updated according to the actual compositions of constructions. The utility assessment method is completely free for the user. He can define his own utility assessment vector composed of his own aspects, he can identify his own values of weights (significances) of these aspects, he can even design his own database of constructions with allotting of the amount of FIN to every utility aspect in every building construction that is included in the database.

Nowadays, there are 4 types of these databases available – the database for housing and structural engineering, the database for industrial buildings, the database for engineering structures (bridges, roads and infrastructure) and the database for hydraulic structures.



Utility assessment of the project nr. 00000001 Concrete hall

The project lasts from: 5.3.07 to: 21.12.07
Price of the project is: 75000.00 thousand Kč

Utility aspects vector

Nr	Code	Abbrev.	Utility aspect name	M. u.	Quantity total	Aspect weight	Quantity weighted
1.	U10	TECHN	REALIZATION TECHNOLOGY	FIN	78580612	0.0876435	6887087
2.	U20	ENVIR	ENVIR.INPACT OF BUILDING	FIN	79256600	0.0708628	5616344
3.	U30	ENSTA	ENERGY INTENSITY DUR.CON	FIN	83796661	0.0607486	5090536
4.	U40	RIZSTA	RISK DURING CONSTRUCTION	FIN	70586319	0.0764446	5395949
5.	U50	ZIVOT	LIFETIME & FIRE RESIST.	FIN	104440751	0.1416290	14791843
6.	U60	KVALIT	QUALITY	FIN	107087227	0.1349184	14448046
7.	U70	ENPROV	OPERATION ENERGY INTENS.	FIN	88770812	0.1338073	11878189
8.	U80	ZASTAV	BUILD-UP OF FREE AREA	FIN	76902469	0.1103511	8486275
9.	U90	EMISE	NOISE,TRAFFIC,OPER.EMISS	FIN	144051937	0.0664359	9570222
10.	U100	RECYKL	MATERIALS RECYCLING	FIN	104046940	0.1171582	12189959
			Sum	FIN	937520331		94354454

Reduction to custom-made measure units (CMU)

	Name	Quantity	Sum/CMU	Weighted sum/CMU
1.	m3 build-in sp.	40000.0	234380.0	23588.6
2.	m2 of area	5000.0	1875040.6	188708.9
3.	Production line	3.0	312506770.1	31451484.5
4.		0.0		
5.		0.0		

Save OK

Figure 2. Calculation of the utility assessment

5. CONCLUSIONS

This paper briefly describes a new design of the methodology of the utility assessment of buildings and projects. It is based on a vector of 10 main aspects (criteria) for utility assessment which was designed with a same measure unit. The aspects were given a certain level of significance each. A database of construction processes was created including the aspects for the utility assessment. On the base of the methodology of the construction technology design a method for modelling of realization of building and projects based on the construction technology network diagram with utility assessment was created and a computer system for this purpose was developed. This system is capable of a quick modelling of a building or a project that is composed from constructions by means of typical construction technology network diagrams. It enables to calculate and tabularly illustrate the resulting utility vector and its sum with regard to the significance of every utility aspect. The methodology is completely free for the user who can define his own values of every utility aspect, even the aspects themselves.

The designed methodology of the utility assessment of buildings and projects can be used especially in the phase of planning the projects by owners, designers and architects for utility assessment and much more – for feasibility studies, planning, obtaining bank loans to finance the projects and last but not least in project management itself. The described system can be used on IBM PC compatible computers under Windows 9x, ME, NT, 2000, XP operational systems.

The data for the utility assessment will be regularly updated. The author plans for the near future to develop especially the database for utility assessment with better precision and to create more version of the database to distinguish some special facilities. We plan to create a database with the data for building and civil engineering facilities, for the infrastructure, roads, railways etc.

ACKNOWLEDGEMENT

The paper presents some parts of the results of a CTU in Prague, Faculty of Civil Engineering research project on Management of sustainable development of the life cycle of buildings, building enterprises and territories (MSM 6840770006), financed by the Ministry of Education, Youth and Sports of the Czech Republic. The author wishes to thank to his workmates, esp. to Josef Ladra, MSc., Miloslava Popenková, PhD., MSc. and Assoc. Prof. Pavel Svoboda, PhD., MSc. who participated in the discussions about the choice of the utility aspects in the definition of the utility vector, in the evaluation and calculation of the weights of the utility aspects and in the organizational aspect of the solution. Out thanks belong to the post-graduate students of the Department of Technology of Structures for the help in defining the utility aspects data of building constructions in the database.

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THE MARKETING CONCEPT IN CONSTRUCTION COMPANIES

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Abstract

Marketing is a competitive process offering goods and services for consumption at a profit. Today, when market conditions are very complex, there is great competition and customers and clients have a choice, in general as well as in the construction industry, so it is necessary to implement a marketing philosophy. Marketing strategy is a fundamental approach for market-oriented business. The authors analyse business strategies and all the relevant elements needed to understand marketing. They also analyse the Croatian construction industry in the period after the defence war. Croatian construction companies do not implement marketing strategy to a satisfactory degree. Although one of their significant characteristics is lack of knowledge about marketing basics, they have done very little (on the company level) to improve marketing methods and techniques in order to find new markets on which to place their products and/or services.

Keywords: construction, marketing, business strategies, marketing concept

Introduction

One of the fundamental characteristics of a successful company is the management's ability to design and implement a profitable business strategy. A successful business strategy implies knowledge of all the relevant factors of business and development, in the first place of its own company, but also of the economy and society in general. Research in the last decade proved that the most profitable companies always had well designed and implemented business strategies whereas the least profitable companies had a poor strategy or had no particular strategy or had a strategy that the company was not able to successfully implement.

Furthermore, a research carried out in more than 400 different companies in the USA in 1996 showed that marketing strategy pays and proved that a marketing business strategy has a very important positive effect on various indicators of business success, such as for example return on investments, sales increase and new products development (Walker, 1996).

Where do Croatian construction companies stand? What is the situation considering marketing strategies on the construction market ? May we say that Croatian construction companies are acquainted with marketing strategy and that they have built it into their business strategy? Or they do not implement marketing strategy at all ?

On Croatian construction market there are signs of the recession as a reflection of that on the world market i.e. after many years there is an excess of flats on the market, conditions for housing loans are becoming tougher, infrastructural investment has decreased. The companies must adjust to changed market conditions by implementing new or different business strategies.

We wish to emphasise here that basing company's business strategy on the implementation of a marketing strategy can significantly improve the competitiveness not only of a particular company, but also of the construction industry as a whole.

1. MARKETING STRATEGY

Market oriented business primarily focuses on securing a constant inflow of work in such a way that, by satisfying clients' needs and requests, the company works with a profit. This is a business strategy or business philosophy that always focuses on the customer, his requests, wishes and needs.

We use the term marketing to define an up-to-date market-oriented business strategy. Marketing in its simplest terms means finding out what customers want and then endeavouring to supply those requirements and to do so profitably. (A.B.Moore, 1984)

The Institute of Marketing is more specific and defines marketing as follows:

"The management function which organizes and directs all those business activities involved in assessing and converting purchasing power into effective demand for a specific product or service and moving the product or service to the final costumer so as to achieve the profit target or other objectives set by a company."

Marketing strategy is the aspect of management that deals with the general courses of development and the company's long-term business policy. Market oriented strategic planning is a management process designed to develop and sustain the company's vitality on the demanding and changing market. Strategy is the basic manner of defining objectives (present and future), resource distribution, interaction between organisation and the market and other environmental elements.

The main task of marketing strategy is to establish and coordinate marketing functions with the purpose of achieving the company's objectives, for a particular product and/or market.

Companies act on the market and in doing so they comply with market conditions and the market environment; implementing a marketing strategy thus becomes every company's key element for establishing a market-oriented business policy. This way of thinking implies complete insight into the market, into all the subjects that appear on it and also into the factors that affect the market environment.

Doing business under market conditions means that every company must define its own business strategy, which generally implies determining its long-term objectives and the principles for achieving them. The concept of business strategy is comparable to the concept of war strategy. According to Sun Tzu's philosophy of warfare, battles (or tenders) are won by the organisation or person with the greatest competitive edge or the one that makes the least mistakes. Much research undertaken in the last decade has proved that the most profitable companies in countries with a developed market economy always had well designed and successfully implemented business strategies.

Therefore, a company must implement a marketing strategy that will enable it to reach its objectives. The concept of strategic planning can simply be explained as a process consisting of the following stages: analysing the company's present market position and the prerequisites for its expected future market position, defining the company's objective and the most advantageous course of development to achieve them, and recognising, choosing and finding the means to achieve the company's objective. (Vranešević, Vignali, Vrontis, 2004) So, marketing includes market research, analysis, advertising, public relations, company promotion and pricing.

The first step in implementing company strategy is defining the company's mission. The mission is the reason why the company exists on the market, it must be long-term, recognisable and must represent a vision of company development in the next 10 to 20 years. The mission consists of four basic elements: purpose, strategy, values and behaviour standards.

All the mission elements must by interconnected and harmonised so as to create a mission statement, which will be efficient and which will have a positive effect on the company. (Galetić, 2005) Company development strategy is formulated on the basis of the adopted company mission.

Marketing strategy starts from analysing the environment in which the company works. Of the many approaches we might singled out the PESTLE[1] model that helps view the external levers of political, economic, social, technological, legal-legislative and ecological changes. The SWOT[2]

[1] PESTLE – an acronym of political, economic, social, technological, legal, ecological

[2] SWOT – an acronym of strength, weakness, opportunities and threats

analysis may also be used to view the nature of the strengths, weaknesses, opportunities and threats in the environment and thus determine strategy in the context of organisational processes. (Brownlie, 1995)

The application of many portfolio models is important in defining company strategy. The basic portfolio model, from which the others developed, is the BCG[3] growth and market share matrix. The McKinsey multifactor matrix[4] is another very useful model. However, to determine the strategy correctly the product (service, idea...) must be recognised as suitable for the market segment chosen. This means that segmentation of the market must come before all of the above. (Vranešević, Vignali, Vrontis, 2004)

Organisation therefore has to decide which parts of the market they are to serve, and to establish a distinctive basis as to how this can, most profitably, be achieved. (Pettinger, 1998) Porter identifies three distinctive positions:

a) Cost leadership – the gaining of advantage through being the most cost-effective operator in the sector,

b) Focus or specialization – the offering of distinctive and often narrow ranges of products in a particular niche, seeking to serve all of those clients or costumers in the particular niche, and seeking as many possible outlets for the distinctive product and service,

c) Differentiation – the purpose is to set the product apart from others in the sector and maintain the ability to sell at a premium price.

If we try to transfer all the above into the context of construction, we might conclude that marketing strategy is a very important management discipline which is not clearly understood by those employed in construction sector. We have to be aware that no organization can serve an entire market, segment or sector for all time; that competition therefore exists; and that customers and clients have a choice – at the very least, the choice to refuse or reject. (Pettinger, 1998)

Construction sector always has a strong impact on the entire economy of a country. Today this is the only activity that is truly universal – global. Many people say that construction is a specific activity – and they are right, it is. But every industrial activity is specific in its own way. Like for any other activity, marketing for the needs of construction means understanding and adopting general marketing principles and applying them to the specific and particular conditions in

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[3] BCG growth matrix – an acronym for the Boston Consulting Group – the leading company in the USA engaged in management – it developed a model known as the growth and market share matrix.

4 McKinsey& Company – management analysis model known as 7 S

construction. This is why it is necessary for construction companies too to focus more strongly on the market, which imperatively imposes the need to adopt a marketing strategy.

In 2002 a structured questionnaire was forwarded in Great Britain to a sample of 106 firms engaged in civil and structural engineering, multidisciplinary civil engineering or multidisciplinary building; 54 complete responses were returned. The majority of participating firms (87%) had a marketing plan and sought to investigate new markets as well as consolidate existing ones. More importantly, companies with a marketing plan attracted a higher proportion of new clients than those without (i.e. 36% compared with 23%). This success would appear to be based on the fact that 96% of companies monitored market trends and 49% of profits were reinvested into future marketing. (Yisa, Edwards, 2002)

Because we can say most simply that marketing strategy implies knowing where one wants to go and the best way and manner to get there. (Vranešević, Vignali, Vrontis, 2004) And this is a sure path for conquering the market and gaining a competitive advantage.

2. CONSTRUCTION IN CROATIA

There is no doubt that construction is very important for the national economic development. In recent years construction was one of the prime movers of economic growth, both in the Republic of Croatia and in the new East European countries, Russia and in the Middle East. Economic growth, growth of the standard of living and the demand for real property are sustaining a high share of construction in the total GNP.

In the last few years Croatian construction companies were engaged in work on great infrastructural projects in the country and, accordingly, 2006 the construction sector participated in the total GNP was as much as 5.9%, it employed 93,297 workers and realised about 21 billion Kuna in executed works.

What causes concern is that in 2006 the construction sector had 10,806 firms, of which as many as 5,227 (or 48.4%) did not have one single employee, and 4,061 firms (or 37.6%) had one to nine employees. At the same time foreign competition has appeared; in 2005 foreign companies registered 117 main branches.

From 1995 the share of construction in the GNP has kept growing which indicates intensive construction activities and is more or less on the level of employment growth in the construction sector. However, it is interesting that productivity per employee (expressed in Eeuros) doubled in the period observed. Comparison of the almost triple increase in the value of works with the increase of "only" 30% in the number of workers means that the growth of prices played the most important role, not the increase in work volume.

Indexes on the permanent basis of 1999=100

Year	Value of works (€)		Share of construction in the GNP (%)		Number of employees		Productivity per employee (€)	
1999	1.082.947.144	100	4.5	100	71.302	100	15.188	100
2000	936.438.413	86	3.9	86	65.222	91	14.358	94
2001	1.178.919.947	109	4.1	91	65.782	92	17.922	118
2002	1.553.852.670	143	4.5	100	71.788	101	21.645	143
2003	2.140.572.890	198	5.4	120	78.276	110	27.346	180
2004	2.254.686.052	208	5.7	126	81.893	115	27.532	181
2005	2.406.335.517	222	5.6	124	85.025	119	28.302	186
2006	2.926.470.432	270	5.9	131	93.297	131	31.367	207

Source*: State Bureau of Statistics*

Analysis of the value structure of construction works in 2005 shows that state participation in investments was still very high (estimated at 65%). Thus for example the state invested in

- traffic infrastructure 47.4%,
- housing 14%,
- non-residential buildings 24.9%,
- pipelines, utilities and energy infrastructure 11.6%.

However, the motorway network throughout Croatia will soon be completed, the important infrastructural facilities in which the state previously invested are almost finished or will be built in the nearest future, and the housing sector already shows indications of a decrease in demand.

That means that very soon Croatian companies will be faced with the need to find and conquer new markets and/or introduce new products and/or services.

Meanwhile, the value of construction works realised abroad since 2000 has constantly been decreasing. In 2000 about 1 billion Kuna was realised and 3,435 workers engaged, and in 2005 about 822 million Kuna were realised abroad (only about 0.5% of the value of works executed in that year) with 2,006 workers (only 0.4% of the total number of workers), which best shows how "interested in export" Croatian companies today are.

3. THE USE OF MARKETING STRATEGY IN CROATIAN CONSTRUCTION COMPANIES

More serious attention began to be given to the introduction of marketing strategy in construction companies at the end of the eighties, because the economic crisis in the former Yugoslavia had reached worrying proportions. When in 1991 the social and economic system changed, Yugoslavia fell apart and the war in Croatia began. It lasted for almost five years brought great destruction and almost all construction activities stopped. As a direct consequence of the destruction of factories, hospitals, schools and the entire infrastructure of many towns, of the exceptionally great "costs of war", many companies failed and people lost their jobs.

Although the reconstruction of destroyed cities and infrastructure started as early as beginning of 1992 the significant renewal process began only in 1995. With the final ending of the war the renewal began with more intensity and the state was the greatest investor. By that time the construction sector has been drastically transformed (the large construction companies disappeared or were fighting against great difficulties brought about by transition). Many new small to medium size companies were born and Croatian construction companies began their expansion as there was more work than the builders could do. The market was unbalanced and there was no need to introduce any kind of marketing strategy at that time.

A rough estimate shows that direct or indirect state participation on the market of investment services was about 70%, while state participation in developed Western countries, under normal conditions, is usually between 40% and 50%.

Today the situation is gradually changing. Croatian construction companies are realising a value of almost €3 billion or €31,000 per employee. In 2006, the ten largest construction companies realised 21.2% of the total income in the construction sector.

But how to estimate how many of the 1,518 (out of 10.806) construction companies with more than 10 registered employees have a business strategy that includes a marketing strategy? Most construction companies equate marketing with sales or advertising. However, marketing strategy is a much more complex concept of doing business.

In 2002 a small research was conducted to discover the actual “conditions in marketing” and the main reasons why Croatian construction companies do not use a “marketing philosophy”. The survey was conducted among 7 of the largest construction companies, which in 2000 employed 9,900 workers (14% of the total number of workers) and made an income of US$ 380 million (13.2% of the total income). The questionnaire had a small number of questions and the results were very interesting. Four companies had a marketing sector but they had a very different understanding of marketing. Three had no marketing sector or department, because they considered that they do not need marketing. All the respondents used catalogues, brochures and participated at specialized fairs. Only one company used modern forms of promotion on a website. All the respondents secured work through tendering but sometimes also through direct agreements.

What to conclude from these results? If this is the condition among the “large” companies, which have the personnel and financial potentials to invest in marketing, how do things stand in the “small” companies that cannot employ specialists and which are barely making ends meat?

Very often the management suffers from strategic inertia – the automatic continuation of strategies successful in the past even though current market conditions are changing. And that is, in our opinion the case in Croatian construction sector. The main reason for not changing management strategies in our construction companies is inertia, but unfortunately not as a result of successful business strategies but more as a result of the habit that "others" have to solve problems and introduce changes. (Katavić, Cerić, 2002)

4. CONCLUSION

The purpose of implementing a marketing approach is to build and strengthen the organization as a going concern. From this form of assessment and in devising "a strategic standpoint" the result from a marketing point of view is to combine what the organization is good at, together with how it can be best presented to the client. (Pettinger, 1998)

In market economies profit is only realised through the successful placement of the product and/or service on the market, which means being present on the market with the right product/service which has the "right" price, on the right place and at the right moment. These rules also hold for construction.

One might ask what the marketing strategy of construction firms in Croatia should be. The answer to this question is very complex and we will not be able to give it for some time. The basic reason is that companies still do not feel the need to implement elementary market research. This can clearly be seen in the housing sector where a surplus of flats is already appearing on the market and their price is falling. The lack of housing policy has also resulted in flats in Zagreb being much more expensive in relation to people's standard of living than in other European cities; for example, Croats need 8.8 annual incomes to buy a flat, and Czechs only 3.2.

In Zagreb the demand for flats of about 50 square metres costing up to €100.000 exceeds the supply, but because of the recent increase in interest rates on housing loans the credit rating of the purchasers of such flats has decreased and they are no longer are able to raise a sufficient loan to buy a flat. They thus decide to wait in the hope that the sellers will decrease the prices or the banks will decrease the interest rates.

Another problem is that of so-called urban villas that do not satisfy even the basic criteria for this name, with exceptionally highly priced square metre, so many such flats do not sell although they are allegedly "very desirable". Only then when there is very small demand the developers begin to promote and advertise, and often lowering the prices.

Although we have already stepped deep into the 21st century, Croatian construction operatives have not yet seriously met the demands of the market. Even though they face great problems in the placement of services, many companies are still not able (for many objective but also subjective organisational weaknesses) to produce the "perfect" product at an acceptable price in the determined deadline. This kind of behaviour does not promise prosperity because the market solves problems of quality very quickly. Only the best succeed, and the others sooner or later fail.

We therefore think that the time has come for Croatian construction companies also to begin to systematically introduce marketing strategies in their business operations and to work according to marketing principles

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Current issues in the implementation of assessment methods and strategies for sustainable planning and building

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Sustainability policy guarantee belongs to the most important tasks of architecture and construction of the new millennium.
40% of the total energy consumption within the EU is used for heating and cooling of buildings. Only within Austria, one fifth of the total CO_2-emissions are caused by buildings. The recent sharpened EC-requirements in terms of climate protection and minimization of the CO_2-emissions underline the urgent necessity for development and application of strategies and innovative technologies for the sustainable planning and building.
This paper will present current problems the planning and building process for sustainable buildings are faced with.
The evaluation strategy based on the coherences of the different parameters determining the sustainability performance of a building will be introduced.
Two energy efficient office-buildings will be tested on sustainability performance and comparison with a standard building will be carried out.

Keywords
Sustainable building, low energy house, passive house, energy efficiency, building performance

1. Introduction

Sustainability assessment is often mistaken through solemnly environmental assessment; which does not correspond to the holistic, life-cycle oriented approach. Building performance assessments also often lie solemnly upon the consumption of heating energy, the primary energy consumption for construction and demolition as well as for the cooling-, lightning- and operation energy demand is hardly considered.
A life-cycle oriented sustainability assessment reflects the balance between the three pillars of economic, ecologic and social interests throughout the life-cycle of a building. The institution can be seen as the fourth, regulating component.
For the building industry, the sustainability-issues can be defined as:

- Economic interests: the fulfilment of the economic objectives throughout the calculated economic life duration of the real estate
- Ecologic Interests: protection of the natural resources, reduction of the environmental impact and resources- and energy consumption
- Social interests: fulfilment of individual needs, protection of social stability, equal opportunities and resources distribution

2. Problem identification

The new requirements of the European Commission foresee by 2020:

- Minimisation of the CO_2-emissions by 20% and
- Increase in the ratio of renewable energies of 20% (Presse, 2008).

However, current tendencies show the opposite:
The CO_2-emissions and energy-consumption have increased for 15% since 1990, instead of by Kyoto-Protocol foreseen decrease of -13%. (Koeppl, 2008)
In the long run, till 2050:

- the predicted energy-demand will rise for 100-120%,
- at the simultaneous request for minimisation of CO_2-emissions by 60-90% (Achammer, 2008).

The measurements for securing sustainable building performance are urgently necessary; however the implementation is hindered through essential problems:

- The overdue traditional planning process, with building-completion as the last horizon. The linear alignment of planning phases and services results in buildings with wrong orientation and interior climate that is hard to handle. Unsatisfied users, high following costs, high life-cyclic resources consumption, short economic life-duration, are the consequences of such planning process. The life-cycle oriented, interdisciplinary planning process with simultaneous co-work of different disciplines from pre-design phase is a precondition of sustainability.
- The configuration of the real-estate market – "Investor-architecture".
  The investors are generally interested in lowest possible construction costs and the highest possible yields and profits. The buildings are mostly seen as asset in portfolio, to be transferred as soon as built. The future tenants are confronted with high following costs.

The question rises, how can energy-effective buildings be lucrative for investors; interested in sustainable rents or further sale (building as portfolio-asset) where return of investment period is sometimes longer that 30 yrs. through extremely costly façade (double façade) or innovative HVAC (heating, ventilation, air-conditioning) technology. Moreover, the building with optimal energy-performance does not necessarily have to be optimal in terms of life cycle- cost or emissions.

3. Case Study

The investors of office and commercial developments as well as the public investors have increasingly started showing interest in alternative concepts of heating, cooling and ventilation of the buildings. This trend can be seen as the consequence of:

- The new increased institutional requirements on climate protection measurements
- Matured and tested energy efficiency-technologies and their implementation on the small scale projects (passive-technology in single-family houses).

The first office and administration buildings in low energy/passive-house technology have appeared, however most of them have been built for clients own use (not as portfolio-asset or speculative office real-estates).
The current issues in the energy-efficient building when implemented in the investor oriented realm of office and administration buildings have been analysed and evaluated on the case study of two energy-efficient office buildings in Vienna.

3.1. ENERGYbase

ENERGYbase, the first passive-house technology office building in Austria, was taken in operation in summer of 2008.
The mix-use concept is based on (WWF, 2007):

- Ground floor containing a polytechnic school for renewable energy
- Four upper floors in total of 7.500 m² RA (rentable area) situating flexible office-spaces, which rentable area varies from 250m² up to 1400m²

The energy concept is based on the activation of the concrete core by the means of heath pump (underground-water temperature is used for heating and cooling).
The south façade is composed of 400m² photovoltaik elements and 300m² solar collectors; additionally providing for the cooling and heating energy as well as to own electricity production. (Kittel, 2007) The ventilation system includes 500 plants in the "green-buffer-zones", that provide sufficient humidity in the winter months. (WWF, 2007)

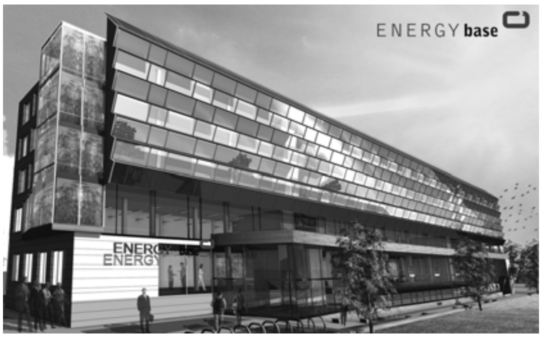


Figure 1: ENERGYbase (Kittel, 2007)

3.2. Haus der Forschung – House of Research

A new headquarters of Austrian research funding agency was built in 2006 in low-energy standard. The planning objective was to achieve the highest possible energy efficiency and comfort at the working place.
The building was build without governmental subsidiaries, as a standard market-conform lease-object.
The heating and cooling of the building follows through the concrete core activation – the concrete structure is used as accumulation mass; resulting with comfortable interior climate due to the mild cooling and low air exchange rates.

Figure 2: „HdF", (Mascha 2007)

4. Building performance evaluation

A building performance evaluation of the two case-study buildings in terms of sustainability will be carried out applying the **dynamoB^{sd}** evaluation strategy (Kovacic, 2007). The strategy is based upon two basic tools:

- **Flow-concept** (Kohler, 1999): superposition of different flows taking place through a life-cycle of a building: resources - materials and energy, capital - investments, reinvestments and profits, and information
- **Parametric model** (Kovacic, 2005): a system of sustainability indicators reflecting the "prism of sustainability".
  The main indicator-structure describes performance of aspects:
  - *Ecology*: construction demand, land- and water protection, pollution- and emissions reduction, long life duration, health friendly building materials, reduction of energy- and resources consumption (BMBW, 2001)
  - *Economy*: initial investments, following costs (heating and cooling, ventilation, lightning, maintenance, inspection and service), function, formal criteria, construction/technology, economy power and competitiveness
  - *Socio-cultural aspects*: urban identity, individual needs, social stability, equality

The parametric model represents the ambivalent nature of a building as composition of tangible and intangible aspects:

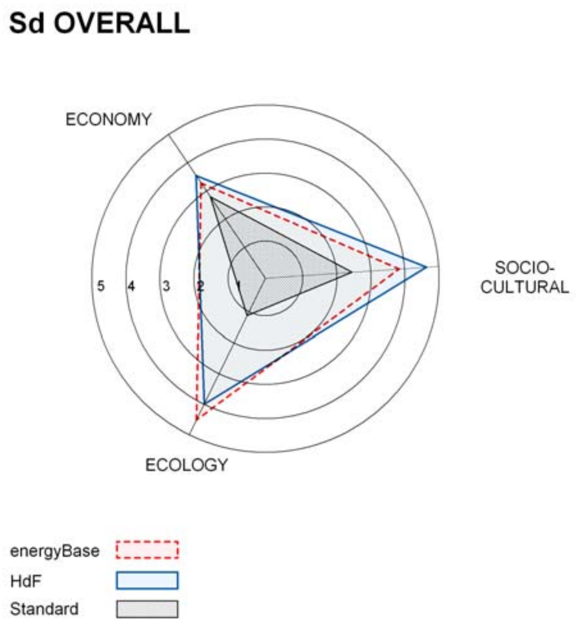
- The tangible data are building's quantitative characteristics: ecological (consumption of resources and energy, emissions) and economic data (investments, initial and life cycle cost).
- The intangible data is expressed through qualitative characteristics such as formal, cultural and functional aspects.

Both tangibles and intangibles will be evaluated upon the same grading–scheme: by the means of scale-rating: 1 being the weakest and 5 the strongest score.
The tangible, real values are compared to the benchmark or target values and graded accordingly, where as the intangibles are simple yes/no questions or scale-ratings.
The evaluation results with an absolute value of factor of sustainability **– Sd**, defining the sustainability performance potential.

4.1. Evaluation of the building performance of the two case study buildings in terms of sustainability

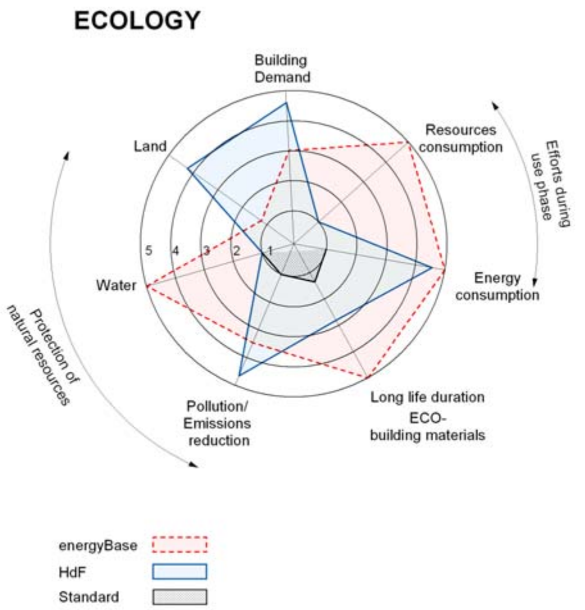
The evaluation and performance comparison of ENERGYbase and HdF was carried out through application of the **dynamoB^{sd}** evaluation strategy. The results of these were compared to the performance of a Standard Building, an office building prototype as currently developed with respect to the Viennese building code.
The evaluation resulted with following outcomes:

Potential:	*ENERGYbase*	*HdF*	*Standard Building*
Economy	3,20	3,33	2,30
Ecology	4,51	4,01	1,14
Socio-cultural	3,93	4,59	2,62
Total Sd	**3,88**	**3,98**	**1,71**



The overall performance of both energy-efficient buildings in terms of sustainability can be rated as GOOD; whereas the **Sd** factor of the Standard Building rates only as POOR.
The economic performance of the two buildings appears as the weakest aspect;
for the Standard Building is the ecology-aspect by far the weakest.

The performances within three aspects can be analyzed in more detail through comparison of single aspect-indicators, and depicted by the means of the cob-web diagrams:



For the **ecologic** aspect, the main conclusions are:

ENERGYbase

Strengths:

- Passive house standard: heating energy consumption of 12 kWh/m²a GFA (Gross Floor Area) (90-100kWh/m²a GFA at standard office building)
- 180 Tons of CO_2 emission saving compared to standard building
- Integrated energy management concept and use of related loan programs
- Innovative technologies: green-buffer zone for better interior climate, solar cooling

- Recyclable elements, environmentally friendly materials, renewable materials – wood

Weaknesses

- High consumption of new building land, sprawl supportive
- Low level of accessibility – upcoming of personal traffic, upraising of CO_2-emissions

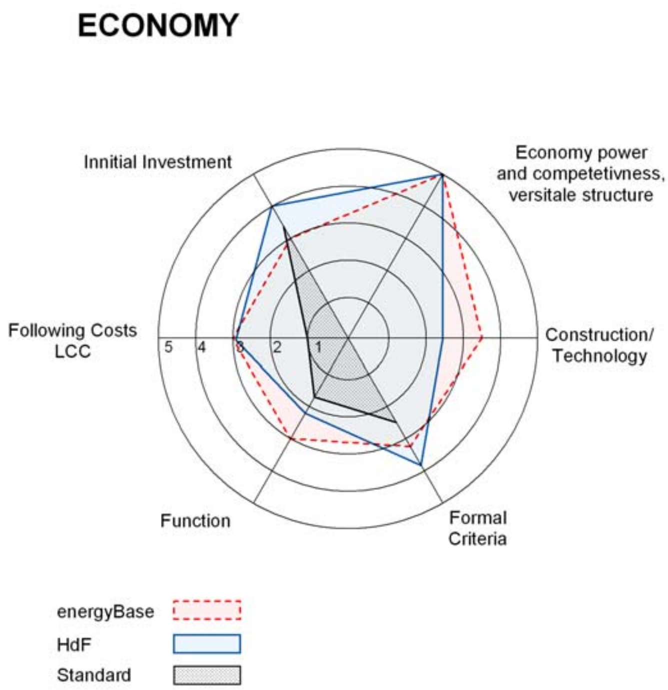
Haus der Forschung

Strengths:

- Low energy standard - heating energy consumption of 30 kWh/m²a GFA (90-100 kWh/m² GFA at standard office building)
- Electricity consumption for cooling and ventilation 12 kWh/m² RA (20 kWh/m² RA standard office building) and for lightning 8 kWh/m² RA (24 kWh/m² RA standard office building)
- Gaining back of the land - inner city project
- High level of accessibility by public transport or walking distance

Weaknesses:

- Building elements hardly recyclable, no renewable building elements



For the aspect of **economy**, it can be concluded:

ENERGYbase

Strengths:

- Flexible floor plans
- LCC (life cycle cost) for heating, cooling and lightning of 18.000 €/a
- (90.000 €/a at standard office building)
- Construction cost of 1120 €/m² GFA, despite innovative technologies and energy efficiency (1200 – 1300 €/m² standard conditioned office building)

Weaknesses:

- Only 30% of the areas are rented
- Location – low access to the public transportation, suburban location
- Built for free market – tenants unknown

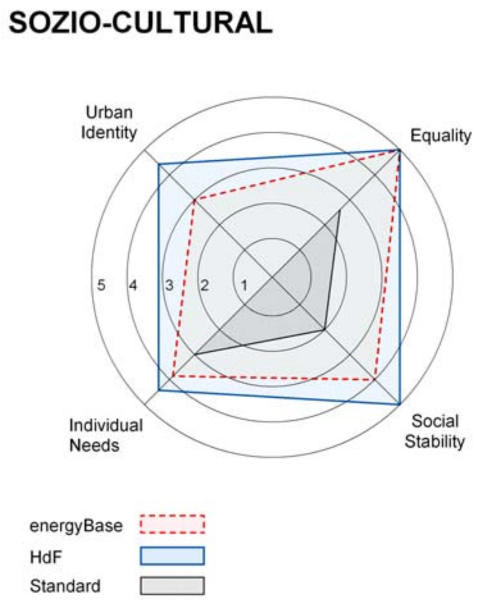
Haus der Forschung

Strengths

- Free financing, no governmental subsidies
- Tenants known – no risk

Weaknesses

- Inflexible floor plans due to the 500 Lux limitation for energy saving



In the **socio-economic aspect**, HdF strikes out with the best performance, mostly because of its location as the inner city project – high level of accessibility of working place and infrastructure, as well as the creation of livable urban identity.

5. Conclusion

The main objective of the evaluation of investor-oriented office-buildings was to prove the eligibility of additional expenses for ecologic issues (innovative energy-efficiency technology, environmentally friendly materials) in respect to the economic sustainability (return of investment, profits).

The evaluation process encountered several major problems:

1. Lack of data accessibility

- The question of how the additional construction-costs can be rationalized through leases and yields can hardly be evaluated at this point in time, since the real-estate owners/managers are declining to publish the actual data on yields and leases.
- The same principle applies to the LCC for cleaning, inspection and maintenance – the real data has sill not been collected, since the buildings are not in operation for long enough; the approximated data by the facility managers is not accessible.

2. Lack of data-standardization

When comparing the performance of the expected operational costs and energy consumption, as well as the CO_2-emissions of the two case study buildings, the problem of the data-standardization emerges. The values are not obtained upon the same calculation base – in one case the consumption is calculated per m² of GFA, in the other per m² of RA. Further on the consumption data is not separated for the aspects of heating, cooling, ventilation and lightning; but bound together – therefore the building performances can hardly be comparable.

The evaluation process resulted with the following insights:

- The economic aspect being the weakest implies on the need for closer examination of initial investment cost vs. following costs and profits, which again demands exact data on rents and yields. For the evaluation of cost-effectives of energy-efficient office-buildings a few years of operational experience are still needed, in order to obtain representative data.
- The evaluated buildings are not as flexible in the operation and floor organization as the standard core-and-shell real estates (delay in tempering due to the concrete core activation, floor-plan inflexibility due to the illumination by predominantly natural lightning, for energy saving reasons etc.) and therefore harder to sell on the market for standard tenant.
- Current state-of the-art energy-efficient buildings can be interesting for a specific market-segment, such as companies dealing with energy efficiency, governmental agencies, spin-offs with governmental subsidiaries etc.

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MANAGEMENT ROLE WITHIN THE CIVIL ENGINEERING COMPANY

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Summary

Selecting the theme of this document, we are intending to present some of the basic characteristics of management within the civil engineering company in its general issue; to refer to operating of the same within the area we live in, and all of the mentioned, through monitoring the civil engineering company business running which is, at the moment going thru its expansion phase.

On the example of the civil engineering company, there shall be presented the importance of the management structure of sufficient quality properties for running successful civil engineering activities in nowadays prevailing market conditions. Dynamics, strong competition, continuous improvement of prevailing one as well as appearance of new technologies, qualified personnel education and continual work on quality improvement of construction products and services – present just few of the properties present within the civil engineering, which themselves impose the necessity of management establishment being capable enough of responding to all challenges of such an specific market like the civil engineering one is.

There will be made some issues on the most important characteristics which managers of the civil engineering companies should take into consideration, all for the purpose of being successful in their business running. The most important among them are just those which might be acquired by learning, and as a leading one, we would make a point on the continual which on learning and acquirement of new knowledge. Yet, there are present some obstacles, the ones which civil engineering company managers are daily faced with, and which they should know how to properly and timely eliminate them.
Finally, we have elaborated the theme just due for a reason of assuming the same has not been granted a sufficient consideration; so in this way, we wanted to point out the

importance of young and qualitative management in general - especially in civil engineering industry, acting as bearer of development in each and every segment of economy development.

Key words: Management, Civil Engineering Company, Process, Knowledge, Quality

1. INTRODUCTION

Civil engineering significance within the economy system of the Republic of Croatia, is primarily based upon the fact that civil engineering has a strong impact to the dynamics of economy and infrastructural movements, since in the civil engineering final product, there participate economy subjects out of various different branches.

Civil engineering market issues, being extremely propulsive economy activities, do impose the necessity of a qualitative approach to organizing the business running, all for the purpose of subsisting within the market, improvement of business results and creating long-term qualitative relationship with customers and suppliers.

Making the civil engineering companies' being stronger within the domestic market, and by this issue having their impact to economy in whole, has been determined by macro-economy actors which civil engineering companies should be stressing; yet, it would be necessary to point out that civil engineering companies should be comprehended into innovation processes and detailed reconstruction of their own business running. Only in this case, it might be possible to make a prestigious step forward of the civil construction operations.

As far as market economy is concerned, the market demands and risks are ever so quickly changing. Thus, it would be necessary to presume future demand of development, technology development and decision bringing – all in pursuance with expected changes.

Management efficiency of the civil engineering company depends on organizational quality and knowledge regarding management methodology. The most important links inside the chain are the owners and managers of civil engineering companies who should ensure the corporate capital flow, creation of values according to the criteria prevailing on the market, improvement of counter-trade, competition follow-up, economy sciences impacts, introduction of flexible and entrepreneurship business running. Contemporary management theory and practice adopts innovations as being inseparable to entrepreneurship, so the issue appears to be on innovations in entrepreneurship and management, too. The existing enterprises, companies, institutions – they all tend to their drop, in case of not introduction innovations into their work procedure. On the other hand, each and every organization, enterprise, company or institution are faced with difficulties if they fail to introduce contemporary-based management.

2. CIVIL ENGINEERING BASIC MAGEMENT CHARACTERISTICS

In nowadays market conditions, the civil engineer management team should monitor as well as study the following management process, and based upon collected information, the same should bring their decisions.

The management process elements are as follows:

- Planning
- Organizing
- Human resources management
- Leadership
- Controlling

Planning – civil engineering company and the management team are obliged to ensure sufficient resources needed for performance of the contractual works. The decisions on the work planning should be brought in pursuance with the Construction Contract, Professional Regulars and available capacities. Based upon plan-made decisions, there are being granted available capacities or resources (work, equipment, materials) for works and activities throughout the period of time. Tactically based, the management brings the decisions regarding terms of work performance and their finalization, since the same are of importance for the structure to be made within the frame of contracted period of time.

Organizing – as a management function, it presents the conceptual organizing of a certain dynamical structure, i.e. system. During performing organizing the work, there would be necessary to link - on a procedural base - all of the participants of the organizational structure (management, informational one and contracted system), all within the civil engineering company.

Human resources management – proper management of human resources presents the most important one within the civil engineering industry, since nothing within the civil engineering industry is feasible to be done in lack of humans. Management with human resources presents one of the utmost challenges of our time-organizing – at first place; it refers to works involving a large portion of manual work and implementing the up-to-date technology machines and equipment. Responsible personnel of the civil engineering company should make their decisions on importance of activities and number of necessary people to be engaged, all for the purpose of accomplishment of each of the projects. Decisions made regarding labour force are the following: employment, work observation, motivation, training and firing.

Leadership – presumes motivation of all employed ones for achievement of planned goals of the civil engineering company, acquaintance of each of the employed ones with the scope of their authority and responsibilities with reference to their work posts, as well as continuous development of conscious on importance of their skills, knowledge, potentials and ambitions.

Controlling - in sense of following-up and correcting the activities aiming to achievement of the planned goals, has the purpose of efficiency increase of the civil engineering company process and measuring the business running process successfulness, too.

2.1. Adaptation to organizational structure of the civil engineering company

Intelligible vision of the civil engineering company, presents the predisposition in lack of which there would not feasible to achieve positive business results. A qualitative vision thus parallel includes a mission as well, but owing to the fact that the vision presents the idea in its wider sense, the same extends further to the future. The vision should give the answer to the question: What the civil engineering company should look like in the future period?

The business running model alteration and approach to the buyers requires provision of certain structural changes, and nowadays requires also the application of informatics technologies. Structural changes are those, which certain activities or organization, change in their basic instances. Upon such a change, the organization appears to be completely different, meaning that there occurred improvements.
New knowledge acquirement, planning and new technologies implications cause the existing systems' obsolescence. The organization that does not constantly adapts nor improves itself, apparently appears to be uncompetitive, so the structural changes in its organization and/or activities should be necessary where there exist out-of-date issues.

The process approach is applicable within every company and/or organized job, which is being organized based upon classic hierarchical organization, under the circumstance of fulfilling the following:

- Management should be acquainted with benefits of the process' approach; must valuate the system efficiency as well as to ensure the resources necessary for its accomplishment;
- Performance of analysis of all of the activities within the frame of main production processes, as well as finding out of logical links between the same;
- Recognition of main processes and support processes.

Common characteristic appears to be - disregarding the level and volume of the change - the need on organizational alterations.
Table 1 shows the basic characteristics of the process enterprise, thus comparing the same with traditional ones.

Table 1 *Traditional and process enterprise [1]*

CHARACTERISTICS	TRADITIONAL ENTERPRISE	PROCESS ENTERPRISE
Business Vision	Business Function	Process
Organizational Unit	Department	Process Teams
Work Tasks, Jobs	Closely defined	Flexible, vast volume

Focus of the Employees	Superiors, Managers	Buyers
The fee is based upon	Activity Accomplishment	Achieved Results
Role of Management	Supervision	Advisorship
Key Person	Department Manager	Owner of the Process
Business Culture	Superiority, Conflicts	Participation, Supervision

For initializing the integer change of business running, there should also be fulfilled certain terms. Management, i.e. higher-level-management should abandon poor, outdated and inefficient procedures and rules of business running, and inappropriate organizational structures and models, and should define new strategy goals of the company which would materialize new business running model [1].

2.2. Civil engineering company business running in current environment

Nowadays excellent operating results might be achieved exclusively by employment of synergy consisting of three elements:

Prestigious, vocationally eligible management who conceives rules prevailing on the market, and adjusts issues for the interest of the company.

Contended vocationally eligible and adequately paid employees also present the element in lack of which a long-lasting stableness and development of the company would appear being inconceivable. Just the lack of understanding of aforementioned resulted in discouraging the people in performing their tasks, poor image creation for company owners who had not been applying this rule, and in final issue, resulted in stagnation, i.e. collapse of economic subjects where such a model had been present.

Acquirement of the managements' skills is imposed as a need for contending the third necessary element for high-level operations of civil engineering company. **Social accountability** appears to be necessary, namely owing to the feeling of affiliation and a wish for achieving prosperity of the local, regional and national community. By testifying their social accountability, the civil engineering company comes in a position of being capable of achieving exact benefits too within its operations, since a positive publicity and a positive image creation in public, present categories in lack of which the rise and capturing the desired position on the market, are in present times inconceivable.

3. PROCESS APPROACH WITHIN HE CIVILE ENGINEERING COMPANY

For the purpose of its efficiency increase, each civil engineering company should follow the ISO standards 9001:2000 introduce them, too. The ISO system defines business processes, flow of documentation and orientation for contending the needs of the buyers. Numerous advantages might be achieved by implementing the ISO system. On one hand - correctness of business activities might be achieved as well efficiency and on the other hand – there would exist additional orientation towards wishes and needs of the buyers, and there should not be neglected the fact that introducing of such a system, rating as well as image of the company shall additionally raise its perception with business partners.

For successfully accomplishment of the goals, the entire civil engineering system should introduce into its business, a system on quality, i.e.: process approach with performance, orientation to the ordering party of the works and/or services, and development of a culture regarding quality.

Application of the system of the process within the organization, their identification and mutual operation of the process, and managing with the same might be interpreted as being "process approach". The desired result might be more efficiently achieved in cases when the activities and facilities are operated as with a process.

Process approach presents contemporary mode of approach to all activities within the company. The same ensures numerous advantages compared to a classical approach. The advantages are as follows:

- Setting the requirements on the process;
- Mutual actions and interactions between all of the activities;
- Logical function of all of the activities;
- Defining the responsibilities within the process.

The operation work is unique with each of the companies and presents a work technology. This is the point which makes us being different from our competitors, and defines issues like: what, who, where, when and how.

Organizational structure in civil engineering companies which are dealing with work of civil engineering and services should be directed to processes and process organization, and this considers inclusion of employed staff and service ordering party and other interested parties for creating, implementing, improving and understanding the process and process approach.

Basic processes of the civil engineering company are the following ones:

- Marketing and sales;
- Development and research;

- Purchase;
- Production and submitting the services;
- Controlling;
- Communicating with the ordering party.

The purpose of support of the process lays in efficient basic processes performance. Examples of the process of support within the civil engineering company are as follows:

- Management with human resources;
- Financials and accountancy;
- Maintenance of equipment;
- Managing the information;
- Valuation of suppliers;
- Strategically planning.

On Photo 1 there are shown processes inside the civil engineering company and their mutual actions:

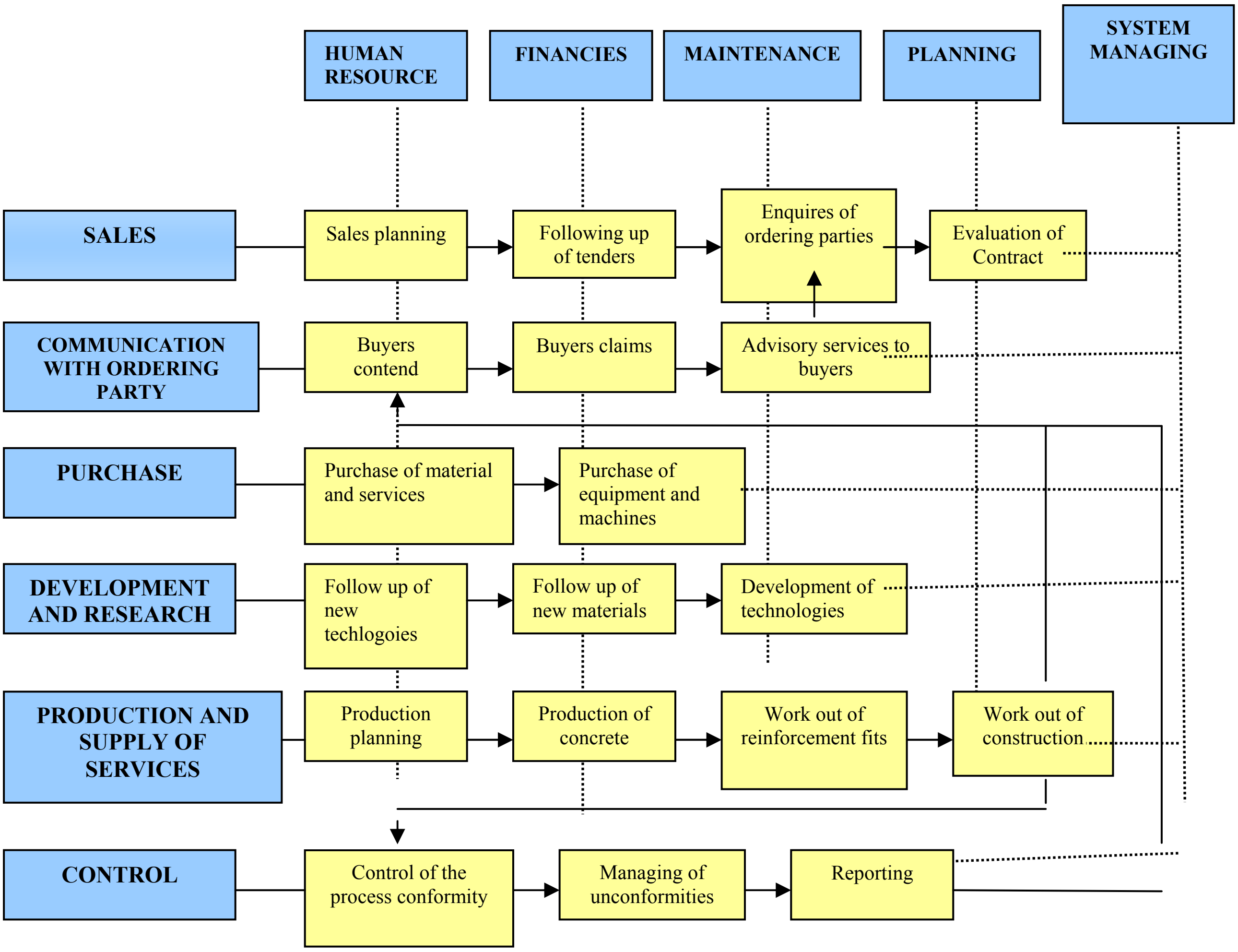

Photo 1 Processes inside the civil engineering company

4. EXAMPLE ON THE COMPANY KT "TEHNOGRADNJA" d.o.o. OSIJEK

Company KT "TEHNOGRADNJA" d.o.o Osijek is at the moment passing through its expansion phase. Process of defining the team consisting of top-management members is a dynamical one, and years of experience on activities of higher-level and medium-level management, accompanied with additional education, lead to continuous improvement on the hierarchy scale.

Seminars, educative presentations, advanced training are not treated as an unnecessary cost but contrary to the same, they are treated as the opportunity for acquiring fresh knowledge, so within this segment we have the advantage against our competitors. We are exchanging our business experience and new ideas within the team-building groups and which is supported by organized exchange.

Implementation of up-to-date management within the segment of building construction becomes a comparative advantage regarding our competitors. Proper management shall enable the company to improve its position within the market and open up new business opportunities in future period.

Strategic goals which the company "TEHNOGRADNJA" d.d. imposes to itself are the following ones:

- Providing the long-term position for its products and services (purchase of quite a few building plots in order to ensure intensity and dynamics of construction of residential-office block of the company);
- Development of new products and services and implementation of new technologies (construction of public garages, catering establishments, models of public-private partnership , implementation of new technologies in the form of building up concrete production plants);
- The company brought the decision on a strategy of intensive expansion, emphasizing circumstances that used to prevail and are still prevailing within the market, and are termed by a vast demand for residential units, ever improved and more favourable financing models of buying the residential units and by increasing number of civil engineering companies that enable implementation of such a strategy model. In spite the civil engineering issues within the city of Osijek comprises larger civil engineering companies that the one, i.e. KT "TEHNOGRADNJA" d.d. is, this fact has not discouraged the company in its endeavours to obtrude itself by new products, services and technologies, so in this way, it would approach its entering and staying in the environment in which in the past it did not have a role of significance;
- By continuous investing into prestigious personnel and staff, by purchasing more expensive and more efficient equipment and by raise of credit rating with banks (improvement of the good standing), in last several years the company is progressively entering, apart from the segment of residential construction, into the segment of construction of business, infrastructural and other facilities, too.

This fact means that the company’s efficiency reaches the level where by its appearance with tenders, even in a very strong competition, it proves itself being one of the leading civil engineering subjects in the city of Osijek and the surrounding area.

Achievement of the process approach and accomplishment of strategically goals, KT “TEHNOGRADNJA” d.d. acquires by new organizational scheme which is presented on Photos 2 and 3.

ORGANIZATIONAL SCHEME OF WORK – DIVIDED PER HEAD OFFICES AND DEPARTMENTS

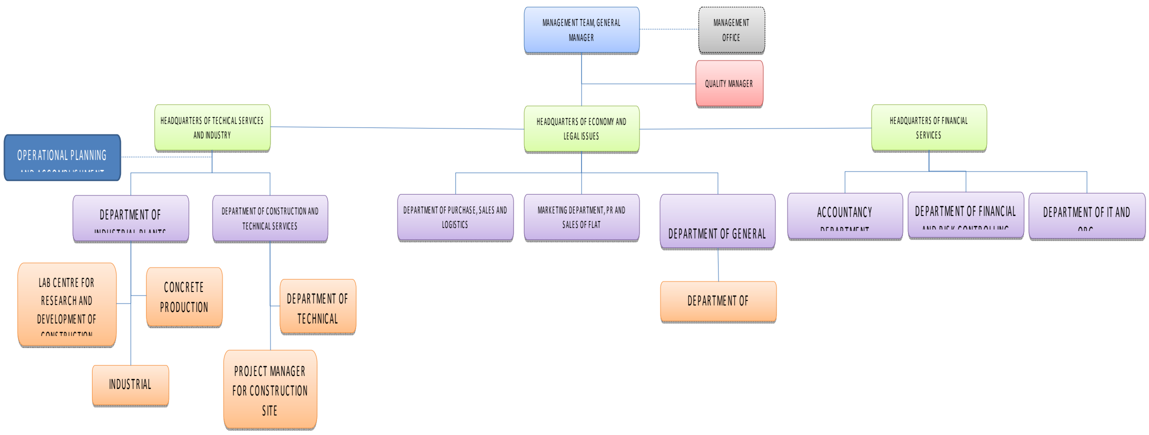

Photo 2 *Organizational scheme*

COMMISSION FOR OPERATIONAL PLANNING AND ACCOMPLISHMENT

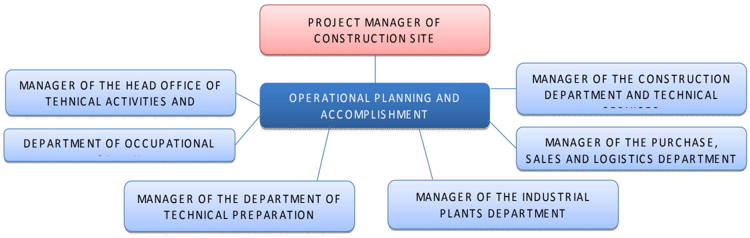

Photo 3 *Operational planning and accomplishment*

5. CONCLUSION

Leadership in civil engineering has been opposed to extremely poor level of production management and overall civil engineering business running. The consequence of such a level might be searched within the process of transition of Croatian economy, which has transformed itself out of planning economy to a market economy. The leadership and management level have reached the lowest possible margin and had the impact to the competition loss of Croatian companies, which, at that time were present on world civil engineering markets. Inappropriate education of human potentials – the ones, who occupied various different organizational leadership level posts within the company, had significantly contributed to loss of share on already mentioned world civil engineering market.

Post-war years within the Republic of Croatia also had significant impact to economy recover sluggishness and decreased investments, where operations of civil engineering lost domestic market as well. Lack of knowledge and insufficient implementation of excessively needed knowledge being important elements for leadership and management within the civil engineering company, limits construction subjects in achieving and increasing productivity - both in civil engineering as a whole and building construction as one of its most important segments.

At the end of this Conclusion, we would like to point out that we consider implementation of contemporary management in leadership and managing the civil engineering company, being a comparative advantage of significance, relating to most of competition subjects. It appeared that business results which are rising year after year, are directly connected with management of the system of KT “TEHNOGRADNJA” d.d., and prestigious implementation combined of all management elements, we consider as a key issue for continuing achieving successful business results in time ahead.

Contemporary approach to leadership with civil engineering company might be adopted only by acquiring fresh knowledge. All participants of the process should actively be engaged while introducing the system in such a way that the same is understandable and later – applicable. It is necessary to adopt new cognitions connected to construction and maintenance of structures and to change the way of consideration. By implementing the contemporary approach to management, the quality and reliability of services of the civil engineering company shall be improved, and there shall be gained confidence from the ordering parties of the works, and by this, competitiveness prevailing within the construction market as well, and there shall be accomplished conditions necessary for performing construction works throughout the EU countries.

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GREEN BUILDING – STRAW BALE CONSTRUCTION

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Abstract:

Environmental protection, pollution awareness, new regulations, bring traditional materials back to building. That includes both traditionalal building with stone, wood, brick, and some new methods and materials. Straw has been used for centuries but it's only recently that the methods of straw bale building became popular. A large number of tests have proved the qualities of straw as a material.
There are several types of straw bale constructions: load bearing method (bales overtake the load of roof construction), post and beam method (bales simply act as insulation blocks), and a method of light frame construction (combination of the first two).
The advantages of straw include the fact that it is environmentally friendly, cheap, easy to shape, and has high - quality insulation characteristics. Although baled straw satisfies building regulations, it still isn't a certified building material in Croatia. Germany is the first European country where it's legal to use straw as construction material.
Keywords: Straw, Traditional material, Building

Sažetak:

Zaštita okoliša, svijest o zagađenju, nove zakonske mjere, vraćaju u graditeljstvo tradicionalne materijale. Pod time podrazumijevamo već poznatu gradnju kamenom, drvetom, opekom, ali i iznalaženje novih metoda i materijala. Slama je materijal sa stoljetnom tradicijom korištenja, ali tek odnedavno metode gradnje kuća od balirane slame postaju popularne. Sve je više ispitivanja provedenih na slami koja svjedoče o njezinim kvalitetnim svojstvima. Nekoliko je tipova gradnje sa baliranom slamom: metoda nosivih zidova (bale nose krovnu konstrukciju), ne - nosiva metoda (bale služe isključivo kao ispuna) i metoda laganih konstrukcijskih okvira (kombinacija prethodne dvije). Prednosti slame su u njezinoj neškodljivosti za okoliš, niskoj cijeni, lakom oblikovanju i kvalitetnim izolacijskim svojstvima. Iako balirana slama zadovoljava graditeljsku regulativu po pitanjima nosivosti i otpornosti na požar, u Hrvatskoj još nije certificirani građevinski materijal. Njemačka je prva europska država u kojoj je dozvoljeno korištenje slame kao građevinskog materijala.

Ključne riječi: Slama, Tradicionalni materijali, Građenje

INTRODUCTION

Environment constitutes of natural features: air, ground, water and sea, flora and fauna in the complexity of their mutual impacts, as well as the cultural heritage as a part of the man-made surroundings. At the turn of 19th to 20th century, people began to think about the human influence on the environment, while today the inauspicious consequences have become alarming.

Changes in the environment due to global warming and pollution, lead us to more intensive use of alternative energy sources and materials. A well known Indian proverb which says: „We do not inherit the Earth from our Ancestors, we borrow it from our Children" is completely in accordance with assumptions of sustainable development. The term sustainability is used more and more in the context of environmental protection.

In 1987 the Norwegian ex Prime Minister Gro Harlem Brundtland gave a definition of sustainable development which is still often quoted: „Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Sustainable building is a part of sustainable development which aims at abating the effects of civil engineering on the environment. According to that, it encourages the use of materials which will not harm the environment, energy efficiency of buildings, and management of construction waste. Sustainable building should provide durability, design and construction quality, together with the financial, economic, and ecological support.

According to Shiers (2000) within property, environmental issues are now a key consideration and have impact on virtually all aspects of property investment, development and management.

Utilization of straw as a construction material is the topic more frequently mentioned recently (Lazic, 2008). Straw is a renewable material that can be grown every year. The energy required to produce this material is – Sun, a renewable energy source. After an object stops beeing used, the straw that was built in can be composted and used in gardening. Thus, there is no problem with waste.

Another reason for straw bale building is the insulation characteristics of straw: a strawbale wall 45 cm thick has thermal conductance of only 0.13 W/m^2K, and current regulations for thermal envelope of a building require that thermal conductance doesn't exceed 0.35 W/m^2K.

Although the straw bale building isn't a new building method (in Nebrasca, straw bale houses were built over a hundred years ago), in Europe this method is still in its rudiment. Germany is the leading country in the use and testings of characteristics of straw as a building material, and in 2006, after three years of work, the German Straw Bale Building Association – FASBA, managed to obtain the official general approval from the German Institute of Structural Engineering for the usage of straw bales as heat insulation in buildings. In USA, straw can legally be used in load bearing wall construction of buildings that don't use any other bearing materials.

TRADITIONAL MATERIALS

Traditional building is conditioned by morphological characteristics of a landscape, that is by the presence of certain materials, like stone, wood, straw, clay, mud and others. It took centuries of experience to find the best way of using them. The advantages of these materials are that they are renewable, regenerative and have no negative emissions.

Traditional building, that is traditional architecture, is based on human needs and that is why it is also called „architecture without architects“. Since all these materials come from natural sources, traditional building can also be called – ecological building.

Numerous buildings from ancient times show us the wide use of stone, and the present time condition of these buildings prove durability as one of the most important characteristics of this material. Throughout the centuries of its usage, stone has been the main constructive as well as decorative element, but at the end of 19th century its constructive role was overpowered by modern materials such as steel and concrete, but its decorative role in aesthetic design is still irreplaceable.

Stone belongs to a group of geomaterials, which are materials of geological origin. The main characteristics of stone are its compressive and tensile strength, hardness, durability, wear - resistance and, of course, its aesthetic aspect.

Building stone derives from one of three rock types: igneous (for example granit), sedimentary (examples are sandstone and limestone), and metamorphic, examples are marble and slate (Sustainable Build, 2008)
We distinguish hard rock (all types of eruptive rock) and soft stone, which encompasses all other types.

Another constructive material that has been widely used since ancient times is wood. An important characteristic of wood is its strength, with propitious elasticity and small weight. Wood is a good thermal and acoustical conductor. A disadvantage of wood is its sensibility to moisture and wormholes, which can destroy wood completely (Peulić, 2002). Insufficient durability is also specified as one of the main disadvantages of wood as a constructive material.

Besides stone and wood, which are used as constructive materials, a few other natural materials are increasingly used as infill and insulation. Some of them are flax, sheep wool, cotton, hemp, and straw. The latter is described in the text that follows.

STRAW - THE BUILDING MATERIAL OF THE FUTURE

Straw consists of dry stems of cereal left after the seed heads have been removed by harvesting. It comes from different kinds of cereals: wheat, rice, barley, oat, and others. As a constructive material, straw is used in bales, compressed blocks of straw tied with a wire or a rope. Most of baling machines produce bales 450 mm wide, 350 mm high and 900 mm – 1125 mm long. Some baling machines (rotary combines) chop straw into very short segments before baling, which results in bales that are not as coherent as desired for construction. Experienced builders will require fiber at least 25 mm long. Bales of all dimensions can be used, which affects the foundation dimensioning, wall beams, and other elements.

The three key bnenefits of building with the strawbales are (Riley et al., 2006, p.146):

1. *the conservation of forest resources through the utulization of an agricultural waste product in lieu of wood framing;*
2. *The volonteer-friendly nature of building process, which fosters community involement ind building construction; and*
3. *the durable. Energy efficient performance of strawbale walls, which dramatically reduces maintenance and heating costs*

To be used in civil engineering, straw bales have to satisfy minimal conditions of density, shape, moisture, and cohesion.

Moisture content depends on the conditions of baling, as well as those of transport and storage. Drier straw is better; moisture percentage should not exceed 15 %. Decomposition begins a 5 ° C and 20 % of moisture. Dry density of bales should be at least 112 kg/m' if the bales are to be used in construction.

Straw bale walls have to satisfy reqirements of bearing, fire resistance and insulation. Early test results of unplastered straw walls on the compressive strength found failure at a loading of 15.9 kN/m^2. In some recent tests plastered wall specimens, 244 cm high, and 366 cm long, were analysed, with polypropylene fiber mesh stucco reinforcing, subjected to eccentric axial loads simulating a roof truss bearing. Each specimen deflected less than 2 cm before failing, the failure that occurred 47 kN/m'.

Reference books on strawbale construction provide limited criteria for loadbearing walls based on empirical test results. The Pima County, CA building code does set height/width guidelines of 5.6:1, length/width limits of 13:1, and permits 5.82 kN/m' in bearing, but leaves seismic engineering up to the professional (Penn State, 2002).

After straw is baled and compressed, it doesn't contain oxigen, which is why bales are hard to burn. After a bale is built in a wall, it behaves just like a massive wooden frame. The same as wood, straw produces a carbonized layer which prevents fire from spreading any further.

As mentioned earlier, straw has very good insulation characteristics. Thermal characteristics are described with U and R factors, where U - factor is a measure of thermal conductance. The lower U - factor means the material has better thermal insulation. U - factor for straw is 0.13 W/ m^2K and regulations for thermal envelope of a building require that U – factor doesn't exceed 0.35 W/m^2K.

R - value is the inverse of U - factor (R = 1 / U) or how the material resists heat passing through it. Tests have also proved that the value of R factor is between R - 17 (450 mm bale) and R - 65 (580 mm bale). However, the differences between R - factors starting with R - 30 on are very small and therefore insignifficant, especially when we know that the average R - factor for wood is R - 19, which makes straw definitely a better insulation.

STRAW BALE HOUSES

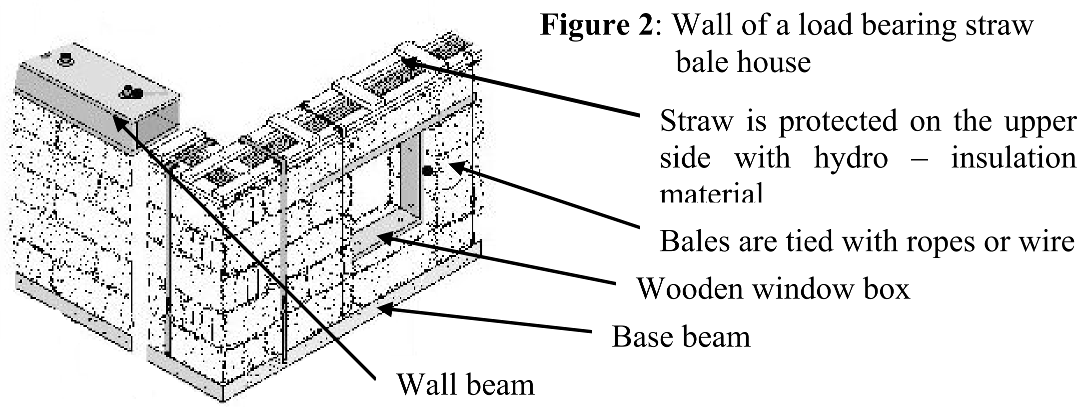
There are three basic types of building a straw bale house: load bearing method, post and beam method and method of light frame construction.

A load bearing method, also called Nebrasca method, is the most interesting. All walls are built of straw bale blocks that take on the load of the roof construction and have a bearing role. However, there are some disadvantages of this method. The holes left for doors and windows mustn't exceed 50 % of any wall area. An unsupported wall must not be over 6 m long.

Figure 1: Load bearing straw bale house

Source:<http://www.rosefellowship.org/work/hopielderhousingprototypes/>; 09.06.2008.

Figure 2: Wall of a load bearing straw bale house



Source: <http://www.foodforest.com.au/strawbaleWallDiagram.jpg>, 20.04.2008.

Figure 3: Load bearing straw bale house during construction

Source: <http://www.fieldlines.com/story/2007/11/28/155725/28>, 20.04.2008.

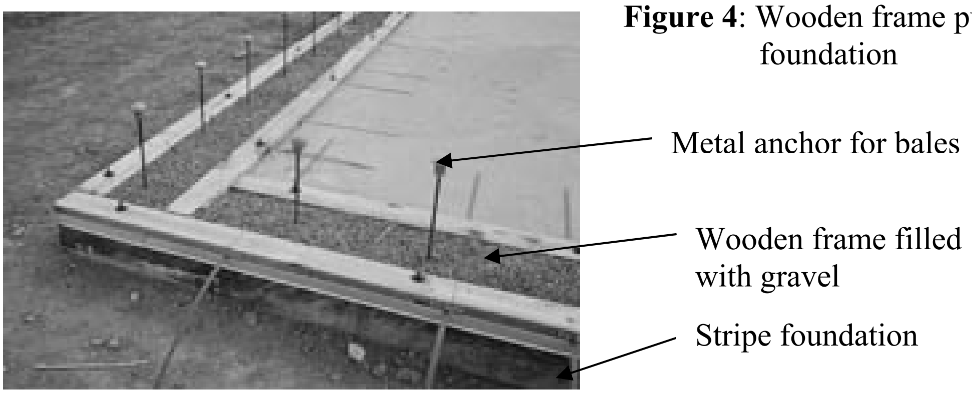
Foundations of straw houses are mostly constructed as stripe foundation with hydro - insulation placed on it. Then a wooden frame is put on the foundations. It is aproximatly 10 cm high and filled with gravel, which prevents straw from being placed in water.

In a load bearing method, anchors are laid in the foundations and the first row of bales is placed on them. Two anchors are put in a bale. Hazel bolts are stuck through the next three bale rows to fortify the construction.

Wooden frame boxes are laid in the places where doors and windows are to be built in. A regular one-floor house has 6 or 7 rows of bales, and on the top of the last row there is a wall beam that carries the roof construction. The walls are plastered both inside and outside, preferably with clay, but cement and lime stucco can also be used.

A straw bale is 450 mm wide, but the selvage of 50 mm doesn't have a bearing capacity. Therefore, foundations can be 350 mm wide . Also, bales are trimmed later in order to create a smooth wall surface, which will also decrease the witdh of a bale. Foundations shouldn't be wider than bales to prevent water retention that could be absorbed by straw

Figure 4: Wooden frame put on foundation



Source: www.grisb.org/publications/pub21.doc; 09.06.2008.

Roof construction is made of wood and it is not different from those in regular houses. Still, it's important to keep in mind that a house made of 7 bales will subside between 12 mm and 15 mm. Straw bale houses are characterised by large canopies that are a good protection from rain.

When it comes to installations, there is no difference in comparison to regular houses. Electrical power cables are installed inside plastic pipes which make them safer due to the heat they produce in the walls with perfect thermal insulation. Cables can be burried in the straw and plastered. Water pipes should preferably be built in the inner walls in case of flooding. In any case, pipes should be properly insulated to avoid condensation.

In post and beam method straw is only used to fill in the walls, while the load bearing construction frame is made of some other material, usually wood. That is the reason why construction of such houses is identical to straw-bale houses construction. Straw was used as a filling before in traditional architecture. It was shredded and mixed with clay and walls were then filled with that quality material.

One of the advantages of this method is that the roof can be constructed before the installation of straw bales, which provides protection of straw in bad weather conditions. Another advantage is that the frame construction doesn't have to be constructed on the construction site. It also provides better stability of the doors and windows frames (Jones, 2006, p. 19).

Figure 5: Post and beam strawbale house

Source: http://www.flickr.com/photos/73416633@N00/304363867/; 10.06.2008.

The method of light frame construction is a combination of the former two. It sucessfully eliminates disadvantags previously mentioned. The same as in load bearing method, a wooden frame is put on the foundation, and the straw bales are fastened with anchors built into the foundation. Unlike in the first method, light beams are placed in the corners (for example, 12 cm x 10 cm), and the boards 5 cm thick next to the doors and windows frames. The construction is put into the slots in the wooden floor frame. It is so light that it has to be supported by booms during work. After the straw bale walls have been set in their places, a wall beam with slots for other beams and boards is put on them. This way the load bearing of the construction is improved.

Figure 6: Wall of a light frame straw bale house

Source: <http://www.ecobob.co.nz/_ImgUser/2/2994.jpg>, 12.05.2008.

CONCLUSION

The problems with pollution have become alarming, and only after the balance between man and environment was seriously disturbed, this problem has got the proper attention.

Civil engineering is the area of human activity that directly and irretrievably changes human environment. That is one more reason to pay attention to such building that will produce minimal effects on the countryside, solving the problems of construction waste and high energy consumption.

Ecologically aware builders are more and more oriented to the use of regenerative and renewable materials such as wood, stone, straw, clay, etc.

Frequently used in the past, straw is becoming omnipresent in building today. Although there are still not sufficient tests of straw characteristics and empirical conclusions about straw houses, all results up to now indicate the great potential and quality of this material; straw completely satisfies civil engineering regulations considering load bearing, fire resistance, and insulation.

Straw has all attributes of an ecological material: it is of natural origin, it will biologically decompose, so there are no waste problems; insulation characteristics are better than in most materials which are being used at the moment.

Straw is very easy to shape, which offers wide possibilities to house design; it is possible to build very imaginative objects with round or curved walls, something that is very difficult (and expensive) to achieve with other materials.

Since testings and usage of straw as a building material have increased in almost all countries of EU, as well as in the USA and Australia, there is a reason to believe that such trend will expand in Croatia, too.

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SUCCESS ANALYSIS OF THE PROJECT USING THE MODEL OF BALANCED SCORECARD

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Abstract:

This paper considers the possibilities of applying the Balanced Scorecard on succes analysis of the project.

Balanced Scorecard is used as a means of recognizing the intellectual value, and its transformation into real value. This paper is using examples to analyse the project results, causes and measures which need to be undertaken in order to minimize the deviations, and to make sure that they are not a threat to the project.

Keywords: intellectual capital, Balanced Scorecard, project results

1. INTRODUCTION

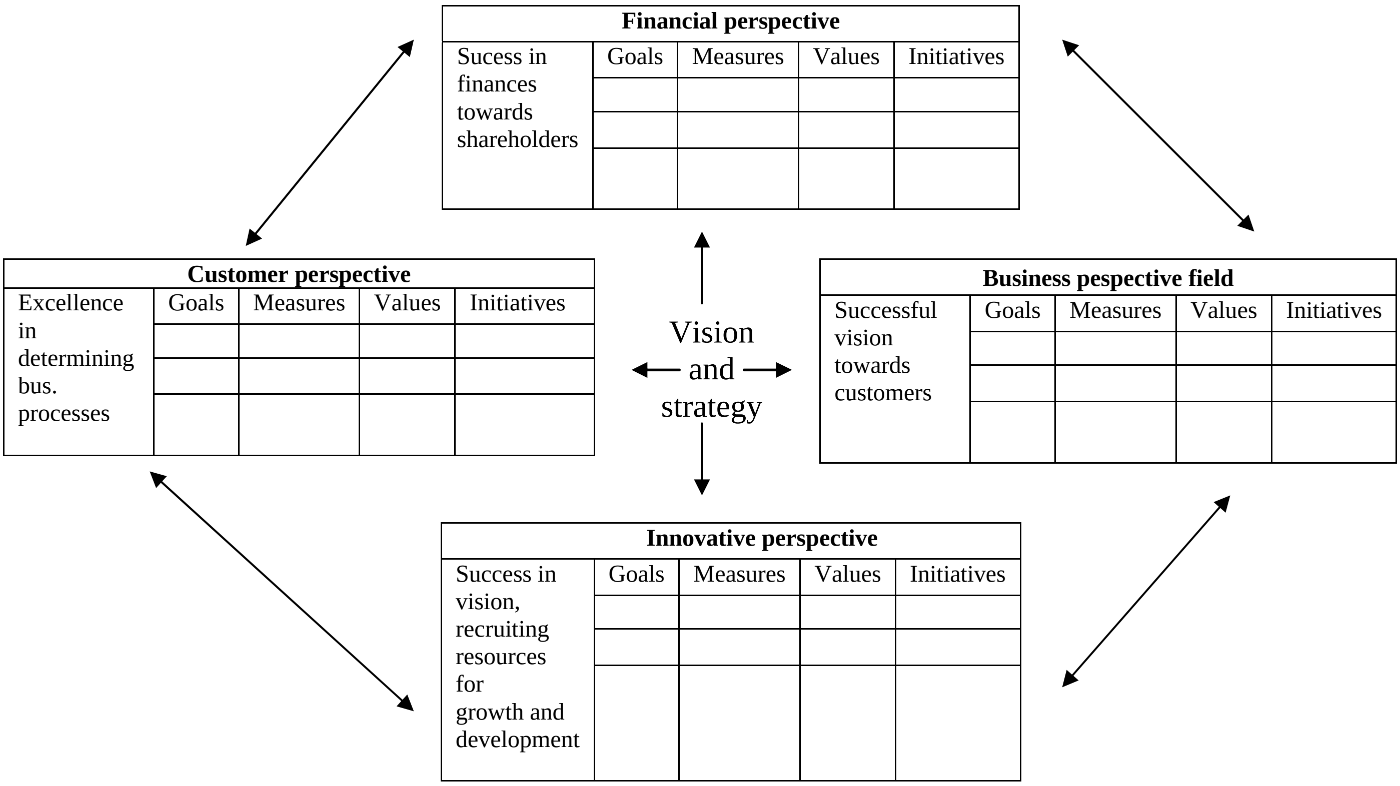
Evaluation of the achieved project results, i.e. realization of goals formulated by the project, requires recruiting appropriate human and financial resources of the business system. Although the business system managing methods have undergone considerable changes in the recent years, the measuring of business performances retains the traditional approach, since evaluation is mostly done based on the material property. However, in the contemporary business environment, the influence of intellectual capital is increasing, which is reflected in the level of employees' knowledge and its application, development and the application of innovations, cherishing innovation culture, development of information technology, relations with business partners etc. All these elements have considerable impact on the quality of business activities and competitiveness of the business system, but it is hard to quantify them and present in financial reports. A need arouse for such methods which will balance financial indicators and formulation of intellectual driving mechanisms, as well as provide the most efficient realization of strategic goals. This method was found in Balanced Scorecard. Business systems tend to achieve the formulated strategic goals which are integrated into projects, hence the emphasis is put on the project result analysis. Balanced Scorecard was created as a model in 1990 after the publishing of works by R. Kaplan and D. Norton, who performed measuring on several business systems, and in 1996 the book "The Balanced Scorecard-Translating Strategy into Action'' was published. In time, the model itself has undergone many changes, but its basic concept remained the same.

The concept of the model is based upon relating strategic vision and its realization indicators. This relation is reflected in four categories: financial, customer, innovative (including knowledge innovation as well) and permanent analysis of business processes. Each of the categories mentioned above comprises those adequate parameters which are related to the achievement of business success.

The goals whose realization provides business success are formulated, measures for their realization are determined, quantitative indicators are chosen – initiatives and changes which are necessary for the realization of formulated goals.

2. MODEL STRUCTURE

Balanced Scorecard **of** results, according to its authors, should relate strategy development with its implementation through the presentation of collective data in each of the four categories mentioned above. In the first published version the goals and measures were stated, and later on values and initiatives were added to the scorecard. Picture 1 shows the model of Balanced Scorecard of results.



Picture 1. Balanced Scored model

Balanced Scorecard model integrates the following:

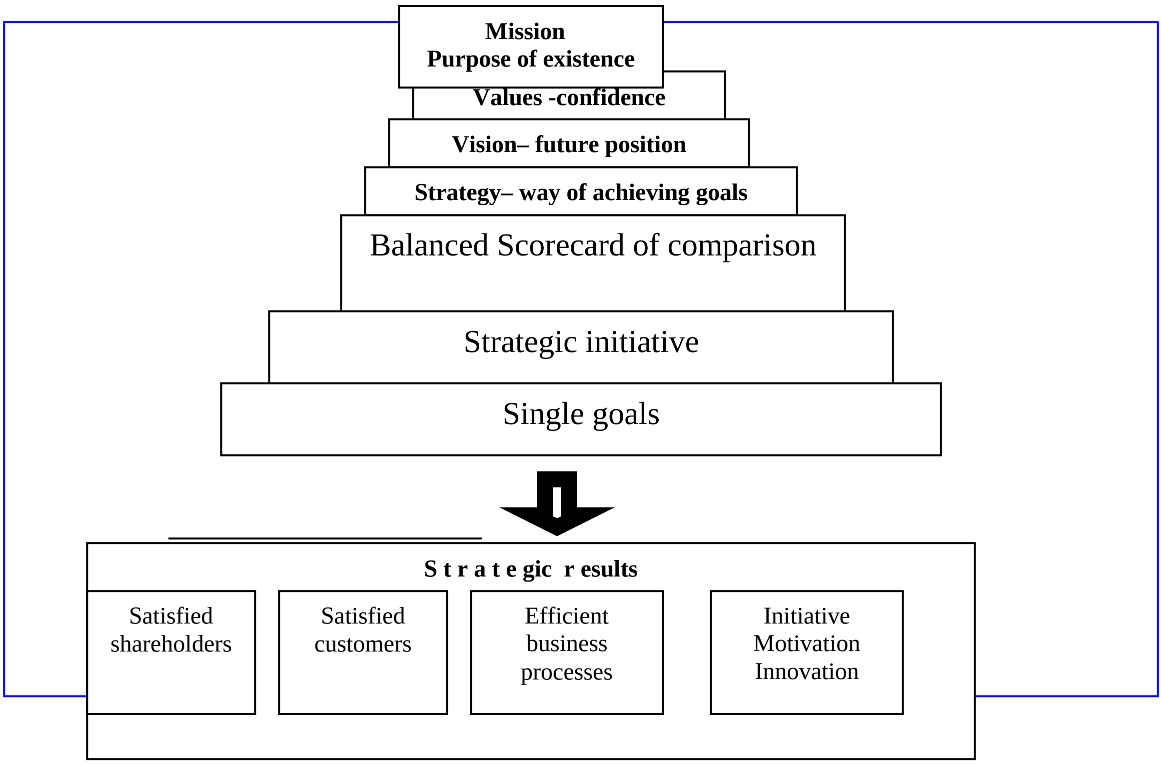
- Vision and strategy
- Business processes
- Relations with customers
- Employee creativity and initiative which contribute to the success
- Emphasis on innovative activity
- Measuring of realization
- Improving project performances and business system itself
- Comparative analysis of achieved results in relation to formulated goals
- Comparative analysis of realized goals in relation to the vision
- Analysis of adequate strategy
- Taking improvement measures
- Comparative analysis of growth and development

3. MODEL IMPLEMENTATION

Starting from the basic concept of Balanced Scorecard model, its implementation depends upon the following premises:

- **Mission statement –** which business activity is done, for what customers, with which values – which activity of the business system.
- **Vision statement** – basic global development concept of the system for a relatively longer period of time (10 or more years) – long-term goal which changes under external influences**.**
- **Choice of strategy**- measures and strategies along with recruiting certain resources for goal achievement. **Balanced scorecard model uses generic business strategy.**
- **Creation of strategy maps –** causal - consequential relation between the goal and results.
- **Selection of business activities indicators –** combination of financial and non-financial indicators; short- and long-term indicators.
- **Adequate communication and information system - enabling** communication among the employees**.**
- **As well as with the environment-** understanding the strategy and boosting motivation for achievement of business results.

The stated premises present the basic approach to project modeling of business systems management, where the implementation of Balanced Scorecard model is done through **development projects**.
Implementation of Balanced Scorecard model is shown in Picture 2.

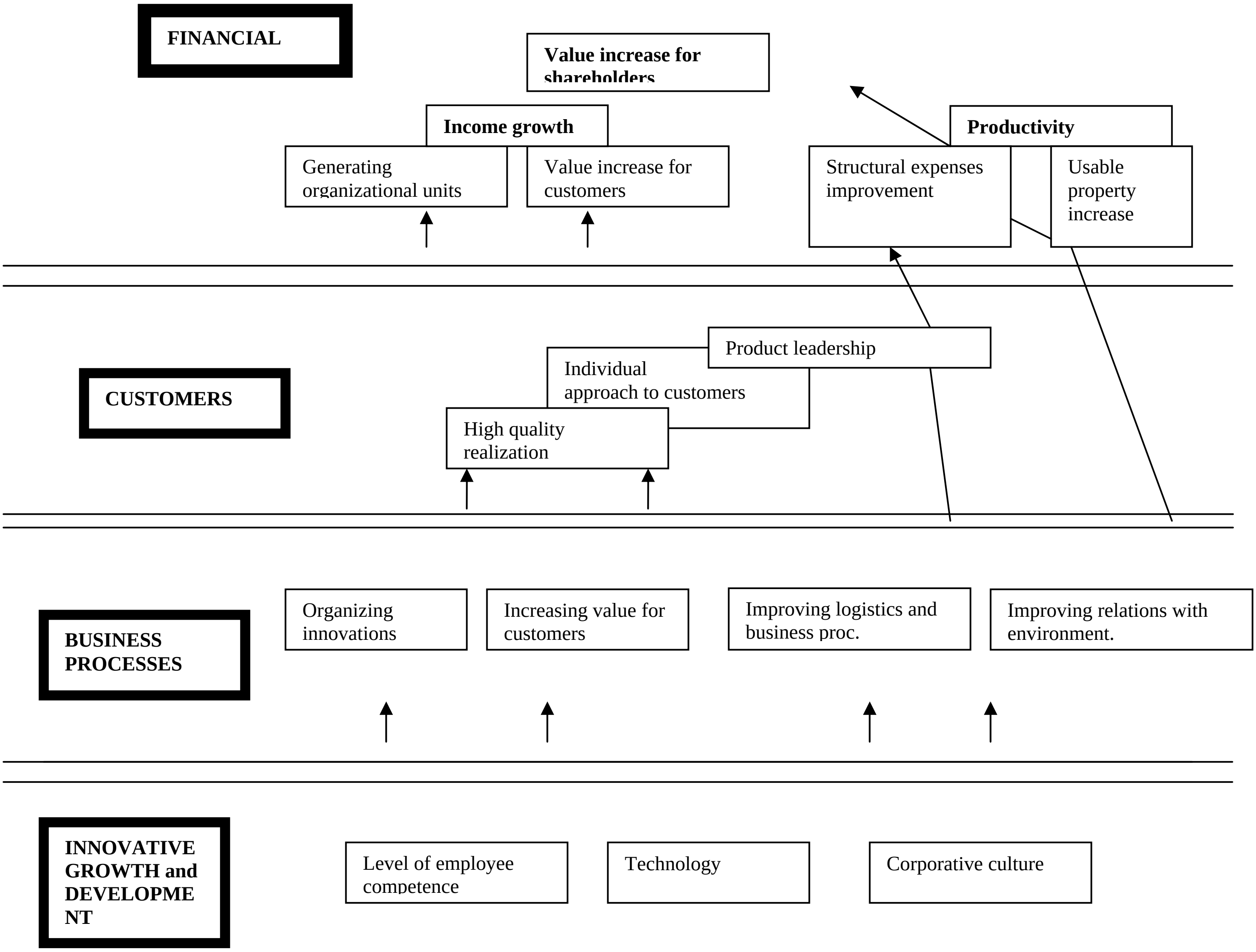


Picture 2. Implementation of Balanced Scorecard model

Picture 2 clearly shows that the Balanced Scorecard takes the central position and makes a connection between the mission, value, vision and strategy on one side, and activities for their realization which are reflected in strategic initiative and identification of single goals, as well as presentation of strategic results.

For the efficient analysis of project success using the Balanced Scorecard model, apart from the clear mission and vision statement, it is necessary to create the strategy map of all categories in the first place, as well as to make the adequate **choice of success indicators**.

Strategy map, according to Balanced Scorecard concept, comprises all four categories, as shown in Picture 3.



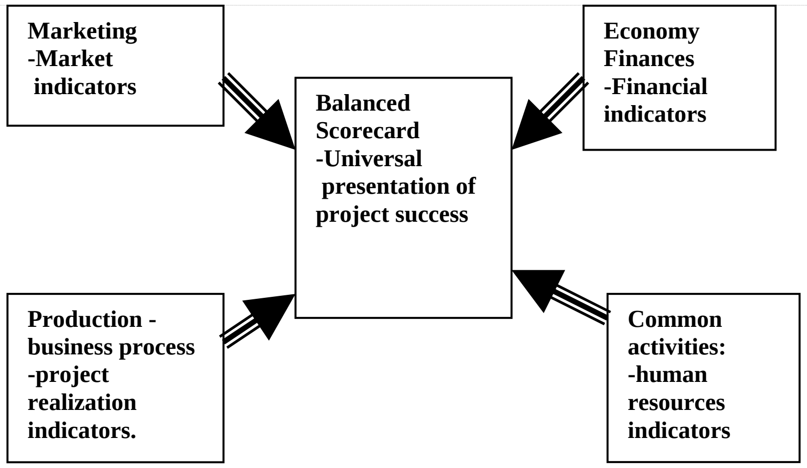
Picture 3. Strategy Map

Taking into consideration that Balanced Scorecard needs to set the balance between the realization drivers and the results, it is necessary to choose adequate indicators which will show causal-consequential relations.

In real life, this relation can be unequal, thus the Balanced Scorecard has to coordinate it permanently, taking care of perspective. For each of the categories – financial, customer, business processes, growth and development- quantity and quality indicators which are correspondent to goals, vision and mission are used.

Properties of Blanaced Scorecard provide a more thorough analysis and control of project realization, testing at the same time causal - consequential relations and their impact on project success.

Picture 4. shows an example of the use of Balance Scorecard in project success analysis



Picture 4. Project success analysis

4. PRESENTATION OF THE EXAMPLE

Application of Balanced Scorecard is shown through the example of the management of constructing a residential building. For the purpose of the analysis Balanced Scorecard Designer software was used.

Short description of a residental building:

The number of floors of the building : ground floor plus five other floors. Total area is 3200m2. Total investment value amounts to 2,266,450,00 EUR. Planned duration of works is 16 months.

Short description of the analysis:

Within four basic categories 11 goals are defined, according to the acquired methodology, through which the analysis of important indicators of project performances is done.
Categories , as well as goals, are shown in Table 1.
When the plan of project management was made, it was determined that the control should take place five months after the beginning of works. The first control was carried out according to the plan and the information that wes gained indicated certain deviations from the realization plan. Success results, reasons for deviation as well as the planned correction measures are shown in the table. All the goals were evaluated according to 0% to 100% scale, where the 100% score was set as a goal, except for the number 4 goal - number of supervisor's objections about the work, where the goal is the minimal number of objections.

Goals numbered as 1, 2, 3, 4 and 6 are those that used quantitative methods of estimation, taking into consideration the characteristics of the data which determine them. For other goals, methods of evaluation by qualitative descriptions which were later quantified were used.

Strategy tree and scorecard details :

Perspective and Goals	Weight (x of 10)	Description	Performance (%)	Target Values	Initiative
Financial category	3		91.69%		
Goal 1 - Variation from planned expenses	3	Planned 664.938,60 EUR. Variation from planned expenses is 31.157,82 EUR. It was the result of delays and prolonged works on installations. Increased expenses are directly related to recruiting unplanned work force.	95.31%	100%	Since a subcontractor was hired, they take the complete risk of the excess of expenses.
Goal 2 - percentage of payability of temporary situations	3	644.990,44 EUR paid. Due to certain defects in installations, certain positions were not paid.	97%	100%	It is necessary to correct the defects before making another temporary situation in order to realize the payment.
Goal 3 -percentage of realization of planned profits	4	Planned profit 20%. Payment variation 3%. Payment variation led to temporary lack of realization of the planned profit. Due to this, deformation of CASH FLOW plan occurred.	85%	100%	By neutralizing defects and payment the planned profit will be realized. Taking the planned reserves into consideration, CASH FLOW deformation can be absorbed before payment.
Total Performance in group		**Financial category**	**91.69%**		
Consumer category	2		92.50%		
Goal 4 - Number of supervisor's objections about the work	7	Worth of repairs is14.312,00 EUR. Worth of completed works is 664.938,60 EUR. Due to defects while completing them, the quality of certain works was diminished. Estimation was formed as the share of the repair works in the total worth until the point of control.	2.15%	0%	All the defects should be corrected as soon as possible.
Goal 5 - Investor's satisfaction with the communication up to date	3	Investor's satisfaction with the communication was examined. The major objection is related to notification about defects which was not up to date.	80%	100%	Satisfaction is high, but needs to be improved.
Total Performance in group		**Consumer category**	**92.50%**		
Business processes categor	3		88.35%		
Goal 6 - Realization of timing plans.	5	151 days planned. 21 -day- delay. Delays in realization are due to delays on the works on shelter equipment installation, as well as heating installations, electricity, plumbing and sewerage.	86.10%	100%	Delays can be absorbed by planned reserves in dynamics or increasing the speed of activities on critical path in allowed limits.
Goal 7 - Level of coordination between contractors and producers	2	The level of coordination is high. Decrease was due to the above mentioned works on equipment and installations.	87%	100%	It is necessary to influence the producer, or change them as a last resource, if the variation occurs again due to their fault.
Goal 8 - Level of coordination between the realization process and the supply process	3	Supply process for the most part takes place within the company. Variations occurred due to a minor shortage of materials on the market.	93%	100%	To check the situation on the market for potentially problematic materials and to incorporate the information into the realization plan .
Total Performance in group		**Business processes category**	**88.35%**		
Innovative category	2		81.60%		
Goal 10 - Implementation of the information system of connection between the building site and central office.	4	Implementation of the system is still in its initial phase and constant revision is required. Variation occurred due to human error.	87%	100%	It is necessary to influence the person in charge, in case a part of training needs to be repeated.
Goal 11 - Level of realization of corporative culture improvement, about the safety at work.	6	Regular controls of both knowledge and safety plan realization are carried out. Variation occurred because the planned training was not realized.	78%	100%	To realize the training and influence the person in charge.
Total Performance in group		**Innovative category**	**81.60%**		
Total Performance in **Balanced Scorecard**			**88.83%**		

5.CONCLUSION

The aim of this paper was to point to the possibility of using the Balanced Scorecard in project success analysis. The use of Balanced Scorecard provides a more comprihensive insight into the project success, since thecausal – consequential relations and the use of chosen indicators provide timely initiative for deviation correction in project realization.
Since it is necessary to ensure the premises stated in section 3 in order for this model to function properly, their insufficient presence undermines the efficient application of Balanced Scorecard.

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Introducing the adaptive process in construction management

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ABSTRACT

Construction management issues continually change over time in response to the relatively new concept sustainable development. Therefore the need for new approaches arises from the co-evolving social, economic and environmental criteria.. Under these conditions adaptive management, or 'learning by doing', offers an opportunity for more proactive and collaborative approaches The potential for adaptive management as an approach to more closely link research with construction management is discussed. However, it is often difficult to ensure adequate stakeholder participation in developing and managing information to support collaborative decision making and subsequent change 'on-the-ground'. An initial framework for a collaborative approach to managing information within an adaptive management approach is outlined in this paper. Concepts of active adaptive management utilizing these criteria are being gathered though a research survey. Data for this paper was obtained from professionals participating in the construction phase of a construction project. There was no treatment introduced and random sampling was used, whose results were generalized to the construction industry (target population). Information was obtained through the use of questionnaires. From the data analysis existing gaps between the awareness and the implementation/application levels of sustainable construction practices were noticed, that have led to failure of realizing the benefits of a sustainable approach to construction projects.

Keywords adaptive management, sustainable construction

INTRODUCTION

Construction is defined as the activity involving creation of physical infrastructure, superstructure, housing and other related facilities. It comprises all civil engineering works and new building projects (Khalfan and Malik 2000). The construction industry as defined as "that sector that plans, organizes and produces building and civil engineering projects." The construction industry in Greece undertakes both building and civil engineering works and mainly consists of small firms although there are a few comparatively large organizations. The sector plays a very major role the country's economic development through its contribution to gross domestic product (creation of employment and production of capital facilities and assets required for production in other sectors, as creating demand for their products. However, its contribution is underscored as its activities constantly fail to safeguard the environment and arrest the degradation of the resource base.

PROBLEM STATEMENT

The construction industry, while contributing to overall socio-economic development in the country, is a major exploiter of natural non-renewable resources and a polluter of the environment. It contributes to the environmental crisis through resource depletion, energy consumption, air pollution and generation of waste in the acquisition of raw materials, the construction site processes, as well as the utilisation of the resultant facilities In order to reduce these detrimental impacts of construction on the environment, there is need to develop and apply techniques and methods to achieve the goals of sustainability. Owing to the rapid expansion of the construction sector the industry uses natural resources for materials production, fabrication or secondary materials production and on-site construction processes. (Raynsford 2000).

Therefore, the problem and challenge that the construction sector is facing today is not only to find the best balance between various constraints (technical, architectural, social and economic) but also endeavour to favour decisions without regret at every moment in the life cycle of a building and especially in the construction phase. There is then a need to introduce more sustainable construction practices and performance in pursuing an overall development in the context of human settlements.

RESEARCH METHODOLOGY

Research Questions

This paper sought to answer the following questions:

What is the awareness level of sustainable construction practices among professionals in the construction industry?

Are sustainable construction practices implemented in the Greek construction industry?

What constraints exist to hinder the achievement of sustainable construction?

How can these constraints be overcome?

Is there any hope of sustainability of the industry in Greece?

Rapid urbanisation will increase demand for construction activity. This will be in terms of skill requirements, materials and financing for the construction, maintenance and rehabilitation of housing and infrastructure are often not available or of inferior quality. Thus, an adequate supply of cost effective building materials, construction technology and building finances need to be facilitated to avoid the bottlenecks experienced in the sector.

Research Design, Sampling and Data Collection Processes

The research design adopted for this paper was a survey design. Survey research seeks to obtain information that describes phenomena by asking people about their perceptions, attitudes, behaviours or values. The target population in the study was defined as all the professional firms in the construction industry comprising Architectural, Surveying, Engineering and medium building contractors. Professionals sampled from a specific firm are taken, as representatives of these firms, and that the ideas expressed by these professional(s) constitute the professional practice of that particular firm. The target population was 83 firms distributed as follows:

Table 1: Survey Target Population

Type of Firm	*Number*
Architectural	20
Engineering	28
Surveying	15
Building Contractors	20
Total	83

Forty-nine questionnaires were returned, representing 73% of the issued questionnaires and these were used in the analysis presented herein.

Data for this paper was obtained from professionals participating in the construction phase of a construction project. There was no treatment introduced and random sampling was used, whose results were generalized to the construction industry (target population). Information was obtained through the use of questionnaires. This justifies the study to be a survey. Two principal methods were relied upon to collect data from the field:

Questionnaires issued to architects, quantity surveyors, engineers and contractors.
Data collected was presented in form of tables and charts showing frequencies and percentages and analysed by way of description of responses to various questions.

CONCEPTUAL FRAMEWORK

The concept of sustainable construction is derived from that of sustainable development.

Sustainable development has been variously defined as:

- a pattern of social and structural economic transformations, which optimises the economic and societal benefits available in the present without jeopardizing the likely potential of similar benefits in the future (Goodland et al 1998).
- fulfilment of human needs through simultaneous socio-economic and technological progress and conservation of the earth's natural systems; (Sage 1998)
- a development strategy that manages all assets, natural resources and human resources, as well as financial and physical assets, for increasing long-term wealth and well being (Repetto 1986).

Data is collected on what is actually happening in the field of interest by asking people who have had experience in it to reconstruct their experiences A survey investigates without introducing treatments or control over any of the interacting variables. It is aimed at measuring the knowledge component of a phenomenon by accessing feelings and actions based on knowledge of a particular subject. Knowledge is measured by measuring awareness using aided or unaided recall. The feeling component is measured by evaluating people past, present and future behaviour towards the phenomena (Pamela & Settle 1985).

Sustainability therefore is the subject of major concern in sustainable development. It is defined as a relationship between social, environmental and economic realities and constraints, which are changing. This makes sustainability a dynamic concept rather than a static one thus necessitating decision-makers to be flexible in modifying their approaches according to changes in social needs, environment and technological innovation. Sustainability comprises of three broad themes of social, environmental and economic factors. These factors are also known as the pillars of sustainable development.

APPLICATION TO SUSTAINABLE CONSTRUCTION

An operational definition of sustainable construction is `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.

This definition includes details on how different process phases deal with resources at various scales of the built environment. Sustainability in construction embraces not only procurement (new construction, refurbishment work and maintenance) but also operation and demolition of constructed work. It encircles such matters as tendering, site planning and organization, material selection, recycling and waste minimization, and extends to education for the new homeowner (Vanegas et al, 2002). It does not only concentrate on the built environment. Housing and the social, commercial and transport infrastructures around them must all be built in ways that are sustainable in environmental and economical terms. They must add value to the quality of life of the individual and the community i.e. social sustainability. Currently the construction industry operates in an unsustainable linear system

. This system disregards constraints to material and energy consumption. In this model, several systems are linked in a linear process that begins with both renewable and non-renewable natural resources. In this model, exploitation of natural resources occurs to provide inputs for industrial processes. The outputs of these industrial processes become the inputs of the next sub-system, production and use of energy sub- system. The output of production and energy use sub-system is a critical input to all the systems in the linear process and resource processing and manufacturing subsystem, whose output is a set of industry-specific products or services that are transported and commercialised within the transport and commercial sector (Jones et al, 1998). This linear system, it is argued, ends with the use and consumption of products and services of all the other subsystems. Inputs enter the system and move in one direction and are finally disposed of. They go through the system once hence process is linear.

The linear construction process is divided into pre-construction phase, construction phase and post-construction phase. Pre-construction phase consists of the pre-project phase and pre-construction phase itself. It includes the procurement process; costing of the project, design of the facility, user requirements, clients' awareness and involvement. Construction phase includes the on site construction process, waste management or recycling, supply and management of construction materials. It also involves the suppliers of factors of production during the construction of the project. Post-construction phase includes the processes carried out after commissioning of the building. These include maintenance of the facility, life cycle cost/economy and efficiency, and demolition of the facility at the end of its economic life. The whole process of the construction project should be planned in such a way that in each phase, sustainability issues are kept in mind. Due to lack of recycling, there is increased pressure for exploitation of natural resources, expansion of energy production, resource processing and manufacturing to meet the increasing demand for consumption of products and services. From each of the systems there is emission of hazardous and non-hazardous waste, thus leading to an increase in environmental impacts. This linearity has led to problems of natural resource depletion, accumulation of waste and environmental degradation (Khalfan,&Malik, 2000)

Due to the challenges presented by the linear process, a new way of thinking must be adopted by all the stakeholders in the construction industry if sustainability is to be achieved. There is need to shift thinking towards a cyclic sustainable process. This system employs two aspects: use of non- renewable energy and natural resources prudently, and minimizing negative impacts on the earth's ecosystems. The closed cyclic system has additional subsystems of natural resource management, resource recovery, waste disposal, and environmental technologies.

The principles of the sustainable construction can thus be identified to include:

- Minimization of resource consumption
- Maximization of available resource reuse
- Use of renewable and recyclable resources
- Protect the natural environment
- Pursue quality in creating the built environment
- Create healthy and non-toxic environment.

SUMMARY OF FINDINGS

From the data analysis it was found that although all professionals claimed to consider Environmental issues while on site, the answers they gave in response to subsequent questions indicate otherwise. The methods of safeguarding the Environment of soil erosion control, and pollution control with exception of reduction of land contamination by hazardous substances were not found to be very popular with the firms. They all had an application rate of less than 70%. In addition 91.5% of professionals felt that the industry has not effectively safeguarded the Environment. This idea is supported by the cases of environmental degradation cited by the firms. It can be concluded, therefore that environmental issues are not effectively enforced during the execution of construction projects. It is also clear that coordination of environmental conservation and protection for sustainable utilization of natural resources within the construction industry is weak. This is indicated by the poor response as to existence of legal requirements to restore land on site to its original conditions after construction. Waste reduction measures, water conservation measures, sourcing of construction materials and use of recycled materials while having a direct relationship in regard to environmental impact, can be used as measures of economical sustainability of construction activities. Though to some extent such measures are put into place, they are not adequate. Their application in the industry can therefore be concluded as being unsustainable.

The technology applied in the industry is clearly unsustainable. This is concluded on the basis of the problems experienced in regard to its application. There is unavailability, it is inadaptable to local conditions and most of it is outdated or obsolete. It is very expensive to obtain and utilize as it increases the costs of capital projects. The sector also lacks any measures to safeguard itself from entry of obsolete technology from foreign countries. Therefore though majority of professionals are aware of sustainable construction practices, implementation of these practices is almost negligible. The hypothesis stated for this study is: Gaps existing between the awareness and the implementation/application levels of sustainable construction practices, have led to failure of realizing the benefits of a sustainable approach to construction projects.

From the data analysis that has been carried out and the conclusions obtained, the above hypothesis has been confirmed as true. This is because it has been found that though most professionals (firms) are aware of sustainable construction practices, they rarely apply/implement them fully in the execution of their projects. There is gross mismanagement of construction resources and little or no regard to the effect of construction activities to the environment. Gaps between the awareness and implementation levels can be seen in the sense that even though professionals aim to safeguard the environment, while on site they consistently fail to do so as they do not implement the practices that would lead to competent protection of the environment.

This can be said to be the result of inadequate or lack of legislative laws requiring sustainable practices to be implemented in every single construction project. There has been a general tendency of the government and the private sector ignoring to address vital issues of land use decisions and environmental contamination.

Negative attitudes towards the use of innovative materials for construction instead of imported materials contribute to lack of economic sustainability. Due to high costs of imported materials capital projects are generally expensive than would otherwise be if innovative materials were used for construction.

ACHIEVING SUSTAINABLE CONSTRUCTION: THE WAY FORWARD

Based on the findings, a number of measures would help in kick starting the process of entrenching sustainable construction in the Greek construction industry. These would include: Educating all segments of society about the need for sustainable construction and training construction professionals in sustainable construction concepts and methods are the most important ways of encouraging adoption of sustainable construction practices. This could create a greater demand for sustainable construction, which would spur more innovation bringing prices of construction projects down.

Existing educational and training programs should be evaluated to ensure that they include and take advantage of the existing knowledge base. This would require collaboration between the academia, government and the private sector Substitution of imported building materials with locally produced innovative materials and the use of local skill and labour intensive technology. Encouragement and full use of relaxed building by-laws, planning and building regulations. Upgrade building codes and regulations in light of environmental degradation to remove barriers impending new practices and products in the construction industry.

Apply environmental impact assessment on major projects to reduce (the impact of) environmental disasters. Intensify research into suitable architectural designs and materials for use in the country and design for recyclables. Publicize the long-term cost savings of buildings that incorporated sustainable practices during execution. Assist the funding for sustainable building projects.

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MOST LIKELY TIME FOR CONSTRUCTION OF SPORTS HALL IN VARAZDIN

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Abstract

There are many circumstances in which the contractor may wish to speed up work on a contract, including being behind programme and having to increase production in order to minimise extensive liquidated damages. Since Croatia was selected to host World Championship in Handball in 2009. Government of Croatia has step in to help the host cities build needed sport halls. This paper will provide an insight in a case study of sport hall in the town of Varaždin, in Croatia. Through this case study, the optimistic, most likely and pessimistic times of construction will be emphasised and discussed. Aim of this paper is to show how a Private partner – Constructor can also benefit from opportunity to plan most likely time of construction of the project using their know - how and taking the risks involved during construction of this project. Paper will also demonstrate added values which might be considered when deciding whether to spend additional effort and time to plan and define most likely time of construction of this project.

Keywords

Time planning, Optimistic, Most likely and Pesimistic times, Added values, PPP and Construction.

1. Introduction

When planning a project it is very important to get a feeling about the project by studying project documentation, assessing scale, scope and project value. Determine overall project time period is based on experience and consulting best practice of previous projects [1]. The important step is to establish key project dates e. g. start and finish of the project, holiday periods, handover date, which can be determined by client and given in tender documentation. After establishing key project dates it is possible to establish key activities to be carried out [2]. During project planning it is necessarily to assess activities duration, in early project stages it is based on experience and judgment of manager or a planner. Later on activities duration can be anticipated based on quantity of work and rate of production, expressed in hours, weeks or years. It is possible to establish the sequence by preparing a list of significant activities with duration and resource implication and related duration, whereas it is important to establish first and last activity in the sequence, which activities must be completed before next one starts, and parallel activities. Program technique used in this case study were Bar chart and Network analysis (The Critical Path Method) in order to determine most likely time of construction of the project [3]. The contractor may wish to speed up a work on the project under various circumstances e. g. client can request from the contractor to indicate the additional cost of completing the project before project completion date in order to balance the time savings against the cost of speeding up the work. This enables the assessment of the effect on the direct and indirect costs when reducing overall project period and comparing savings and damages due to earlier completion [4]. Building new infrastructure and renewing maintaining and improving the existing infrastructure as well as improving efficiency in providing services sets out goals for many governments in EU and the rest of the world. These goals are often set out along with continuous need of governments to contain public spending wile encouraging economic growth [5]. To cope with these problems and to try to solve them, many governments have applied the new type of procurement and new model of delivering infrastructural projects known as Public Private Partnership's (PPP).

PPP have introduced some new ways of defining project participants. The role of Public sector in delivering projects has changed in PPP projects and Public sector does not procure separately designs, building, project management and operating but instead Public sector defines the service it needs [6]. This is defined through "output specifications", which defines what services and standards of those services public sector need and not how it should be performed, organised or done. "Output specification" along with "Payment mechanism" should guarantee public sector to pay only for services delivered to specified standards. Achievement of specified standards should not be prescribed so that private sector could use its know how and introduce its innovations in delivering specified services as it has happened in the past that private sector is more efficient in implementing new and innovative techniques, methods and technologies then the public sector [7].

In recent years Croatia has followed the example of large number of the European countries and has implemented a few PPP projects. There were different types of PPP models used for different projects depending on the nature of the project itself. In the last year the biggest interest in PPP projects in Croatia raised the decision to build multifunctional sport halls for the purpose of hosting World Championship in Handball. Two cities have decided to procure these projects applying Private Finance Initiative (PFI) model, the city of Varaždin and the city of Split.

A lot of problems have followed these projects. From the very short time for preparation of these projects by the public sector to short timelines/deadlines for the designing and construction phase set out as a requirement to potential private sector bidders. At this paper the the PPP project in the City of Varaždin will be emphasized, from time of execution point of view.

2. Case study – PPP project in Varaždin

Innovative application of the Design Build Finance Own Operate and Transfer (DBFOOT) model under the PFI structure will be demonstrated at Case Study, PPP Project procured by the Town of Varaždin, who defined need for the 5.000 seats Sport Hall, including all necessary commercial areas and facilities. One of the important criteria for selection of Private Party is that the construction phase has to be finished by the end of 2008, in order to host World Handball Championship, which will be held at the beginning of the 2009 in Croatia.

For realisation of PPP/PFI project in Vraždin, the bidder who was nominated as the economically most advantageous tender, providing *Best and Final Offer*, based on the Conceptual design of the complex that has to satisfy all esthetical and functional needs and requirements of public partner, but one important criteria of evaluation was the time of completion of construction, due to the World Championship in Handball, which will be carried out in Croatia in 2009.

The Optimistic, most likely and pessimistic times of construction were calculated, as it is demonstrated in table 1.

Table 1. THE OPTIMISTIC, MOST LIKELY AND PESSIMISTIC TIMES OF CONSTRUCTION:

N°	ACTIVITY	OPTIMISTIC	MOST LIKELY	PESIMISTIC
I. CONCEPT PHASE				
1	Idea	2	5	6
2	Feasibility Study	3	5	6
3	Studying urban and space planning	9	10	11
4	Studying Croatian regulations	4	5	7
2. PLANNING PHASE				
1	Required documentation acquisition	3	5	8
2	Preliminary design	13	15	18
3	Location permit acquisition	21	25	28
4	Detailed design	24	30	35
5	Design review	7	8	9
6	Building permit acquisition	25	30	36
7	Bidding documentation	2	3	4
8	Invitation to tender for building	13	15	18
9	Working design	31	35	40
10	Selecting contractor	6	7	8
11	Signing of an agreement	2	3	5
12	Invitation to tender for construction supervisor	4	5	7
13	Selecting construction supervisor	5	7	10
3. EXECUTION PHASE				
1	Existing buildings removal	8	10	15
2	Site clearing and grubbing	4	5	8
3	Site organization	4	5	6
4	Setting out	4	5	8
5	Excavation	9	10	12
6	Concreting foundation	9	10	12
7	Prestressed concrete elements production	35	40	50
8	Waterproofing work	4	5	10
9	Concreting columns and walls - ground floor	6	8	9
10	Ground floor storey walling	9	10	15
11	Concreting floor construction	5	8	9
12	Workshop design of steel load-carrying truss structure	25	30	40
13	Purchasing and installation of concrete columns	8	10	11
14	Concreting columns and walls - 1st storey	5	8	9
15	Concreting floor construction - 1st storey	6	8	9
16	1st storey walling	6	8	10
17	Concreting grandstands	30	40	45
18	Purchasing and installation of prestressed concrete roof grider	2	3	4
19	Concreting columns and walls - 2nd storey	5	8	9
20	Concreting floor construction - 2nd storey	5	8	9
21	2nd storey walling	5	8	9
22	Purchasing and installation of steel load-carrying truss structure	2	3	5
23	Roof construction lining	9	10	11
24	Partition wall construction (All storey's)	15	20	22
25	Floor insulation construction	15	20	22
26	Purchasing and installation of internal and external joinery	18	20	23
27	External plastering	21	25	30
28	Rough water supply and sewerage installation	30	45	55
29	Rough electrical installation	45	50	60
30	Rough installation of communication and sounding	18	20	22
31	Rough mechanical installation	40	50	65
32	Internal plastering	21	25	30
33	Stonework and tiling work	32	35	40
34	Installation of air - conditioning equipment	10	15	17
35	Installation of suspended ceiling and paneling	13	15	17
36	Walls, ceilings and floors finish work	20	30	35

37	Installation of sanitary equipment	7	8	10
38	Final installation of communication and sounding	30	35	45
39	Final mechanical installation	35	40	50
40	Final installation of gymnastic equipment	7	8	9
41	Road, car park and sport terrain construction	50	60	80
42	Installations testing (Heating, electric, water supply)	7	8	9
43	Preparation for technical inspection	7	8	9
44	Technical inspection and operating license	15	20	22

In accordance to defined activity list and based on an optimistic, most likely and pessimistic times for each activity, expected time of all activities was calculated. Next step was to do Gantt chart and Network diagram for most likely and expected time. Gantt chart and Network diagram enables to obtain project information about overall project duration and the Critical Path for both, most likely an expected time. From the overall analysis of this project and according to calculation of most likely time, the total project execution time, according to expected time is 6 days more then calculated most likely time. This made foundation for project control procedures, in terms of construction project time. Gantt chart and Network diagram could be an effective management tools in order to record progress and analyze the operations/activities which are ahead or behind the program. In this study case simulated control was conducted 210 days after project started. Bar chart progress tool is used and the simulated percentage completed for each task is monitored. Then it was possible to trace delay of construction project occurred when programmed activities do not start or finish on time or both. As a result of this exercise, the activities are given which should start on a specific date so that project would finish on time without any delays or disruption. This also enebles contractor to speed up work on a contract, including being behind programme and having to increase production, in order to minimise extensive liquidated damages.

Figure 1.: Sport Hall in town of Varaždin, under construction.

PPP project, and Sport Hall which is under construction in the city of Varaždin presents an innovative way of procurement and business collaboration between the public and private partner in Croatia with the following characteristics:

- Most of the risks are allocated to private partner, especially the risks relating to time and cost of the construction phase, availability risks (if services are not provided to specified standards or quality) and commercial risks of demand for specified services (relates to variability in demand for services that private partner offers to sport clubs, visitors, general public and potential business partners and represents typical commercial risk to the private sector).
- This project agreement integrates a number of different stages in realisation of project: design, construction, finance, operation, maintenance, and provision of defined services, and finally transfer of ownership to the public authority at the end of the specified 25 years period. Private partner will finance all activities without Public Authority involvement.
- Agreement states amount of monthly payment that public partner pays to private partner for delivered services in equal monthly payments, starting from the first day of operation of the constructed facilities. Amount of monthly payment is subjected to deductions in accordance to payment mechanism if services are not provided to specified standards and quality.
- Agreement sets out requirements for quality and standards for functionality of spaces, provision of services, operation of facilities, etc., and also proscribes methodology for controlling performance standards which enables public sector to clearly measure given standard and quality of provided services and to pay only for services provided to specified standards and quality.
- Public partner has to control the methods, processes and dynamic of construction works and also has to control the quality and quantity of provided services.
- The investment for this PPP project is accounted as off-balance sheet treatment for the Public Authority.
- This PPP project results in different added values to the Public Authority and intensifies development of the Local Authority infrastructure.

3. Conclusion

There are legal and fiscal limitations in Croatia, as well as in other EU countries, which compose greater barriers to fund capital public investments only from budgetary resources. Therefore, the Croatian Government demonstrates greater political will and help to procure a few PPP/PFI projects from which one of them is presented in this paper. PPP/PFI project – Sports Hall in Varaždin, presents an innovative way of procurement and business collaboration between public and private partner in Croatia and emphasis of this paper is on the main characteristics of time planning during the execution phase.
This paper demonstrates the value of calculating the various times of construction. It also demonstrate values which might be considered when deciding whether to spend additional effort and time to plan and define most likely time of construction.

The PPP project demonstrates added values to the Public Authority and Private Partner when request for time optimisation is added to the evaluation of Private Partner selection procedure.

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THE MODELLING AND SIMULATION BUILDING LIFE CYCLE COSTS

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Abstract

Our research deals with modelling and simulation building life cycle costs (BLLC) which are build from various materials. In the centre of our interest there are especially new building products made out of secondary raw materials and their price impact on BLLC. The cost simulation is solved with software support on the base of model. In addition to prices our model works with lifetime of functional parts of building and their cycles of repairs and maintenances and time value of money (discount rate). The simulation with software support is used to evaluate alternative designs that have higher initial costs but lower operating costs over the project life than the lowest-initial-cost design. BLCC of two or more alternative designs are computed and compared to determine which has the lowest LCC and is therefore more economical in the long run.

Keywords:
Building Life Cycle Costs, Economic Efficiency, Secondary Raw Materials

Introduction

This report resolves issues related to determination of building cyckle life costs for living with application related to replacement of selected building materials. It is a substitution of materials manufactured from standard natural raw materials by materials manufactured from secondary raw materials. A new software is designed for modelling of building cycle life costs, reflecting the modification of BLCC in a model building object.

Simulation model setup

The representative of a building object for establishment of model and the subsequent calculations of life cycle cost is a family house. The model is currently undergoing a phase of calculation testing to substitution of ten selected construction materials under predefined conditions.

The model operates on the principle of matrix representation of consumption and material costs and column vectors of other cost items.

The calculation of total building life cycle cost is divided into to areas, that is to say to calculation of costs in the realization stage (acquisition) and calculations of costs in the operational and disposal stage. The calculations of costs in each area are performed separately. In the acquistion stage, the costs are structured according to the construction elements, in the operational and disposal stage, the costs are transformed into functional parts. Classification of costs according by construction elements is based on the historical classification based on Register of construction structures and works, which was established in the Czech Republic for the purpose of construction, and it has been used up to the date. For the costs related to the operation of the object, a new classification structure by functional parts was established within this research task. Thus, for the calculation of building life cycle costs, it is necessary to interconnect partial calculations in individual areas based on various cost structures.

Process of life cycle cost calculation

Life cycle costs are divided to acquisition and operational costs. Operational costs cover maintenance costs, repairs and reconstructions of individual functional parts of the building. Calculations reflect its assumed life-time and the level of the discount rate for providing for the time value of costs.

The calculation of costs is then performed by the following relationship.

$$LCC = \sum_{i=0}^{n} \frac{C_i}{(1+r)^i}$$

The life cycle costs reflected in the model structure are stated in the following table.

Table 1: Life cycle costs for functional parts

Functional Part	**Acquisition Stage**	**Operational Stage – maintenance cost, repairs and reconstructions**				**Disposal Stage**
	YEAR 0	**YEAR 1**	**YEAR 2**	**…..**	**YEAR n**	**YEAR n+1**
FD_1	c_{sp1}	c_{p11}	c_{p12}	…..	c_{p1n}	c_{L1}
FD_2	c_{sp2}	c_{p21}	c_{p22}	…..	c_{p2n}	c_{L2}
...				…..		
FD_o	c_{spo}	c_{po1}	c_{po2}	…..	c_{pon}	c_{Lo}
Total SO	c_{sp}	c_{p1}	c_{p2}	…..	c_{pn}	c_L
Discount factor	DF_0	DF_1	DF_1	…..	DF_n	DFn_{+1}
Total SO – discounted	$c_{sp}*DF_0$	$c_{p1}*DF_1$	$c_{p2}*DF_1$	…..	$c_{pn}*DF_n$	$c_{pp}*DF_{n+1}$

Where:

LCC life cycle costs
FD functional part
t is indication of a functional part (description of functional part), when t=(1,2, ...,0)
p number of lifetime years of a building
c_{sp} costs for acquisition of a functional part
c_p costs of the operational stage (maintenance, repairs, reconstructions)
c_L disposal stage costs
DF is a discount factor ($DF = 1/(1+r)^i$, where *r* is a discount rate in %/100 and *i* is the respective year of the building lifetime: i = (1, 2, …, n))

Software-aided calculation

To simulate calculations on the family house model, the software we developed may be used. To conveniently compare the cost modifications in substitution of materials, the model was set to the acquisition price, or basic LCC value, of CZK 1.000.000.

The software-aided calculation may be performed in the following steps.

In the "varianta“ (variant) window, the new calculation is indicated by a numeric code.
The functional parts, for which material modifications are to be performed, are selected from the menu.
In the menu, the assumed lifetimes of the selected functional parts are setup.
The discount rate is setup in the menu.
Replacement of materials is made in the menu.
Life cycle cost calculation is carried out.

Example:
Simulation of family house life cycle costs.
Discount rate: 5 %
Lifetime of functional parts: based on the menu in the model
Period evaluated: 50 years
Substitution: roof tile

The following table no. 2 contains a part of the life cycle cost calculation for several functional parts.

Table 2 Basic Variant - Total costs CZK 1 181 029,10

Year (df)	Foundations incl. digs			Vertical structures			Roof		
	FD Foundations (100/)	FD Digs (100/)	FD Isolations against ground moisture of the bottom structure (100/)	FD Vertical supporting and enclosure structures (100/)	FD Partition and separating walls (100/)	FD Chimneys (100/)	FD Wooden frame (60/10)	FD Dormers (40/)	FD Tough covering (40/10)
0	46 600,00 1,00 46 648,78	34 300,0 1,00 34 300,0	21 300,00 1,00 21 323,60	143 000,00 1,00 143 045,00	14 200,00 1,00 14 200,00	5 500,00 1,00 5 500,00	64 000,00 1,00 64 007,30	10 900,00 1,00 10 900,00	102 300,0 1,10 102 309,0
6 (0,746)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3 817,23
11 (0,585)	0,00	0,00	0,00	0,00	0,00	0,00	1871,19	0,00	2 990,90
16 (0,458)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2 343,45
21 (0,359)	0,00	0,00	0,00	0,00	0,00	0,00	1148,75	0,00	1 836,15
26 (0,281)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1 438,67
31 (0,22)	0,00	0,00	0,00	0,00	0,00	0,00	705,23	0,00	1 127,24
36 (0,173)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	883,22
41 (0,135)	0,00	0,00	0,00	0,00	0,00	0,00	432,95	1 474,57	13 840,53
total	FD 46 648,78 0,00 46 648,78	FD 34,300,0 0,00 34,300.0	FD 21 323,60 0,00 21 323,60	FD 143 045,00 0,00 143 045.00	FD 14 200,00 0,00 14 200.00	FD 5 500,00 0,00 5 500.00	FD 64 007,30 4 158,11 68 165,41	FD 10 900,00 1 474,57 12 374,57	FD 102 309,0 28 819,6 131 128,6

Table 3 Example of LCC calculation after substitution

Year (df)	Foundations incl. digs			Vertical structures			Roof		
	FD Foundations (100/)	**FD Digs (100/)**	**FD Isolations against ground moisture of the bottom structure (100/)**	**FD Vertical supporting and enclosure structures (100/)**	**FD Partition and separating walls (100/)**	**FD Chimneys (100/)**	**FD Wooden frame (60/10)**	**FD Dormers (40/)**	**FD Tough covering (40/10)**
0	46 600,00 1,00 46 648,78	34 300,00 1,00 34 300,00	21 300,00 0,86 18 327,00	143 000,00 1,00 143 045,00	14 200,00 1,00 14 200,00	5 500,00 1,00 5 500,00	64 000,00 1,00 64 007,30	10 900,00 1,00 10 900,00	102 300,0 1,10 112 690,0
6 (0,746)	0,00	0,00	0,00	0,00	0,00	0,00	2 388,16	0,00	8 409,10
11 (0,585)	0,00	0,00	0,00	0,00	0,00	0,00	1 871,19	0,00	6 588,75
16 (0,458)	0,00	0,00	0,00	0,00	0,00	0,00	1 466,12	0,00	5 162,46
21 (0359)	0,00	0,00	0,00	0,00	0,00	0,00	1 148,75	0,00	4 044,92
26 (0,281)	0,00	0,00	0,00	0,00	0,00	0,00	900,07	0,00	3 169,3
31 (0,22)	0,00	0,00	0,00	0,00	0,00	0,00	705,23	0,00	2 483,23
36 (0,173)	0,00	0,00	0,00	0,00	0,00	0,00	552,57	0,00	1 945,68
41 (0,135)	0,00	0,00	0,00	0,00	0,00	0,00	432,95	1 474,57	15 244,88
total	FD 46 648,78 0,00 46 648,78	FD 34 300,00 0,00 34 300.00	FD 21 323,60 0,00 21 323,60	FD 143 045,00 0,00 143 045.00	FD 14 200,00 0,00 14 200.00	FD 5 500,00 0,00 5 500.00	FD 64 007,30 9 804,27 73 811,57	FD 10 900,00 1 474,57 12 374,57	FD 112 690,0 48 242,8 160 932,8
Total costs CZK 1 216 479,45									

The resulting output of the table is the total discounted building life cycle costs. If, due to the material substitution, this value is decreased, then it is advisable to perform the substitution, from the economy viewpoint, and to utilize the new material in the construction of the respective building.

Conclusion

Simulation calculation of the family house model life cycle cost implied, that it is possible to determine the degree of influence of material substitution on these costs by utilizing a software aid. The calculation result reflects predefined conditions, which, apart from the substitution itself, influence the value of respective building life cycle costs. This is namely the lifetime of functional parts and the level of discount rate applied.

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The report was elaborated with the financial contribution of Research Scheme of Ministry of Education, Youth and Sports MSM 0021630511, Progressive Construction Materials Utilizing Secondary Raw Materials And Its Impact on Lifetime of Structures.

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APPLICATION OF CHRONOMETRY METHOD TOWARDS CALCULATION OF REGULATION

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Summary

Work study is an area of construction production rationalization in which with scientific, logical, holistic and system analysis methods of the process we gain optimum in way of work and time of work. Chronometry method is one of the work study methods which is appropriate for recording shorter cyclic processes and is based on statistical sampling theory. Study shows applied chronometry method in work of standard cyclic construction machine. Technological process of loading material with hydraulic excavator into transport vehicle is shown. All the processes were recorded with snapback chronometry method in order to gain higher precision of labor time of each work operation in production technological process. This study's goal is accomplishing regulation due measured time cycle and compare measured effects with effects obtained with standard regulation of hydraulic excavator practical achievement. According to research results gained using snapback chronometry method on two construction sites show that the practical achievements average is around thirty percent higher when recorded on the site than it can be calculated by standard methodology.

Keywords: work study, snapback chronometry method, cyclic time, standard cyclic construction machine regulation

Introduction

Many engineering and construction projects are based upon repetitive or cyclical processes, such as earthmoving. Fast development of production in today's world is based on project management regards on time, costs and quality which are key factors of every successful company on the market. Rationalization of production is a goal of every company. That goal can be achieved by minimization of time which has an effect on cost minimization (Pinter, Lončarić, 2006). Also it effects quicker reimbursement of invested assets. By production organization we comprehend performing as direct result of quality planning. With planning we set capacities, costs and the dates in advance, by managing we take into account realization and monitoring of achieved results. Planning of cyclic construction processes is often difficult due to their stochastic nature. In order to reduce this difficulty, many planning engineers maintain a large databank of productivity rates recorded from past projects. For a new construction operation, these productivity rates are adjusted**,** taking into account specific site factors and conditions that may influence productivity. Quality project management and achieving the minimization of time depends on various factors whose characteristics and impacts are engaged by work study. Work study is the systematic examination of the methods of carrying out activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out. Work study is divided in two groups in order to gain higher productivity. First group is a group of method studies which are used to simplify the job and develop more ergonomic methods of doing it. Second group is a group of work measurements which are used to find the time required to carry out the operation at a defined level of activity (Russell, Taylor, 2005a). One of the methods of performing work measurement is stopwatch time study which application in comparison to calculation of standard cyclic construction machine regulation will be presented in this paper.

Stopwatch Time Study

Stopwatch time study measures how long it takes an average worker to complete a task at a normal pace. A "normal" operator is defined as a qualified, thoroughly experienced operator who is working under conditions as they customarily prevail at the work station, at a pace that is neither fast nor slow, but representative of an average. The actual time taken by the above-average operation must be increased, and the time taken by the below-average must be reduced to the value representative of normal performance. Performance rating is a technique for equitably determining the time required to perform a task by the normal operator after the observed values of the operation under study have been recorded (Nakayama, 2002).

Frederick W. Taylor started to develop time study at 1881 when he started measuring time at a machine shop at home with stopwatch and clipboard. That was the beginning of time study. Even Taylor used stopwatch, as basic tool for recording time, present tools hasn't changed much. Today besides standard tools of time study, stopwatch and clipboard, we use digital stopwatches, computers, barcodes and accustudy software (Izetbegović, 2007).

There are few directions which should be followed when we use stopwatch time study for recording durations of our operations. Therefore here are seven suggested basic steps for using stopwatch time study.

Stopwatch time study basic steps (Russell, Taylor, 2005b):

1) Establish the standard job method,
2) Divide the job into elementary operations,
3) Study the job,

4) Rate the workers performance,
5) Compute the observed average time,
6) Compute the normal time,
7) Compute the standard time.

Stopwatch time study knows two methods of recording short cyclic processes:

1) Continuous chronometry method,
2) Snapback chronometry method.

Continuous chronometry method is a timing technique in which the stopwatch is allowed to run for the entire job. Method results present a complete record for the entire observation period including all delays and foreign elements. Foreign elements are external things to the process that delay the work from moving forward such as supervisor interruptions, power losses, leaving workstation and tool breakage. When using continuous method clerical work is required.

Snapback chronometry method is another timing technique which is used to record duration of each work element process. Using this technique we must reset our stopwatch after each breakpoint. No clerical work is needed to substract from previous observations as in continuous method. We directly read and record observed time.

With both methods, if they are used correctly, we gain equivalent results. Despite possibilities of achieving equal results, the snapback chronometry method is recommended due to few advantages in relation to continuous chronometry method (Taboršak, 1987):

1) Time of each work operation can be directly read and recorded,
2) Observer error can be calculated,
3) It's the same way of recording time not considering the order of performing operations,
4) Irregularities in work can be easily noticed,
5) Time of justified delays bounded to technological process can be calculated,
6) Easy recording of delay times during the work which are not connected to technological process,
7) If the recording was interrupted for any reason it can always be continued.

Application of snapback chronometry method

In this research we used snapback chronometry method to record duration of work processes of standard cyclic construction machine. Technological process of loading material with hydraulic excavator into transport vehicle is shown.

Measurements were taken on the part of local road number 233, Jurjenići – Šporova jama section, which is a northern connection of two cities, Kastav and Rijeka. Great significance of this regional road for the city of Rijeka and surroundings is gaining the alternative traffic route which will be used during whole year in order to reduce traffic load especially during summer time.

Data was recorded during the work of Komatsu PC340NLC standard hydraulic excavator. This is a modern hydraulic excavator built for very complex and demanding job in engineering especially earth digging, loading and demolishing. This machine weights 35 tons. Excavations were taken with the bucket capacity of 2,2 m^3.

Measurements were taken during winter conditions in November and December of 2007. Average day temperature was 8.7°C and the average humidity was 48%. Almost three quarters of all time N-NE wind blew.

At the beginning we divided our supervised job into elementary work operations as shown in Table 1. Each work operation is numerated.

Table 1: Work operations

No.	Work operations
1.	Clutching material
2.	Rotation of excavators boom with the bucket full of material
3.	Loading into transport vehicle
4.	Return into start position

Table 2 show measured time of each operation during fifteen cycles. Table shows fifteen representative measured cycles of overall 375 measured cycles.

Table 2: Recorded cycles by each work operation

Number of Cycles														
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
5,87	6,48	5,73	7,24	8,33	6,60	5,97	6,79	6,98	4,73	6,58	5,55	7,07	5,70	4,25
9,18	8,60	8,17	8,51	7,23	6,44	6,78	8,28	9,06	8,25	11,08	7,11	7,49	8,63	7,01
4,28	4,42	4,04	4,37	4,81	3,66	3,38	8,41	4,35	3,12	3,25	3,45	4,39	4,87	7,52
7,39	8,31	8,61	7,97	7,34	5,84	8,89	6,52	7,15	6,84	7,28	7,66	5,61	6,72	7,84

Table 3 shows summary time of recorded cycles presented in Table 2 by each work operation. Beside summary time, rating factor and normal time of each operation is shown. Normal time is product of average time of each operation and related rating factor. Normal cycle time is a sum of normal times of each operation.

Table 3: Overview of normal cycle time calculating process

Summary time					Rating factor	Normal time $N_{vs}=\Sigma N_t$
x_{max}	x_{min}	Σx (sec)	Σx (%)	x_{sr}		
8,33	4,25	93,87	23,83	6,26	1,10	6,88

11,08	6,44	121,82	30,92	8,12	0,95	7,72
8,41	3,12	68,32	17,34	4,55	1,00	4,55
8,89	5,61	109,97	27,91	7,33	1,05	7,70
						N_{vs}=26,85

Normal cycle time:

$$N_{vs}=\Sigma N_t$$

$$N_{vs}=26{,}85\ \text{s/cycle} \rightarrow 0{,}00746\ \text{h/cycle}$$

Standard time (N_v) is a product of normal cycle time (N_{vs}) and additional time coefficient (K_D):

$$N_v=N_{vs}*K_D,$$

$$K_D=1+k_a*k_n+k_d.$$

Table 4: K_D – Additional time coefficient

ka	*From Taboršak*	1
kn	*From Taboršak*	1
kd	$(t_P+t_N+t_E)/100$	0,035
K_D	$K_D=1+k_a*k_n+k_d$	2,035

$N_v=N_{vs}*K_D=0{,}00746*2{,}035=0{,}01518$

$N_v=0{,}01518$ h/cycle

$U_p^v=1/N_v$

$U_p^v=65{,}88$ cycle/h

We calculated our regulation with measured time that resulted in having to spend 0,01518 hours per cycle. Our cyclic construction machine is Komatsu PC340NLC hydraulic excavator with the bucket capacity of 2,2 m^3. In order to load material into transport vehicle, boom of the excavator turns around for 180°. In order to compare these results with results that we gained with calculation of regulation due standard methodology we must determine how many cubic meters is included in one cycle.

1 cycle=$q*x_r$

Using observation method (Lopez, 2005) we estimated that with each bucket loading only 75% of bucket capacity is filled (x_r=0,75).

1 cycle=2,2*0,75=1,65 m^3

$U_{px}^v= U_p^v*1{,}65=108{,}70\ m^3/h$

$U_{px}^v=108{,}70\ m^3/h$

$N_{vx}=1/U_{px}^{v}$
$N_{vx}=0{,}00920$ h/m^3

Calculation of regulation based on standard methodology

For the calculation of regulation based on standard methodology approximately the same data is used as in snapback chronometry method. Bucket capacity is 2,2 m^3 and the angle of boom rotation is 180°. Excavation was semi hard one and the cycle time (t_c) is taken from tables in total of 28 seconds i.e. 0,0078 hours (Linarić etc., 2007).

The practical achievement is calculated by following expressions:

$$U_p = \frac{q*T}{t_c} * k_A * k_B * k_C,$$

$k_a=k_p*k_r*k_{vm}$, $k_b=k_{rp}*k_o*k_{ut}$, $k_c=k_{og}*k_{rv}*k_{ds}$.

Table 5: Selected reduction coefficients

Coefficients of:	Material coefficient k_A	Working condition coefficient k_B	Organization coefficient k_C
Loading bucket capacity (k_p)	0,90	-	-
Meuble material (k_r)	0,90	-	-
Humidity of material (k_{vm})	0,95	-	-
Working area (k_{rp})	-	0,95	-
Rotating of boom (k_o)	-	0,70	-
Loading (k_{ut})	-	0,90	
Mechanic work condition (k_{og})	-	-	0,83
Utilization working time (k_{rv})	-	-	0,92
Machine wear and tear (k_{ds})	-	-	0,91
Σ	0,670	0,5985	0,695

Up=(2,2*1/0,0078)*0,670*0,5985*0,695=78,69 m^3/h

Up=78,69 m^3/h

$N=1/Up$

$N=0{,}01323\ h/m^3$

Conclusion

Work measurement determinates time required to carry out the operation at a defined level of activity in order to achieve higher productivity. Work measurement is the careful analysis of a task, its size, the method used in its performance and its efficiency. The objective is to determine the workload in an operation, the time that is required, and the number of workers needed to perform the work efficiently. Work measurement can be extremely effective at informing supervisors of the working times and delays inherent in different ways of carrying out work.

The purpose of a measurement method is to achieve full coverage of the work to be measured. A good work measurement system has many benefits. It helps to reduce labor costs, increase productivity and improve supervision, planning, scheduling, performance appraisal and decision making.

This paper shows the application of snapback chronometry method which is the one of time study methods. The snapback approach requires a stopwatch with a reset button that allows the observer to read and record the time at the end of each work operation than reset the watch to zero.

Job times are vital inputs for manpower planning, estimating labor costs, scheduling, budgeting and designing incentive systems. In addition, from the worker's standpoint, time standards provide an indication of expected output. Time standards used under Standard Cost Systems reflect the amount of time it should take for an average worker to do a job under typical operating conditions. The standards include expected activity time plus allowances for probable delays.

Snapback chronometry method is used to determine standard time of a standard cyclic construction machine in one standard earth moving technological process. Technological process of loading material with hydraulic excavator into transport vehicle is shown.

In our research we determine that the standard time apropos regulation is 0,00920 h/m^3 for our specific cyclic construction machine and specific but realistic conditions where the measurements were taken. Results gathered by snapback chronometry method were compared with calculation of regulation based on standard methodology. In that calculation with reduction coefficients we gave the best possible approximation of working conditions which occurred on our measured construction site. Regulation which calculation is based on standard methodology is 0,01323 h/m^3. That is 30% higher than the regulation results gained by snapback method.

Although popular, the time study method is subjective and relies heavily on the experience of the time study analyst. A computerized data collector provides more accurate timing than a stopwatch. However, converting actual time to the expected or normal time remains a problem.

Most of work measurement methods are designed for measuring the work in industrial (ideal) surroundings while construction sites are far from ideal. Thus there is a large gap in application and calibration of work measurement methods on construction sites.

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PLANNING AND ORGANIZING THE PROJECTS IN TEAM Co ČAKOVEC, CROATIA

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Abstract

The paper systemizes standard methods of planning, monitoring and controlling the realization of construction works in civil engineering projects and overviews the implementation of the methods in Team Co Čakovec from Croatia. The specificities of the methods are shown through the different construction works projects. Also, paper reviews the implementation, modification and improvement of existing methods for planning, monitoring and controlling the realization of projects in Team Co.

Key words: plan, monitoring, control, S-curve

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 1.600 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, expenses and resources, company Team switched initial line organizational structure to functional and finally to matrix organization what provided higher flexibility in project management. Parallel with organizational structure development, central work preparation developed, that is sector of project preparation and realization.

Planning

Planning is a process in which events and activities in future processes are being predicted and than on basis of known data and documents, applied technology and work organisation, their integration, dimensioning, allocation and realisation control is pursued. Planning includes past (data, experience), present (norm, calculation, control) and future (plan, projection). Task of planning is to, in advance, predict possible variants of realisation and to make a decision of best optimal way and integrate it into a plan, than to assure documents for control and work completion evaluation, documents for decision making and managing during completion. Based on completion plan tracking database of plan and completion past projects are made. Goal of planning is to coordinate four variables (time, costs, resources and risks) through optimal usage of available resources minimising duration, costs and risks in project.

Planning is carried out through work in four phases, which can all, or some of them cyclically repeat. It starts with creation of initial plan, based on which is made optimal distribution of work. During realisation of work control and comparison planed vs. realised is carried out as well as prognosis of further realisations. Depending on work stage and in relation with planed vs. realised, it's possible after prognostic state to make new plan, distribution or control.

This paper elaborates part of planning and organisation of project that besides costs planning, resources and other elements refers to construction and tracking of completion of time plans.

Approach to planning can be partial, systematic, ad hoc and nihilistic.

In phase of bidding, most of contractors are completely oriented on calculation of price, while planning of realization deadlines is less favoured. The reason for such behaviour is fear that in case of rejection of proposed time schedules their offer will be declined or expectation that with extremely short time schedule they will gain extra points. However, after contracting most of contractors very critically claim to time schedule. Most of contractors have approach hockey stick approach (slower beginning – faster ending), so they stretch initial activities and plan final activities in peak deadline what is very risky. In other words, completion is forced without quality preparation.

Plans

Plan, as a written document should be complete, clear, with possibility of reconstruction of data, furthermore dynamic and legitimate. Completeness of the plan implies content of all activities required for completion of project. Also, plan must be readable and easy for understanding for all project's participants. Possibility of data reconstruction refers to reconstruction of all data and results within short time period on simplest way. In case of deviation from plan's completion, it is necessary to ensure input of changes for maintaining the goal with less additional actions and effort in plan. Also, it is very important that plan would be accepted from all participants of the project.

Methods of planning can generally be divided on techniques of network planning and techniques of line planning (Gant chart, orthogonal plan, S-curve, histogram). Every of these techniques have a different way of presenting result, that is type of information. Whole presentation of data, time report, time presentation of resource usage and dynamics of planed costs and profit enables usage of different planning techniques. The most common combination of methods of planning in civil engineering is network diagram – Gantt chart – S-curve or in simple projects Gantt chart – histogram – S-curve.

Plans according to activities level are divided to basic, overviewed and detailed.

Basic plan is made in phase of biding and after signing of contract it is corrected according to contract time schedule. Usually it contains 10 to 40 summary activities and all key interim deadlines. It shows activities and links for construction of documentation, supply and procurement, implementation and realization, handover. Time scale of plan is month so plan is updated once a month.

Overview plan is made on basis of basic plan and includes contract interim deadlines and other significant deadlines for supplying equipment, materials, and documentation delivery by participants involved in the project. In this plan there are shown all activities/links for construction of documentation, supply and procurement, implementation and realization, handover. Usually it is part of contracting documentation. Time scale of plan is month or week so plan is updated once a month or week.

Detailed or operational plan represent further details of overview plan. It's made during realization of project, and it can embrace total duration of realization, but it is often made for certain period; month, week or day. Time scale of plan often is week or day so plan is updated weekly or daily.

Planning and organizing the projects in Team Co from Čakovec, Croatia

Team Co has matrix organizational structure with strong central preparation of projects, so since the very beginning of possible future signed contract in bidding phase, the project manager is involved in creation of basic plan. His task is to contribute the creation of optimized plan with his experience form the realized projects. Every bid includes creation of term plan, weather it is demanded from the investor or tender or not, in the preparation and realization of projects sector in department for planning, monitoring and controlling. After the contract is signed, project is assigned to the project manager, who is from that moment to the end responsible for the project success.

Project manager was involved in the bidding phase and creation of basic plan and with extra information there is no reason to avoid the creation of overview plan that contains key interim deadlines, latest dates of documentation delivery form the other participants in project that aren't within the organizational structure of the company, and also other obligations of the involved participants in project.

After the overview plan is created, project manager who is a member of central preparation sector approaches to the creation of detail plan with site staff.

Described organization avoids the standard process in small and also big companies. Planning in small companies is left to the site staffs who think of plan as a document for pressuring the investor or to be pressured by company management, but they are already pre-occupied and responsible for everything. Big companies have central planning in departments without participation of the site staff, so they think of plans like they are pushed upon and unrealistic. Consequences of both approaches are frightening, and it is boycott of plan. To avoid that, project manager in Team Co is a person, also member of central preparation and realization sector, responsible for project success. This way means the link from site to the central sector over project manager and demand of legitimacy of plan is fulfilled, so all participants in the project accept the plan.

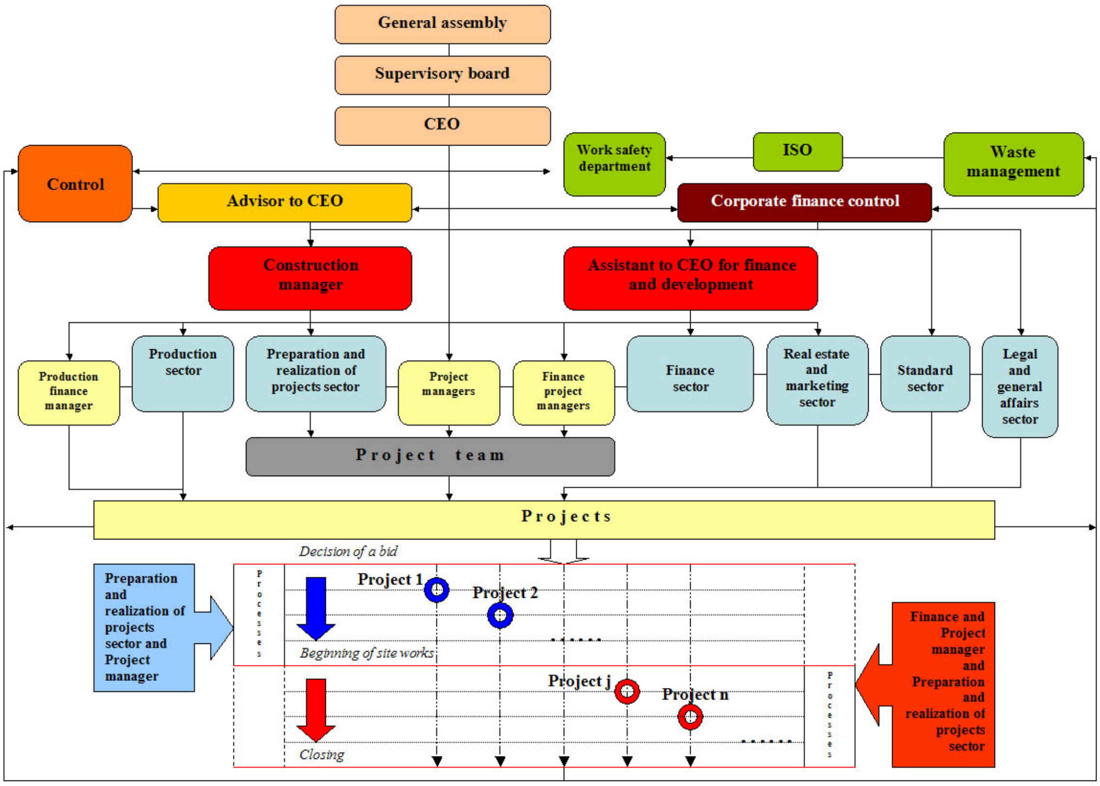

Figure 1. *Organizational structure scheme of Team Co*

Gantt chart is used in Team Co for creation of basic, overview and detail plans. Network planning is used for the project phase that understands the construction works. After the plans are created work progress is monitored and by control and corrective actions affected on noticed changes and deviations from plan.

Project approach involves detailed plans that are created, usually, for three phases of the new building construction:

- construction works
- craft and installation works
- start-up and ending

Detailed plan and related S-curve is created for every phase of the project. In every phase, at least two systems of monitoring and control are used, so the possibility of system error is minimized. Work progress monitoring on plan view was introduced because mentioned methods don’t always show a clear picture about the work progress. This method provides a good overview for the higher level of company management. For example, construction work progress is monitored by the quantity of the concrete built in, activity tracking by Gantt chart and plan view progress work.

Main focus during planning is simplicity, which means little input quantity but accuracy of interpretation of output data, so the decisions could be right and on time. Usage of S-curve method, as a simple graphic technique, has shown as very good indicator of status, trend and prognosis of work progress, and also as good basis for making decisions in project. Except S-curve, in planning, monitoring and controlling, histogram is used to show daily planned and completed quantities and resources. Main characteristic of project realization control system is the speed of reaction and possibility to forecast the future scenario.

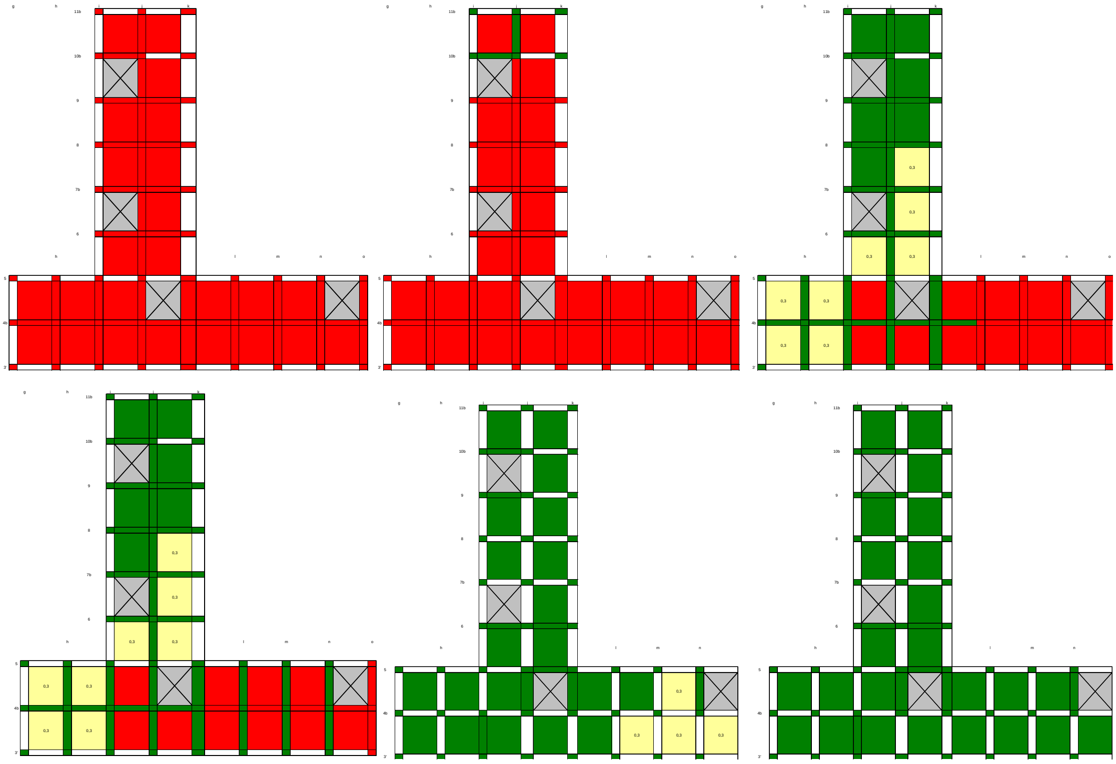

Figure 2. *Work progress monitoring on plan view during 6 weeks*

Work progress monitoring on plan view is a simple method that shows completed area and remaining to be done, with green and red colour. This method is connected with its own S-curve.

Monitoring and controlling of realization of projects, no matter of a kind, make two questions that have to be answered:

- is everything going according to the plan?
- is the project going to finish on time?

Monitoring reports can be regular, special or as separate analyses. Monitoring task is an early and clear direction to the changes and variation, and also showing trends and clear direction to the key data with great influence for the entirety.

Control is a process that compares planed parameters with the monitored ones. Control is continuous, very complex and responsible work, that has to be flexible, understanding to the work performers, easy to maintain, ethic, accurate, fully documented, directed to mistake corrections instead of punishing.

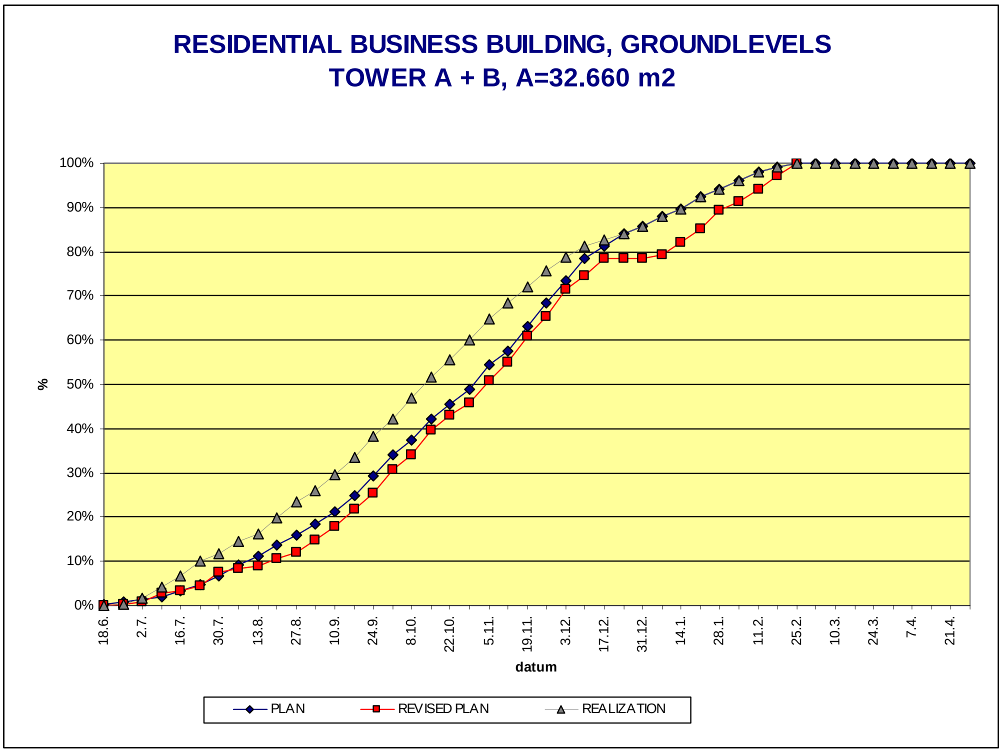

Figure 3. *S-curve of plan and progress*

Processes of monitoring and controlling are integral and continuous through all phases of project. Full support of planning is provided by participation of members responsible for work progress of plan, which is accepted as their own.

Conclusion

The paper shows methods of planning, monitoring and controlling in Team Co. Method of S-curve is described as a simple model for prognosis and as a good base for decision-making. Every project is unique, so is the approach to planning individual using the existing and verified techniques. Team Co has central preparation of works sector, matrix organizational structure, own database for realized projects and also experience of project managers, so is the approach to the planning and organization of the projects systematic which enables good preparation, and we all know that good preparation means half work done.

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EXPERIENCE WITH ACCESS CONTROL SYSTEMS OPERATING ON CONSTRUCTION SITES

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ABSTRACT:

Increase security, health and safety requirement and demand on productivity induce the management to think upon instalment hi-tech attendance tracking and access control devices on their project.

Protection of sites and recording the working hours is nothing new in the industry, but there are new ways the companies can reach the expected results. All the more in the high profile projects such as airports, prisons or pharmaceutical laboratories, the design of the access control system has a significant impact on the flow of goods and labour and this affects the financial result.

The paper is based on the result from 4 building sites in the UK and Ireland where different type of systems were installed. The first project presented is located in Edinburgh and consists of an extension of chemical laboratories where biometrics readers were implemented. The second project shows the experience from Dublin Airport, Pier D construction where the client and the contractor decided for full height turnstiles supported with digital picture recording. The next comparable project of residential and retail development was completed in Dublin and for labour monitoring purpose the swiping cards were utilised. The last and traditional system of mechanical puncture clock cards is brought from a civil project; particularly from the construction of bridges for Dublin's light rail system.

The integral part of paper is SWOT and the value analysis accompanies the personal and project management feed backs for each project

KEYWORDS:

Access control systems, time attendance, biometrics, protection of sites

INTRODUCTION:

Nowadays construction business is exposed to broad offers of "essential" programs and tools from external companies operating in IT. Variable spectrum of technologies and systems are also presented in Access Controlling and Working Hours Monitoring sectors.

In general the system could provide many outputs. Particularly following functions are the most common:

- <u>Protection of site</u>
    - Insurance purpose
    - Elimination of thievery
- <u>Monitoring attendances and visitors</u>
    - Full control of people on site in case of emergency and evacuation
    - “Electronical” guest book
- <u>Access control</u>
    - Different levels of authorisation to different location
    - External monitoring via central board
- <u>Controlling of working hours of labour and staff</u>
    - Wages calculation including overtimes
    - Time management
    - Checking holidays balances
- <u>Labour resources allocation and planning</u>
    - Cost analyzing and control
    - Human resources planning
    - Labour allocation

Other factor entering in the decision is level of integration to overall company’s IT structure. When protection and access monitoring is requested a single-use system is suitable. Time management function is recommended to install for whole company.

The paper presents author personal experience from 4 building sites in the UK and Ireland where different type of systems were installed.

COMPARISING PROJECTS:

The first project – laboratories in Edinburg:

<u>Description of project:</u>

Extension of laboratories; cost of project € 98mil; duration 18 months; peek staff and labour on site 210.

<u>Location:</u>

Private hospital, South of Edinburg, Scotland

<u>Function:</u>

Biometrics solution verifies the employees via fingerprint readers. The readers never store actual finger prints; instead they hold an algorithm (mathematical representation) of the fingerprints which are used to confirm employee identity. It is impossible to recreate a finger print from an algorithm, thereby ensuring employee security.

Cost of system:

Software including installation and non-limited licence – €1,300

Fingerprint readers - external for clock in – €210
- internal for prime data entry - €150

PC & cables – approximately €1,450

SWOT:

Strength	No cards needed Elimination of time fraud Time and security identification function in one Instant result
Week	Fingerprint readers are expensive and must be additionally protected (CCTV)
Opportunities	Link to main payroll system Link to external monitoring Good system reduce administration Future fingerprint readers cost reduction
Threats	Refuse by users Problem with personal data collection

The second project - airport in Dublin:

Description of project:

Airport – Pier with 12 gates; cost of project € 120mil; duration 23 months; peek staff and labour on site 290.

Location:

Dublin Airport, Pier D, Ireland

Function:

Full height turnstiles operate via chip store in keychain. Due to specific environment the digital picture recording with round-o-clock airport police attendance is also present.

Cost of system:

Turnstiles (cost, installation and running) - €12,800

Digital picture recording - €2,650

Keychain with chip - €8 / pc (500 pcs needed) = €4,000

PC & cables – approximately €1,450

Police attendance - free

SWOT:

Strength	Permanent security Time and security identification function in one Double control
Week	Cost of keychain with chip Total cost
Opportunities	Link to main payroll system Control of material
Threats	Lost of keychain Electrical supply needed

The third project – residential and retail development in Dublin:

Description of project:

Residential and retail development; cost of project € 240mil; duration 29 months; peek staff and labour on site 520.

Location:

Beacon South Quarter, Dublin South, Ireland

Function:

Time management device with swiping cards for control of labour and subcontractors. Single terminal with card reader and card holder is installed in one of the entrance.

Cost of system:

Card reader and software - €4,500
ID cards with picture - €5 / pc (700 pcs needed) = €3,500
PC & cables – approximately €1,450

SWOT:

Strength	Traditional and known
Week	Limits of entrance Administration with issuing of cards Cost
Opportunities	Could be used with barrier or turnstiles
Threats	Limits of users Risk of time fraud

The fourth project – light rail system in Dublin:

Description of project:

Enabling phase of light rail system – 4 bridges and 2 underpasses; cost of project € 28mil; duration 13 months; peek staff and labour on site 110.

Location:

Sandyford, Dublin South, Ireland

Function:

Mechanical puncture clock cards are implemented for recording labour working hours. Each labour is equipped with a clock card for each structure. Six locations are built for clocking.

Cost of system:

Clocks (cost, installation and running) - €230
Paper cards - €30

SWOT:

Strength	Traditional and cheap No electricity needed
Week	Cost of administration More paperwork No instant result
Opportunities	Effective for smaller and spread sites

Other systems – pilot project:	Threats	Single use Risk of time fraud Loss or damage

Rapid spread of mobile technologies with GPS allocation and digital camera leads to idea of utilisation in resources allocation and time management. Selected site supervisors make their personal picture when entering and leaving the site. They also send MMS to central office including information of global coordinates of their location. Current high price of devices holds the overall spread.

The pilot project has been introduced just recently and therefore is not included in the SWOT analyze.

CONCLUSION:

When comparing the above mentioned systems many advantages and future usage possibilities of Biometric and GPS technologies can be seen. Moreover the role of those who implement these systems is extremely important in both technologies. Correct introduction, endorsement of using system by all participants and avoidance of any exploitation of personal data are key factors that rest on project managers.

The system will only be as good as the data entered are maximum correct and fully completed.

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REPORTING STAKEHOLDERS ON CONSTRUCTION PROJECT PERFORMANCE

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Abstract

As there are more and more complex conditions involved in the project performance, there appears a bigger need for qualitative control and tracking projects. Reporting stakeholders is the result of tracking process on projects, whether sponsors, investors, supervising engineers, contractors or other stakeholders. Project management Team has to define and choose ways and contents of reporting every phase of a project, from start to the end of it. Researches proved that inadequate reporting is often the cause of inappropriate and delayed actions which could limit success of project performance. The paper addresses the construction project stakeholders. The paper involves also the description of communication channels which transmit the project information in Croatian construction practice. The paper explains existing types of reporting and provides suggestions for improving report effectiveness.

Keywords: construction performance, stakeholders

1 Introduction

We are witnessing increasing concerns about the poor performance of the construction industry and its lack of innovation at the time when customers' demands rise and projects are becoming ever more complex. In the terms of tracking and predicting the project performance, there are many tools to implement in the early stage of the project performance.

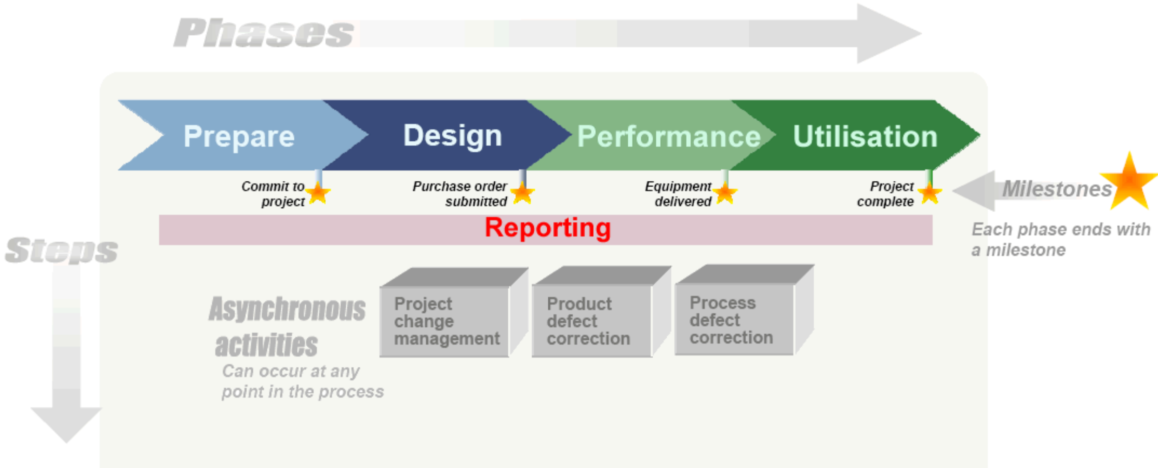

Figure 1. Project phases and reporting

2 Stakeholders and reporting in the construction project performance

Stakeholders are defined as entities or individuals that can reasonably be expected to be significantly affected by the organization's activities, products, and/or services; and whose actions can reasonably be expected to affect the ability of the organization to successfully implement its strategies and achieve its objectives. This includes entities or individuals whose rights under law or international conventions provide them with legitimate claims vis-à-vis the organization. Stakeholders can include those who are invested in the organization (e.g., employees, shareholders, suppliers) as well as those who are external to the organization (e.g., communities).

It is widely agreed that a project has many stakeholders, whose interest may be related or in conflict [3]. A project manager shall seek the stakeholders input to the project in order to achieve project success. The PM literature requires that a project manager does not limit the project team within the boundaries of his/her own organization, but also includes other key stakeholders as part of the project team [3,4]. In the construction project context, project stakeholders include project owner, PM organization, contractor, designing company, supervising Engineer Company and many others. They are connected with communication channels that have to be defined by communication plan of the project performance.

The reasonable expectations and interests of stakeholders are a key reference point for many decisions in the preparation of a report, such as the scope, boundary, application of Indicators, and assurance approach. However, not all of an organization's stakeholders will use the report. This presents challenges in balancing the specific interests/expectations of stakeholders who can reasonably be expected to use the report with broader expectations of accountability to all stakeholders.

For some decisions, such as the report scope or boundary of a report, the reasonable expectations and interests of a wide range of stakeholder will need to be considered. There may be, for example, stakeholders who are unable to articulate their views on a report and whose concerns are presented by proxies. There may also be stakeholders who choose not to express views on reports because they rely on different means of communication and engagement. The reasonable expectations and interests of these stakeholders should still be acknowledged in decisions about the content of the report. However, other decisions, such as the level of detail required to be useful to stakeholders, or expectations of different stakeholders about what is required to achieve clarity, may require greater emphasis on those who can reasonably be expected to use the report. It is important to document the processes and approach taken in making these decisions.

3 Communication plan for construction process

Preparing the project communication plan include: gathering planning inputs, identifying stakeholders, determinating stakeholder needs, identifying communication Methods and WBS Products, preparing the Communication Plan Draft and developing a Conflict Management Strategy, distributing the Communication Plan Draft, as well as incorporating changes and finalizing the Communication Plan. Proper information distribution makes information available to project stakeholders in a timely manner. Following the communication plan ensures that all members of the project team are aware of their responsibities to communicate with external stakeholders. The more information stakeholders have regarding a project or deliverable, the less likely last minute conflicts, changes, or complaints will affect a project.

Information on performance should be placed in context of projects needs and goals. The organization’s own sustainability and business strategy provides the context in which to discuss performance. The relationship between sustainability and organizational strategy should be made clear, as should the context within which performance is reported.

The appropriate communication plan has to be implemented in the early phase of the project performance. Communication channels depend on type of the project and its goals.

This paper analysed nine smaller construction projects and ways of communication and reporting on project performance. The paper addresses communication channels of project stakeholders as inseparable part of the research. Reporting is often the result of tracking which goes through existing communication channels.

There are three main channels of reporting common for all research projects.

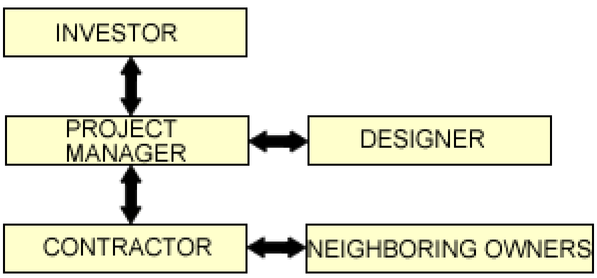

Figure 2. Communication Channels of reporting 1

This Figure shows slow investor's decision making, which is a critical point, and his additional requirements which project management made more complex. Investors often assume wrong post neglecting project manager's roles. Time and cost are being overspent. It is crucial to define responsibilities between an investor and a project manager. If an investor makes decisions about important factors of the project, he restrains project manager in his duties. Sometimes their interests seem to be different because investor isn't aware enough of positive sides for his project. He can't take a long-term view and must let the project manager to direct him. Project manager has to build defence strategy on conflict of interests in the early start of project performance and project management.

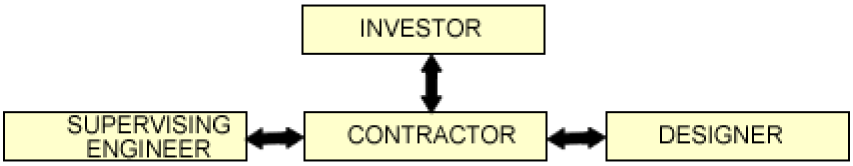

Figure 3. Communication Channels of reporting 2

On the construction sites where communication channels were set as in Fig.3., there was a significant problem of bad tracking of project performance. Every stakeholder measured project success by his own interests. A supervision engineer has taken over some functions of the project manager as far as it was within his scope of work. Communication between contractor and designer seemed to be very effective because some decisions could be faster reached, but only where it was allowed.. This communication channel makes the process faster but may put a damper to tracking the project performance.

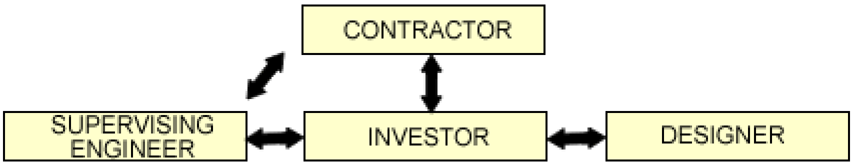

Figure 4. Communication Channels of reporting 3

Reporting as in Fig .4, shows the critical point in getting replies from designers on time. As communication and reporting go through investor in bidirectional way, he transfers and gets back the answers from designer. In study cases of this research, the problem was redesigning some solutions after initial plan, which caused overspending time and money.

4 Reports on construction projects performance

Projects are faced with a wide range of topics on which it could be reported. Relevant indicators are those that may be reasonably considered important to reflect the organization’s economic, environmental, and social impacts, or to influence the decisions of stakeholders.

Therefore, they merit to be included in the report. Materiality is the threshold at which an issue or Indicator becomes sufficiently important that it should be reported. Beyond this threshold, not all material topics will be of equal importance and the emphasis within a report should reflect the relative priority of these material topics and Indicators.

There are three main report's principles that have to be discussed: defining report content, ensuring report quality and boundary (see Fig. 5., Fig. 6.)

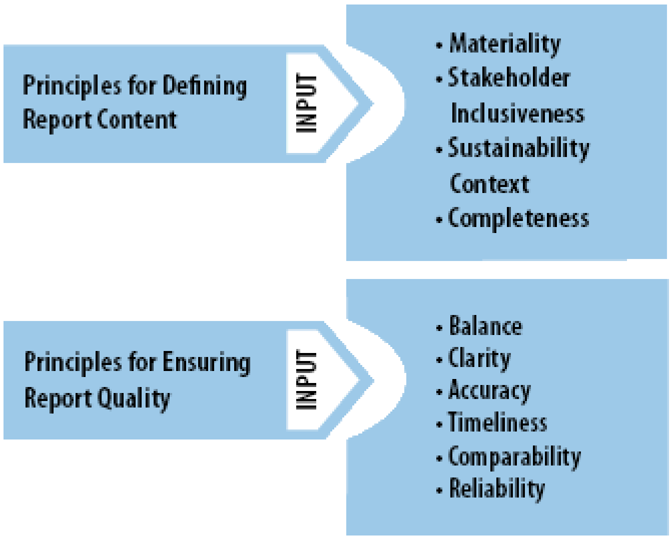

Figure 5. Principles for Defining and Ensuring Report Quality

To better understand every factor of principles, the definition of it is given, as it is shown in Fig.6.

Reporting principle	Definition
Materiality	The information in a report should cover topics and indicators that reflect the project's significant economic, environmental, and social impacts, or that would substantively influence the assessments and decisions of stakeholders.
Stakeholder Inclusiveness	The reporting should identify its stakeholders and explain in the report how it has responded to their reasonable expectations and interests.
Sustainability Context	The report should present the project's performance in the wider context of sustainability.
Completeness	Coverage of the material topics and indicators and definition of the report boundary should be sufficient to reflect significant economic, environmental, and social impacts and enable stakeholders to assess the reporting project's performance in the reporting period.
Balance	The report should reflect positive and negative aspects of the project's performance to enable a reasoned assessment of overall performance.
Clarity	Information should be made available in a manner that is

	understandable and accessible to stakeholders using the report.
Accuracy	The reported information should be sufficiently accurate and detailed for stakeholders to assess the reporting project's performance.
Timeliness	Reporting occurs on a regular schedule and information is available in time for stakeholders to make informed decisions.
Comparability	Issues and information should be selected, compiled, and reported consistently. Reported information should be presented in a manner that enables stakeholders to analyze changes in the organization's performance over time, and could support analysis relative to other organizations.
Reliability	Information and processes used in the preparation of a report should be gathered, recorded, compiled, analyzed, and disclosed in a way that could be subject to examination and that establishes the quality and materiality of the information.

Figure 5. Definition of Principles for Defining and Ensuring Report Quality

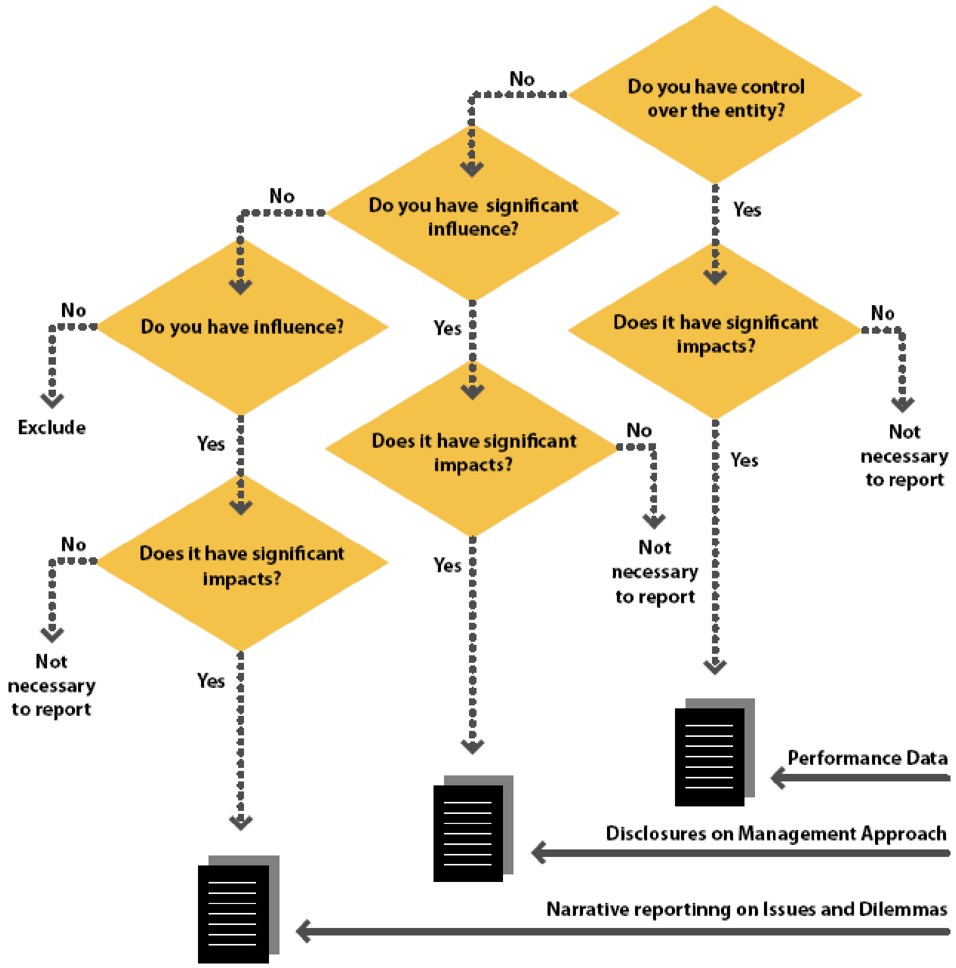

Figure 6. Boundary settings of report

There are many communication methods to deliver project information, including meetings, telephone calls, email, voicemail and websites. Meetings are often the most effective way to disseminate information to project stakeholders. Here are some of the methods and their description:

Method	Purpose	Frequency	Audience	In Croatia
Project development team meeting	Develop a formal document called the baseline work plan, which is used to define, monitor, and manage project execution	Weekly until baseline work plan is signed	Project manager and all stakeholders	Yes, weekly
Project management senior staff meeting	Communicate changes in Department policy or procedures, manage program expectations, and enhance training processes	Weekly at designated time	Project manager and functional managers	Yes, monthly or weekly
Project status review meeting	Report status and progress of scheduled milestones and activities. Identify and discuss problems and solutions for project obstacles.	Monthly at designated time	Project management and database administrative staff	Yes, often integrated in other weekly meeting
Project team meeting	Report status and progress of scheduled milestones and activities. Identify and discuss project issues and corrective actions	As needed (weekly, monthly, quarterly, or ad hoc)	Project manager, functional managers, and task managers	Yes, often integrated in other weekly meeting
Office meeting	Report status and progress of scheduled tasks. Identify and discuss project issues and corrective actions.	As needed	All stakeholders	Yes, often integrated in other weekly meeting
External customer and/or supplier	Involve external customers and suppliers in the project	Project manager, functional manager, or	As needed	As needed

meeting		task manager		
Project Internet site	Report status and progress of scheduled milestones and activities	Webmaster	Monthly or as needed	Rarely
Teleconference	Communicate changes in Department policy or procedures, manage program expectations, and enhance training processes. Report status and progress of scheduled milestones and activities. Identify and discuss problems and solutions for project obstacles.	Varies	Weekly at designated time	Rarely
Correspondence (letters, memos, email, etc.)	Document status of action items, decisions made, and problems encountered.	All stakeholders	As needed	Yes
Site visit	Identify and discuss problems and solutions for project obstacles	Project manager or functional manager	As needed	Yes

Figure 7. Reporting methods

As it is shown in Fig.7., in Croatia weekly meetings often take place in order to discuss the issues. It is a good practice to solve problems of project performance. Slow replying is often critical for project success.

5 GRI

The Global Reporting Initiative's (GRI) vision is that reporting on economic, environmental, and social performance by all organizations is as routine and comparable as financial reporting.

Figure 8: GRI reporting framework

It has application in all types of activities, as well as in construction. There are principles and guidance of general meaning and every project has to be concerned individually. Every standard and procedure is good if it is completely implemented in project. Partially defined report and its partly implementation is the same as no reporting.

6 Guidelines for further development

In order to provide project success, it is necessary to periodically revise the effectiveness of established communication plan. Project manager asks the project stakeholders if the project communication is sufficient to suit their needs. In some cases, project stakeholders may need greater detail or more frequent delivery. In other cases, certain stakeholders may need summary information, or may request notification only if problems arise. There are four steps for evaluating and reporting communication performance:

1. Review the project communication plan

2. Solicit feedback from the project stakeholders, verbally or in writing, as to whether the current information or communication method is adequate, based on the following criteria:

- Type of information

- Frequency of information

- Depth/detail of information

- Format of information

- Method of information

3. Discuss the stakeholder feedback wit the PDT

4. Update the project communication plan if needed

7 Conclusion

There are nine smaller construction projects analyzed in this paper, total investments of 20 000 000 kn. It is proved that essential communication takes place between client, designer and project manager. Most problems are caused by inadequate clients' and project managers' awareness of possible client's negative impact on project management and therefore on the project success.

Reporting process efficiency is rarely planned or managed. The unfortunate result is that most data waste substantial dimension. Today it is both possible and prudent to plan, measure and improve project success by planning and implementing content, time and responsibilities of reporting.

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COMPARISON BETWEEN PLANNED AND REALIZED INVESTMENTS IN WATER SUPPLY FACILITIES IN KRAPINSKO-ZAGORSKA REGION

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Abstract

There are four main water supply systems in Krapinsko-zagorska region: Zagorski vodovod, Krapina, Pregrada and Hum na Sutli, as well as 10 major and about 340 minor water supply systems out of the main ones. In the period from 2006 to 2011 it is planned to invest about 31.800.000,00 € for work, goods and services under the Program of Krapinsko-zagorska water supply system. Extra 700.000,00 € under the Program ensure work, goods and services' investors, represented by communal organizations authorized for water supply management. Krapinsko-zagorska region is in terms of the size one of the smallest areas in Croatia (1225 km²), but according to the population density (122 pop./km2), one under the average (which is 84 pop./km2). There are about 148.700,00 inhabitants living in the region, which is next to the Međimurska and Varaždinska region the most inhabited region in the country. Water supply system exists only in the 60% of region and that is why effective and well planned development is essential for developing region in general. The paper starts from the analyses undertaken on 15 June 2008 discussing scheduled and realized investments, as well as the methodology of analysis and prediction of state at the end of the period (2011), unless no intervention will be undertaken to improve project success.

Keywords: planning, investments, water supply

Introduction

There are at least three very important reasons for taking effort of good water managing:

1. *Economic growth:* water is an essential industrial raw material – as essential as steel. Without reliable and affordable water supplies, existing factories cannot run at full capability and new factories cannot be justified. Similarly, commercial and residential development relies on reliable and affordable fresh water.
2. *Agricultural productivity:* To put agricultural water demand in perspective, 1 km2 of farmland will evaporate up to one million gallons of water every day. In many regions agricultural usage represents 40% or more of overall water demand.
3. *Public health:* Today, globally 1 in 5 people lack sufficient access to fresh water. This statistics is expected to climb to 3 in 5 by 2025.

Megaprojects such as Program of Krapinsko-zagorska water supply system are vital for any community. The purpose and price of these projects represent a complex and challenging task due to the existence of diverse components and the extended construction time. The estimation of reasonable mark-up still relies on individual's experience and judgement. Therefore, the need for further investigation and structured analysis procedure.

Typology of construction investments in water facilities:

- Building the new infrastructure system in the terms of increasing needs
- Completing water supply facilities which are partly constructed, including completion of water supply system
- Construction of main water supply network components for connections with existing adopted system
- Partial modernisation and/or exchange of existing infrastructure according to rigid regulations
- Activities directed to saving the water resources and/or ensuring of their effective usage

State of the water supply system in Krapinsko zagorska Region

There are now about 52% of Krapinsko-zagorska region's inhabitants connected to the Public water supply system. This is under the Croatian average percentage. The problems present also fewer water facilities constructions in the smaller municipalities (0-24%) in comparison with cities (41-80%) and significant number of improper local water supply facilities (over 300). It is necessary to ensure additional water source for water supply system in the region. In the area of 1234 km2 there are 7 cities (Krapina, Zabok, Zlatar, Klanjec, Oroslavje, Donja Stubica and Pregrada) and 26 municipalities.
According to Habitant list from 2001 there are 142,432 habitants in the Krapinsko-zagorska region.

Methodology of analyzing

Four main water supply systems in Krapinsko-zagorska region: Zagorski vodovod, Krapina, Pregrada and Hum na Sutli are considered. From 2006 to 2011 it is planned to invest 226.900.000,00 kn for work, goods and services under the Program of Krapinsko-zagorska water supply system. Extra 5.000.000,00 kn were invested within the Programme of Work, Goods and Services' Ensuring, which would be carried out by an authorized municipal company concerned with water supply. In this paper planned and realized state of the investment is compared. Realized state implies all settled investments.

Comparison of scheduled and realized state

Figure 1. shows investments in Kn that are planned to be realized in the period 2006-2011. Planned investment would bring water in 95% area of Krapinsko-zagorska region until 2011.

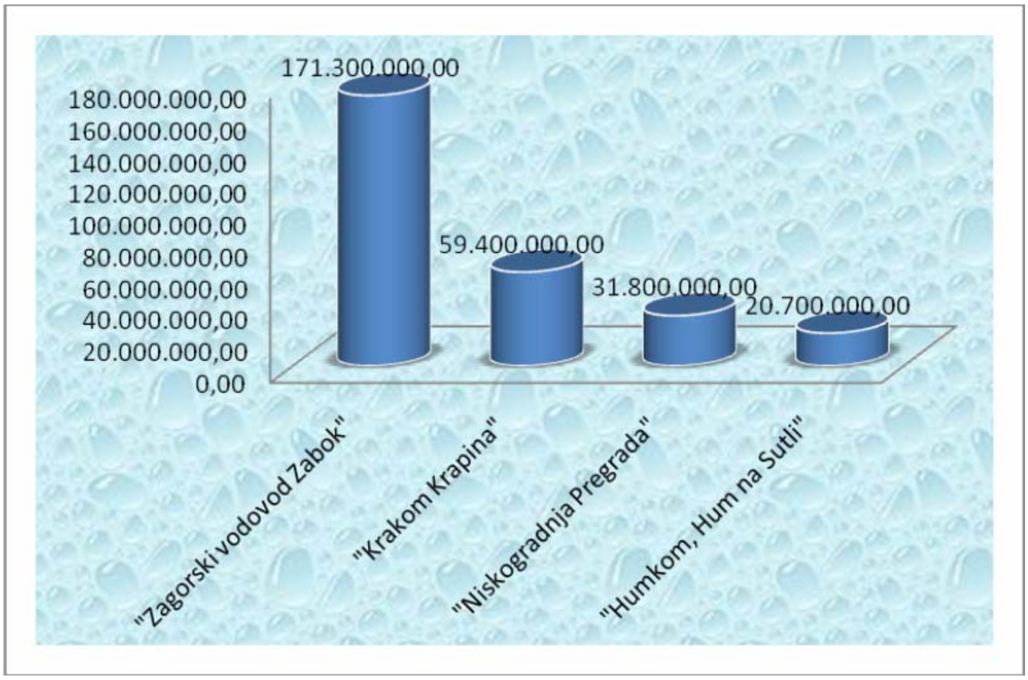


Figure 1. Investment - Planned Estimation – (Kn)

Investments in water supply system, as shown in Fig. 2, are planned to behave uniformly through time, with almost linear distribution per year. Zagorski vodovod is the main one to cover the most of region's area, and therefore the planned investments are higher than others.

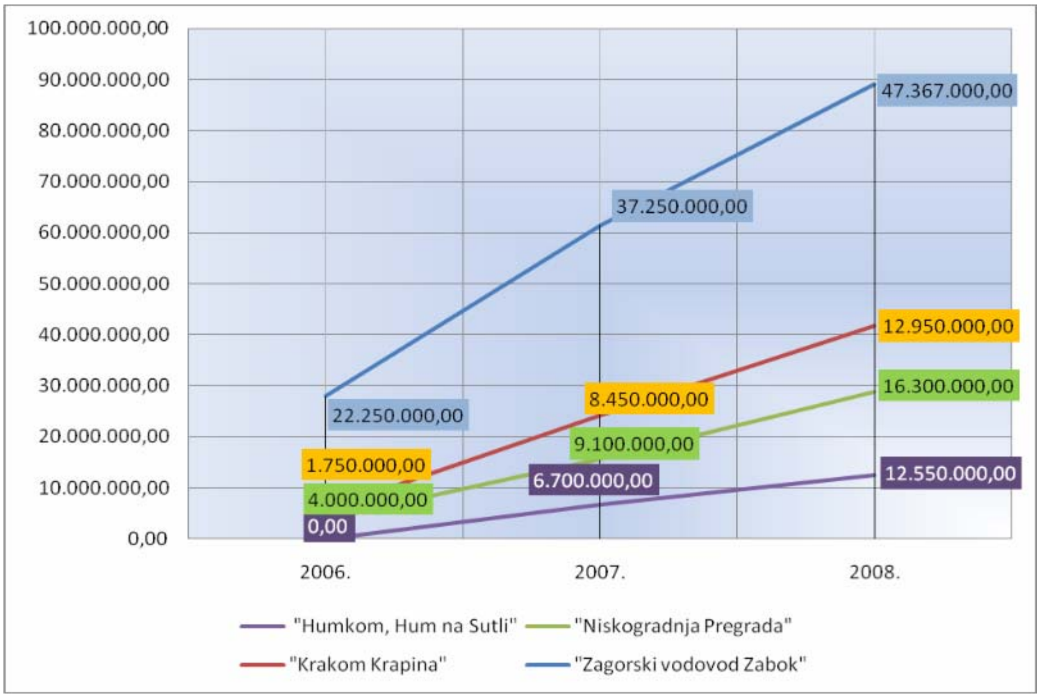
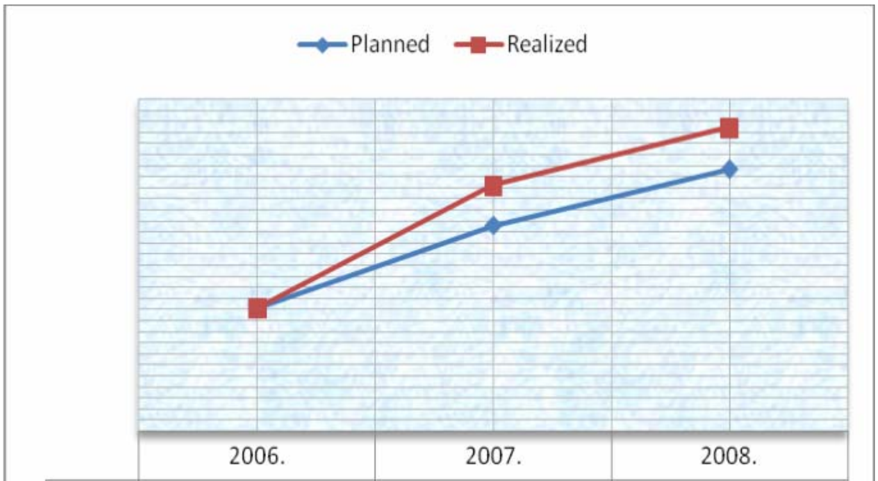


Figure 2. Investments planned per year

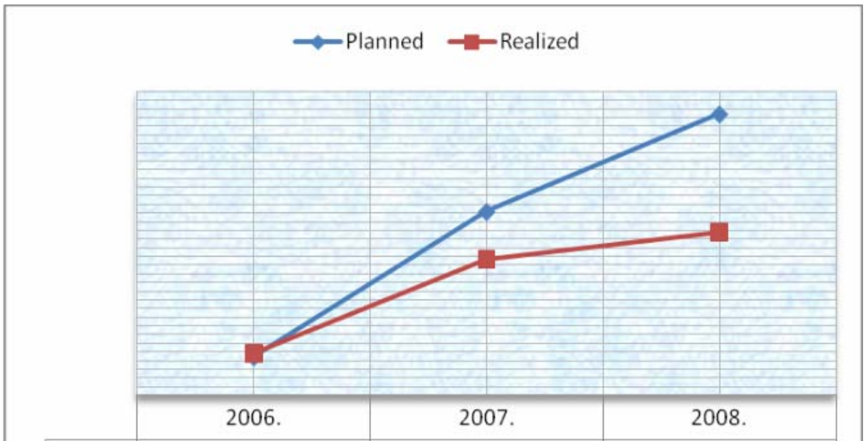
Figure 3 to Figure 6 show planned and realized investments in each of the distribution object. It is recognized that the Program 'Zagorski vodovod Zabok' has some advantages at the first phase of implementation. As it is very large area, it is obvious that achieving the success of this part of the project is crucial for the general results.

Other water supply system investments show relatively bigger difference between planned and realized condition, but their investments are all relatively small in the comparison with investments in ¨Zagorski vodovod Zabok¨.



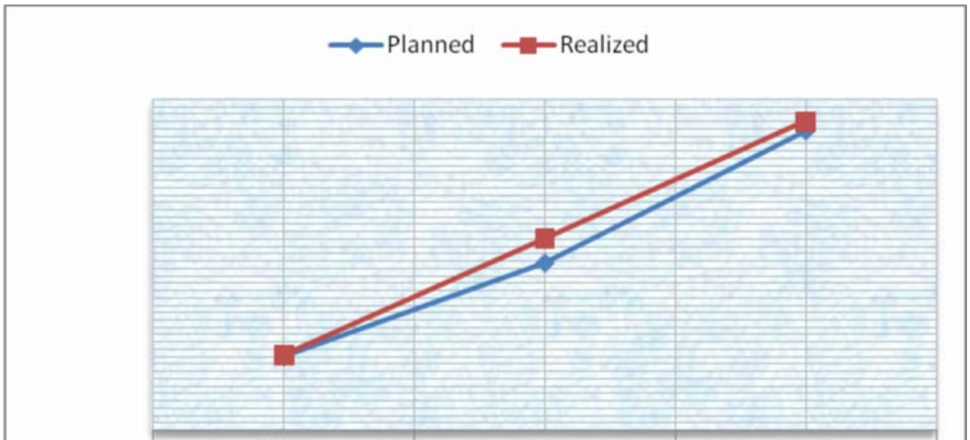
	2006.	2007.	2008.
Planned	22.250.000,00	37.250.000,00	47.367.000,00
Realized	22.249.340,87	44.361.951,82	54.818.951,82

Figure 3. Planned and realized investment of „Zagorski vodovod Zabok"



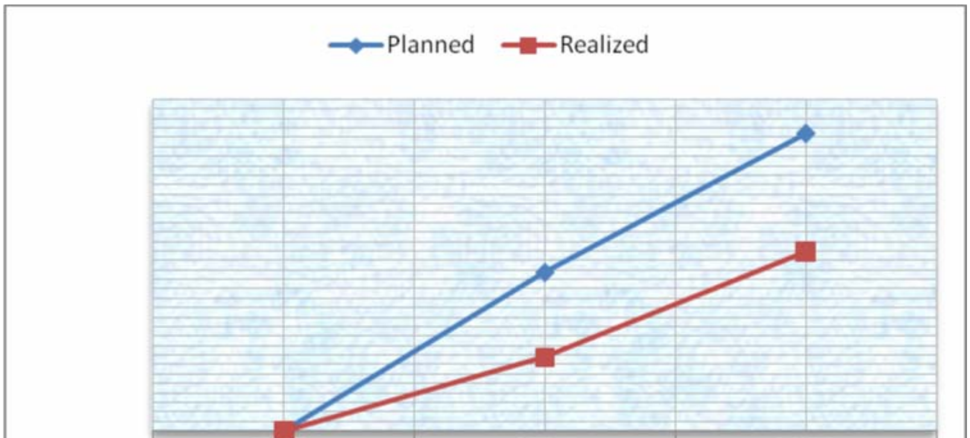
	2006.	2007.	2008.
Planned	1.750.000,00	8.450.000,00	12.950.000,00
Realized	1.939.999,98	6.266.813,63	7.512.821,02

Figure 4. Planned and realized investment of „Krakom Krapina"



	2006.	2007.	2008.
Planned	4.000.000,00	9.100.000,00	16.300.000,00
Realized	4.110.050,00	10.440.154,69	16.793.614,24

Figure 5. Planned and realized investment of „Pregrada“



	2006.	2007.	2008.
Planned	0,00	6.700.000,00	12.550.000,00
Realized	0,00	3.107.999,92	7.557.579,37

Figure 6. Planned and realized investment of „Humkom“, Hum na Sutli

Those differences between planned and realized state have to compensate in the future, which is better than the fact that ¨Zagorski vodovod Zabok¨ would be lagging.

Guidelines for the present state development

Uncertainties and risks are inherent in investment decisions. Energy strategy, Demand Management, Public policy and some other multidisciplinary activities have to be applied to enhance management so that difference between planned and realized point would be as small as possible.

There is disproportion of planned investments by long term and short term. It is very important to establish uniqueness on the planning because it is the main factor for the program success quality tracking.

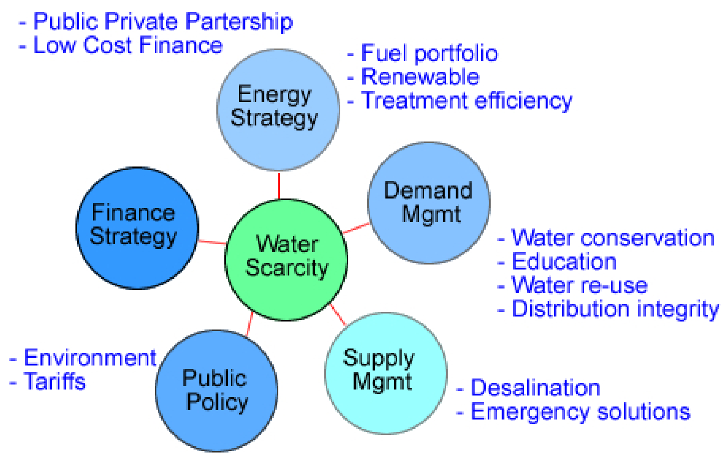
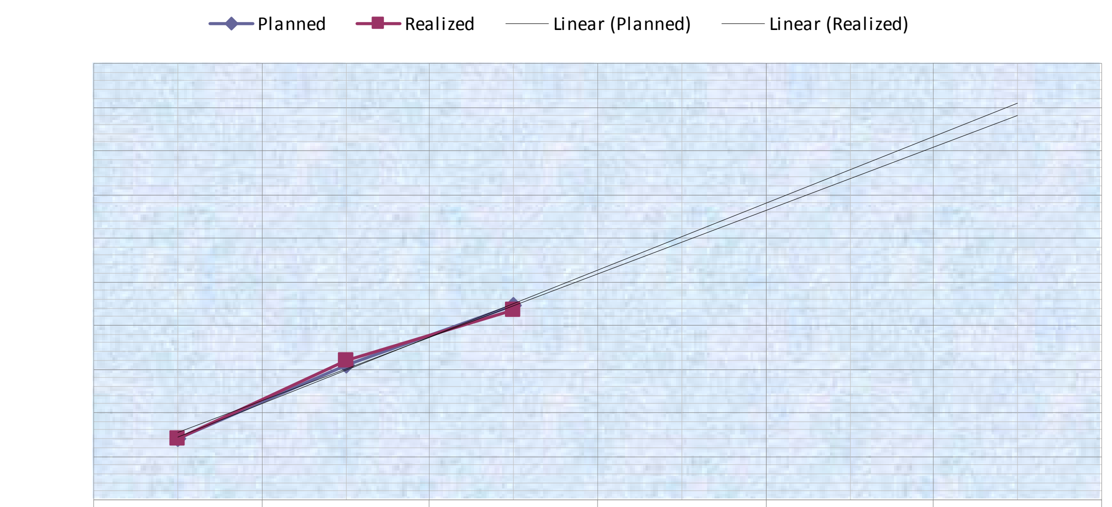


Figure 7. Water Management

Conclusion

Managing the whole area by one integral system in Krapinsko zagorska region would give more opportunity to develop and complete the Program, and would point more clearly to the region's priorities. Figure 8 shows linear trendline of planned and realized investments by 2011. Keeping the today's dynamic development the difference between planned and realized state would be about 3.000.000 Kn. With today's dynamics at the end of the Program, in 2011, about 180.000.000 Kn will be invested. If we want to reach the initial plan of 226.000.000 Kn from the long term plan, we have to improve Program performance.



	2006.	2007.	2008.	2009.	2010.	2011.
Planned	28,000,000.00	61,500,000.00	89,167,000.00			
Realized	28,299,390.85	64,176,920.06	86,682,966.45			

Figure 8. Estimation of whole project realization in KZR – linear trend line

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and
**Davor Rajčić, LLB

GENERAL CHARACTERISTICS OF LIABILITY FOR DAMAGES IN CONSTRUCTION INDUSTRY

Abstract

The paper describes the general characteristics of liability for damages in construction industry and the relevant provisions laid by the Law of Obligations in the area of damages. The paper deals in detail with the issues relating to the supposed liability for damages, to legal subjects, to damage, to harmful acts, to wrongfulness and fault, to systems of liability for damages, to fault and strict liability, to own liability and liability for third parties, to contractual, extracontractual and precontractual liability, to liability for damages by more than one party and to compensations.

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General characteristics of liability for damages in construction industry

1. General remarks

Construction industry is regulated by a large number of provisions. Besides provisions which directly relate to construction, and are predominantly administrative, civil law plays a significant role in this area of legal practice. It regulates the ownership of structures, legal relationship between constructors and clients (investors), and other parties participating in construction (e.g. designers, reviewers, supervisors) who, in principle, regulate their relations through contracts (e.g. the clients/investors sign construction contracts with contractors). The civil law provisions, precisely, the regulations of the Law of Obligations (hereinafter: LO)[1] govern the liability for damages in construction industry. The regulations stipulate when a party is liable for damages, who is liable for damages, how damages will be repaired, how the amount of compensation is determined, etc. Namely, although the provisions for construction industry, principally the Law of Planning, Zoning and Building[2], stipulate the repair of damages caused by construction, they do not contain specific regulations on liability for damages but they refer to the provisions relevant to that area[3], that is, LO. Besides, LO contains further specific regulations on liability for damages in construction industry.[4]

The liability for damages occurs under particular circumstances. If certain conditions between an injurer and an injured party are met, the liability for damages occurs and the injurer is obliged to recover the injurer's damage. If the injurer does not fulfill his obligation to the injured party, the injured party is authorized to realise his/her right at court or at other competent body.[5] The same applies to the cases when damage occur during construction.

2. Preconditions for damages
General remarks

Legal entities are expected in their everyday and work life to perform their activities without causing damage to other legal entities. However, it does not mean that a party causing damage to others will automatically be obliged to repair it, that is, that it will be liable for damages. Particular preconditions regulated by LO have to be fulfilled to make a legal entity liable for damages. Pursuant to LO the preconditions for liability for damages are as follows:

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[1] Law of Obligations, Official Gazette of the Republic of Croatia (OG), 35/05. The law entered into force on January 1, 2006. It was amended, OG, 41/08. Before the Law of Obligations entered into force in 2005, the Law of Obligations from 1978 was in force, which was adopted by Croatian legislation in 1991 through the Law of Adopting the Law of Obligations (OG,53/91) and was amended a few times (OG, 73/91, 3/94, 7/96, 112/99 and 88/01). The new law is in force for all obligatory relationships that arised after the law entered into force.

[2] The Law of Planning, Zoning and Building, OG, 76/07.

[3] See, e.g. regulations of the Law of Planning, Zoning and Building, article 210, par.2 (liability of the party who has violated the right and started an administrative action for damages suffered by an investor), article 208, par. 5 (liability of the head of the team drawing the document on planning for damages suffered by the investor), article 312, par.3 (liability for damages of the person registered for designing for damages suffered by the investor), article 313, par.5 (liability of the designer for damages suffered by the investor), article 314, par.3 (liability of the reviewer for damages suffered by the investor), article 315, par. 5, (liability of the person authorised to nostrify the project for damages suffered by the investor), article 316, par.10, (liability of the constractor for damages suffered by the investor), article 317, par.4, (liability of the person authorised for professional supervision for damages suffered by the investor), article 318, par.4, (liability of the chief supervisory engineer for damages suffered by the investor), article 319, par.4, (liability of the property owner for damages suffered by the third party).

[4] Article 1108, LO on shared liability of the client and the contractor for damages suffered by third parties with regard to the construction on the property.

[5] Besides courts of law arbitration courts can be authorised. for damage repair in construction industry

1. entities have the relationship of liability for damages (the party causing damage is an injurer, and the party suffering damage is an injured.), 2. damage is caused to one legal entity (the injured party)., 3. harmful act by the party causing damage (injurer), 4. causal relation between a harmful act by the injurer and the damage, 5. wrongfulness (consists of objective wrongfulness and fault).[6] The above rules are applied only in case of so called fault liability for damages, which is usual in Croatian legislation, but with a series of exceptions, when it regulates strict liability for damages (liability for damages regardless of fault). Strict liability does not require presumed fault. In some cases of liability for damages caused in construction industry the regulation of strict liability for damages is applied, meaning that fault is not relevant to liability for damages. This issue will be dealt with in the paragraph on particular systems of liability for damages.

The relationship of liability for damages arises when general presumptions of liability for damages are fulfilled, and the injurer will be obliged to compensate the injured party for damage, and the injured party is authorised, if the injurer does not fulfill their obligation, to realise their right through judicial proceedings, respectively before other competent body. The fulfillment of presumptions of liability lead to the relationship of liability for damages caused in construction industry regardless if the regulations of the Law of Planning, Zoning and Building or any other construction provision specifically regulate the liability for damages. It means that liability for damages in construction industry can occurr when the Law of Planning, Zoning and Building or any other construction provision do not regulate any sanctions. In this respect it is enough to fulfill the presumptions of liability for damages which are stipulated by LO.

Legal subjects

Legal subjects must exist to create the relationship of liability for damages, and they are the injurer and the injured party. The injurer is the party which has caused the damage, and the injured party is the party who has suffered damage. The injurers and the injured can be natural persons and legal entities. The injured party does not have to confront any particular provisions to establish the relationship of liability for damages. In case of the injurer it is different. Namely, if an injurer is a natural persons he/she has to be competent, meaning minimum 14 years of age and rational (capable of judgment). Exceptionally, persons younger than 14 can be liable for damages, if they are 7 years of age and capable of judgment.[7] Unlike natural persons, legal entities are always liable for damages they have caused.

Damage

The relationship of liability for damages occurs only if the injured party has suffered damage. Namely, the relationship of liability does not occur until the injurer causes damage, even if his acts are illegal.[8] Illegal behavior without damage is not sanctioned by the regulations of civil law, but by offence and criminal laws. The LO thus defines the notion of damage: the reduction of patrimony (regular damage), lost profits and infringement of personal rights. Regular damage and lost profits are patrimonial damage and infringement of personal rights is non-patrimonial damage. Patrimonial damage is reflected on the patrimony of the injured party. The infringement of personal rights (non-patrimonial damages) occurs when the injurer violates the personal welfare of the injured party. The LO, among other things, recognises the

[6] P. KLARIĆ, M. VEDRIŠ: Građansko pravo (Civil law), 9th edition, OG, 2006, p. 583-584
[7] Article 1051, LO
[8] P. KLARIĆ, M. VEDRIŠ: ibid., p. 587.

following rights of natural persons: the right to live, physical and mental health, respect, honour, dignity, name, privacy of personal and family life, freedom etc.[9] Besides personal rights of natural persons the LO recognises and protects the personal rights of legal persons. Legal persons have the same personal rights as natural persons, save the ones that are related to the fact that natural persons are biological beings and legal entities are not. Legal persons are entitled to the following personal rights: the right of respect and reputation, honour, name, namely the company name, business secret, freedom to do business etc.[10] It is essential to note that the number and the content of personal rights is not limited by the regulations of LO, therefore leaving the legal practice a wide space to recognise and protect personal rights. Besides, due to the development of the system of personal rights, it is impossible to regulate all the rights precisely.[11]

Construction industry recognises all the above mentioned types of damage. An investor who was forced to partially rebuild a structure after it had to be knocked down through a contractor's fault is suffering patrimonial damage, i.e. regular damage. The damage a contractor is suffering because of an investor's late payment for performed work results in patrimonial damage in the form of lost profit (the loss of possible interest gained if the money was invested). Persons living in the close vicinity of a construction site can suffer non-patrimonial damage if a landslide on the property has caused them physical or mental injuries.

Parties directly involved in construction or third parties can suffer damage. Pursuant to the Law of Planning, Zoning and Building parties directly involved in construction are the participants in construction: the investor, designer, reviewer, contractor and supervisor.[12] They can all either be injurers or injured parties. Third parties can also be potential injurers or injured parties. The current practice has had some cases of third parties suffering damages resulting from construction, like the owners and/or occupants of neighbouring properties and buildings on them. They can suffer various types of damage if the construction impairs the stability of their property. Croatian civil law specifies regulations which authorise property owners to undertake measures against impairment of their property's stability. Thus the Property and Rights in Rem Law (hareinafter: PRRL)[13] stipulates that the owner is not allowed to dig on his land or perform any reasonably foreseeable acts on his real property which can endanger the stability of a third party's property.[14] The owner of the property with endangered stability is allowed to require the termination of the work which endangers the stability of his property until all the justifiable measures have been undertaken, including special structures, if necessary, against endangering the stability of his property.[15]

If it is impossible to successfully implement the above measures without installing special structures on the property whose stability is endangered, its owner has the right to require that the work endangering his property be prohibited. [16] The property owner who has installed a special structure to ensure the stability of other people's property is liable for every damage

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[9] Article 19, par.2, LO.
[10] Article 19, par.3, LO.
[11] This view on personal rights is reflected in legal theory – more: see GAVELLA, N: Osobna prava (Personal Rights), Part I, Faculty of Law, University of Zagreb, Zagreb, 2000, p. 30-31.
[12] Article 177, Law of Planning, Zoning and Building
[13] Property and Rights in Rem Law, OG, /96, 68/98, 137/99, 22/00, 72/00, 114/01, 79/06 and 141/06.
[14] Article 109, par.1, PRRL.
[15] Article 109, par.2, PRRL.
[16] Article 109, par.3, PRRL.

caused by the structure, while the neighbour whose property is endangered has the right to require a proper maintenance of the structure.[17]

PRRL also stipulates that everybody may demand from other persons to remove the source of danger which threatens to cause a considerable damage to himself or others, and to abstain from the activities causing disturbance or danger of damage, if the disturbance or damage cannot be prevented with relevant measures.[18] Upon request of the interested party the court will prescribe that relevant measures be undertaken that will prevent damage or disturbance or that the source of danger be removed at the cost of the possesor of the source of danger, if he does not do it himself. [19] If the damage is caused by a common good activity authorised by a competent body, the compesation may be required for the damages beyond usual limits (excessive damage), but in that case socially justified measures can be demanded to prevent or reduce damage.[20]

Damage in construction industry is not necessarily related to construction work, designer or supervision work etc. Thus an investor can cause damage to an investor if he delays or does not pay the contracting fees. In that effect the nature of damage suffered by the contractor is no different from the damage suffered by business parties when their partners in the contract do not fulfill their obligations. This type of liability for damages is also within the scope of LO.

Harmful act

A harmful act is defined as every act or omission committed by the injurer which causes damage to the injured party.[21] Therefore, the notion of a harmful act must be considered in its broader sense since it does not only apply to the intentional activity by the injurer, but to his omission. It is particularly important in the area of professional liabilitiy for damages (liability for damages caused by professionals) because all the professionals, including the professionals in construction industry, are obliged to be careful not to cause damage with their activities, and to undertake all the measures according to the regulations of their profession in order to prevent damage. Their omission in undertaking the measures for prevention of damage is a harmful act.

A harmful act can be characterised as a civil offence or a contractual obligation, subject to the the existance or non-existance of a contractual relashionship between the injurer and the injured party. [22] If there is a constractual relashionship between the injurer and the injured party then it is the case of a breach of contractual obligation, and if the injurer and the injured party prior to damage did not have a contractual relationship it is the case of a civil offence. In construction industry a harmful act is characterised as a breach of contractual obligation when the injurer and the injured party have been in contractual relationship as the participants in construction pursuant to Article 177 of the Law of Planning, Zoning and Building. It will be a frequent instance since there is the relationship between an investor and other participants in construction, whereas the investor starts a contractual relationship with these legal entities (e.g. construction contract concluded between an investor/client and a contractor). When

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[17] Article 109, par.4, PRRL.
[18] Article 109, par.1, PRRL.
[19] Article 109, par.2, PRRL.
[20] Article 109, par.3, PRRL.
[21] P. KLARIĆ, M. VEDRIŠ, ibid., p. 586.
[22] P. KLARIĆ, M. VEDRIŠ, ibid., p. 586-588.

participants in construction do not have a contractual relationship and cause damage to each other, a harmful act is referred to as a civil offence. In construction industry a civil offence arises when participants in construction cause damage to third parties (most frequently to investors and contractors), but also vice versa, when third parties cause damage to the participants in construction (e.g. a party in proceedings which violates its right by starting an administrative dispute is liable for damages caused to the investor by it – Article 210, par. 2 of the Law of Planning, Zoning and Building).

To establish the relationship of liability for damages it is not relevant whether a harmful act is a breach of contractual obligation or a civil offence since the liability for damages arises in both situations. However, the distinction has a certain significance when setting the amount of compensation. Namely, if damage arises from a breach of contractual obligation the injurer will be held liable for forseeable damages if he/she has been negligent, and if his acts have been fraudulent or intentional, respectively ultimately careless, he is liable for recovering total damages.[23] In case of liability for damages arising from a civil offence, the injurer is obliged to recover total damages regardless of the category or degree of fault.[24]

Causality

There mus exist causality between damage and a harmful act for the purpose of determining liability for damages as a legal obligation.[25] In other words, it is required that the damage is caused by an injurer. There is no liability without causality.

If there is a possibility of a larger number of potential causes of damage the question of causality in Croatian law is estimated according to the adequation theory.[26] It means that a harmful act is a condition for a typical cause of a damage.[27] In case of fault liability for damages, as in any other case unless otherwise stipulated, the burden of proof lay on the injured party to prove causality. In case of strict liablity for damages related to a dangerous thing or a dangerous activity the causality is foreseen, meaning that the injurer will be held liable unless he/she proves that the dangerous thing or a dangerous activity have not caused damage.[28] This fact must be emphasised in construction industry, in cases of strict liability for damages caused by dangerous thing or a dangerous activity where the burden of proof lies with the injurer who has to prove that the damage is not related to the dangerous thing or a dangerous activity in order not to be held liable for damages.

The rule which requires the liability for damages to establish the causality between a harmful act and a damage is particularly prominent not only with the presumed liability for damages, but within the rule regarding release from strict liability for damages. According to this rule, the owner of a dangerous thing is released from liability if he/she proves that the damage arises from a non-foreseeable cause beyond the thing, which could not have been prevented, avoided or eliminated. [29] The owner is also released from liability if he/she proves that the damage arised solely from the activity of the injured or a third party, which they have not

[23] Article 346, LO. On intention and gross negligence in more detail within the paragraph on culpability as the presumed liability for damages.
[24] P. KLARIĆ, M. VEDRIŠ, ibid., p. 633.
[25] P. KLARIĆ, M. VEDRIŠ, ibid., p. 594.
[26] P. KLARIĆ, M. VEDRIŠ, ibid., p. 594-595.
[27] P. KLARIĆ, M. VEDRIŠ, ibid., p. 595.
[28] Article 1063, LO.
[29] Article 1067, par.1, LO.

been able to prevent and whose consequences he/she have not been able to avoid or eliminate.[30]

Wrongfulness and fault

As a rule the fault of the injurer is necessary to establish the relationship of liability for damages. In civil law, fault can be intentional or negligent. Intention is a form of fault when an injurer acts knowingly and intentionally.[31] It means that the injurer knows and wants to cause damage. Within the professional liability for damages (a professional liability for damages) the intention is relatively rare. Therefore it is of a little interest when damage is caused by third parties (e.g. then the landowners want to prevent construction work on the naighbouring property.) Negligence is far more significant within the liability for damages in construction industry. There are a few degrees of negligence. Thus we distinguish gross negligence from ordinary, and ordinary can be defined according to an abstract or concrete criteria.[32] A gross negligence (gross negligence, gross recklessness) arises when an injurer acts below the standards of an average individual.[33] This form of negligence is close to intention. An ordinary negligence arises when an injurer does not act as a particularly good economist, professional, respectively householder (depending on the type of legal relationship)[34] It is essential to note that even ordinary negligence suffices for the occurence of liability for damages.

The fault of legal entities is estimated according to the standards of due care. It must be emphasised that pursuant to Article 177 of the Law of Planning, Zoning and Building professionals are all the participants in construction, save possibly an investor. Namely, only an investor is not a professional in the field of construction, unless it is a person with the relevant professional education.[35]

It is important, because when fulfilling their obligations within the scope of their professional activities, they are obliged to act with utmost care, according to their professional regulations and practices (the care of a good professional).[36] Every professional is obliged to act with the same care as an (abstract) professional in his/her trade. The importance of the rule on the standard of care of a good professional is evident in the fact that professionals are not obliged only to respect legal regulations but also the rules of their profession. It means that wrongfulness in this case does not comprise only the activities contrary to legal norms, but to the activities contrary to the rules of the trade. Thereby professional rules are relevant to the estimate whether a professional is guilty of the caused damage. A professional is obliged to act in accordance with the rules of his/her profession even if a client (investor in construction industry) demands contrary from him/her.

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[30] Article 1067, par.2, LO
[31] P. KLARIĆ, M. VEDRIŠ, ibid., p. 597.
[32] P. KLARIĆ, M. VEDRIŠ, ibid., p. 598-599.
[33] P. KLARIĆ, M. VEDRIŠ, ibid., p. 598.
[34] P. KLARIĆ, M. VEDRIŠ, ibid., p. 598.
[35] The Law of Planning, Zoning and Building recognises this possibility and in Article 178, par.6 regulates as follows: A natural person who is an investor of residential and residential/business building whose construction (gross) area is not larger than 400 square metres or a simple building for his/her needs is allowed once in five years to design and supervise him/herself the construction if he/she has a Bsc in civil engineering or is an engineer of the relevant profession with an engineering exam.
[36] Article 10, par.2. LO.

3. Systems of liability for damages
Fault and strict liability

In the descriptions of presumptions for liability for damages two systems of liability have been already set out – fault liability and strict liability. Both systems can be found in construction industry. Croation law accepts that fault liability is a rule, and strict liability and exception to the rule. Croatian general obligations legislation favours the injured parties, because the fault of the injurer is presumed, and within the system of fault liability the injurer will be liable for damages unless he proves his innocence.[37] The lowest degree of fault is always presumed (ordinary negligence), [38] meaning that the injured party bears the burden of proof to prove that the injurer acted intentionally or with gross negligence. In other words, the injurer, if he/she wants to be released from the liability for damages, must prove that he is not liable for damages.

In principle, in the system of fault liability for damages, the liability exists even when the injurer acted with the lowest degree of liability, i.e.with ordinary negligence.
An important exception to the fault liability system are the cases of strict liability for damages when an injurer is liable for damages independently of his guilt. The fault in this effect is not relevant to the liability. According to the rules on strict liability for damages, the injurer will be liable if the damage was caused by things or activities which present a considerable danger to the environment (so called dangerous thing and dangerous activity), and in other instances as defined by law. [39] Case law has played a crucial role in determinig what are dangerous things and dangerous activities. Namely, a dangerous thing is described as a thing „...which by its purpose, features, position, place and manner of usage or in any other way constitutes an increased danger of causing damage, and therefore has to be supervised with the increased attention“.[40] Case law can give a concrete answer to this question. For construction industry relevant are the decisions by the courts which decreed that e.g. a pipe is dangerous because of its dimensions (1 m long, 12 cm in diameter) and its position (it was left unprotected on a roof of a four- story building, and fell off it in stormy wind).[41] In another case the Supreme Court of Croatia decreed that polyester pipes of a large diameter and weight lying in a construction site are not a dangerous thing, because they were properly secured and fastened.[42] A dangerous thing is, e.g. „... timber – piled raw beech panels, 3.5 m in height in open space exposed to climatic changes.“[43] In a similar legal action it was deemed that „beech piles“were a dangerous thing, because they were piled to more than 3 m of height on a slope.[44] The court decided identically in a case of timber piled to 3.5 m above ground in the area known for strong winds. In that case a strong wind knocked down the timber onto the vehicle of the plaintiff who, as a consequence, suffered damage.[45] According to case law a terrace built too close to a high voltage trunk also presents a danger.[46]

[37] Article 1045, par.1, LO.
[38] Article 1045, par.2. LO.
[39] Article 1045, par.3. LO.
[40] P. KLARIĆ, M. VEDRIŠ, ibid., p. 615.
[41] Croatian Supreme Court, Rev 1738/1997-2 (www.vsrh.hr)
[42] Croatian Supreme Court, Rev. 890/04-2 (www.vsrh.hr)
[43] Croatian Supreme Court, Rev. 190/2007-2 (www.vsrh.hr)
[44] Croatian Supreme Court, Rev. 831/05-2 (www.vsrh.hr)
[45] Croatian Supreme Court, Rev. 1131/1992 (www.vsrh.hr)
[46] Croatian Supreme Court, Rev. 7/1992 (www.vsrh.hr)

According to the rules of strict liability, an injurer will be liable for damages if the damage resulted from dangerous activity. A dangerous activity is any activity which presents an increased danger of causing damage „... when in its regular course and by its technical nature and manner of performance, an activity can endanger lives and health of people or their property, so that the endangering asks for an increased attention by persons who perform this activity as well as persons who come in contact with it."[47] In construction industry there are examples of dangerous activities (working with explosives, working on heights, working on scaffolding etc.) [48]

Individual liability and liability for others

Individual liability and liability for others have to be mentioned within the systems of liability. With individual liability there is no difference between the injurer and a responsible person, because a person guilty of damage is liable for damages (or has only caused the damage, if it is the case of strict liability for damages).[49] Liability for others is a system of liability where an obligatory relationship of liability for damages regularly start between the injured party and a resposible person, and not between the injured party and the injurer.[50]

In construction industry there are also cases where liable for damages is not the person who caused the damage (the injurer), but another person (a responsible person). Thus, for example. according to the LO, a contractor is responsible for the damage caused by his workers. Pursuant to the provision of Article 1061 of the LO, the employer is responsible for the damage his employee caused to the third party in the course of his work or in connection to his work, unless he proves there were reasons which excluded the responsibility of the employee. A current employer will be held liable for damages. Within six months from the day when the damage was done, the employer who recovered the injured party for damages is entitled to demand the compensation from his employee if the employee has caused the damage intentionally or negligently.[51]

3.3 Contractual, non-contractual and pre-contractual liability

With the relationship of liability for damages in construction industry, there is a possibility to apply the regulations of contractual, non-contractual and pre-contractual liability for damages. The regulations on contractual liability for damages are applied when the injurer and the injured party have a contractual relationship (in this case, a harmful act is regarded as a breach of contract). The regulations on non-contractual liability for damages are applied when the injured party and the injured have not signed a contract (a harmful act is a civil offence). Besides, a regulation on so called pre-contractual liability for damages (*culpa in contrahendo*) can be applied. These regulations are applied when an injurer causes damage to an injured party while negotiating or terminates negotiations contrary to the principle of conscience and honesty.[52] In practice they are the situations when the injurer negotiates a contract with the injured party without the intention of signing it, but for instance intends to collect some confidential information. Because in construction industry contracts are negotiated, in this area there are possible cases of pre-contractual liability for damages.

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[47] P. KLARIĆ, M. VEDRIŠ, ibid., p. 615.
[48] P. KLARIĆ, M. VEDRIŠ, ibid., p. 615.
[49] P. KLARIĆ, M. VEDRIŠ, ibid., p. 622.
[50] P. KLARIĆ, M. VEDRIŠ, ibid., p. 622.
[51] Article 1061, par. 3 and 4, LO
[52] Article 251, LO

Liability for damages by more than one person

If more than one person has caused damage there is the question of their liability. There are two solutions to this case. If the liability of injurers is divided, then each of the injurers is liable for his part of damages.[53] On the other hand, in case of shared liability, each of the injurers is liable to the injured party for the whole damage, no matter of his share in the damage.[54] If the injurers have shared liability, the position of the injured party is more favourable because more persons are obliged to recover his damages in whole.It means that, if one of the injurers does ot have sufficient resources to compesate damages to the injured party, the injured party still has the possibility to recover damages from other injurer. Naturally, shared liability does not mean that the injured party will get enlarged compensation. In such a case the injured party is entitled to the same amount as if it was the case of divided liability or an individual injurer, but each injurer ows the whole amount. When the injured party settles his/her entire compensation on grounds of liability for damages from any of the injurers, the relationship of liability for damages is terminated, and the injurer who recovered the damage sets up the relationship of reimbursment with other injurers.

Shared liability for damages occurs when more than one person presumably together cause damage[55], but also when a number of persons cuase damage acting independently, and their share in the damage cannot be established.[56] Persons who have encouraged and assisted the injurer have shared liability for damages, as well as the persons who have assisted the injurer not to be uncovered.[57] Shared liability also have the persons who are connected in any manner, if the damage was caused by only one person, but the person is unknown.[58] All above mentioned regulations can be applied to the liability for damages in construction industry.

LO stipulates another case of shared liability for damages which is directly connected to construction industry. Namely, pursuant to the provision of Article 1108 of LO, the client and the performer of work on the property have shared liability to the third party for damages arising from building. After one injurer recovers the damages to the injured party the right of reimbursement is set up. It means that the injurer who has paied more than his share of damages can demand of each injurer to refund the amount he/she has paid for them.[59] The shares in damages are determined on the basis of the guilt by each injurer and the gravity of consequences of their activities or negligence, and if the shares cannot be determined, the amount of the compesation is divided into equal parts.[60]

4. Recovering damages

Damages are recovered in three manners. The principal manner [61] of recovering damages is the establishment of the previous condition (natural restitution).[62] It means that the injurer is in principle obliged to restore the condition prior to the damage. In construction industry

[53] P. KLARIĆ, M. VEDRIŠ, ibid. p. 625.
[54] P. KLARIĆ, M. VEDRIŠ, ibid. p. 626.
[55] Article 1107, par. 1, LO.
[56] Article 1107, par. 3, LO.
[57] Article 1107, par. 2, LO.
[58] Article 1107, par. 4, LO.
[59] Article 1109, par. 1, LO.
[60] Article 1109, par. 2 and 3, LO.
[61] P. KLARIĆ, M. VEDRIŠ, ibid. p. 628.
[62] P. KLARIĆ, M. VEDRIŠ, ibid. p. 628.

liability for damages it means that if, for instance the damage was caused by the contractor damaging a building on the neighbouring land, he is obliged to perform construction work to eliminate the damage. However, although the establisment of the previous condition is stipulated, in practice are more often other forms of damage recovery. Thus the patrimonial damage is often recovered in the form of compensation, meaning that the injurer is obliged to pay to the injured party the amount of the damage. Thus the compensation is a monetary equivalent to the value of damages.

If in question is an patrimonail damage then the damage is recovered with the settlement which can be moral, but also monetary. A moral settlement consists of announcement of the ruling, announcement of the correction, cancellation of the offence, apology to the injured party or of anything else which can achieve the purpose of the settlement. [63] A moral settlement is most often applied when the injurer causes the damage to the injured party by violating his honour and reputation. Monetary settlement (a just monetary recovery) is decreed to the injured parties for non-patrimonial damage when the gravity of the violation and the circumstances of the case deem it justifiable, whereby the court will take into account the degree and the length of pains and the fear (e.g. with physical injuries or with the violation of the mental integrity of the injured party) and will take into consideration that the monetary settlement does not favour the aims which are not connected with its nature and the social purpose of this form of damage recovery.[64]

[63] P. KLARIĆ, M. VEDRIŠ, ibid. p. 635.
[64] Article 1100, par. 1, LO.

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METHODOLOGY FOR CONSTRUCTION PRODUCTIVITY ESTIMATION COMPARISON

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Abstract

Construction equipment productivity is estimated based on three main approaches: (1) analytical methodologies with the use of historical data, (2) approximate techniques described in equipment handbooks and (3) particular methods, such as statistical analysis. The diversity of the methodologies and the large number of factors involved in the calculations has resulted in limited agreement between the methods applied, along with contradictory productivity estimates. This paper presents a generic methodology for calculating and comparing construction equipment productivity by taking into account the existing techniques, as well as the advanced modeling tools currently used for analyzing construction operations. The methodology uses basic productivity metrics to provide a common denominator among the numerous algorithms and variables used in production estimation. The homogenous parameterization approach facilitates the comparison of different methods and sources of construction operations data. An implementation of the methodology for a typical earthmoving operation is used to demonstrate its applicability. The basic inferences from the study are that the methodology supports the generic representation of construction operations and incorporates stochastic influences in cycle time and productivity estimation. A sensitivity analysis on the results denoted that the methodological and computational differences of the estimation methods can affect productivity, which should be considered when planning the time and cost of construction operations.

Keywords: construction, estimation, model, productivity

Introduction

The construction industry attempts to increase its productivity through intensive mechanisation of the construction process (Peurifoy and Schexnayder 2002). As a result, company profitability is increased. On the other hand, the rising rate of mechanisation in construction increases the cost of equipment acquisition, operation and disposal (Adrian 2004). Therefore, it is of critical importance to be able to estimate the productivity of equipment, select the right fleet size and employ the correct machinery that is going to be most suitable for the job in hand. However, against this backdrop of growing reliance on mechanization, machine productivity is estimated through approximate and, to some extent, intuitive calculations. Productivity estimation has traditionally relied upon three methods based on: (1) analytical methodologies with the use of historical data, (2) approximate techniques described in equipment handbooks and (3) particular methods such as statistical analysis (Eigendorf and Nowacka 2002). Attempts to apply the knowledge contained in these publications to real-world, large scale problems has led to considerable dissatisfaction (Lampropoulos et al. 1996). The diversity of the methodologies and the large number of factors involved in the calculations has resulted in limited agreement between the methods applied, along with contradictory productivity estimates. This paper presents an integrated methodology for calculating and comparing construction equipment productivity by taking into account the variety of existing techniques as well as the advanced modeling tools currently used for analyzing construction operations. An implementation of the methodology for a typical earthmoving operation is used to demonstrate its applicability.

Construction operations productivity estimation

Construction productivity is dependent on a variety of factors including equipments' technical parameters, complexity of work, payload, machine cycle time, operating efficiency and working conditions (Chao and Skibniewksi 1994). Figure 1 is a comparative representation of different methods for calculating equipment productivity with respective definitions of the variables that are used. The generic productivity estimation process for intermittent operations is based on a three-phase procedure, (i) payload estimation, (ii) cycle time evaluation and (iii) correction for efficiency. As shown on Figure 1, the methodologies vary in terms of the publishing body, the area of implementation and the computational approach:

- **Standards:** The publication of standards has helped the establishment of a common terminology among construction operatives (e.g. soil classification) (ISO 1995), as well as the formulation of "best practice" approaches in calculating specific productivity coefficients (e.g. bucket fill factor) (SAE 1994). However, the attempt of productivity calculation standardization has not gone beyond earthmoving yet, which is a considerable disadvantage.
- **Equipment manufacturers' handbooks:** These handbooks contain specific information about construction equipment in terms of their performance capabilities and provide nomographs that can be used for machine selection and fleet configuration (Caterpillar 2004). They cover a broad area of civil engineering works depending on the manufacturer. The methodologies described are experience-based and the data provided has been criticised of "advertising" the machinery or referencing to ideal rather than actual conditions, and thus there is a question of whether such an analysis has much of practical use (Lampropoulos et al. 1996).
- **Professional Associations:** Different professional institutions and industry associations have published guidelines regarding the use, cost estimation and productivity calculation of construction machinery (BGL 2001). These publications contain analytical data and algorithms for calculating productivity of equipment deployed in building, highway, earthmoving and geotechnical works, covering also ancillary activities such as hoisting operations etc.
- **Scientific work:** There have been a number of scientific publications regarding construction productivity estimation (Smith et al 2000; Edwards 2001). However, in essence these seem to be mainly enhancements in certain aspects of the existing methodologies, rather than fundamentally new methodological approaches.

The common feature of the aforementioned approaches is that they are expressed in a non-explicit, non-structured, verbose manner. In this way the methodologies become too complex to perform, given the large volume of variables required, and the comparison of their results is hindered.

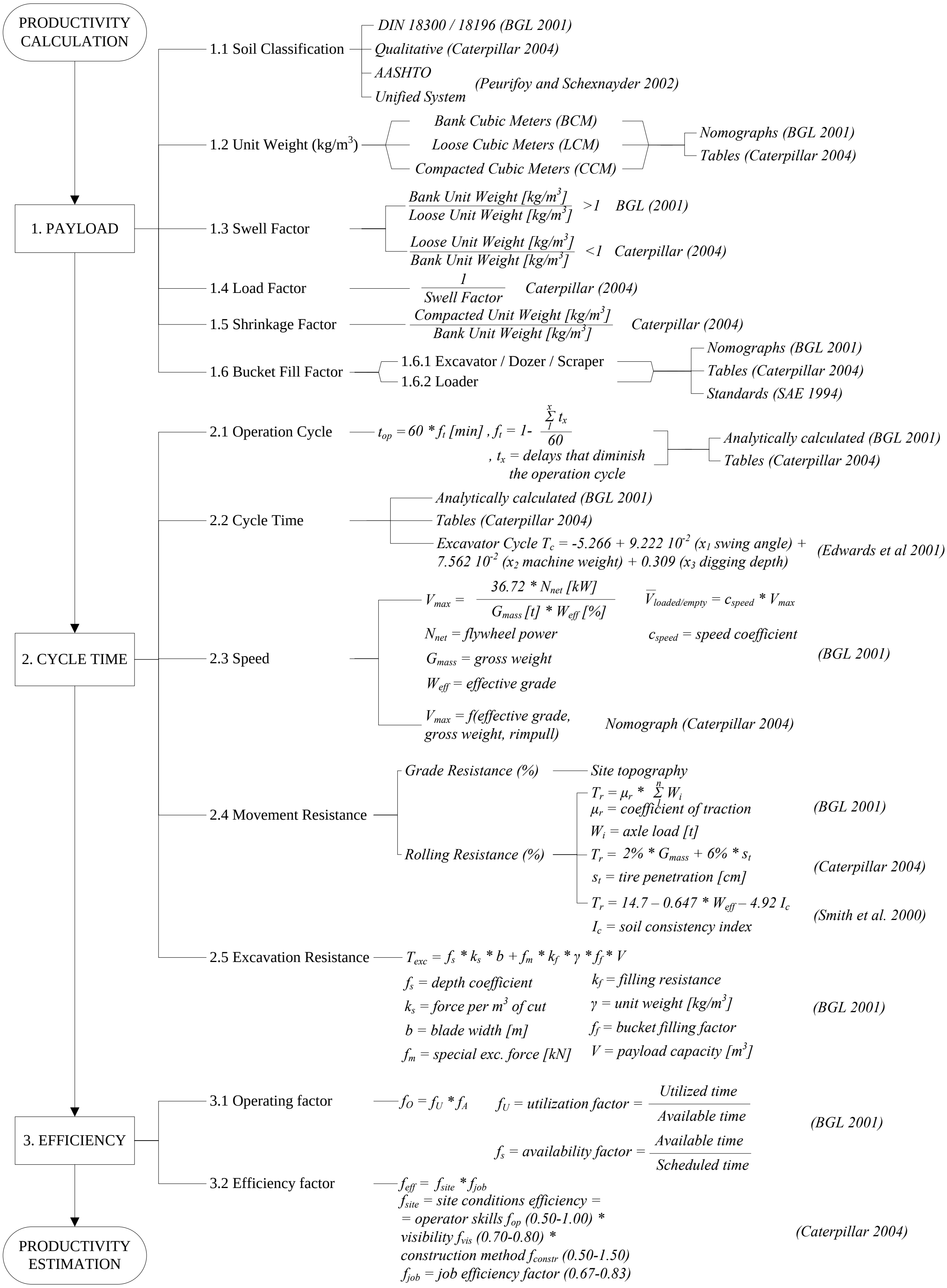


Figure 1: Comparison of productivity estimation methodologies

As a result, current practice is that every practitioner implements a preferred methodology and due to reasons of time-shortage or lack of know-how, rarely undertakes a comparative analysis with another one. Moreover, some methodologies are more analytical in calculating certain aspects of operations than others, which in turn might oversimplify the project's environment. Thus, given that engineers are usually confined within the limits of one specific methodology, they do not exploit fully the partial benefits of one method over the other. In an attempt to overcome this deficiency, this paper proposes a methodology that integrates productivity estimating algorithms and provides the ability to compare their results, thus resulting in more accurate and reliable decisions on earthmoving fleet configuration. This is achieved through a common parameterization and modeling of construction operations in a way that is independent of the methodology that is applied. As a consequence, the engineer has the ability to (a) compare the results of different methodologies, and (b) partially combine methodological approaches on distinct analysis phases, thus resulting in more accurate and reliable decisions.

Description of Methodology

The methodology covers the estimation of production for equipment working in intermittent cycles. The development of the methodology is based upon the premise that regardless of the particular estimation approach (analytical, semi-analytical, experience-based) and the level of analysis (deterministic or stochastic), productivity estimation will be based upon the following steps:

- **Step 1:** Define the construction operation with the use of proper modelling elements.
- **Step 2:** Determine equipment productivity based upon six primary and two secondary metrics: the material that is moved in every cycle (V_{pr} [m^3]), the operation cycle (t_{op}= 60 [min]), the machine's cycle time (t_c [min]), the availability and utilization factor (operating factor f_O) the efficiency of the equipment (f_{eff}), the number of machines that comprise the fleet (N_f), and time correction coefficient (f_t) as well as the productivity correction coefficient (f_{pr}). Below follows the generic relationship for deriving equipment's productivity

$$Q_m = V_p * \frac{t_{op}}{t_c} * f_O * f_{eff} * N_f * f_t * f_{pr} \quad [m^3/h] \qquad (1)$$

This equation can be applied to generic construction operations of cyclic nature. The primary metrics will be either analytically calculated or extrapolated from graphs or derived from tables according to the methodology followed. The main advantage of using the generic equation is that a hybrid methodology can be constructed, by using parts of different approaches so as to reduce inaccuracy in the results. The secondary metrics (f_t, f_{pr}) represent the losses in productivity due to deterministic and stochastic delays respectively (Eigendorf and Nowacka 2002). They are derived as follows

$$f_t = 1 - \frac{\sum_{1}^{x} t_x}{60}, \; t_x \text{ [min]: delays that diminish the operation cycle} \qquad (2)$$

$$f_{pr} = f_1 * f_2 * f_3 ... f_x ... f_n, \; f_x = 1 - \frac{t_x}{60} \qquad (3)$$

The time correction coefficient (Eq. 2) implies that the delays are independent from each other and thus are being summed up to correct the operation cycle. The productivity correction coefficient (Eq. 3) assumes the delays to be interdependent and stochastic, thus overlapping each other. This is why each one of the f_x factors is being multiplied first partially to form an aggregate metric and then it is directly multiplied with the theoretical productivity. Attention has to be paid to classify the delays either as deterministic (calculated in Eq. (2)) or stochastic (calculated in Eq. (3)), and not include them in both equations. If there are no stochastic delays, then f_{pr} = 1.

- **Step 3:** Break down the analysis in sub-processes of estimation (e.g. soil properties, work conditions, cycle time, etc.). For each sub-process define the necessary inputs so as to derive the outputs needed on Eq. (1). Use different methodologies on each sub-cycle.
- **Step 4:** Integrate the results of the sub-processes to estimate the productivity of the equipment. Compare the results of different approaches. Decide on optimum fleet configuration.

The applicability of the proposed methodology is illustrated in the following example.

Example: Productivity estimate of dozing-loading-hauling operation
Experience has shown that in civil engineering projects, earthmoving operations are an important element in shaping the total cost (Peurifoy and Schexnayder 2002). In addition, most of the methodological approaches presented before regard earthmoving works. Therefore, the proposed methodology is implemented within the context of a dozing-loading-hauling earthmoving operation which has been modelled through the CYCLONE modelling elements (Figure 2). CYCLONE methodology has been developed for modeling construction operations and its functions are well documented (Halpin and Riggs 1992; Martinez 1996).

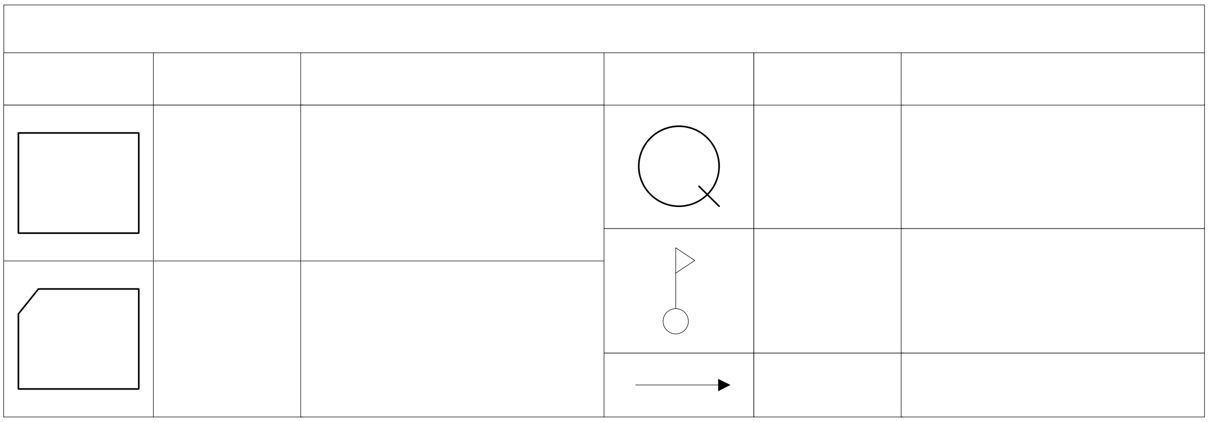


Figure 2: CYCLONE modelling elements (Source: Halpin and Riggs 1992)

Implementation scenario
The network of the earthmoving operation is depicted on Figure 3. Dozers are being used for stripping clay and gravel to the soil stockpile position. Then, loaders load the stockpiled earth to trucks, which ultimately dump it to the dumping pit. The trucks return to the loading area, which is continually provided with earth by the dozers and the stripping-loading-hauling cycle continues. Detailed project information regarding the technical characteristics of the equipment is depicted on Figure 3. The productivity of the modelled construction operations is determined through the step-wise process described below, by utilizing specific input parameters for every project cycle, as shown on the diagram.

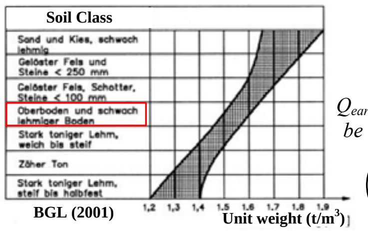
Step 1: Setting up the model
The model has been created with the CYCLONE modelling elements. The dozer and loader operations follow the "slave entity pattern", whereas the truck operations are being modelled according to the "cyclic sequence of work pattern" (Halpin and Riggs 1992; pp. 119-120).

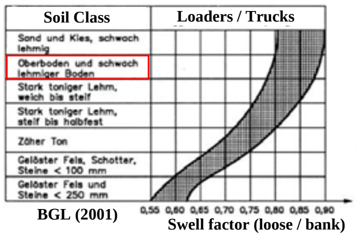
Step 2: Equipment productivity
For each machine deployed (dozer, loader, trucks), productivity is estimated through Eq. (4) of Figure 3, which is adjusted to the equipment characteristics ((4a) for dozers, (4b) for loaders and (4c) for trucks).

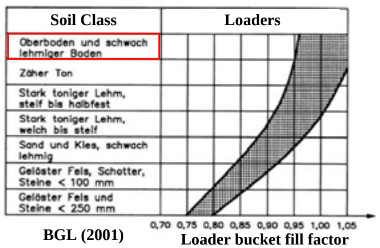
Figure 3: Modelling of earthmoving operations

Soil Classification and Properties

Soil Class: Clay and gravel (wet)
Unit weight γ = 1550 (kg/m^3)
Swell factor f_s = 0.85
Loader bucket fill factor f_f = 1.05







Dozer Technical Characteristics

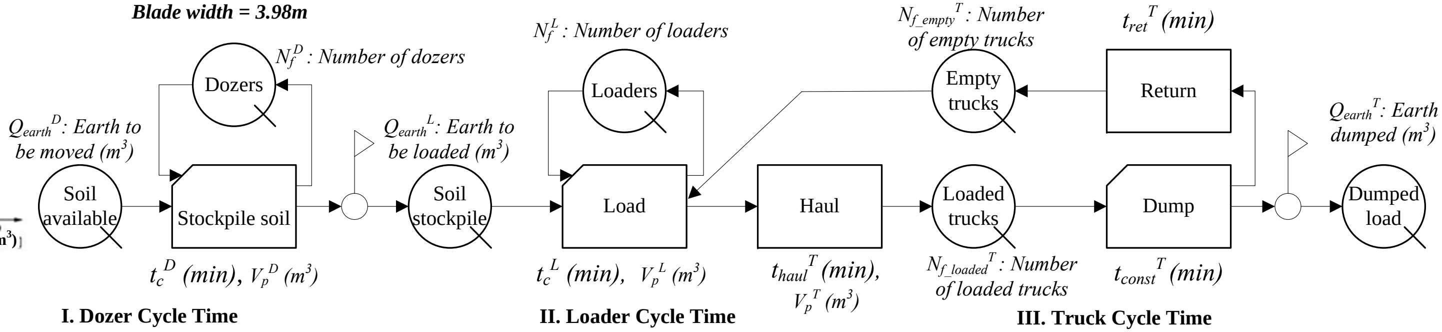
Model: CAT D7R-7U
Blade type: Universal
Dozing: Straight
Blade height h = 1.553m
Blade width = 3.98m

Loader Technical Characteristics

Model: CAT 962G
Bucket size V_{bucket} = 4.5 m^3
Tires: radial ply

Trucks Technical Characteristics

Model: CAT 769D
Capacity V_{load} = 16.5 m^3
Tires: radial ply (18.00R33)



I. Dozer Cycle Time

I.1 Excavation time (min) $\mathbf{t_{ex}^D} = \dfrac{\overline{\mathbf{V}}_{\mathbf{ex}}^{\mathbf{D}}\ [\text{km/h}]}{\mathbf{L_{ex}^D}\ [\text{m}]}$

I.2 Pushing time (min) $\mathbf{t_{push}^D} = \dfrac{\overline{\mathbf{V}}_{\mathbf{push}}^{\mathbf{D}}\ [\text{km/h}]}{\mathbf{L_{push}^D}\ [\text{m}]}$

I.3 Return time (min) $\mathbf{t_{ret}^D} = \dfrac{\overline{\mathbf{V}}_{\mathbf{ret}}^{\mathbf{D}}\ [\text{km/h}]}{\mathbf{L_{ret}^D}\ [\text{m}]}$

I.4 Av. speed (km/h) $\overline{\mathbf{V}}_{\mathbf{loaded/empty}}^{\mathbf{D}} = \mathbf{c_{speed}^D} * \mathbf{V_{max}^D}$

I.5 Max. speed (km/h) $\mathbf{V_{max}^D} = \dfrac{\mathbf{36.72 * N_{net}^D}\ [\text{kW}]}{\mathbf{G_{mass}^D}\ [\text{t}] * \mathbf{W_{eff}^D}\ [\%]}$

I.6 Manouvre time (min) $\mathbf{t_{mn}^D} = 0.9$

I.7 Delays time (min) $\mathbf{t_d^D} = 0.17$

II. Loader Cycle Time

II.1 Operations time (min) $\mathbf{t_{oper}^L} = 0.25$

II.2 Haul time (min) $\mathbf{t_{haul}^L} = \dfrac{\overline{\mathbf{V}}_{\mathbf{haul}}^{\mathbf{L}}\ [\text{km/h}]}{\mathbf{L_{haul}^L}\ [\text{m}]}$

II.3 Return time (min) $\mathbf{t_{ret}^L} = \dfrac{\overline{\mathbf{V}}_{\mathbf{ret}}^{\mathbf{L}}\ [\text{km/h}]}{\mathbf{L_{ret}^D}\ [\text{m}]}$

II.4 Av. speed (km/h) $\overline{\mathbf{V}}_{\mathbf{loaded/empty}}^{\mathbf{L}} = \mathbf{c_{speed}^L} * \mathbf{V_{max}^L}$

II.5 Max. speed (km/h) $\mathbf{V_{max}^L} = \dfrac{\mathbf{36.72 * N_{net}^L}\ [\text{kW}]}{\mathbf{G_{mass}^L}\ [\text{t}] * \mathbf{W_{eff}^L}\ [\%]}$

II.6 Manouvre time (min) $\mathbf{t_{mn}^L} = 0.9$

II.7 Fixed delays time (min) $\mathbf{t_{d\_t}^L} = 0.17$

II.8 Variable waiting time (min) $\mathbf{t_{d\_pr}^L} = 0.21$

III. Truck Cycle Time

III.1 Loading time (min) $\mathbf{t_{load}^T} = \mathbf{n_{cycle}} * \mathbf{t_c^L}$

III.2 Hauling time (min) $\mathbf{t_{haul}^T} = \dfrac{\overline{\mathbf{V}}_{\mathbf{haul}}^{\mathbf{T}}\ [\text{km/h}]}{\mathbf{L_{haul}^T}\ [\text{m}]}$

III.3 Return time (min) $\mathbf{t_{ret}^T} = \dfrac{\overline{\mathbf{V}}_{\mathbf{ret}}^{\mathbf{T}}\ [\text{km/h}]}{\mathbf{L_{ret}^T}\ [\text{m}]}$

III.4 Av. speed (km/h) $\overline{\mathbf{V}}_{\mathbf{loaded/empty}}^{\mathbf{T}} = \mathbf{c_{speed}^T} * \mathbf{V_{max}^T}$

III.5 Max. speed (km/h) $\mathbf{V_{max}^T} = \dfrac{\mathbf{36.72 * N_{net}^T}\ [\text{kW}]}{\mathbf{G_{mass}^T}\ [\text{t}] * \mathbf{W_{eff}^T}\ [\%]}$

III.6 Constant time (min) $\mathbf{t_{const}^T} = 0.9$

III.7 Delays time (min) $\mathbf{t_d^T} = 0.17$

Generic Productivity Equation

$$Q_m^X\ (\text{m}^3/\text{h}) = \frac{V_p^X * t_{op}^X * f_O^X * f_{eff}^X * N_f^X * f_t^X * f_{pr}^X}{t_c^X} \quad (4)$$

Dozer Productivity

$$\frac{(0.8 * b * h^2 * f_s) * 60 * f_O^D * f_{eff}^D * 1 * f_t^D * 1}{t_{ex}^D + t_{push}^D + t_{ret}^D + t_{mn}^D} \quad (4a)$$

Loader Productivity

$$\frac{(V_{bucket} * f_f * f_s) * 60 * f_O^L * f_{eff}^L * 1 * f_t^L * f_{pr}^L}{t_{oper}^L + t_{haul}^L + t_{ret}^L + t_{mn}^L} \quad (4b)$$

Truck Productivity

$$\frac{V_p^T * t_{op}^T * f_O^T * f_{eff}^T * N_f^T * f_t^T * f_{pr}^T}{t_c^T} \quad (4c)$$

Site conditions	**Adjustment factors**
Op. skills f_{op} = 0.80	*Utilization factor f_U = 0.85*
Visibility f_{vis} =0.75	*Availability factor f_A = 0.84*
Dozing method f_{dozing} =1.44	

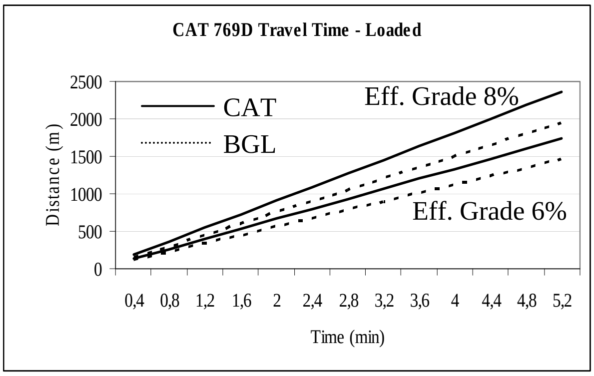
Step 3: Analysis breakdown

The site's productivity is a synthesis of each equipment's productivity sub-cycle. The sub-cycles have to be analysed separately and then integrated so as to derive the fleet's production. The dozer, loader and truck operations comprise of sub-processes regarding the soil classification and properties, work conditions, payload and cycle time estimation. The input for each one of those sub-processes is depicted on Figure 2. It should be noted, that in this particular example, two methodologies are being examined, which are representative of the volatility contained in productivity estimation. The first is based on internationally acknowledged guidelines (BGL 2001) and the second stems from a manufacturer's performance handbook (Caterpillar 2004). The differences between the two estimation methodologies seem to be both methodological as well as computational, in terms of the factors that are being taken into account (Figure 1). In order for the estimation of the results to be more accurate, the analysis methodology partially combines both approaches, in an attempt to provide the most analytical solution. Hence, the BGL propositions have been used for soil properties and cycle time estimation, whereas the CAT suggestions have been followed in determining work conditions and payload. The estimation of the site's productivity is merely a matter of matching the dozers' productivity with the loader-truck fleet configuration. All equipment's production is evaluated based on their payload capacity (V_p^X in m^3), their cycle time (t_c^X in min) and the works' efficiency (f_O^X and f_{eff}^X), where "X" is replaced to denote the respective equipment ("D" for dozers, "L" for loaders and "T" for trucks):

- **Payload:** Dozer blade capacity depends on blade type, soil properties (f_s) and construction method (f_{dozing}) (Eq. 4a). Loader bucket capacity is determined through its rated volume (V_{bucket}) as well as the bucket fill factor (f_f) and soil swell factor (f_s) (Eq. 4b). Trucks can carry payload according to their capacity (V_{load}), the number of loader cycles required (n_{cycle}) and soil parameters (f_f) (Eq. 4c).
- **Cycle times:** Dozer cycle time (t_c^D) is affected, inter alia, by the soil resistance forces and the dozing distance (L_{push}^D). Loader cycle time (t_c^L) depends on the soil parameters and the distance to be covered between the loading pit and the trucks ($L_{haul/ret}^L$). Truck cycle time (t_c^T) depends mainly on the haul and return road profile.
- **Operation efficiency:** It depends on many factors, expressed by the operation's efficiency (f_{eff}^X) and operating factors (f_O^X) (Figure 1). The former contains job efficiency, site conditions (operator skills, visibility) and construction methods. The latter depends on equipment's availability and utilization.

Step 4: Comparison of the results

There is a number of interesting and stimulating observations that can be made based on the results of the analysis. The outputs of the calculation verify the hypothesis formulated in Step 3, that the differences in estimation approached are both computational and methodological. Regarding the computations, as shown on Figure 4, the truck travel time for various transport distances is more conservatively calculated by the BGL (2001) approach than the CAT nomographs. This is due to the different computational factor used by the former, namely the speed coefficient factor. According to BGL (2001), truck speed is dependent on road conditions, such as traffic density (number of trucks/distance), number of junctions etc. Of course, it is evident, that these complexities are highly stochastic and difficult to quantify, not even mention to express through a single metric. Moreover, Figure 5 demonstrates the other dimension of productivity estimation, the choice of methodological approach. As depicted, dozer production output differentiates (<25%) according to the dozing distance. This is not to be solely attributed to the "marketing" efforts of equipment manufacturers but mainly to the experienced-based nomographs, where the provided values are not scientifically justified in the handbooks.



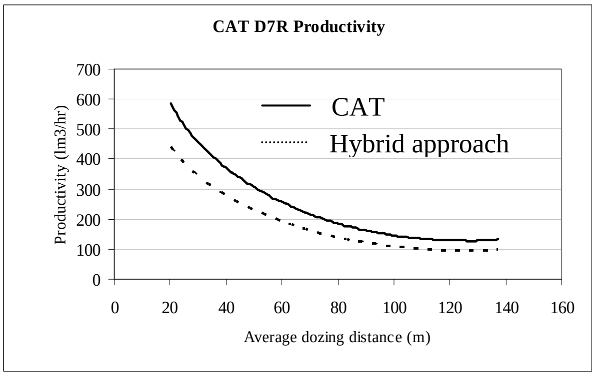


Figure 4: CAT 769D truck travel time **Figure 5:** CAT D7R dozer productivity

Although manufacturers admit these nomographs to be a representation of ideal working conditions, the level of sensitivity to variable site conditions (cycle times, payload estimates, soil parameters, road profiles) is a significant factor sometimes limiting their practical use. The differences on Figure 5 between the manufacturers' standard data and the hybrid approach implemented in this example reflects the stochastic nature of the parameters used in the calculations, as well as the level of abstraction in building the model. Oversimplifying assumptions distort the validity of the model and hence lead to unrealistic estimates.

Conclusions

This paper discussed an integrating approach in calculating construction operations' productivity. A particular example of a dozer-loader-truck operation has been used to demonstrate its applicability. The methodology uses basic productivity metrics to provide a common denominator among the numerous algorithms and variables used in earthmoving production estimation. The homogenous parameterization approach serves as a "shell" on which different methods and sources of construction operations data can be compared, so as to determine equipment productivity. More specifically, the main features and benefits of the integrated methodology can be summarized as:

- Generic representation of different construction operations
- Stochastic influences taken into account in cycle time and production estimation
- Comparison of different methodological approaches
- Consideration of different productivity estimation variables
- Sensitivity analysis on the results denoting significance of the assumptions
- Modelling with CYCLONE facilitates the generation of simulation models for stochastic analysis

The proposed methodology is intended to be embedded in a computer simulation-based system that will model and simulate construction operations. The stochastic approach and the increased computational capabilities promise more accurate results and better manipulation of the enormous volume of data. Realistic cycle time estimates, equipment reliability predictions leading to proactive maintenance policies and minimisation of operational costs are challenges that have to be addressed in view of improving productivity estimates. It is believed that this system will holistically integrate construction productivity estimation approaches and provide distinct advantages to construction operatives when planning the time and cost of construction operations.

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OPTIMISATION OF DEPOSIT LOCATION AT A BUILDING SITE AS A "KNAPSACK PROBLEM"

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Abstract

A partial task of the site organisation is planning the storage of building material at the building site. The objective of the task is to decrease the construction cost by means of decreasing the construction time and/or resource requirement. Several approaches to the problem can be found in the international professional literature.

This paper provides a solution to the problem of a deposit location where the number and volumes of the deposits are not known in advance. This may occur with storing dumped material (offal from demolition, gravel or earth, etc.). I select the locations of the deposits from the nods of a net taken up in advance. I use the "knapsack method" well-known in mathematics so that the sum of the lengths of the horizontal handling paths drawn from the deposits to the structure location will be minimal. I present some examples to demonstrate the deviation of the total lengths of the handling paths to each other from the deposits to the belonging structure location at different number (volume) and location of deposits.

Keywords: construction site, site layout planning, location of deposits, knapsack method

Introduction of the problem and the models in the international profession literature

During a construction the specialized contractors store the necessary equipments and materials on the construction site. On an optimal construction site the building material is arranged so the sum of the horizontal delivery paths from the deposits to the building locations is minimum. The goal of the task is decreasing construction cost and/or time and/or labour and /or resources. This problem is known as the deposit *"location problem"* or *"layout planning"*.

In practice it is usually solved by human judgment using the first-come-first-served strategy but this strategy rarely can cause optimal sites.

Researchers around the world declared several solutions for this problem. One of the known strategies is to place everything everywhere, then choosing the best from all of the arrangements. Another strategy is placing everything one after the other by queuing the activities and the building materials. The queuing criteria can be determined by specialist by weight factors that are calculated from the size, weight, shape, number of pieces and relocation of the objects.

For solving the deposit layout problem researchers developed several computer based site layout system. Some of them use AI (Artificial Intelligence) techniques (Tommelein et al 1991), others use general algorithm (Li and Love 1998, Hegazy and Elbeltagi 1999, Mawdesley et al 2002, Zouein et al 2002), others use fuzzy logic (Soltani, A. R. and Fernando, T., 2004) to find the optimal arrangement.

These models calculate the distance from the deposits to the building locations using Euclidean- or rectilinear (first in x-, then in y-direction) distance by picking the optimal locations from the total space (if the deposits can fall at any points of the site) or from predefined feasible positions (for example from nods of a net with a defined grid or from the available space that is calculated by subtracting the product space and the installation space from the total space (Winch, G. M., and North, S., 2006)).

A special problem of the layout planning problem: locating the unknown volumed deposit

In the international professional literature the volume and the number of the deposits of the materials are used as predefinited absolute terms as well as the geometry (size, shape) and the volume of the structures that is willed to build from the material. These assumptions describe exactly those activities that use that kind of building materials that has unique volumed deposits (like a pallet of brick).

This paper is presented for the activities where the volume of the deposits is not determined in advance. This may occur with storing dumped material (offal from demolition, gravel or earth, or if the number of the units in the deposits is changeable etc.). This paper solves this special problem using the well-known *"knapsack"* method.

The knapsack problem is a problem in combinatorial optimization. It's name comes from the maximization problem of the number of certain objects that can be packed into a bag to be carried on a trip. Given a set of items, each with a cost and value, determine the number of each item to include in a collection so that the total cost is less than a given limit and the total value is as little as possible.

The knapsack method as the working principle of the model

Using the knapsack method in this model the structure (like a wall) that needs to be erected represents the knapsack, the units of the structures (like bricks) represent the items, the volume of the units represent the cost of the items, the volume of the structure represent the limit of the cost, the distance between the certain item and the building location represents the value of the item, the sum of these distances represent the total value of the items which needs to be minimized. The target is to build the structure (to fill the knapsack) out of a given number of units (by items) so the sum of volume of the units is equal the volume of the structure (so the total cost is equal with the given limit) and the sum of the lengths of the horizontal handling paths drawn from the deposits to the structure location is minimum (the total value is as little as possible). On another way to say the target is to find the number and the location(s) of the deposit(s) where from the sum of the handling paths are minimum.

Marking

The deposit is represented by means of the horizontal plane projection of the centre of area of the deposit as points P_k, where $k=1...K$ and K is the number of the nods of a net with a defined grid taken up in advance as feasible locations of the deposits, the coordinates of the nods of the net are x, y, z, out of which $z = 0$.

The volume of the deposit (marked by v) can be measured by the number of the units are stored in it or the capacity of the unit.

In the model the structure is divided to unique volumed structure parts that are represented as points A_r, called building location parts, where $r=1...R$ and R is the number of the location building parts derived by dividing the volume of the structure by the unit volume, the coordinates of the points are x, y, z, out of which $z = 0$.

The volume of the structure (marked by V) can be measured by the number of the units builds up it or the capacity of the structure.

The distance is measured by the Euclidean distance between each deposit and each building location parts.

The model

The model solves the problem by calculating all of the distances from all of the feasible deposit locations (from all nods of the net) to all of the location parts, then queues the combination of the number and the location(s) of the deposit(s) by the sum of the delivery paths in the assumptions the items have to be picked from the deposits, one item can be picked only just one time, one building location part can be served from only one deposit and if an item is picked from a deposit, then the rest of the items have to be picked form it.

Example

In this example there is a wall that is willed to be demolished. It is shown at Figure 1. The wall contains two straight-line-sections closing a 90-degree angle with each other. There is a window and a door in the wall. The volume of the wall is V. The feasible location of the deposits of the rubbish are modelled as the centres of the net and marked as $P_k(x,y,z)$, where $k=1...4$.

The combination of the best deposit location is searched for, where the distance-sum of points P_k, measured from the points A_r is minimal.

I solved this example by following the undermentioned steps by using the software: Matlab7.1.

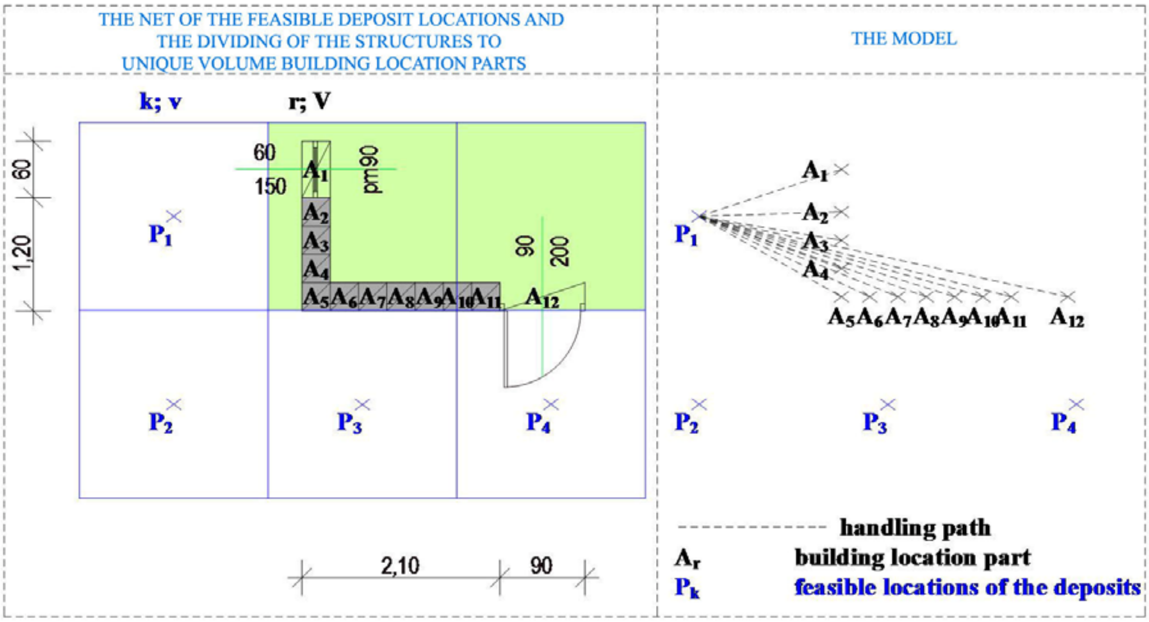

Figure 1.

The 6 steps of the algorithm of the solution:

1st step: determining the coordinates of the building location parts. It is done by dividing the wall to *m* pieces of equal volumed parts, where *m* has to be divisible by all of the *n*-s, where n is the number of the deposits in all combination. These parts are marked by building location parts as the reference plane projection of their balance in the plane *XY* as $A_r(x,y,z)$, where $r=1..12$.

2nd step is to calculate all Euclidean distance between all feasible location and all of the building location parts (Figure 2.)

r / k	1	2	3	4	5	6	7	8	9	10	11	12
1	1,59	1,52	1,53	1,61	1,73	2,00	2,27	2,56	2,84	3,13	3,42	4,00
2	2,91	2,54	2,30	2,09	1,89	2,14	2,40	2,67	2,94	3,22	3,50	4,07
3	2,54	2,10	1,81	1,53	1,25	1,16	1,15	1,22	1,35	1,53	1,74	2,23
4	3,52	3,22	3,04	2,88	2,74	2,47	2,21	1,96	1,74	1,51	1,34	1,15

Figure 2.

3rd step: All of the combination of the feasible location of the deposit needs to be determined. In this certain example it can one (as P_1, P_2, P_3, P_4), two (as P_1&P_2, P_1&P_3, P_1&P_4, P_2&P_3, P_2&P_4, P_3&P_4,), three (P_1&P_2&P_3, P_1&P_2&P_4, P_1&P_3&P_4, P_2&P_3&P_4) and four deposits (as P_1&P_2&P_3&P_4).

4th step: For each combination the minimal sum of the lengths of the handling paths has to be determined by picking *m* pieces of the known delivery distances between the examinated P_r points and the points A_k in such a way so that the sum of these distances is minimal in the assumptions that every building location parts are served only at one time and *m/n* piece of delivery distances belong to one deposit, where *n* is the examined number of deposits.

In this example the sums of delivery distances for each combination are shown at Figure 3.

If the number of the pickable deposits is one		If the number of the pickable deposits is two		If the number of the pickable deposits is three		If the number of the pickable deposits is four	
deposits location	sum of the handling distances	deposits location	sum of the handling distances	deposits location	sum of the handling distances	deposits location	sum of the handling distances
P_1	28,19	P_1 P_2	28,77	$P_1 P_2 P_3$	22,19	$P_1 P_2 P_3 P_4$	18,47
P_2	32,67	P_1 P_3	19,19	$P_1 P_2 P_4$	21,08		
P_3	19,61	P_1 P_4	19,88	$P_1 P_3 P_4$	16,76		
P_4	27,78	P_2 P_3	23,09	$P_2 P_3 P_4$	20,36		
		P_2 P_4	23,78				
		P_3 P_4	20,22				

Figure 3.

5th step: queuing of the solutions is shown at Figure 4.

As it is readable from the table is shown at Figure 4 the best choice is to take the locations arrangement marked by P_1&P_2&P_4.

The second best choice is to place deposits to all of the feasible places, but even this arrangement is 10 percent worse then the best one measured by the sum of the handling paths. The worst arrangement is 95 percent worse then the best one. This model counts each handling path once, eventhought if a worker delivers a piece of material to its destinated building location part, then the worker have to walk back to the deposit before handles the next unit. Figure 4. Even if the model counted with the empty walking as well, it would not effect the queuing of the arrangement or the percentage difference of the sum of handling paths.

queuing the combinations by the length if the sum of the handling distances					
sum of the handling distances	deposits location				The percentage difference of the sum of the distances from the best arrangement
16,76	P_1	P_3	P_4		1,00
18,47	P_1	P_2	P_3	P_4	1,10
19,19	P_1	P_3			1,14
19,61	P_3				1,17
19,88	P_1	P_4			1,19
20,22	P_3	P_4			1,21
20,36	P_2	P_3	P_4		1,21
21,08	P_1	P_2	P_4		1,26
22,19	P_1	P_2	P_3		1,32
23,09	P_2	P_3			1,38
23,78	P_2	P_4			1,42
27,78	P_4				1,66
28,19	P_1				1,68
28,77	P_1	P_2			1,72
32,67	P_2				1,95

Figure 4.

6[th] step: determining the volume of the deposits for the best combination of the deposit location. The best combination is P_1&P_3&P_4 deposits locations, so the volume of the deposits is $V_{structure}/3$, where 3 is the number of deposits.

Conclusion

It is important to notice that the number of the deposits is as important as their location is. In the given example the first four places are taken by four combinations of deposit arrangements where the number of the deposits were different from each other and the best arrangement was not the combination of placing as many deposits parallel to the wall as it was possible.

This model can be used on one hand in the events of the activities where the number and the volume of the deposits are not known in advance, like demolition, earthwork, gravel work, etc. On the other hand in practice in Hungary it is usual that the manufacturers sell their materials in packages with different volumes. It results the volume and the number of the deposits are unknown in advance so this model could be used for most material placing of the constructions.

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MODELLING THE OPTIMISATION OF PLACING BUILDING MATERIALS AT THE BUILDING SITE
IF ONE OR MORE POINTS OF THE STRUCTURE 'S LOCATION IS NOT ACCESSIBLE FROM THE DEPOSIT THROUGH A STRAIGHT PATH

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Abstract

The international professional literature knows several solutions to the partial task of site organisation that is deposit placement. The models define the optimal location of the material deposits[1] by minimizing the horizontal handling paths for each activity and material. The objective of the task is to decrease the building costs.

In this paper I introduce an input data and I make the models supplemented with a further condition. This way I take the obstacles to be evaded into consideration in the lengths of the horizontal paths at the building sites. These obstacles may include:

- currently existing structures (constituting an obstacle at the time of building, material handling)
- the structure itself, that is under construction (constituting an obstacle at the time of building, material handling)
- the deposit of another material also necessary for the activity.

The models lead to a minimizing programming task, which can be solved (e.g. by the programme called Mathematica). I demonstrate it by an example through the continuous model.

Keywords: construction site, site layout planning, location of the deposits, site planning model, plane of path

Introduction of the problem and the models in the international profession literature

Planning the construction site is a compex problem because of the number of factors, which are involved in it. Space on construction sites are recognised as a resource that is as important as other resources of money, time, material, labor, and equipment (Tommelein et all 1992; Hegazy and Elbetagi 1999). During a construction the building material is stored in one or more deposits at the construction site by specialised contractor. The volume of each deposits and the required number of deposits are known.

[1] I define deposits as the final stock piling of the handling and/or storage quantity (such as a pallet) of the material to be built in, before the actual building in at the construction site, from which location the material is handled to the actual building in location in a quantity smaller than the deposition quantity (for example by brick). The volume of the same type of material deposits is equal.

In the event of an optimal spatial organisation the building material is arranged so that the material can be handled to the building location from the deposits along a minimum path. The goal of the task is decreasing construction cost and/or time and/or labour and /or resources by decreasing the sum of handling distance and time.

In practice the deposit allocation is the foremen's duty in Hungary who solves the problem by human judgement using the first-come-first-served strategy as the site managers do it anywhere on the world, which could result decreasing productivity. Researchers worldwide declared several model for the problem. The allocation of the resources (materials, equipment, facilities, demarcated areas and obstacles) on site has led to the problem that mathematica knows as *"location problem"* declared by Francis and White (1972). Allocating site space to resources so they can be functional during the construction is a problem known as *"site layout planning"*. Several computer based site layout systems have been developed to solve this problem. Some of them use AI (artificial intelligence) techniques like the knowledge-based system (Tommelein et al 1991), and the genetic algorithms (Li and Love 1998, Hegazy and Elbeltagi 1999, Mawdesley et al 2002, Zouein et al 2002). They are used to solve unexact, incomplete problems or to deal with too many unknowed factors. Others use hybrid techniques that use professional's knowledge and dynamic space scheduling system (Zouein 1999). Sadeghpour et al in 2004 have developed a CAD-based model that is an object-based model that operates with 3 functions (Database, Project modul, Layout control modeul) in a CAD environment. Another system VICRON (Virtual Construction site) operates by the Critical Space analysis method (Winch and North 2006). Another computer-based tool PECASO (Petterns Execution and Critical Analysis os Site-space Organisation) focuses on the visualization of the "space competition" between the construction activities by the technique of 4D (3D+time) by Mallasi 2004.

The discrete and the continuous model (as the two mainly used model for finding the optimal location of the deposits)

The known approaches to the problem solve the tasks - the optimal arrangement of the required number of material deposits calculated from the structure for each activity and material- by the discrete or the continuous model using the geometry of the structure location. The known models queue activities and the materials by different weight factors in different ways, then place the materials onto the site one after the other. They use the Euclidean distance (or rectilinear (first in x-, then in y-direction) distance) and discrete method in the course of calculating and minimizing the *handling paths*[2].

<u>The discrete method</u> searches for the optimal location of the deposit by dividing the structure into parts with predefined unit volume, starting out of the volume of the structure to be constructed, presuming that the location of the possible deposits can fall at any point of the building site (or at the declared available space).

[2] The handling path is measured and used by the horizontal projection of the paths between the location of the structure and the deposits of the building material. Handling path, Delivery path, Material path are all means the same but called different way by different researhers. This was used only in the time-space and in the critical-space conflicts.

The followings are given: Sections marked as A_3A_4 and A_4A_5, closing a 90° angle with each other, as building locations with x,y,z coordinates, where the sections marked as A_3A_4 and A_4A_5 $\in$ *plane XY*, that is $A_{3z}= A_{4z}= A_{5z}=0$, *and* $A_{4x}=0$, $A_{4y}=0$, $A_{3x}=0$, $A_{5y}=0$. Δ is the length of the building location part, *m* and *n* are the element number of the building location (Figure 1) $i, j \in N$, $m\Delta=d(A_3;A_4)$, $n\Delta= d(A_4;A_5)$

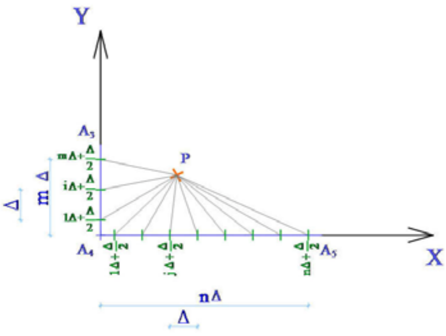

Figure 1.

To be searched for:

$P(x,y)$, as deposit, where $P \in$ plane *XY*

Task:

$$\min f = \sum_{i=1}^{m} \sqrt{P_x^{\,2} + (P_y - i\Delta + \frac{\Delta}{2})^2} + \sum_{j=1}^{n} \sqrt{(P_x - j\Delta + \frac{\Delta}{2})^2 + P_y^{\,2}}$$

The continuous method measures the distance of a given building location from a deposit as the distance sum of each point of the building location measured from the deposit. It is measured at the location of the deposit under examination by the dimension of the building location projected vertically to the envelope of a 45° right cone (Euclidean cone) with an infinite height, set on its apex, the length of the sections closed by the building location and the vertical projection straight lines / planes, or the area of the surfaces or the volume of the bodies in function of the geometry of the building location. For the determination of the optimal location of the deposit the location of the cone shall be determined so that the sum of these section lengths, or surface areas or body volumes shall be minimal, if material is to be handled from the deposit to all the points of the building location.

The followings are given: Sections marked as A_3A_4 and A_4A_5, closing a 90° angle with each other, as building locations with x,y,z coordinates, where the sections marked as A_3A_4 and A_4A_5 $\in$ *plane XY*, $A_{4x}=0$, $A_{4y}=0$, $A_{3x}=0$, $A_{5y}=0$ (Figure 2).

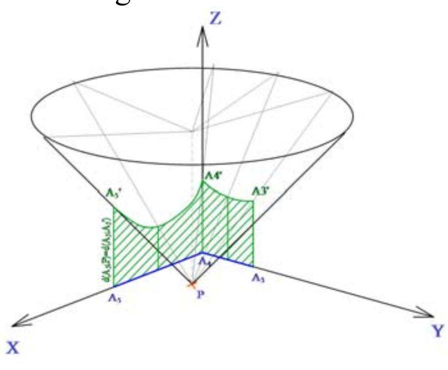

Figure 2.

To be searched for:

$P(x,y)$, as deposit, where $P \in$ plane *XY*

Task:

$$\min f = \int_{0}^{A_{3y}} \sqrt{P_x^{\,2} + (y - A_{3y})^2}\,dy + \int_{0}^{A_{5x}} \sqrt{(x - A_{5x})^2 + P_y^{\,2}}\,dx$$

The problem describing

When a material arrives to the site there can be objects that means obstacle for placing the material and for the handling path either. These objects can be:

- *"site objects"* like currently existing structures, buildings, trees, equipments, etc (constituting an obstacle at the time of the material handling) (Sadeghpour 2006)

- *“construction objects”* like the deposit of another material also necessary for the activity (Sadeghpour 2006)
- the structure itself, that is under construction (constituting an obstacle at the time of building, material handling).

The CAD-based model takes obstacles into account in the available space: *“once an object is positioned on site, its footprint area is deducted from the available site area”* (Sadeghpour, 2006). The critical space method uses the obstacles the same way: $a=t-p-i$ (where a is the available space, t is the total space, p is the product space, i is the installation space) (Winch and North 2006).

In the case of obstacle is in the handling path minimizing the sum of the handling paths by the Euclidean distance will not lead to the optimal location of the deposit because the obstacle has to be evaded what effects the solution. Sadeghpour (2004) counts with these obstacles by using weight factors depending on the building location is visible or not from the current deposit location.

In this paper the obstacles are considerated in the handling path by using another area, the handling area according to the areas are used by Sadeghpour, Winch and North and etc. These areas are: *Total space, Product space, Installation space, Available space, Required space* (Critical space analysis Winch, G. M. and North, S.), and inducting an assumption that is each point of each handling paths has to be a part of the handling area. Handling area is the total area without product area and without the areas of obstacles.

Needed input data:

-In the model structures are represented in the plane *XY* as a building location by 2D geometrical elements (points, lines, areas) depending on the shape and the characteristic of the structure itself. (Like walls can be modeled by lines, pillars can be modeled by points, spaces can be modeled by areas.)

-The deposit is represented by means of the horizontal plane projection of the centre of area of the deposit as a point P, with the coordinates x, y, z, where $z = 0$.

-Handling paths are modelled as straight lines or straight-line-chains.

-The space which describes the area where the material can be delivered called Handling area.

-The site is represented as an area called total area.

-Obstacles are represented as points, lines or areas in the XY plane depending on their shape called installation space.

-Available area is the area that includes all of the feasible deposit locations. It is represented by an area that is given by subtracting the installations space and the building location from the total area.

All areas are given by coordinates of their corner points and the equations of their sides.

Assumptions:

There are handling path from each points of the available area to all points of the building location.

All points of each handling path are parts of the handling area, each handling path has no common point with installation space and each handling path has one common points with the building location.

Algorithm:

I illustrate the 5 steps of the algorithm by an example (shown at Figure 3.) where are two walls (A_1A_2, A_1A_3) that needs to be clothed by ceramic tile (from one side). There is a wall (O_1O_2) that means obstacle for the "Euclidean" delivery path from some deposit locations, because it needs to be evaded it.

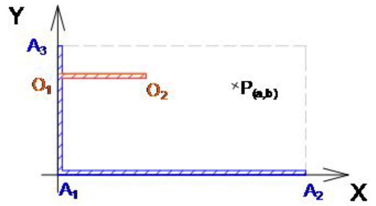

Figure 3.

1, Dividing the Building Location to Building Location parts:

The building location needs to be divided to continuous building location parts. For example in this case the building location is divided to three straight, continuous lines with the ending points: A_1 A_2, A_1O_1, O_1,A_3.

2, Defining the available area parts:

There are three kinds of available area types where from the handling paths have to be calculated by different ways. These types are:

a) "**Visible from**" (Sadeghpour, 2006) It means that all points of the certain Building Location Part (is visible) is accessible from all points of this area
b) "**Invisible from**" (Sadeghpour, 2006) It means that no points of the certain Building Location Part is accessible from any point of this area
c) "**Partly visible from**" It means that one or more points of the certain Building Location Part are accessible and one or more points are not accessible from any point of this area

for each building location parts (as it is shown at Figure 4).

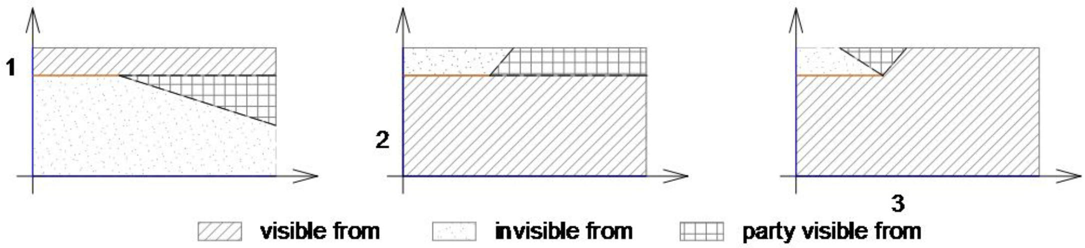

Figure 4.

If all of these accessible areas for each building location parts are picturized in one diagram, then each point of the available area is a part of one puzzles and each point of each puzzle is a part of the available area (as it is shown at Figure 5).

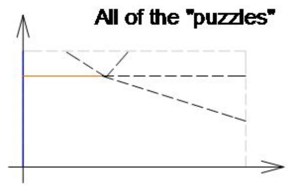

Figure 5.

The available area parts (these "puzzles") can be defined by the equation of their edges and the coordinates of their corners.

3, The equations for each available area part for each location part

The equations of the "sum" of the distance has to be defined to each building location part from all points of each puzzle. There are three kinds of equations and they are described by the accessibling explained above.

a) If the puzzle is the type of "visible from" for the certain location part then the distance between the certain location part and a point of the puzzle can be measured by Euclidean distance using the continuous or the discrete model.

b) If the puzzle is the type of "invisible from" for the certain location part then the distance of the certain location part from a point of the puzzle can be measured by the sum of the volume of the sections (closed by the building location, its vertical projection to the envelop of the Euclidean cone placed at the last point between the location part and the certain point (*D*) where from the building location is completely visible and the vertical projection straight lines / planes, or the area of the surfaces or the volume of the bodies in function of the geometry of the building location) and multiplication of the volume of the building location and the minimal distance between the point of the cone and the certain point *P*.

c) If the puzzle is the type of "partly visible from" then it is necessary to describe the equation of the edge of the location part that divides it to visible and invisible categories for the certain puzzle. Then the equations of the visible from and the invisible from can be adopted on the sides of the edge at each point of the puzzle.

4, Minimizing

At each available area separately needs to find the point where from the sum of the_handling path is minimal. It is done by minimizing the equations described above for *a,b,* where *a* is the *x*, *b* is the *y* coordinate of the deposit.

5, Queuing and deciding

Queuing the solutions of the equations of the minimizing at each available area part (described at point 4) and picking the best one from them, that determines the optimal location of the deposit.

Example: floor tiling

In this example there are three rooms. In two rooms (in room 1 and in room 2) floor tiling is going to be laid. There is no door between these two rooms so the traveling way from one of the rooms to the other one goes through the third one (as it is readable at Figure 6).

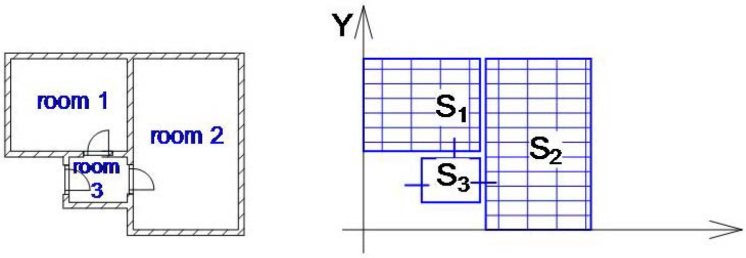

Figure 6.

In this case the total space is equals the available space (the area of all the feasible deposit locations) and the handling space is represented by three areas (S_1, S_2, S_3). These three areas are connected to each other at two points (at the two doors) as shown on the Figure 6. The building location space is represented by two areas (S_1, S_2). The exercise is finding that deposit location of the floor tiling material (that is represented by the point $P_{(x,y)}$) where from the sum of the handling paths is minimal to all points of the building location in the circumstance all points of all the handling paths are parts of the handling area. The sum of the handling paths between the point of any feasible deposit location and all points of the product space can not be measured by using only the Euclidean distance because the currently existing wall is an obstacle in this exercise. I solved this exercise by using the program *Mathematica*.

The followings are given:

- S_1, S_2, S_3 areas together represent the available area and the handling space, separately the available area parts,
- S_1, S_2 areas together represent the Building location, separately the building location parts.

Each S_j Є plane *XY* and all areas are given by their four corner points: $A_{1x}=0$, $A_{1y}=0$; $A_{2x}=3$, $A_{2y}=0$; $A_{3x}=6$, $A_{3y}=0$; $A_{4x}=0$, $A_{4y}=2{,}5$; $A_{5x}=0$, $A_{5y}=5$; $B_{1x}=2$, $B_{1y}=1$;

- S_1, S_2, S_3 areas are connected to each other at the points that coordinates are $[((A_{2x}-B_{1x})/2+B_{1x}); A_{4y}]$ and $[A_{2x};(A_{4y}-B_{1y})/2+A_{2y}]$ (Figure 6)

Assumptions:

All points of all handling paths Є S_1 and/or S_2 and/or S_3 and/or $[D_1:((A_{2x}-B_{1x})/2+B_{1x}); A_{4y}]$ and/or $[D2:A2x;(A_{4y}-B_{1y})/2+A_{2y}]$

To be searched for:

P(x,y), as deposit, where from the sum of the handling paths is minimal if *P* Є S_1 *or* S_2 *or* S_3

The equations and minimizing for each available area part for each location part

The building location is divided to parts by the rooms. Dividing the available area to parts is shown at Figure 7.

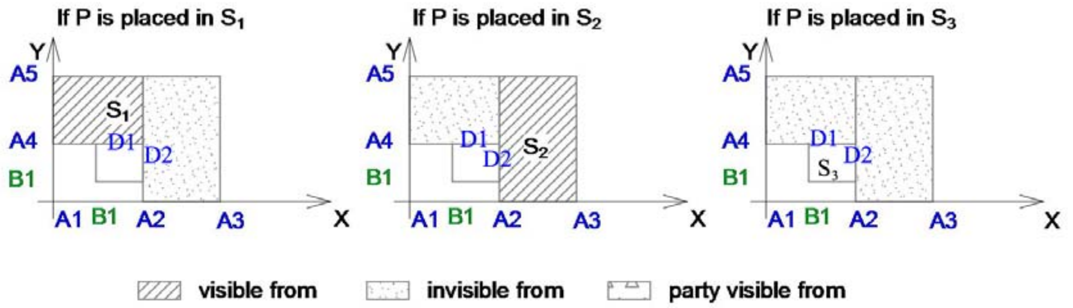

Figure 7.

At each available area parts the point has to be determinated that belongs to the minimal handling path for that area:

If *P* Є *S1*, then minimize F1=

$$\int_{A4y}^{A5y}\int_{A1x}^{A2x}\sqrt{(a-x)^2+(b-y)^2}dxdy+$$
$$\int_{A4y}^{A5y}\int_{A2x}^{A3x}\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2}dxd+[(A_{3x}-A_{2X})(A_{5Y}-A_{2Y})(\sqrt{(D_{1x}-D_{2x})^2+(D_{1y}-D_{2y})^2}+\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2})]$$

If *P* Є *S2*, then minimize F2=

$$\int_{A2y}^{A5y}\int_{A2x}^{A3x}\sqrt{(a-x)^2+(b-y)^2}dxdy+$$
$$\int_{A4y}^{A5y}\int_{A1x}^{A2x}\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2}dxd+[(A_{2x}-A_{1X})(A_{5Y}-A_{4Y})(\sqrt{(D_{1x}-D_{2x})^2+(D_{1y}-D_{2y})^2}+\sqrt{(D_{1x}-x)^2+(D_{1y}-y)^2})]$$

If *P* Є *S3*, then minimize F3=

$$\int_{A4y}^{A5y}\int_{A2x}^{A3x}\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2}dxd+[(A_{3x}-A_{2X})(A_{5Y}-A_{2Y})\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2}]+$$
$$\int_{A4y}^{A5y}\int_{A1x}^{A2x}\sqrt{(D_{2x}-x)^2+(D_{2y}-y)^2}dxd+[(A_{2x}-A_{1X})(A_{5Y}-A_{4Y})\sqrt{(D_{1x}-x)^2+(D_{1y}-y)^2}]$$

Queuing and deciding The output is the queuing of the results and showing the belonging coordinates for each result as it is readable at Figure 8.

F1[{74.4582, {a→1.54172, b→4.17021}}> F3[{69.6652, {a→2.69096, b→2.5}}> F2[{59.8246, {a→4.45093, b→2.84319}}

Figure 8.

The minimal output came from the minimization of equation F2, so the optimal deposit location is in the S_2 available area part at the coordinates: (x→a=4,45093; x→b=2,84319)

Summary and Conclusion

This paper presented a method of finding the optimal location of the material deposit. It describes the layout planning in a more precise way closer to the reality than the only Euclidean distance used models by taking under consideration the obstacles in the handling path near by the other circumstances that are described in other papers by the mentioned researchers. The model is a geometry-based model. The essential of the model is typing the areas of the sites. The example demonstrated that the model is capable to solve the described problem.

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NATURAL STONE EXPLOITATION MANAGEMENT BASED ON PROJECT MANAGEMENT TOOLS AND GIS

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Abstract

An exploitation of natural stone influences social and economic image of a region, so exploitation technology should be accompanied by the development of the management system so as to minimise impact on social, economic, ecological and biological systems. This paper discusses influence factors during the exploitation of natural stone, especially ecological and economic ones. The intention of the presented research is to balance the influence factors thus making the management support system acceptable both economically and ecologically. The proposed methodology combines project management tools, Life Cycle Assessment, Life Cycle Cost as well as Work Breakdown Structure. In order to enhance the management system and bearing in mind that quarry management takes into account lot of spatial data, a GIS-based Management Information System is also proposed. GIS could be used as an excellent data source thus being a basis for a decision making process related to investments and other business issues.

Keywords: quarry management, LCA, LCC, WBS, GIS,

1 INTRODUCTION

A sustainable development concept urges the development of various regulations and tools that are focused on constant improvement of production processes. These regulations and tools are standards of processes. Such group of standards is ISO 14000 standard which implements environmental management paradigm (EM).
A very intense interaction of a quarry with an environment leads to the need of implementation of such standards in the quarry management. A state of the art technology of exploitation of natural stone produces huge amount of the waste-rock, up to the 60 to 90 percent of excavated stone. This is the main problem regarding production, as well as protection of the environment, particularly regarding deterioration of the landscape. Additional negative side effects are: utilisation of vast amount of water, emission of dust and noise.
Because of existing technological limitations related to the vast amount of the waste-rock, it should be treated as secondary raw material. Management of secondary raw material in parallel with an exploitation of natural stone is often neglected although it could reduce a number of openings of technical stone quarries. An optimisation of the

exploitation process is usually preformed through optimisation of quarry development regarding geological as well as other conditions that are variable and should be monitored permanently.

This paper proposes monitoring system through decomposition of a production process into subsystems. Input and output data of such subsystems make a basis for a quarry information system which includes waste-rock subsystem. Integration of databases of a range of quarries enables efficient waste-rock management at different decision levels. Changes of quarry purposes, after its closure, as well as quarry reactivation that are difficult in practice because of either long exploitation life of quarry or possibility to better survey stone reserves face the same problems.

All mentioned obstacles should not burden the company that exploits mineral resources and should not influence its competitiveness on the market. The main idea is to present quarry as a project with complete life-cycle. An application of whole life costing method in the phase of investment decision for planned quarries, or as early as possible for quarries in operation, should enable both recovery and monitoring cost assessment during exploitation and closure procedure. Nature of geo-referenced exploitation objects and necessity to integrate quarry into the environment leads to the application of geographical information systems.

The approach presented in this paper starts with an assumption that quarry management improvement can be achieved by applying sustainable development concept and defining measuring parameters that should be monitored throughout project lifetime.

2 METHODOLOGY

The methodology is based on a combination of project management tools: Life Cycle Assessment (LCA), Life Cycle Cost (LCC) and Work Breakdown Structure (WBS). The procedure follows LCA methodology phases. This is the basis that enables full implementation of LCC economic dimension. WBS structure serves for the definition and monitoring of both LCC and LCA parameters, as well as their integration into relational data base within GIS.

Although each quarry is specific, production process fits into a certain framework. Quarry production process could be presented by sequence of work packages. Decomposition of production process into smaller, manageable pieces, known as Work Breakdown Structure, essentially is a project management tool. Herein, used for decomposition of production system, WBS helps to efficiently determine sub-systems, system borders and system performance. WBS is usually used for systemic recognition and definition of various kinds of tasks (activities, operations, processes) within the project. Even though it does not defines tasks dependencies and durations it defines the structure of the project. Besides planning, WBS structure supports control of activities, resource, responsibilities and helps reporting about system characteristics.

Besides using WBS as an input to another project management tool such as network planning the researches uses it as a framework for control process. Jung and Woo (2004) propose a flexible work breakdown structure for integrated cost and schedule control. They argue that concept of flexible WBS can greatly alleviate problem of increased management efforts required to manipulate detailed data by reducing the number of control accounts.

Life Cycle Assessment (LCA) methodology treats the whole system lifecycle whose phases vary in needs for resources and levels of efforts. LCA consists of the following phases:

- Definition of objectives and working tasks
- Definition of a system, sub-systems, system boundaries, that is definition of functional system units
- Definition of both input and output parameters for sub-systems/functional units as well as for a whole system
- Collection of data about input and output flows [LCI – Life Cycle Inventory]
- Finalisation of modelling process and data analysis [LCIA - Life Cycle Inventory Analysis]

Control of these phases is the basis for quarry management model. LCA analyses material and energy parameters for the purposes of system management which was introduced for profit gaining. Many authors use LCA for estimation of efficiency and environmental impact of different systems. Pehnt (2005) investigates a dynamic approach towards the LCA of renewable energy technologies and proves that for all renewable energy chains, the inputs of finite energy resources and emissions of greenhouse gases are extremely low compared with the conventional system. Emery et al. (2006) uses a life cycle assessment (LCA) computer model for comparison of the environmental impacts of a number of waste management scenarios. An interactive Microsoft excel spreadsheet model was also developed to examine the costs, employment and recovery rates achieved using various waste recovery methods including kerbside recycling and incineration. Treloar et al. (2004) propose a hybrid LCA method that uses input-output data to improve conventional LCA inventories. They demonstrated developed hybrid LCA method on a life-cycle energy study of eight different road designs, including vehicle manufacture, maintenance, replacement, and operation.

It is necessary to introduce economic parameters, as well. That is why proposed methodology implements Life Cycle Cost (LCC) and combines it with WBS and LCA methods. LCC methodology is based on net present value (NPV) method that enables discounting of all investments, costs and revenue during project lifecycle to the beginning of the project. Considering selection of alternative solutions of quarry lifecycle flows, LCC method, by implementing NPV, represents a powerful tool for solving such problem. The alternative that shows the highest value of NPV is considered as the most convenient. There are efforts to use LCC for environmentally influential systems. Glucha and Baumannb (2004) discuss theoretical assumptions and the practical usefulness of the LCC approach in making environmentally responsible investment decisions. They argue about ability of LCC to handle irreversible decisions and to support decision making under uncertainty. Reich (2005) proposes methodology that consists of a financial LCC used in parallel with an LCA as well as an environmental LCC for municipal waste management systems. The financial LCC covers all the costs incurred by the extended waste management system, as though the LCA system was a single economic actor. By the combination of LCA and LCC methods all relevant input and output parameters of the system are comprised.

3 QUARRY MANAGEMENT MODEL

Management is a process based on decision making aiming at fulfilling objectives. Decisions-making environment ranges from extremely structured to unstructured problems. One of the tools that could help decision making process at all management levels is Management Information System (MIS). It is formal computerised system that integrates data from different sources in order to promptly provide information for decision making to a manager (Turban, 1993). As decision levels rise MIS become more inappropriate, but it could transform into other tool for top decision levels such as Executive Information System (EIS).

Dynamism of the quarry system as well as its environment requires constant monitoring and improvement of both system itself and posed objectives. Diagrammatic presentation of a quarry monitoring system as well as its interaction with the environment throughout its lifecycle phases is showed on Figure 1.

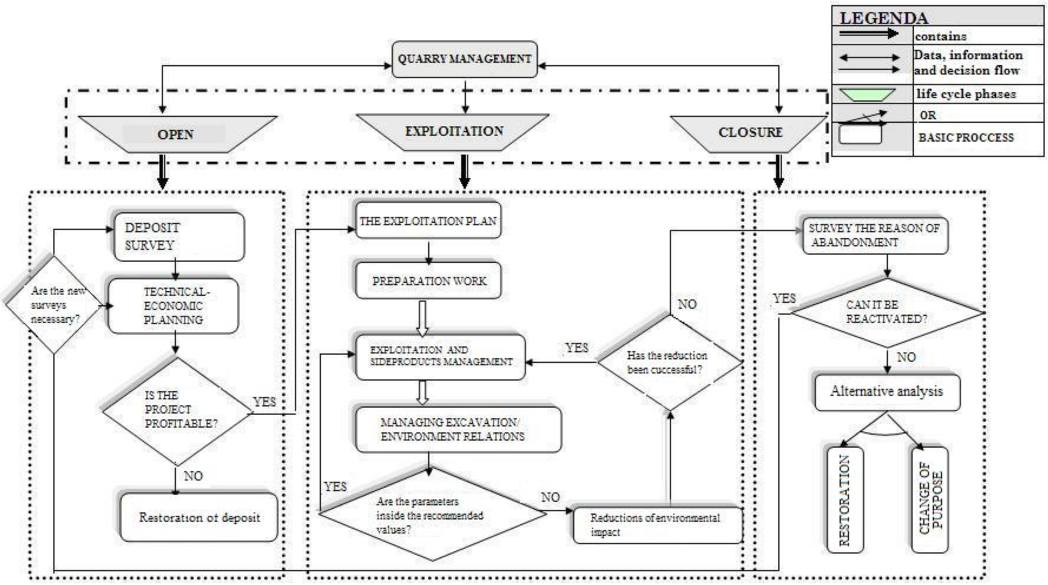

Figure 1: Diagrammatic presentation of a quarry management model in different phases of lifecycle

Presented schemata could be interpreted as a fractal structure, i.e. as cyclic processes at different time scale and values of spatial locations, because all such processes have been repeated during the lifecycle of the quarry. In such way it is possible to test monitoring and rehabilitation methods and to aquatint knowledge in order to improve long-term management.

The main objective of the quarry exploiting natural stone for architectural constructions is to optimise stone blocks of the commercial dimensions. Besides the flow of the blocks through whole system, it is necessary to monitor the flow of the side-products, mainly fragments which are irregular and sub-regular blocks, as well as shapeless smaller blocks. Proposed conceptual model of the quarry system management is showed on the Figure 2. All products and side-products are deposited on the depot, temporary ($t>0$, Figure 2), or permanently ($t \rightarrow \infty$), otherwise they could be sent directly to the market without being deposited ($t=0$).

Most countries introduced taxis for the deposited materials, thus motivate companies to plan management of the secondary raw material emerged from the exploitation. At the same time a long-term planning of the openings of technical quarries are being stimulated. By separation of the fractions manipulation of the depots are easier so the cost are lower. Moreover, by removing of the fractions the manipulation on the depot as well as outside the facility site is easier and less costly. This leads to the need for the depot management system for the both blocks and side-products of the exploitation. Quarries are water consuming production plants, so the possibility for water reuse should be considered as well.

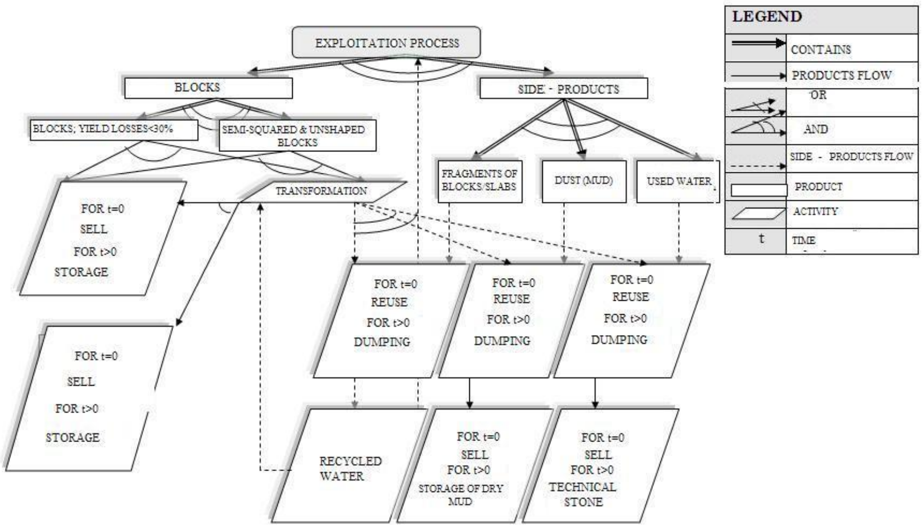

Figure 2: Quarry products during exploitation, processing and rehabilitation

Functioning of the proposed model is possible only by continuous system monitoring. First and very important step is to implement Management Information System based on relational data base.

MIS is organised according to the scheme showed on Figure 3. The data base structure is based on the sustainable management concept that will satisfy both economic and ecological criteria. This could be fulfilled by application of LCA, LCC and WBS tools each of which covers a part of the concept as it is shown on Figure 2.

The proposed system considers following functional parts:

- Data collection
- GIS layers
- Data editing and analysis

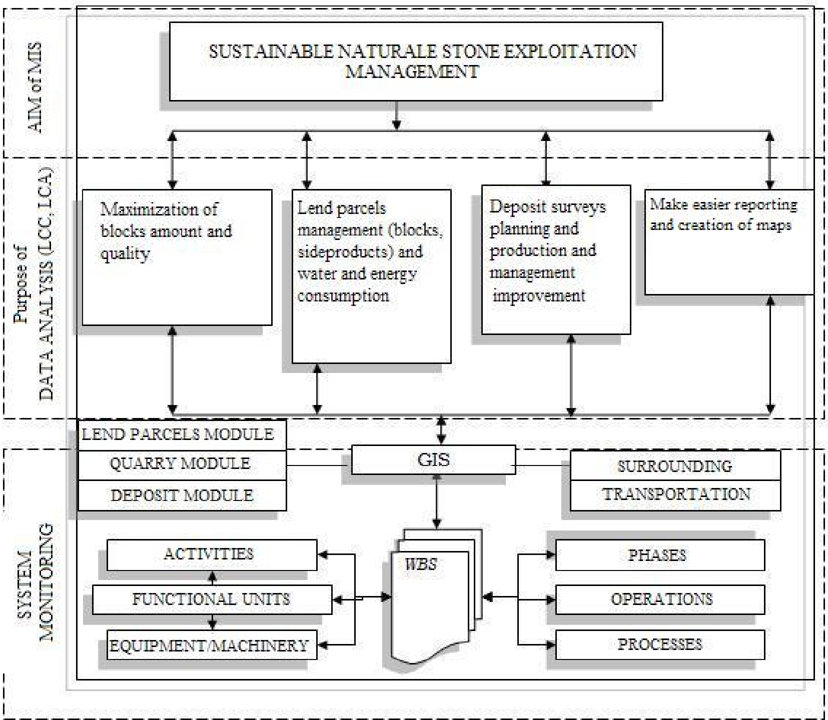

Figure 3: Structure of the Management Information System of the project

The main objective of the system is an exploitation process support. The Figure 3 shows functional parts. Arrows determine information flows through the system. Two-ended arrows should emphasise the fact that data could become management information.
Designing of the management information system is based on modelling of real system so it should follow its rules: data entering the system, sate of the data base is changed via code for updating, and via software for reporting (Plastić, 2006). General architecture of the information systems consists of process model and data model. Process (function) model is a structured set of the processes which change the system state and processes which from output of the system. Processes driven modelling is based on detailed analysis and decomposition of processes (Plastić, 2006) that is implemented by WBS structure. WBS structure is a base framework of the both proposed exploitation management model and data base. Data model is a basic concept for data base system development, because it implements data structure into a certain data base model. Data base model of the proposed information system is realised as a relational data base and implemented into MS Office Access 2003. Central entities and relationships of WBS based data base are shown on Figure 4. The main role of WBS is production decomposition, but regarding data analysis WBS has integration role and it unites all production phases into unique process. It is a backbone of MIS and data base that enables structural process control.

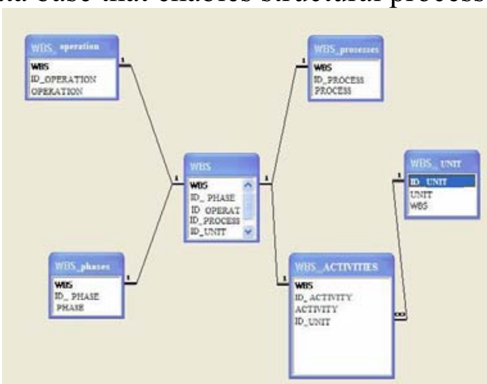

Figure 4: Relationships between basic data base entities

3.1 System monitoring

For the data that describe operations, activities, equipment a WBS structure is used. WBS structure is defined through five levels: phases, operations, processes, activities and basic functional units. Phases of the WBS structure are the phases of the quarry life cycle from the idea, design, production i.e. exploitation to closure and rehabilitation. Logically and organisationally they can be defined differently, but in the most cases the main criterion is successiveness of the phases. In the practice there could be exemptions regarding available staff and mode of the organisation, but in such case operations which are constitutive parts could be defined differently. The main objectives of the WBS are:

- Planning and monitoring of the all sort of costs;
- Planning and controlling of the production system
- Controlling of the quantity and composition of stone waste, air emissions, water as well as depot cost
- Creating and analysing of the environmentally sound alternative solutions
- Definition of the input into information system of the project (company)

WBS can serve for another activities such as planning and control of:

- Duration of tasks and activities
- Efficiency of equipment and plants/facilities, and avoidance of idle status
- Equipment maintenance costs, transportation equipment and plants, administration and management
- Efficiency of labour
- Assignment and control of tasks and responsibilities
- Eventual profit from side products
- Material and energetic input and output data according to the life cycle phases of the project, functional units or other parameters

Functional units are defined in a combination i.e. as processes or plants/facilities or equipment depending on system needs. They are components of WBS but also of LCIA. Each functional unit is described by its technical and economic characteristics. The main objective is responsible environmental management by mutual application of LCA and LCC analysis. A sustainable management concept tries to find a compromise between these two approaches.

LCA method enables choice of both types and quantities of materials, quantities as well as environmentally sound technologies. LCC lifecycle outputs relevant economic parameters that should not be in conflict with previously mentioned demands. LCC analysis gives both total and types of costs for each phase, process or functional unit, as well as for a whole lifecycle.

3.2 Architecture of the Geographic Information System

Data obtained in accordance to the initial MIS structure (Figure 3) are being classified aiming at obtaining an organised structure of GIS, thus making easier updating procedures. Choosing GIS as a main information system can be very useful for distance analysis of the markets, transportation costs, as well as for the remote monitoring of quarries and depots with GPS devices.

The management approach presented in this paper is possible to apply to the middle and top decision and management levels, as a support for tactical and strategic decisions. It can serve as a support for both short and long term planning of management of natural resources as well as support for local authorities.

Possible application is in coordination of economic parameters and responsible environmental management by systemically applying LCA and LCC analysis.

4 PILOT PROJECT -QUARRY „MILOVICA“ ON THE ISLAND OF BRAC

Production of the quarry Milovica is 2000 m^3 blocks per year. Considering priorities and side-products of the exploitation, following production alternatives are defined:

1. Disposal of the side-products on the different depots that are created by revision of unique depot during the exploitation phase, there is possibility for reuse and influence on a closure of the quarry.
2. Disposal of the side-products on the different depots that are designed at the beginning of the exploitation phase, there is possibility for reuse and influence on a closure of the quarry.

3. Disposal of the side-products on a one common depot that are designed at the beginning of the exploitation phase, there is possibility for reuse and influence on a closure of the quarry. This alternative describes how quarry works now.

Rehabilitation costs are defined according to the depot costs of 3€/m^3 of deposited material. The costs are distributed throughout production phase. The existing scenario, the third alternative, has not got such kind of costs because, at the moment, it is not part of the quarry management and it is not part of the legislation.

4.1 LCA analysis of the alternatives

By monitoring process the parameters about percentage of blocks' categories obtain in total production as well as non-block mass are obtained. Non-blocked mass is the same because the same technology is used in all alternatives. Only difference is in non-blocked mass management. Besides a register of produced blocks sorted by the categories which is very important for exploitation efficacy, information about the quantity of the side-products is also important.

The amount of the material in the quarry of the second alternative is lesser than in the other alternatives. The part which is left serves for construction of approaching roads to the quarry levels and other similar purposes.

4.2 LCC analysis of the alternatives

Economic analysis of the main scenario as well as of the proposed alternative solutions was performed by modified software P2/FINANCE. The concept of the analysis is to compare the alternative solutions with main scenario. The basic assumption was that there no differences in blocks' prices. The amount of waste-rock is also the same, but it is treated differently for each alternative. The basic scenario is compared to the situation in which quarry does not exist. Beginning of restoration payments here is in 15th year of project life cycle.

Despite of 18 % higher payments for the fuel, the total amount of the item Energy/Water/Fuel is the lowest for the second alternative because almost 90% of the water is saved, that is very important for the karst region as Island of Brač. Although it has 82% higher capital investments, even 142% higher payments for salaries and investment in same kind of "environment portfolio", which does not exist in the basic scenario, the second alternative shows the best net present value (63.964.416 kn) according to the first alternative (31.190.211 kn) and basic scenario (34.578.805 kn) for the period of 15 years. Internal rate of return is also the best for the second alternative (41%), if compared to the first alternative (23%) and the basic scenario (29%) for the same period. The values for net present value and internal rate of return also show that the second alternative guarantees the shortest payback period of 3,6 years comparing to the first alternative (5,5 years) and the basic scenario (4,5 years).

Those results are achieved by management of average amount of 12.500 m^3 by-products per year: unformatted (18%) and unshaped (22%) blocks convenient for strips, tiles and slabs; stone fragments (39%) convenient for aggregates; soil (14%) for restoration; and water decanted from mud (8%).

5 CONCLUSION

During the quarry lifetime there are many limitations starting from geological to spatial, time, law, market, social and others. Inside of them system have to be maximal develop and used. Quarry development should be monitored as well as optimise throughout its life-cycle regarding spatial, time, legislative, market, social and many other constraints. The paper proposes an application of the "whole life costing" approach as early as possible, namely, in the phase of an investment decision-making process so as to include both rehabilitation and monitoring costs, during the exploitation and also after closure of the quarry. The proposed combination of the project management tools, such as Life Cycle Assessment, Life Cycle Cost as well as Work Breakdown Structure in the unique GIS-based Management Information System could make both functional and sustainable management of quarries more efficient. The methodology was applied to the case study of quarry of island of Brac. Application proved that it could be very helpful in both strategic and short-term planning of natural stone, for either architectural or technical purposes, as one of non-renewable resources.

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RISKS MINIMANIZATION OF PRODUCTION PROCESS

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Summary

The article is a proposal of development of anhydrite screed and subsequently carrying out samples of examination of anhydrite screed without fibres and with different kinds of fibres. Furthermore, there are mentioned determination and comparison of mechanical as well as physical characteristics of those different samples. There have been performed calculations of critical point of proliferation of breach by means of fracture energy and cross-cutting module for validation of differences between proliferation breaches of anhydrite fry with and without fibres. Based on the comparison of both results there have been determined different criteria for proliferation of breach for firmness in bending tension and for linear fracture mechanics.

1. Development of the process

Monitoring individual elements and their interrelation (input check, takedown check), compare their real quality parameters with standard parameters (output check) and their evaluation should lead to proposal of precautions (especially repeatable defects). This proposal of precautions has to lead to process improvement. During this phase it is necessary to :

- Identify defect – in spite of observance the technological requirements there are cracks in the screed,
- Analyze defect in the parts of production process and during their relation – while object changes into product (anhydrite screed) the screed dries up and cracks create (cracks could cause draught, projecting object – corner, column..)
- Work out proposal of precautions which leads to defect elimination – proposal for using fibres into mixture
- Realize proposal of precautions, whereas development of production process have to go out of elements which are divided into following parts :
  - Input elements – contain information about working object and product (including specification of detected defects) – anhydrite mixture + different kinds of fibres,
  - Created elements – contain information about transformation of working object into product, progress of transformation and solution – uniform placement of fibres into anhydrite mixture
  - Elements of production – contain results of known production processes analyzes, theoretical branches and their results, practical knowledge, outer influences, …
  - development of production process results requirements – minimization of cracks creation
- Monitor course of developed production process with focus on developed elements and relations
- Interpret the proposal of precaution – see picture 1.

2. Specimens for tests of anhydrite screeds

Characterized procedure of development of production process is presented by practical example. New progress enables minimize or eliminate risks which are caused during production process.

There is proposed development of transformation of working object into product in order to minimize defects caused during realization of anhydrite screeds – i.e. change has been made by new properties of working object (improving its properties). This change goes out of requirement of minimization of the cracks creation during anhydrite screeds realization – during drying phase and during loading phase.

There has been made following mixtures in conjunction with TBG Metrostav PLC. Composition of tested mixtures was based on equal amount of sand and binder, only water was dosed in different amount. Mixing of mixture was made in free fall concrete mixer therefore it was needed to monitor sufficient shuffle of all components.

Specimens made of different anhydrite mixtures (without fibres, with different kind of fibres) were tested at laboratory of CTU. Following tests were made with indurated specimens :

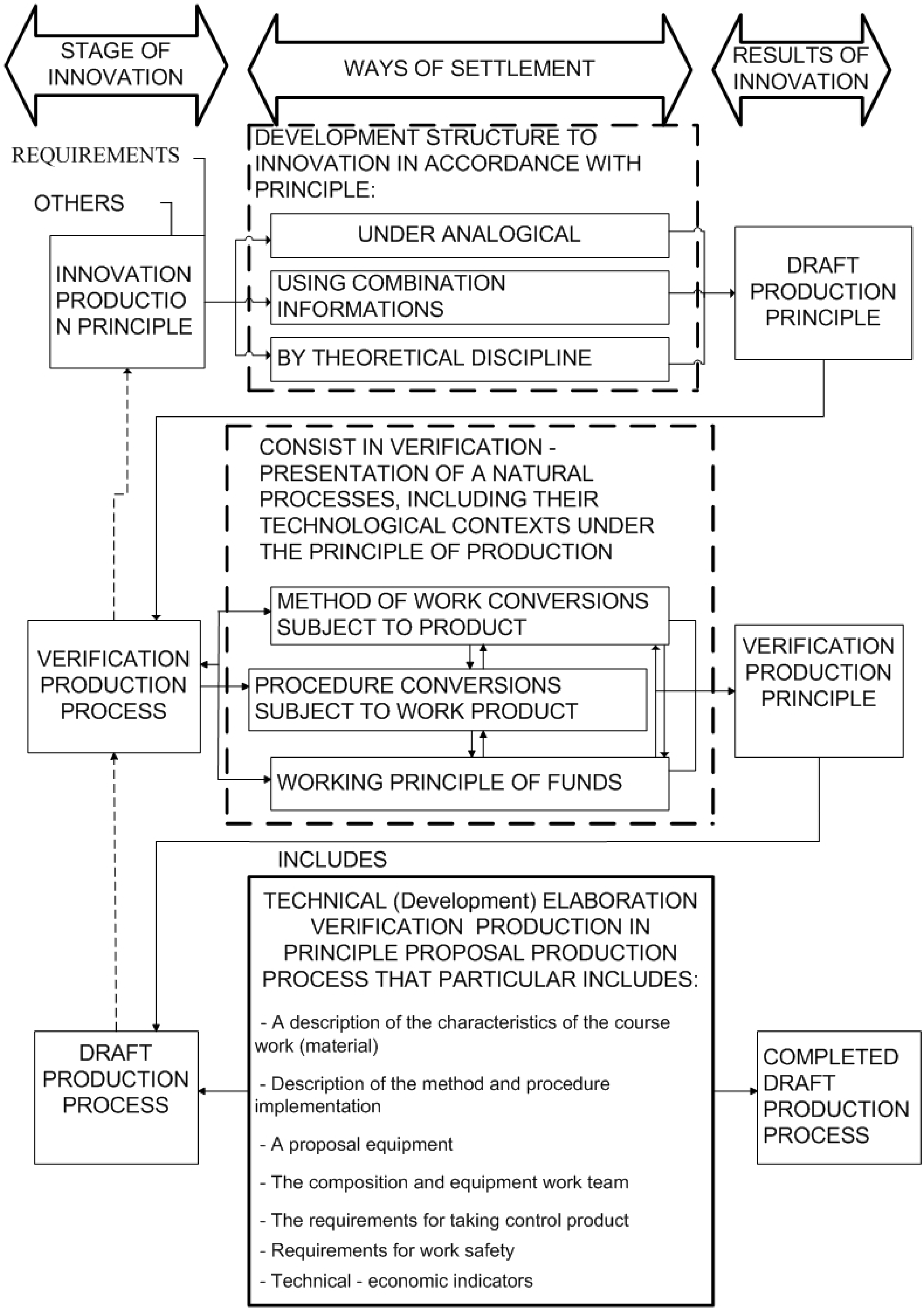
⇒ compression strength of tested specimens
⇒ splitting tensile strength of tested specimens
⇒ flexural strength (4-point bend) including scan of deflection for data evaluation of fracture energy and equivalent tension
⇒ processing of results and evaluation of tests

Note : Results of those tests are at the end of the article.

Pic. 2 Free fall concrete mixer, mixture with polypropylene fibres

Tab.1 Composition of tested mixtures

Composition of tested mixtures						
Dosed components	Units	**AP1**	**AP2**	**AP3**	**AP4**	**AP5**
Sand	kg	28	28	28	28	28
Binder	kg	11,1	11,4	11,4	11,4	11,4
Water	l	6,5	6,5	6,8	6,9	6,5
Glass fibres ANTI CRAK HP (length 12 mm)	g	-	20	-	-	-
Glass fibres ANTI CRAK HPL	g	-	-	250	-	-
Polypropylene fibres FIBRUCO (length 12 mm)	g	-	-	-	20	-
Polypropylene fibres ECONO MONO (length 19 mm)	g	-	-	-	-	20
Total amount	kg	45,9	45,92	46,45	46,32	45,92
Properties of the fresh mixture						
Spillage of cone for mortar tests	mm	250	240	220	200	210



Pic.1 Improvement of production process

Five mixtures of anhydrite screed (marked AP1-AP5 – see Tab.1) were designed and experimentally tested. Referential mixture was selected mixture without fibres marked AP1. Other mixtures contain glass or polypropylene fibres. Following specimens were tested :

- 15 x beam 40x40x160 mm
- 10 x beam 100x100x400 mm

Specimens were stored in laboratory conditions in temperature 20°C ± 5°C until start of the tests – i.e. 10.10.2005.

Obr. 3 Spillage test, series of specimens

Final results of individual test are presented at the following tables. More detailed results are at the end of article.

Tab.2 Flexural strength test and compression strength test of the beam specimens 40 mm x 40 mm x 160 mm

Specimen's mark	**Flexural**		**Compression strength**			
	Force [kN]	**Tension [MPa]**	**Force 1 [kN]**	**Force 2 [kN]**	**Tension 1 [MPa]**	**Tension 2 [MPa]**
AP1-10	1,38	3,23	22,3	26,0	14,0	16,3
AP1-20	1,37	3,24	21,8	21,5	13,8	13,6
AP1-30	1,65	3,90	30,8	32,0	19,4	20,2
Ø		**3,46**				**16,2**
AP2-10	2,02	4,73	39,0	38,3	24,4	23,9
AP2-20	1,95	4,54	39,8	39,3	24,7	24,3
AP2-30	1,97	4,64	38,5	40,3	24,2	25,3
Ø		**4,64**				**24,5**
AP3-10	2,15	5,06	37,0	37,0	23,2	23,2
AP3-20	2,05	4,85	39,8	39,8	25,2	25,2
AP3-30	2,09	4,87	34,3	34,3	21,3	21,3
Ø		**4,93**				**23,2**
AP4-10	2,06	4,72	38,5	34,8	23,6	21,3
AP4-20	2,37	5,50	38,3	33,8	23,7	20,9
AP4-30	2,05	4,80	33,5	34,8	21,0	21,8
Ø		**5,01**				**22,1**
AP5-10	2,13	4,98	37,0	36,8	23,1	22,9

AP5-20	2,25	5,38	38,0	37,8	24,2	24,1
AP5-30	2,41	5,46	41,0	36,8	24,9	22,3
Ø		**5,27**				**23,6**

Tab. 4 Four point test of the beam specimens 100x100x400 mm – assessment of fracture energy

Specimen's mark	D^{C}_{n} [Nmm]	$D^{f}_{fl,I}$ [Nmm]	$D^{f}_{fl,II}$ [Nmm]	**Fractural energy G_f for different parts of graph [J/m^2]**				
				$G_{f,fu}$	$G_{f\ partial,I}$	$G_{f\ partial,II}$	$G_{f,I}$	$G_{f,II}$
AP1-1	904			90,4			90,4	90,4
AP1-2	904			90,4			90,4	90,4
Ø	**904**			**90,4**			**90,4**	**90,4**
AP2-1	1112	382	502	111,2	38,2	50,2	149,4	199,6
AP2-2	1103	375	473	110,3	37,5	47,3	147,8	195,1
Ø	**1103**	**378**	**488**	**110,3**	**37,8**	**48,8**	**148,1**	**196,9**
AP3-1	1346	1968	3 748	134,6	196,8	375	331,4	706,2
AP3-2	1461	2206	4683	146,1	220,6	468,3	366,7	835
Ø	**1404**	**2087**	**4216**	**140,4**	**208,7**	**421,6**	**349,1**	**770,6**
AP4-1	1430	1659	1659	143	165,9	165,9	308,9	474,8
AP4-2	1167	522	781	116,7	52,2	78,1	168,9	247
Ø	**1299**	**1091**	**1220**	**129,9**	**109,1**	**122**	**238,9**	**360,9**
AP5-1	1530	1318	1318	153	131,8	131,8	284,8	416,6
AP5-2	1439	1356	1356	143,9	135,6	135,6	279,5	415,1
Ø	**1485**	**1337**	**1337**	**148,5**	**133,7**	**133,7**	**282,2**	**415,9**

2.1 Specimens for tests of anhydrite screeds: Conclusion

It is evident from finished laboratory tests of specimens, i.e.

- ⇒ compression strength of tested specimens
- ⇒ splitting tensile strength of tested specimens
- ⇒ flexural strength (4-point bend) including scan of deflection for data evaluation of fracture energy and equivalent tension

there are significant differences between specimens. Anhydrite screed specimens reinforced by fibres have better properties then specimens without fibres.

3. Calculations of critical point of proliferation of breach

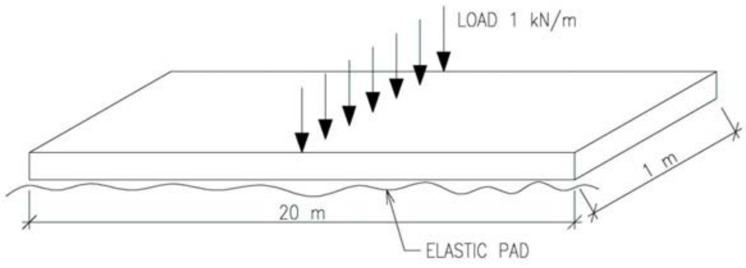
Since the cracks in anhydrite screed are the first reason of the board fracture, there were made other analyzes after evaluation of results (to compare possible influence of fibres with creation of cracks in the anhydrite screed) :

- ➢ specimens without fibres and
- ➢ specimens with polypropylene fibres ECONO MONO – length of fibre 19 mm. Those specimens reach to the best properties (if we pass away fractural energy of specimens with ten times amount of glass fibres).

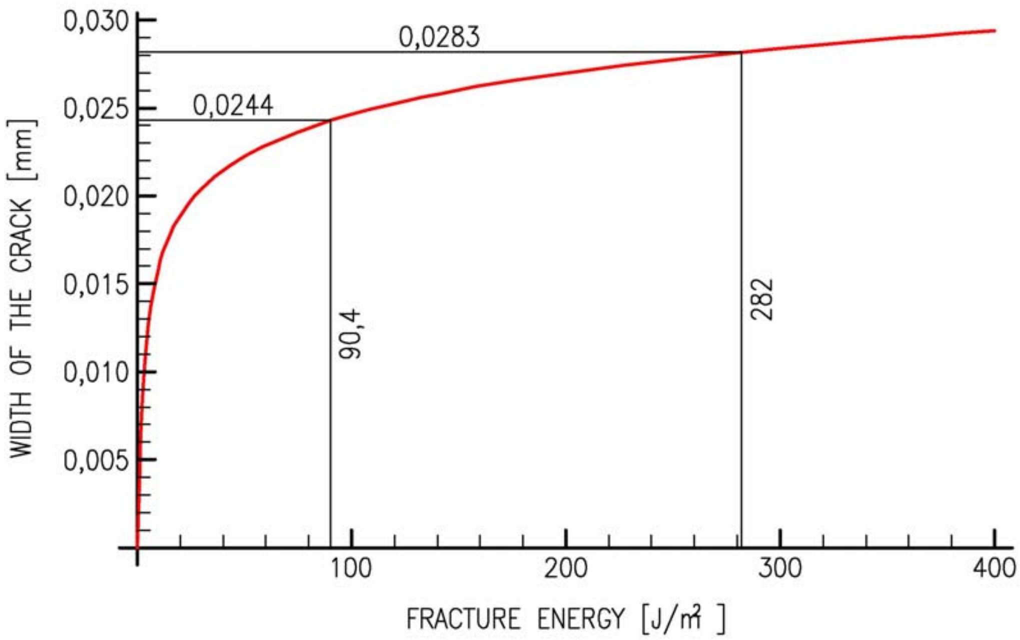
For computer simulation of anhydrite screed behavior was used model board with following properties :

- ➢ Width of the model board was 1 m, length 20 m, thickness 30 mm

- Board was put down on the elastic pad with max. compressibility of 5 mm with load of 2 kN.m^2
- Fracture energy was taken over from tables above
- Stress modulus of anhydrite was used 30 GPa
- Computation was made in software Mathematica



- Depth of initial defect (see Pic.4) – results from the computation of the depth of initial defect compared to fractural energy it has been set crack propagation at bending moment maximum value 226 Nm. Results from graph below :
  - The lesser fractural energy is, the lesser is depth of scratch – the reason of initial defect
  - Fractural energy of anhydrite screed without fibres is 90,4 J/m^2 – depth of scratch is 24 mm on 30 mm thick board
  - Fractural energy of anhydrite screed with polypropylene fibres length 19 mm is 282,2 J/m^2 or 415,9 J/m^2 – depth of scratch is 28 mm or 29 mm on 30 mm thick board



Pic.4 Depth of initial defect (mm)

- ⇒ Those ascertained results do not replay to practical knowledge, especially at anhydrite screed without fibres. In this case failure usually happen in the places where the scratch reaches 1/3 thickness of the board. During realization of anhydrite screed with polypropylene fibres of tested type there were no cracks in the rugged area of 48 m^2.

With regard to conclusions resulting from computer simulation based on fractural energy, comparison of scratch depth computation has been made.
In accordance to Tab.2 there were determined average values of flexural strength of:

- anhydrite without fibres 3,46 MPa
- anhydrite with polypropylene fibres 5,27 MPa

from formula [1]:

$$\sigma = \frac{M}{W} \qquad [1]$$

σ - flexural stress, W - section modulus, M - bending moment

$$W = \frac{1}{6}bh^2 = \frac{1}{6}1 \times 0{,}03^2 = 1{,}5 \times 10^{-4}\ mm^3$$

$$W = \frac{M}{\sigma}$$

$$\frac{1}{6}bh^2 = \frac{M}{\sigma} \quad \Rightarrow \quad h = \sqrt{\frac{6M}{\sigma \times b}}$$

1) $\sigma = 3{,}46\ MPa$

$$\Rightarrow \quad h = \sqrt{\frac{6 \times 226 \times 10^{-6}}{3{,}46 \times 1}} = 0{,}198\ m = 19{,}8\ mm$$

2) $\sigma = 5{,}27\ MPa$

$$\Rightarrow \quad h = \sqrt{\frac{6 \times 226 \times 10^{-6}}{5{,}27 \times 1}} = 0{,}1603\ m = 16\ mm$$

4. Conclusion

Resulting from comparison of used methods there are different criteria for crack propagation for method based on flexural strength and for linear fracture mechanics. According to [1] "Linear fractural mechanics is based on mathematical apparatus of flexible continuum and is trying to find quantitative characteristics. Those characteristics are decisive quantities for assessment of stability or lability of the crack".

- ⇒ According to computation of flexural stress it is possible to state – the crack begin to expand if stress achieves tensile strength (there is no concentration stress expected at the edge of the crack - pure bending)
- ⇒ According to computation of fractural mechanics it is possible to state – the crack begin to expand when the depth of scratch achieves value of fractural energy (singular stress is infinite, it is not on the edge of the crack)

- ⇒ The influence of fractural energy is minor for crack creation; major influence has flexural strength of material.
- ⇒ Minimizing of crack creation should be reached by additions of fibres, i.e. increasing the tensile strength of material.

These conclusions are part of habilitation project of Ing. Miloslava Popenková, CSc. “Minimization of risk in the realization of anhydrite screed” .

Key words: anhydrite screed, breach, fracture energy

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WORKSHOP – MODEL OF COMMUNICATION IN CONSTRUCTION COMPANY

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Abstract

This paper reviews workshop as a model of communication in construction company. Also, it reviews implementation of workshops in project management through all phases (preparation and performance) in Team Co Čakovec from Croatia. Characteristics of workshops are overviewed through all stages. Especially, the significance of workshops in creating the database of the projects in a construction company is presented, as well as good and bad experiences that are used for higher-quality planning and implementation of construction works for the future projects.

Key words: workshop, project, plan and control

Introduction

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. 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 resources nowadays, resources, which mostly facilitate his work, 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, cause without good communication system that kind of information is missing when it is necessary.

Models of communication

Communication represents exchanging messages that are containing some information. Information is an interpreted message, something that eliminates or reduces uncertainty and increases knowledge. Communication can be verbal (oral and written) and nonverbal known as a body language. Furthermore, communication can be formal and informal. On projects it is necessary to dedicate special attention to communication because communication between people is not always smooth. Type and size of project significantly affects number of people and structure of the team, but for successful functioning of team atmosphere, skills of every team member is very important. In fact, certain conflicts appear, more or less dramatic. Project manager often struggles with conflicts between people in and around project, so that their presence would have less negative influence on project, all in aim of project success.

Workshop – project management component in Team Co

Nowadays workshops and teambuildings are very popular. They take place in many companies regardless to kind of business that they are in. Workshop is a gathering or training session that may last up to several days in length. It emphasizes problem-solving, hands-on training, and requires involvement of the participants. Following trends, as raising quality and level of project management within organization structure of construction company, Team Co Čakovec from Croatia introduced workshop as a new way of communication in project management.

Project gathers a large number of participants, starting from investor, designer, project team and realization company, which can as a main contractor have more subcontractors and suppliers. Listing of participants in project indicates on very significant element of project, which is referring to mutual communication that is important for end project result. Also, within mentioned participants exists a complex organizational structure, which requires coordination, so that everything could be carried out in according to project goals. Model of communication through workshop in phase of project lifetime related to realisation of construction projects is very important part of project management in Team Co. Since the company started with realization of bigger projects, so it developed organisationally. To achieve successful project realisation, line and functional organisational structure of company was developed 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. Project manager, who is in fact a 'general director in miniature', is responsible for managing and success of the project. Since 2004 as important part of project management, workshop was set up as important communication tool. Till today in company there were held workshops for over forty (40) projects. Main function of workshop is the same as for project management: planning, organizing, team grouping, control and leading.

Despite the fact that every project is unique itself, there are standard project phases. Different sources provide civil engineering project partition on phases as follows:

1. Concept
2. Defining
3. Realization
4. Usage

5. Demolition.

This paper contains project management in a realisation phase, which is in Team Co divided to the following sub phases:

1. Preparation
2. Realization
3. Handover
4. Warranty period
5. Closing

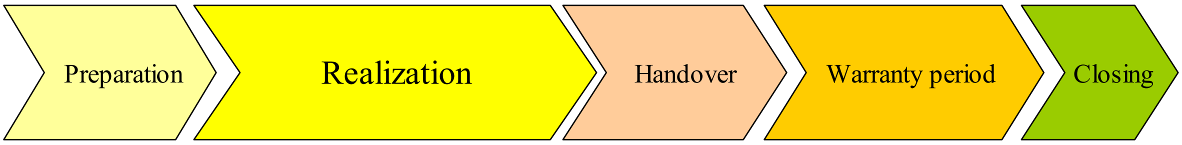

Figure 1. *Sub phases of project in realization*

Workshops are organised in all project sub phases, so depending of sub phase there are preparation, control and final workshop.

Preparation workshop

Start of the work on project, regardless its value or duration, in every case it is important situation that needs announcing. Perhaps it seems as unnecessary formalism, but it is very important to accurately define beginning of project realisation and there is no reason not to clearly present that. Announcement of beginning of the project can't harm, mostly it can have benefit in informing all participants involved in project. Document, which indicates the beginning of project, doesn't contain only announcement of the beginning but also other information. Immediately when new project is assigned to project manager, he must produce a document that contains numerous information in brief, clear, informing and well-organised form, which is distributed to all members of project team. In some organisations that document is called project management plan or project plan but in Team Co it is called preparation workshop. This significant document, required from project manager and his team, contains key parameters and project demands in sense of time, costs and quality answering the following questions:

- Why?
- What?
- When?
- Who?
- Where?
- How?

The final content of project plan or preparation workshop clearly varies depending of type of project but main points are standardised for all projects. Project manager is obligated to gather all information about project, latest within two weeks after signing the contract, in contact with company construction manager, project preparation and realization sector manager, other project managers in company, designer, supervising engineer and investor what will surly help him to completely understand the project when he classifies very often largely documentation. Methods and procedures are standardised within company what ensures that project manager doesn’t 'invent the wheel'.

Besides project identification, with declaration of project beginning, person in charge for producing the main plan document determines the main participants and project organisation, also accompanied frames and alternatives in project progress. This document is delivered to all participants as notice that project is formed what results in their commitment to the project.

Decision to hold workshop is brought by company construction manager or other competent sector manager on basis of information that investor, after successful process of bidding and contracting, will sign the contract. Furthermore, competent manager can also decide based on project information in situation when signing of contract is certain or when project is set up as internal in the company. In that way he would gain on time.

Workshop is produced and led by project manager whom the project is assigned to. On basis of all collected known commercial, technical and other information about project, interviews with participants who were involved in bidding and project contracting, as other project managers in company, his duty is to present the way of organisation to top company management, as well as methods which will result project success with assigned project team. Accordingly project manager is responsible for project success to contribute to company's strategic goals.

Concept of project is defined at workshop, and makes the plan with following content:

1. Basic project information
   - Title of the project
   - Technical conditions
   - Commercial conditions
   - Location of project

2. Important characteristics of project
   - Goals of the key participants in project
   - Ranking criteria of project success
   - Project phases
   - Main interim deadlines
   - Main restrictions
   - Documentation status

3. Project management programme
   - Organisation breakdown structure (OBS)
   - Work breakdown structure (WBS)
   - Roles and responsibilities of project team members
   - Site organisation plan
   - Basic term plan
   - Monitoring the realization of plan
   - Analysis of the realised projects
   - Planned income, costs and result
   - Subcontracting plan
   - Planned subcontractors and suppliers

- Cost significant activities
- Financial plan
- Cost monitoring during realisation
- Risks
- Project reporting

4. Analysis
   - Analysis of risks of realised projects and projects in realisation
   - Analysis of restrictions of realised projects and projects in realisation
   - Analysis of defects of other similar projects
   - Feedbacks from realised projects

5. Conclusion

Basic project information includes official and informal (working) title of project, also information about contract, investor, construction and other key information about the project. Overview of technical and commercial conditions, as project location that is construction site, gives a close description to project team members that weren't involved in project preparation, to gain clear picture about size and demands of project. On basis of this information, in clear way the content of project is presented, as key elements its realisation – deadlines, resources, costs, etc. At the same time in this part of workshop activities in phase of bidding and negotiations are analysed with emphasizing on specifics and information about needs, requests and expectations of investor.

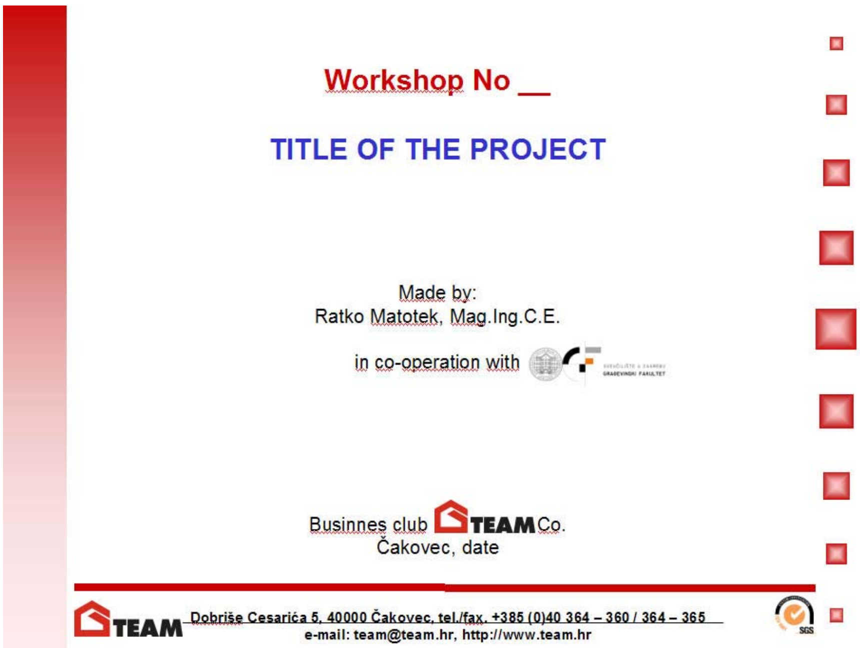

Figure 2. *Workshop*

Participants of different levels are involved in the project. In the project are usually involved governing, local, regional and state bodies, end users, investor, designers, contractor, subcontractors and suppliers. Every one of key project participants has its own goals that don't have to be the same as the one on higher or lower level. For example, contractor has a goal of higher money income, but for investor that income means cost that has to be lower. So, it is important to recognize, set up and compare the goals of each key project participant.

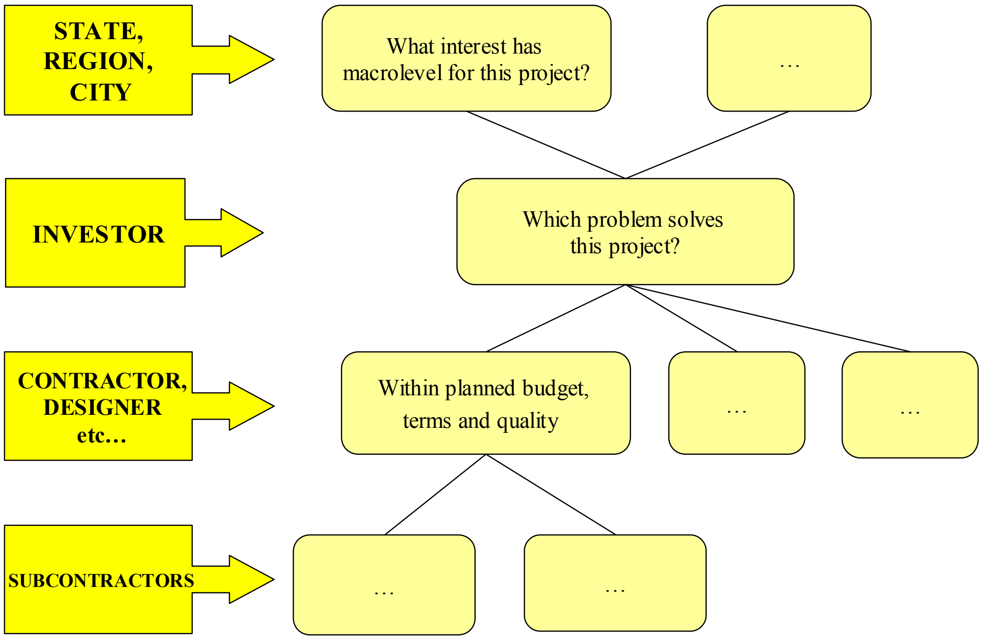

Figure 3. *Goals of key project participants*

Definition of contractor project goals needs a ranking of criteria of project success that is specific and underlined for each project. Almost always the same goals of project for contractor are related with minimum of costs, time, resources and risks and maximum quality, so they need to be ranked because there are projects where one of the elements is more important then other. That is why a ranking is needed, so the right balance is set up between basic elements of project realization – time, costs, quality and risk. Usually the tourism projects have the most important element finish on time, exactly to the day because capacitates are filled in advance and every delay means the lost for investor and it means appliance of penalty and charge of damage for contractor. For housing and residential projects the quality of construction work is the most important because the apartments have to be sold to the end users. The ranking of the goals also needs the answers why is the setup just the way they are, also having on mind that goals have to be defined, measurable and verifiable. Setup goals must be measurable that during realization the corrective actions could be taken on time when plan deviates.

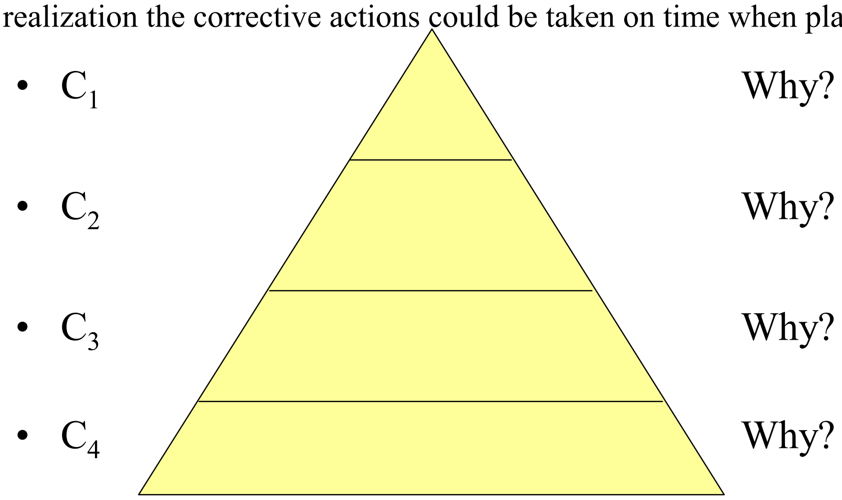

Figure 4. *Ranking the criteria of project success*

Every project has a lifetime and goes through phases. This part of workshop analyzes previous phases and upcoming ones. Rough segmenting of project phases can be preparation, realization and finish. Also, the contract can specify the interim deadlines that have to be achieved. This part of the project must be separately monitored.

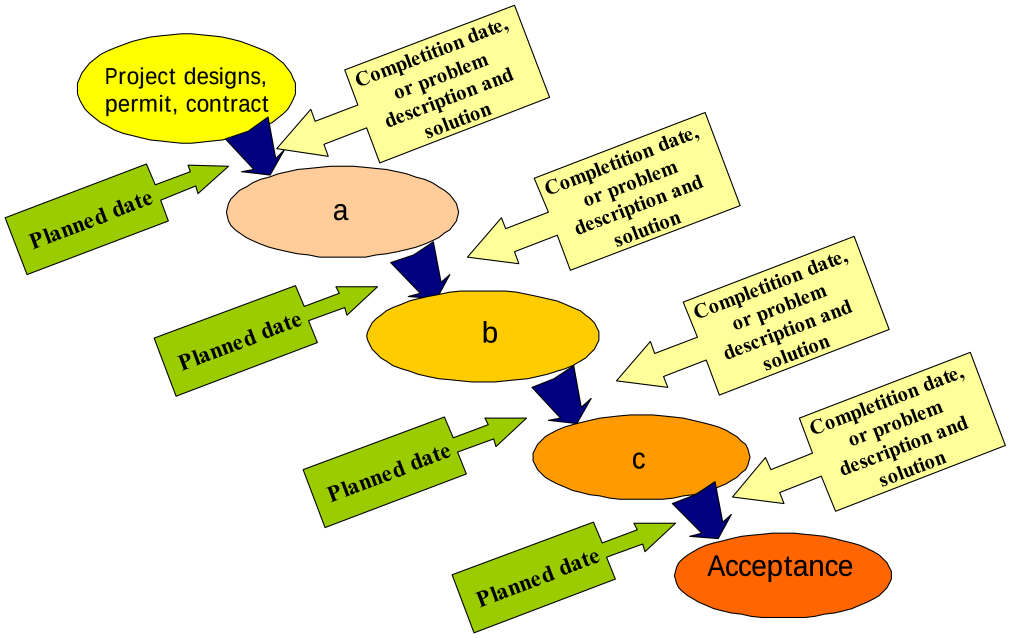

Figure 5. *Project phases*

Every project has primary restrictions; time and money, but as every project is unique it has the other restrictions, like organizational, technical or technological. In preparation workshop the noted restrictions are analysed and categorized. Every restriction is than related to the way of performance and responsibility of the team member.

RESTRICTION	CHARACTERISTIC	PERFORMANCE	RESPONSIBILITY

Figure 6. *Main restrictions in project*

Status of the documentation is overviewed through the list of delivered documentation (design, technical, contract, permits etc.). List of missing documentation includes the deadlines of deliveries and are included in the overviewed plan. This analysis is a good basis for presenting the possible scenario in a case of delay of the other participants involved in project that aren’t in organizational structure of contractor, especially designers and investors.

Project management programme organizes the project team by work breakdown structure (WBS) vs. organization breakdown structure (OBS) Matrix of roles and responsibilities includes team members by activities and defines responsibilities in the project.

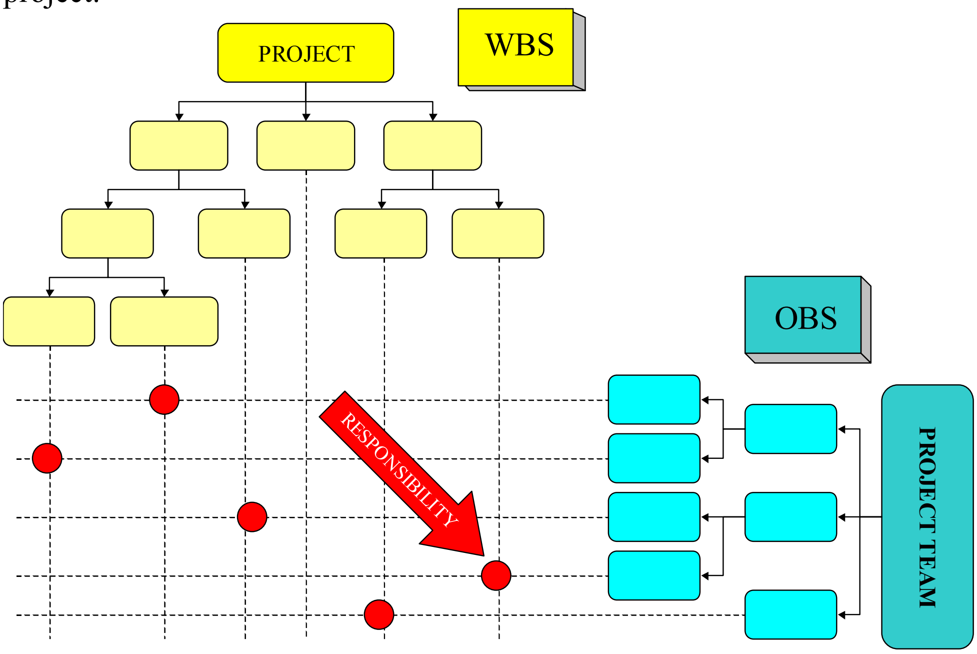

Figure 7. *Work breakdown structure (WBS) vs. organization breakdown structure (OBS)*

Analysis of basic time plan that is usually created in phase of biding, key interim dates and discussion with other team members, gives all information to create the overviewed plan that includes all obligations of other participants in the project (investor, designers, subcontractors, suppliers etc.). This plan is developed through detailed week operating site plan presented as Gantt chart, S-curve or some other technique of planning. Accepted and improved by company's experts technique of monitoring the performance by S-curve appeared to be the best indicator of unplanned changes because one graph shows plan, trend and prognosis of possible scenario. This presentation of graph on week site meetings enables allegations of site team members on problems.

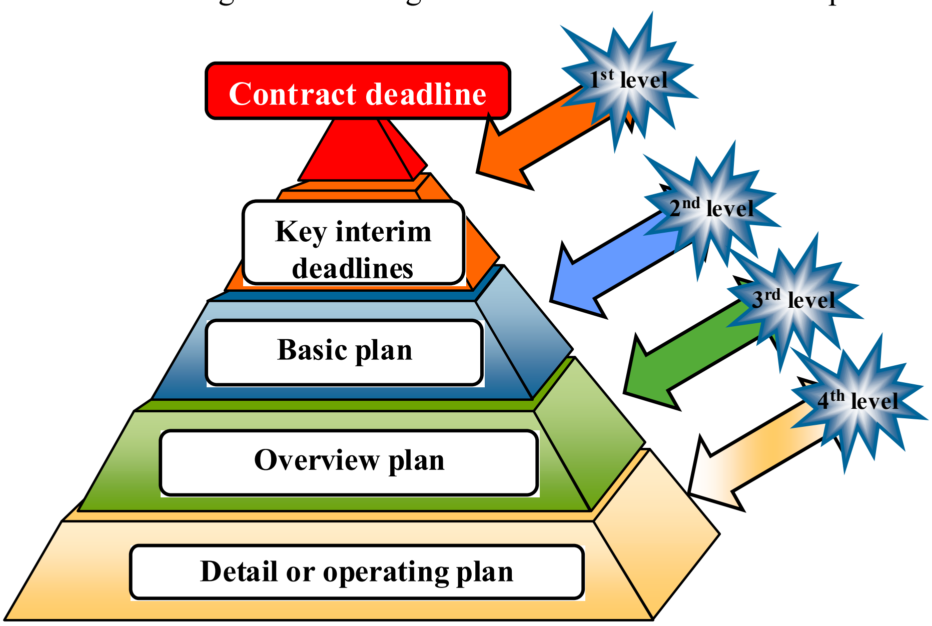

Figure 8. *Term plan ranking*

As realized projects are connected by some criteria, such as the same investor, category of building, size, work performance period or some other, these analyses are used for conclusions by lessons learned of previous projects and provide possible expectations.

Presenting the planned income, costs and result of the project, all costs are analysed because from this moment this is the basis for monitoring the overall result of the project including subcontracting plan.

Continuous monitoring and evaluation of subcontractors of realized projects and also monitoring on current projects gives a basis for decision of managing the suggested ones.

Cost significant activities are important for every level of project team organizational structure, from foreman to higher level, because during the work performance, every team member always has on mind that controlling these 20% activities, you can control 80% of all costs.

Finance plan is a good basis also for monitoring the realization of the project and indicator of work performance.

Team Co owns little database of risks of realized projects that are used for analysis and planning of the future projects. Risks are related to the answer in the event of appearance, scenario and also responsibility of the team member whom was the risk assigned to.

RISK	ANSWER	RESPONSIBILITY

Figure 9. *Analysis of risks*

Acceptance of the reporting form formalizes the communication in project. For major projects, not only because of its size, but the short period of realization or high value, special templates are adjusted to the project. System of reporting is established from the foreman level to higher levels by synthesizing the information from lower level to higher one.

Quality plan includes:

- goals of quality in project, that have to be measurable and verifiable
- project organization structure with clear presentation of quality insurance
- quality insurance programme
- plan of control activities
- responsibilities for quality insurance.

REPORT No __ – STATUS OF WORKS					
RN					
PROJECT MANAGER					
SITE ENGINEER					
INVESTOR					
PERIOD last 7 days					
- … - …					
PERIOD next 7 (14) days					
- … - …					
PROBLEM – URGENT TO SOLVE					
- … - …					
Date:		Made by:		Signature:	

Figure 10. *Template of week report*

Figure 11. *Workshop*

Participants in the preparation workshop are members of the project team. Intention of the workshop is to present the project team members and to define roles and responsibilities. During workshop it is very important for every team member to understand the goals and concept of project managing, also to understand the responsibility for the part that considers each member. It is necessary to solve every current problem and discuss all issues related to the project and also to answer first requests for action. The participation on workshop has to be actively and constructively, clear and concise, focused on key elements and problems that have to be solved by team. Workshop is not the place for description of the problems, but to present it with suggestion of solution. Part of the moderator during workshop is to notice the key elements that have to be detail analyzed and explained to the participants, so the project is clear presented, as well as the role of each member. Moderator directs the workshop to the end and conclusion that is delivered in written form to every participant of workshop and also to the others that are related to the conclusions. Intention of the written report of conclusion is not the report who said what, but to remind every member what was agreed so their work could continue in all for the success of the project.

Control workshop

As control is the keeper of the property neither system functions without it. Created project plan according to the concept of preparation workshop defines plan and programme, assigns roles and responsibilities, with respect to start up the realization of the project and presents the basis for continuing the project and also the basis to compare performance with the plan. Accepted plan is the basis for monitoring, reporting and controlling the standard parameters (time, costs and quality) and also the other noted specifics in the project. Monitoring of the realization and comparing the plan–performance with criteria time–costs–concept–quality, the control is based on the setup project goals. System of control includes:

1. Plan update
    - presentation of performance and comparison with the plan
    - analysis of interim deadlines
    - risk analysis
2. Brief presentation of planned, performed and remained quantities
3. Report of planned and actual costs, also prognosis with the budget status and list of the unnecessary costs so far
4. Analysis of changes
5. Report of quality control with list of problems and solutions
6. Week reports about progress, current problems and suggestions of solving, also other information
7. Monthly reports of progress with list of control actions and reinstate
8. Description of the group, time and size of corrective actions, analysis of responsibilities, separate studies of suggested and alternative solutions of current and problems that could appear

Final workshop

The main goal of final workshop is presetting the final report of the realized project. Content of the final workshop is:

- brief presentation of achieving the setup goals
- presentation of time, cost and resource performance
- overview of the changes during the project realization
- clear evaluation of the project success.

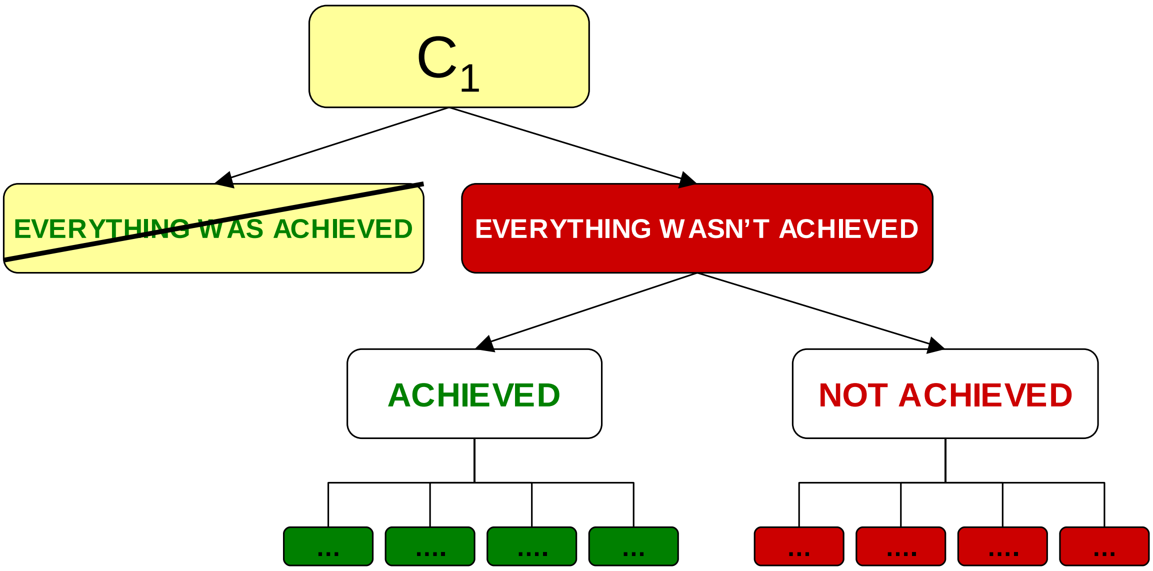

Figure 12. *Analysis of criteria for project success*

Form of the final report is adjusted for the future analysis of the results on the higher levels in company. Final workshop presents the end of all activities and handover the building to the investor. Achievement of the set up goals on the preparation workshop evaluates the organization and project management. Aim of the final workshop is the analysis of the feedback based on the experiences that is part of the final report. Analysis of the feedback is related to the overview of the experiences so that can be used in the future projects. Everything positive should be repeated and negative avoided. Of course, that isn't easy because the projects are carried out in another circumstance, but there is no doubt that experiences are always welcome, wetter they are good or bad.

	WHAT?	GOOD	BAD	FEEDVACK	MONITORING
GOALS	CONTRACT/INVESTOR				
	TERM				
	QUALITY				
	COSTS				
	RISKS				
	RESTRICTIONS				
	CHANGES				
ORGANIZATION	PROJECT TEAM				
	PROJECT MANAGER				
	SUBCONTRACTORS				
	TEAM Co				
	PROCEDURES:				
	a) PLANNING				
	b) MONITORING				
	c) DOCUMENTATION				

Figure 13. *Conclusion from the final workshop*

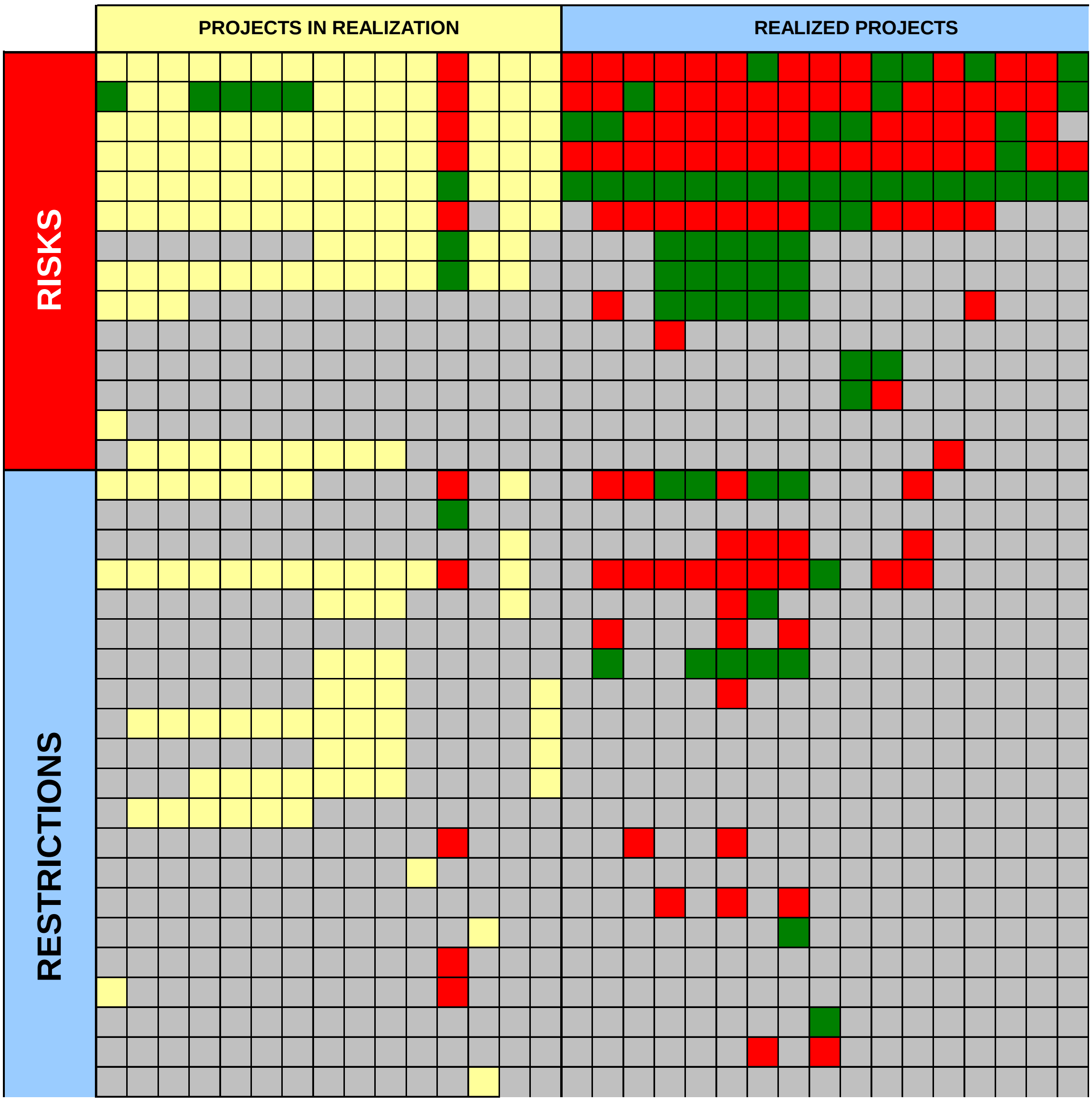

Figure 14. *Analysis of risks and restrictions*

Conclusion

The world market research trends point to project management as the most important job in 21st century so has company Team changed its own organization structure to follow up the world trends. Work of project management is very complicated, responsible, difficult and influential and can't be performed by improvisation, old time experience or intuition. The workshops are organized to avoid every improvisation and achieve clear definition of goal, organization and project management by teamwork that is the basis of monitoring and control in aim of project success that has to be included in strategic goals of the company.

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RESEARCH ON CUSTOMERS' PREFERENCES CONCERNING THE PURCHASE OF FLATS AND HOUSES ON THE POLISH PRIMARY AND SECONDARY RESIDENTIAL MARKET

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Summary

The present research was conducted in the period from 08.03.2007 to 29.04.2007 among the potential customers of the residential market in Cracow, Poland.
The present research indicates that the demand on the primary residential market in Cracow is definitely higher than on the secondary market. Such a distribution results above all from the fact that the purchase of a house or a flat is still a purchase for one's whole life. Moreover, the purchase of a flat on the primary market makes it possible to adjust a flat to one's individual needs while on the secondary market it is difficult to find a flat that would be suitable in all respects. The respondents realise that the purchase on the primary market is connected with a longer period of waiting for a ready flat but they accept it because it is a purchase of a lasting item. Similarly, the price is important but it is not a priority in the case of a purchase for one's whole life.

Key-words: primary residential market, secondary residential market

Introduction

The present research was conducted in the period from 08.03.2007 to 29.04.2007 among the potential customers of the residential market in Cracow, Poland. The method applied was the direct and the Internet questionnaires. The direct questionnaire was distributed with the method of snowball sampling (a respondent recommends another prospective respondent, who would fulfil given criteria related to the research) among customers interested in the purchase of a house or a flat in Cracow. The questionnaire was also placed on the website and information about it was provided on Polish Internet forums. The total number of respondents was 103.

A statistical respondent of the questionnaire may be described as a woman aged 21-30 with higher education and living in a city of over 50 thousand inhabitants. On average, respondents work in financial institutions and their net monthly income ranges between 1,000 and 4,000 PLN.

1. In what way would the respondents like to buy a house or a flat?

Almost half of the respondents want to buy a house or a flat on the primary market. 34% of the respondents have not made their decision yet and only 19% are in favour of the secondary market. Some of the hesitant respondents will probably add to the number of the ones interested in buying a house or a flat on the primary market. The author of the present paper states that, in the nearest future, the residential market is going to be dominated by developers who offer new flats and houses.

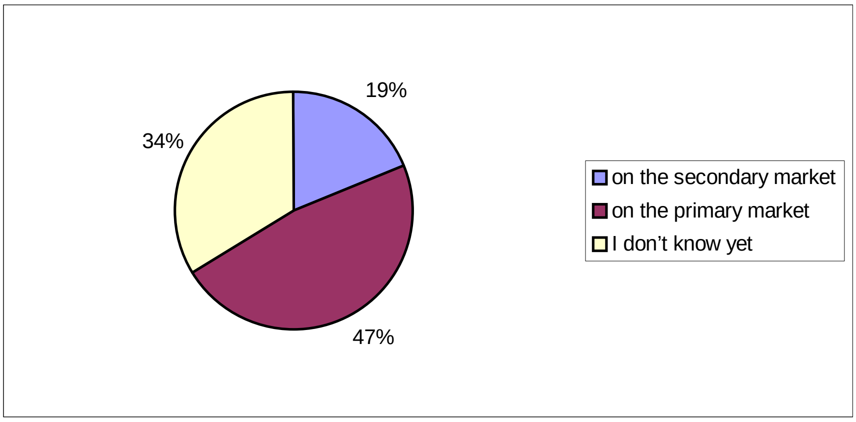

Figure 1. The percentage of replies to the question "In what way would you like to buy a house or a flat?"

2. What, according to the respondents, are the reasons for buying a house or a flat on the secondary market?

The greatest advantage of buying a flat on the secondary market is, according to the respondents, a possibility to see the flat, its layout and the natural light (61.2%). Another important factor, mentioned by half of the respondents (51%), is a much quicker purchase than on the primary market. The present study has shown that prices are not the decisive factor in making a purchase. It is the time and, above all, the appearance of a flat, that is the most important for potential customers.

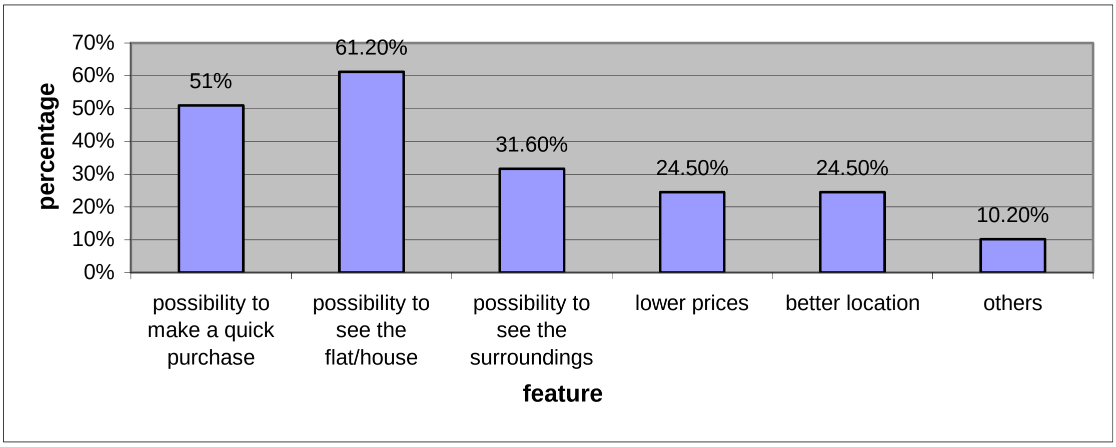

Figure 2. The percentage of replies to the question "What, according to you, are the reasons for buying a flat/house on the secondary market?"

3. What, according to the respondents, are the advantages of buying a house/flat on the primary market?

According to the decisive majority of the respondents (74%), the greatest advantage of a purchase on the primary market is the fact that the house/flat is new and "fresh". Another important factor is the possibility to adapt the flat to one's individual needs (63.5%). A large majority of the respondents do not think that buying a flat on the primary market is connected with a smaller risk. The percentage of the respondents who believe the contrary is 8.30%.

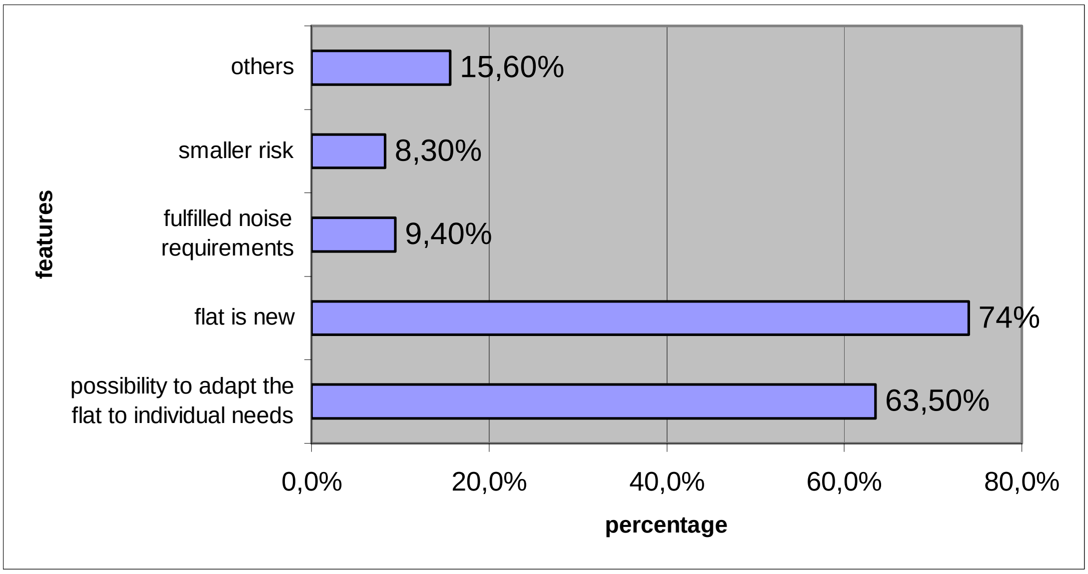

Figure 3. The percentage of replies to the question "What, according to you, are the advantages of buying a flat/house on the primary market?"

4. What, according to the respondents, are the disadvantages of buying a flat/house on the secondary market?

As many as 72.4% of the respondents think that the greatest disadvantage of buying a flat/house on the secondary market is that it frequently requires repairs, which means additional costs and a delay in moving in. It is also difficult to find a flat/house which is suitable in all respects (51% of the respondents). The smallest problem is, according to the respondents, bad acoustics, which is troublesome to every tenth respondent. A good idea for sellers on the secondary market is to redecorate the place before offering it for sale. This will certainly increase the number of potential buyers.

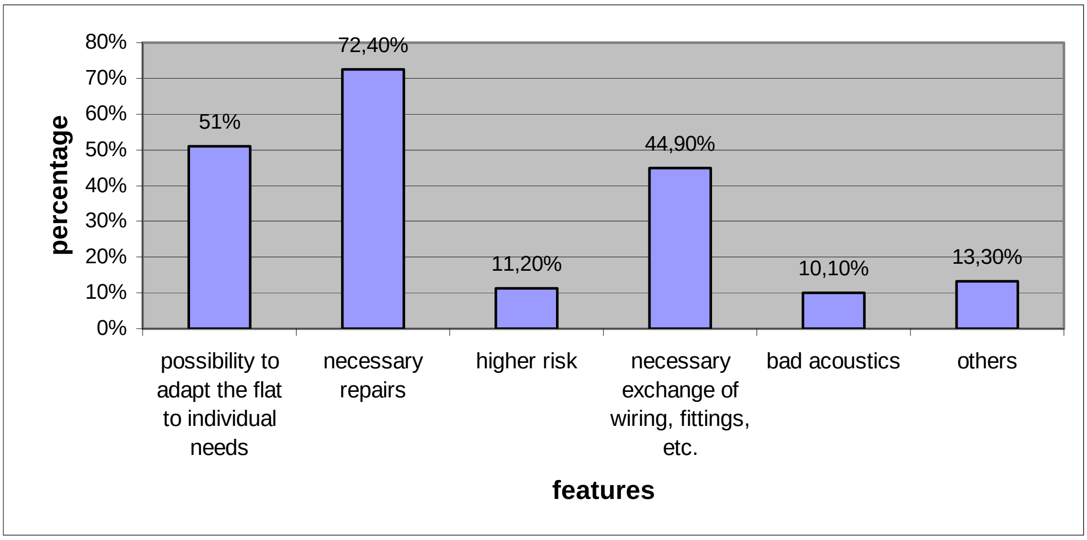

Figure 4. The percentage of replies to the question "What, according to you, are the disadvantages of buying a flat/house on the secondary market?"

5. What, according to the respondents, are the disadvantages of buying a flat/house on the primary market?

It is the ever prolonging time of waiting for a flat/house on the primary market that most respondents (54.5%) consider a disadvantage. It is already the second question that indicates that the period of waiting for a flat/house is very important for potential buyers. Half of the respondents (50.5%) think that a purchase on the primary market carries a risk of not knowing what the flat will look like after its decoration. The smallest percentage of the replies concerns a higher price than that on the secondary market (35.4%). This again indicates that, in the case of a "once-in-a-lifetime" purchase, the price is not the most important factor.

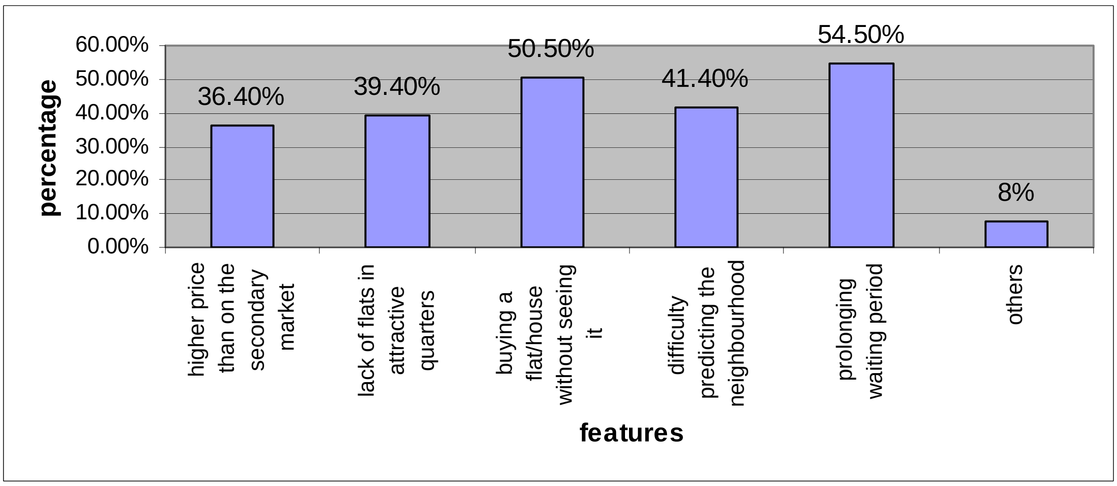

Figure 5. The percentage of replies to the question "What, according to you, are the disadvantages of buying a flat/house on the primary market?"

6. Where would the respondents like to buy a flat in the case of the primary market?

A purchase on the primary market interests many respondents. The most popular choice is with a developer, as was declared by 70.5% of the respondents. This information seems to be good for developers. Despite cases of dishonesty in this branch, the respondents still place much trust in them. A large number of the respondents would like to buy a new house/flat from an individual, as stated by 30.5% of the respondents. The smallest popularity is enjoyed by a kind of rental building developers, called “TBS” (social housing developers), which build rental flats funded in 70% by a loan from the National Housing Fund and in 30% from payments made by participants (legal or natural persons). Every natural person (not a tenant) can be a participant; usually this is a person who is close to the tenant. Because participants co-finance the construction of flats, they may indicate subsequent tenants in the cases of rental contract termination.

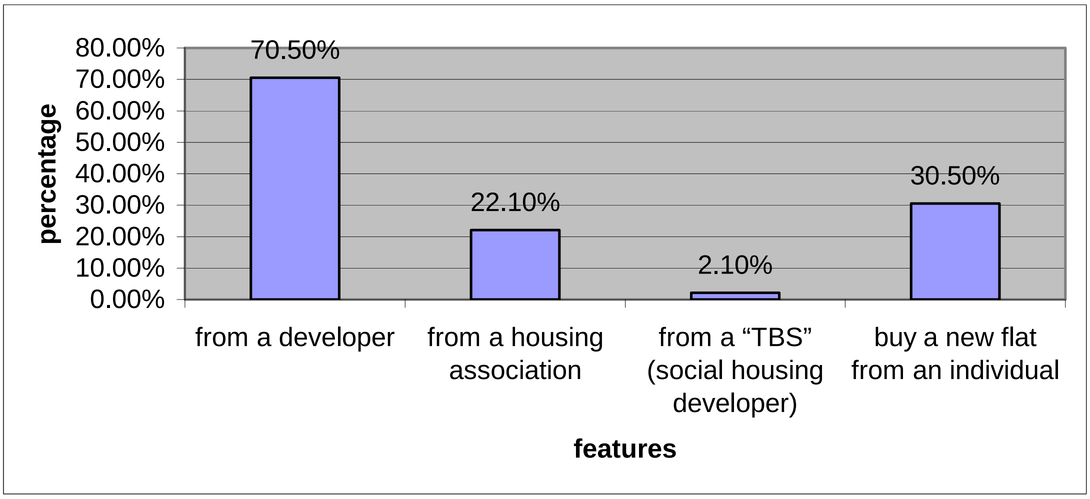

Figure 6. The percentage of replies to the question “Where would you like to buy a flat in the case of a purchase on the primary market?”

Conclusions

The present research indicates that the demand on the primary residential market in Cracow is definitely higher than on the secondary market. Such a distribution results above all from the fact that the purchase of a house or a flat is still a purchase for one’s whole life. Potential customers prefer purchasing new flats as they do not want to do larger repairs or redecoration in a few years. Moreover, the purchase of a flat on the primary market makes it possible to adjust a flat to one’s individual needs while on the secondary market it is difficult to find a flat that would be suitable in all respects. The respondents realise that the purchase on the primary market is connected with a longer period of waiting for a ready flat but they accept it because it is a purchase of a lasting item. Similarly, the price is important but it is not a priority in the case of a purchase for one’s whole life.

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PUBLIC FUNDS TRANSPORT LOGISTICS CENTRE IN CR

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1. Introduction

The Moravian-Silesian region (MSR) lies in North-eastern part of the Czech Republic – it is a region where great part of foreign investments directs. It is an important economic region with connection to industrial areas in Poland and Slovakia. Also establishment and development of industrial zones relates to development of current already restructured industry and new entrepreneurial activities. Necessary precondition for correct and successful operation of materials and possibly also information flows among single subjects is creation of required background in the form of a public logistic centre (PLC).
Public logistic centre can be characterized as an area where various operators realize their activities related to transport, logistics and distribution of materials and goods. Principle characteristic features of public logistic centre are:

- joining of carriers and hauliers, logistic services, industry and business companies etc.,
- joining of public administration organs, financial and insurance companies etc.,
- connection of at least two types of transport,
- support of synergic effects by assertion of cooperative projects of participating companies.

The aim of one of the projects solved at VSB-Technical University of Ostrava within EU programme Infrastructure was to select a suitable area for location of PLC fulfilling urban, economic, transport and ecological conditions.

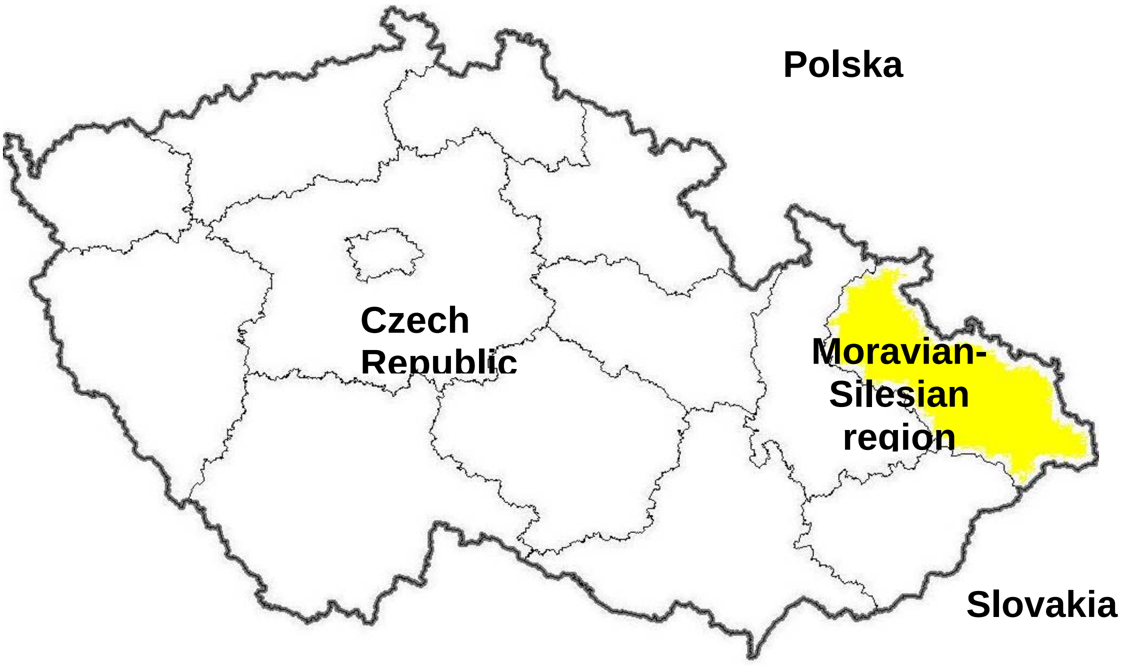

Fig. 1 Moravian-Silesian region in the Czech Republic

2. Proposals and location of logistic centres within Moravian-Silesian region

After analysis of current transport infrastructure of MSR and analysis of materials flows in the area of MSR was done, selection of an area for construction of PLC occurred. Then analysis of economic parameter of particular localities was done which resulted in choice of an optimum variant for location of PLC within Moravian-Silesian region.

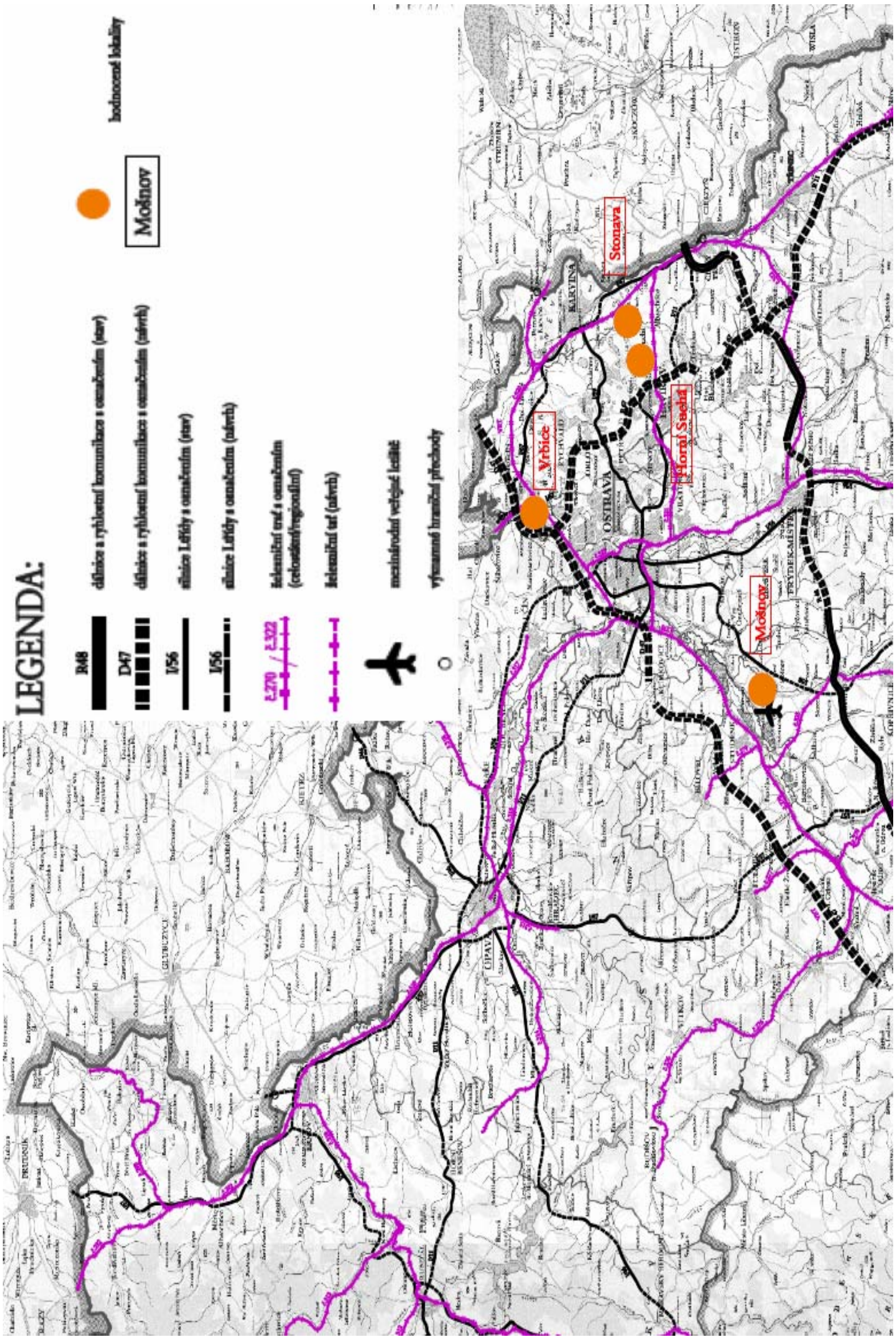

Fig. 2 Allocation of compared locations of PLC

Public logistic centre Mošnov

The locality is close to international airport Leoš Janáček and in the neighbourhood of developed industrial zone. The aim is to build significant centre of combined transport with use of containerization and flight cargo.

Transport connection can be realized through D47 highway and roads of 1st class (I/48 a I/58), railway connection on national railway Bohumín-Přerov by regional track Studénka–Veřovice.

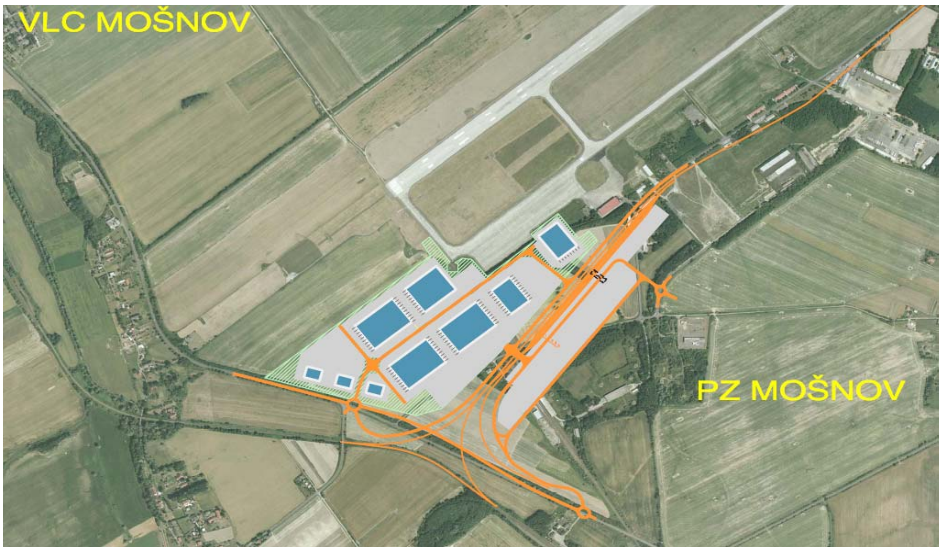

Fig. 3 PLC Mošnov

Public logistic centre Bohumín-Vrbice

The locality is an area in front of the railway station Bohumín-Vrbice. Proposition for creation of PLC including a terminal for combined transport represents inter-modal logistic centre in trans-European multimodal transport corridor VI.B (Baltic – Adriatic sea).

Transport relations are presented by D 47 highway, prospective speed road R 67, roads I/58 and I/67, II. and III. transit railway corridor, prospective Oder water route and cooperation with flight cargo transport from Ostrava-Mošnov airport.

Railway transport can be provided by current railway route Praha-Bohumín and Bohumín-Petrovice u Karviné–border with Poland and Dětmarovice-Mosty u Jablunkova-border with Slovakia. The railway tracks are a part of European VI. multi-modal transport corridor.

Fig. 4 PLC Bohumín-Vrbice

Public logistic centre Horní Suchá

With an outlook of broadening cross-border cooperation between the Czech Republic, Slovakia and Poland it is suitable to build PLC close to borders. The searched areas could be abandoned areas of former industrial factories called "brownfileds" situated mainly in Karviná area. Suitable localities are situated in the cadastre of Horní Suchá close to former František Mine.

PLC Horní Suchá is connected with other areas mainly by road I/11 and prospectively by new speed road R46 that would connect D 47 highway with R 48. The primary railway connection of the solved area is provided by railway route Bohumín–Přerov-Praha and Bohumín-Petrovice u Karviné-Mosty u Jablunkova-border with Slovakia.

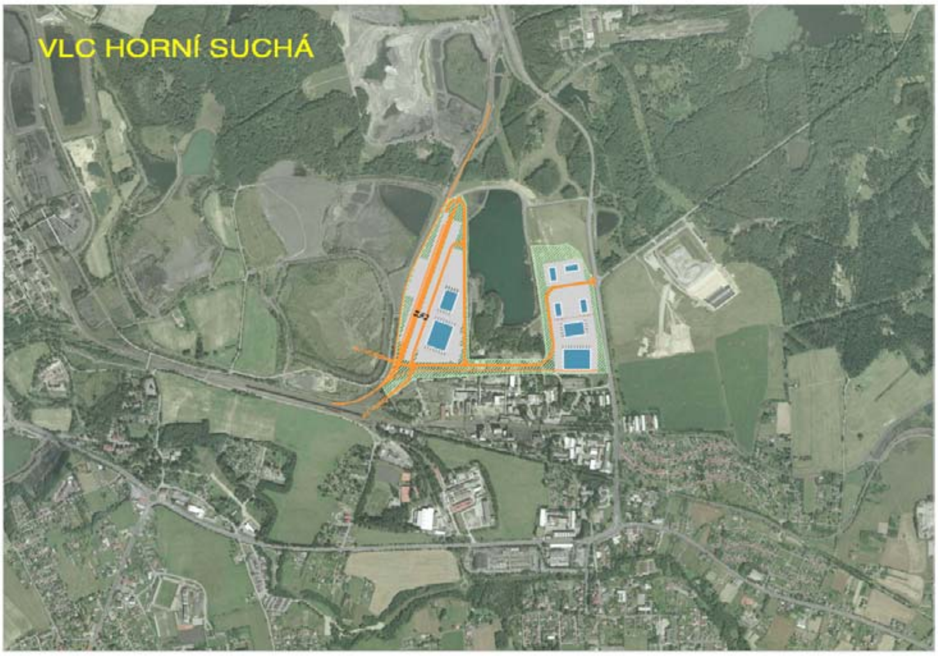

Fig. 5 PLC Horní Suchá

Public logistic centre Stonava

Among the disused areas called “brownfields” belongs an area close to ČSM Sever Mine in the cadastre of Stonava. Neither decline of the ground nor other accompanying phenomena of mining occurs in the area of interest. The primary railway connection of the solved area is provided mainly by railway route Bohumín–Přerov-Praha and Bohumín-Petrovice u Karviné-Mosty u Jablunkova-border with Slovakia.

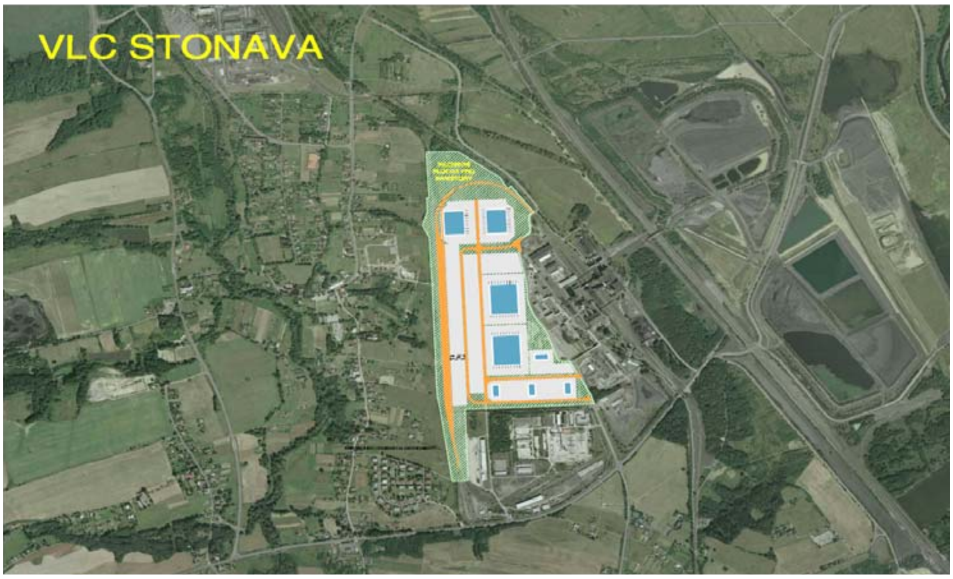

Fig. 6 PLC Stonava

Tab.1 Comparison of selected indicators of PLC

Locality	Total area of PLC (m^2)	Area of objects of PLC (m^2)	Price of objects in mil. Euro	Total costs in mil. Euro
Stonava	590 000	68 400	67	75
Mošnov	421 350	112 500	124	139
Horní Suchá	352 500	43 200	45	50
Bohumín-Vrbice	227 800	35 100	40	75

Great part of realization investments of PLC consists of construction costs of objects (storage halls and administrative buildings) which depend on used construction system, structure and disposition of objects (area, number of floors etc.). Another important part are costs for road and railway connection of PLC and internal communications and areas.

From the aspect of **building preparation** it is preferably the Mošnov locality which is the most favourable that is currently in the preparation phase – regional and building documents is already elaborated. Disadvantage lies in location of the terminal of combined transport that is located outside the area of PLC.

Localities in Horní Suchá and Stonava document utilization of so called "**brownfields**". Both areas are however located outside main transport corridors which can make them additional logistic centres that could serve mainly for regional transport.

3. Effect of realization of PLC on volume and structure of traffic on roads in the region

3.1 Changes of intensities of traffic caused by constructions and modernization of communications

Expected investment construction of new roads and reconstruction of current network is caused by requirements on increase of operational safety, speed up of connections including decrease of negative effects on living environment close to their routes. Changes of routes and to a certain extend also upgrading of parameters of routes will evoke redirection of transport in relation to offered comfort of travelling, source-destination distances, tonnage and sizes of vehicles as well as proposed charging of vehicles passage and other effects.
The period of realization of planned changes on the network of land communications can only be predicted, therefore distribution of transport burden between current network and new routes can have limited prognoses only.
The most important investments in the Moravian-Silesian region are communications of so called Silesian cross consisting of D47 highway (direction Austria-Poland) and ways of connected roads of I. class along border with Poland.
Increase of transport burden can be expected at D47 highway after its finishing and roads of I.class leading to border crossings with Poland in Český Těšín and through Jeseníky area (recreation) to border crossing…
Decline of transport burden can be expected with roads parallel to D47 highway and already mentioned roads to polish border.
On roads of lower transport importance and out of reach of mentioned important constructions changes evoked by expected increase of cars crossing will prevail.

3.2 Changes of intensities of traffic caused by increase of transport

The groundwork for prognosis of intensity of traffic flows of vehicles was elaboration of data acquired within national transport count on roads and highways of the Czech Republic from 2005.
In the future another increase of traffic intensity as a consequence of increasing number of cars and increasing number of covered kilometres in time is probable.

3.3 Changes of intensities of traffic caused by realization of PLC

Through realization of one of the proposed localities of PLC further increase of traffic intensity on the road network close to PLC will occur. The rise of traffic will be created by trucks and takes into account mainly:
- volume of transferred material
- speed of transfer depending on the amount and power of mechanisms, skills of the crew, state of the containers
- parameters of lorries

- speed of manipulation with carriages of railway transport
- custom clearance time etc.

Increase of traffic caused by operation of PLC was identified by traffic modelling of probable traffic in the next ten years after establishment of PLC. The basic value of traffic volume in 24 hours consisted of upper quartile of a unit whose value will be reached more probably than simple arithmetic mean of probable number of lorries.
This value varied from 500 to 700 lorries per 24 hours in all intact areas.

4. Conclusion

After summarization of the main effects of traffic intensities with an outlook till 2015 we set data on transport burden of the highway and roads that directly connect localities of prospected PLC.
The rises from expected transport to and from PLC are in most cases insignificant. However, rise of lorries on roads with low traffic burden is significant.
It is clear that from the aspect of living environment PLC with short connection on superior communications located in undeveloped areas have the advantage. Even in those cases it is necessary to solve particular types of protection.
Rises of freight will not influence level intensities of the highway and roads with connections of entrances and exits to and from PLC. Capacities of intact communications will not be exceeded. Width categories of the highway and roads do not need to be changed with respect to prospective traffic burden.
Entrances/exits to/from PLC in all localities will be realized on a flat terrain so that directional and altitudinal design of the route will be without bigger problems.
Dispositional solution of the communications can be considered in the width of 9,5 m not from the capacity aspect but for providing smooth transit of freight vehicles with containers.
Capacity of crossroads will be sufficient also in the future in comparison with values given in valid regulations where the maximum all-day capacity can reach 18 – 24 000 vehicles/day with uncontrolled crossroads.

From the traffic aspect the most convenient possibility seems to be location of PLC Bohumín-Vrbice which is given mainly by immediate vicinity of B branch of VI. Multimodal transport corridor presented by D47 highway, railway tracks of Czech Railways, prospective realization of water route Oder-Donau and vicinity of international airport of Leoš Janáček near Mošnov.

5. Summary

Development of restructured industry and new entrepreneurial activities are connected with establishment and development of industrial zones with adjoining activities in the area of Moravian-Silesian region. Essential conditions for success are well operating materials and information flows between single economic subjects that require building-technical facilities – public logistic centres (PLC). Concentration and distribution of products by various types of transport go on there together with concentration of transport flows for capacity transport routes outside built-up areas and possibilities of easier access to European transport corridors.

The aim of the study was to choose an optimal locality that can comply with urban, spatial, transport and ecological conditions for establishment of the needed and important public logistic centre.

Keywords:
public logistic centre, logistic, distribution of materials and goods, cross-border cooperation.

6. Resources

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INTERNATIONAL MARKETS AND SLOVENIAN CONSTRUCTION INDUSTRY

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Abstract

Current economic growth and the consequent investments into buildings and infrastructure in Slovenia are reasonably high. Construction, in general, is therefore booming and represents currently approximately 6 % of the Slovenian GDP. The revenue increase in 2007 for executed construction works is significant for both buildings and engineered structures. It can be expected, however, that these trends will not last forever, and Slovenian construction industry must look for work in other countries as well.
The paper reviews the basic strategies to be adopted in entering international markets in the field of construction along with experiences from other countries. Analysis of statistical data related to the current revenues of Slovenian AEC industry generated outside Slovenia is presented, and its results are discussed in the context of future development of these strategic markets.

Keywords: strategic planning, international market, construction industry

Introduction

Current high economic growth in Slovenia is, on one hand, driven by construction activities (particularly highway construction). On the other hand, it is stimulating new investments into constructed assets in industrial, business and residential sector. Construction, in general, is booming for various reasons and represents currently 6,1 % of the Slovenian GDP, which, in total is 33542 million EUR (Pomladna napoved, 2008) . The nominal and real revenue increase from April 2007 to April 2008 for executed construction works in Slovenia is 19,8% and 14,8% for buildings, and 36,4% and 30,0% for engineered structures, respectively (Indeksi vrednosti opravljenih gradbenih del, 2008). It can be expected, however, that these trends will not last forever. Ideally, the Slovenian construction industry should start considering alternative markets while the ongoing business situation brings a satisfactory level of profit.
The purpose of this paper is to create a baseline for the Slovenian AEC industry in relation to international markets. Basic strategies to be adopted in entering international markets in the field of construction along with experiences from other countries will be reviewed, and analysis of statistical data related to the current revenues of Slovenian construction industry generated outside Slovenia will be carried out.
Entering a foreign market is a typical strategic decision that needs to be thoroughly investigated by the top management in the company (Možina *at al*, 2002). Comprehensive information from the organisation environment, as well the internal information about strengths and weaknesses of the company needs to be collected and analysed, and decisions should be taken after a thorough review of all identified alternatives.

The company planning to compete at international markets should also be aware that the associated transaction costs are likely to increase compared to the domestic market (Love *et al*, 2002). The transaction costs, or the costs of carrying out the exchange, can be classified as information costs, negotiation costs and monitoring costs (Hobbs, 1996). Efficient strategies should be developed in order to reduce all these costs when entering the international market.
The goal of these decisions and strategies is to ensure business success by optimization and balancing the project portfolio as well as the available resources. Considering that the projects carried out by a particular company are in different project stages, the attainment of this goal is an extremely complex task (Cekić, 2006).
During strategic planning and decision phase, the companies should also consider the studies carried out by the construction management researchers investigating strategies, competitive advantages and specific features of international markets, which will be summarized in the continuation.

Entering the international market

Construction demand in a particular country depends on several factors. The relationship between construction activity and economic development is well established (e.g. Ngowi *et al*, 2005; Wells, 1985). Recent studies show that despite construction spending per capita increasing as national development proceeds, construction spending per capita fails to maintain its share of GDP, and, therefore, declines in importance ((Ngowi *et al*, 2005). This shows that the role of construction changes as economic development proceeds, and construction demand can not be determined only be investment and economic growth, but also by the stage of economic development of a particular economy (Bon, Crosthwaite, 2000).
There are several ways in which construction firms enter the international market. Economic boom in a particular country, as already discussed, creates substantial construction demand that can not be fulfilled by the local industry. The second route is creating bilateral, or sometime s multilateral agreements, which set up the protocols that enable the companies of the participating companies to enter the markets of each other. The third route is through participation in large international projects (e.g. Three Gorges Dam). Another alternative is carrying out construction work for Multinational Corporations (MNCs). Multinational and global operations are increasing, and when MNCs move from their domestic markets, it is reported that many continue to use their verified suppliers (e.g. the same domestic construction company that built their last domestic project). At the same time, the need for local knowledge has been recognized and multinationals and their suppliers often form joint ventures with local partners (Ngowi *et al*, 2005).
Several researchers have studied the factors that determine the entrance and positioning of construction firms in international markets. The two prime concerns for ”going global” are long term profitability and balance of growth. Three factors were identified that determine the competitive advantage of construction companies when entering into the international markets: technological advantages; sophisticated management systems for scheduling, material tracking and organising subcontractors; and financing capability that enables the company to arrange for favourable project financing schedules (Ngowi *et al*, 2005; Abdul-Aziz, 1994)
Being a small economy, it can be expected that Slovenian construction industry will compete internationally in the EU and neighbouring countries. The majority of EU countries are characterized as mature construction markets. The new members, e.g. Czech Republic, Hungary, Poland, Rumania, and other countries, e.g. Ukraine, Russia can be considered, on the other hand, as big emerging markets. Analysis of construction output per capita in these countries may highlight long-term possibilities for foreign construction companies (Carrillo and Heavey, 2000).

Analysis of Slovenian construction industry

The data collected by the Chamber of Commerce and Industry of Slovenia (Table 1) shows that the Slovenian construction industry is fragmented and diverse in size and number of employees. Out of the 13274 registered construction companies and self-employed, only 0,83% are medium and large companies that are able (and want) to compete at international markets. These companies, of course, employ a large share, 32,8%, of all construction work force and create over 53% of the total Slovenian construction annual output. (Poslovanje industrije in gradbeništva v letu 2003: projekt Kazalniki poslovanja, 2004)

Table 1. General data for Slovenian construction industry (Poslovanje industrije in gradbeništva v letu 2003: projekt Kazalniki poslovanja, 2004)

company size	no.of companies	no.of empl.	annual turnover (10^6 EUR)
self-employed	9551	22401	750
small	3613	20010	1247
medium	66	6943	667
large	44	13750	1597
Total	**13274**	**63104**	**4261**

The majority of information presented in the following section is based on Statistical annual reports. Available statistical data (www.stat.si) are based on semi-annual surveys of executed design and construction works outside Slovenia. The survey includes the AEC companies that had an annual turnover in 2004 more than 55 10^6 SIT (approx. 230.000 EUR). Table 2 shows the total output measured as the total financial value of AEC activities being carried out between 1997 and 2006. It can be seen that foreign markets have so far not been an area of growth for the Slovenian AEC industry; depending on the year, their share is between 3,5 and 9,6% of the total output of the local construction industry. This can be explained by extensive highway construction programme which is currently being carried out in Slovenia; the increased domestic construction demand is engaging most of the resources. It can be noticed, however, that since 2001, the absolute output trend in foreign markets is steadily increasing. The estimated growth of construction works carried out in foreign markets for 2007 is 25%.

Table 2. Annual outputs of Slovenian construction industry in foreign and domestic markets

year	market foreign (10^6 EUR)	market domestic (10^6 EUR)	Foreign markets share (of total output) (%)
1997	94,6	1078	8,1
1998	113,3	1185	9,6
1999	61,3	1416	4,1
2000	58,4	1462	3,8
2001	51,6	1433	3,5
2002	97,9	1513	6,1
2003	104,5	1643	6,0
2004	112,6	1862	5,7
2005	90,6	1993	4,3
2006	97,3	2399	3,9

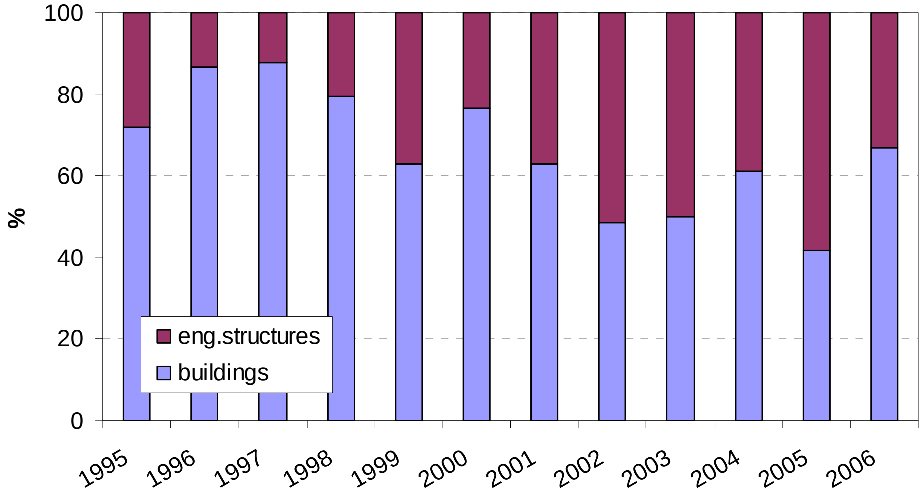

Figure 1. Proportion of building and engineered structures built by Slovenian construction industry in foreign markets between 1995 and 2006.

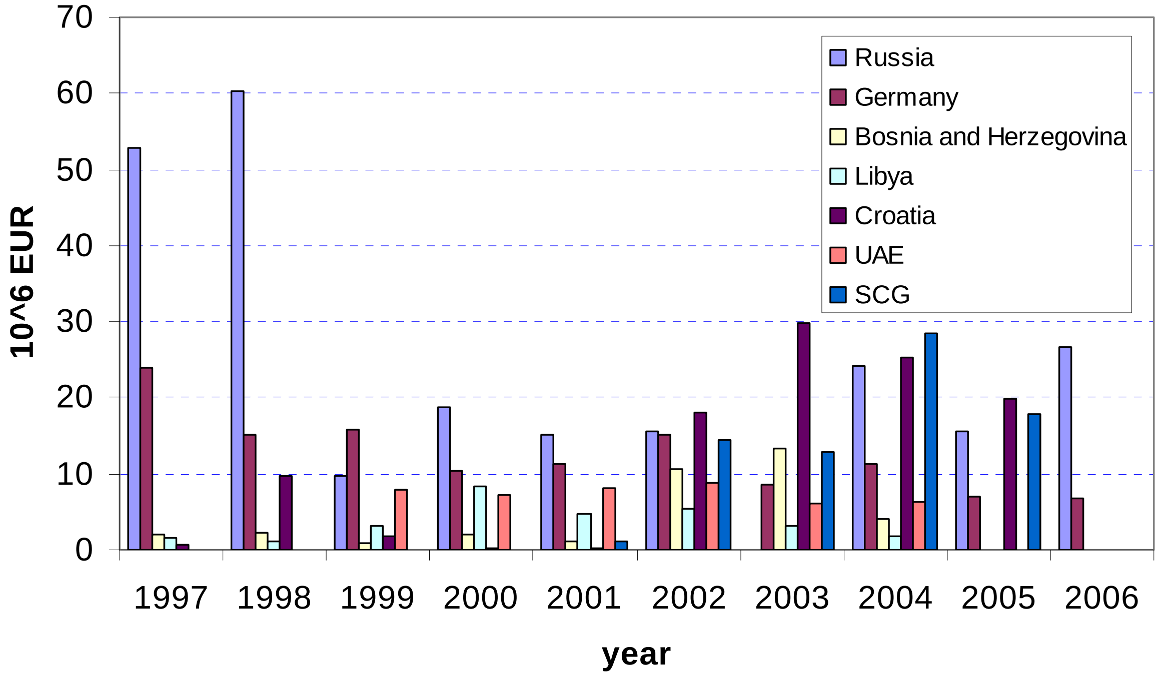

Figure 2. Output of Slovenian AEC industry outside Slovenia in the period from 1997 to 2006.

Proportion of buildings and engineered structures built by Slovenian AEC industry in international markets is presented in Figure 1. It can be seen that although there is a trend of increasing value of engineered structures, buildings remain the major construction market for Slovenian AEC industry abroad.

In Figure 2, the output with respect to the countries where the majority of the work carried out by the Slovenian construction AEC industry was performed is presented for the period from 1997 to 2006. The majority of works has been carried out in Russia, Germany, Bosnia and Herzegovina, Libya, Croatia, United Arab Emirates and Serbia and Montenegro. It should be noted that the methodology employed by the Statistical office of the Republic of Slovenia

prevents public presentation of statistical data if 2 or less than 2 companies are reporting the data (for a particular country) as this could disclose the identity of the companies providing the data; the presented data may therefore not include all activities.
It can be seen that over the past 10 years, the engagement of Slovenian AEC industry can be divided into 3 distinct parts: mature markets in the vicinity of Slovenia, e.g. Germany and Austria; the semi-mature markets of former Yugoslavia, where the construction demand is reasonably high; and emerging markets, such as Russia, Libya and United Arab Emirates, where the construction demand is high. In terms of output, the most stable country is Germany, while for all other countries, no particular trend can be observed. The importance of Russian market seems to decrease with time.

Analysis of semi-structured interviews

Preliminary research of strategies employed by the Slovenian AEC industry was carried out in the form of semi-structures interviews. Senior executives of 4 selected construction companies that compete at international markets were interviewed. The answers show that the companies use all strategies described by Ngowi *et al* (2005). They compete at large international projects (Brcar, 2006); are contracted by Slovenian corporations who extend their activities particularly to Croatia, Bosnia and Herzegovina and Serbia (Figure 3); or are engaged in bilateral agreements. Larger AEC companies create in international markets up to 30% of their total revenue. (Kaplan, 2008).

Figure 3. Factory Gorenje in Valjevo built by Vegrad d.d.
(http://www.vegrad.si/include/image_view.php?img_id=625)

Most of them see their presence at the international markets as a long-term future potential and not a major present source of income. When abroad, they found their subsiduaries or new companies. Sometimes, local partnerships are formed, however cases of local company acquisition can also be observed.

Conclusions

The obtained results show that Slovenian AEC industry is currently predominantly engaged in domestic market, however this is likely to change once the highway construction programme in Slovenia is completed. On long term scale, larger companies aim to widen their project portfolios by acquiring the contracts in (predominantly neighbouring) countries. This is especially suitable for companies who have gained vast experience in either highway or high-rise construction and are able to use this experience as a competitive advantage on international markets.

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ROOFTOP EXTENSIONS AS THE VIABLE SOLUTION OF COMPREHENSIVE REFURBISHMENT PROBLEMS

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Abstract:

The large part of high-rise multiple-family housing stock in Central Europe is degraded or energy inefficient. Its energy efficient refurbishment requires substantial financial resources. Energy neutral, industrial and flexible roof-top extension retrofit has been proven as a viable solution, both technologically and financially, since they reduce the financial burden of individual owners. In spite of the advantages of such approach to the refurbishment, it is not easy to implement in practice. The paper presents the financing, technological, legislative, industrial and institutional and other obstacles to successful implementation of such approach from Slovak as well as European perspective and suggests the ways in which they could be overcome. The proposals represents both the opinions of authors as well as the results achieved by the international project Sure-fit developed within the EU program Intelligent energy.

Keywords: Housing rooftop extensions, housing refurbishment, intelligent flexible design

1. Introduction[1]

Urban renewal of prefabricated panel housing stock is the important problem in Slovak many Central and Eastern European countries, because the substantial share of the population in these countries occupies it. This segment of housing stock was built mostly in 30-year time span (1960-1990), and so the deferred maintenance may cause substantial social and economic problems in the housing markets in future. In the present paper we try to point out

[1] The preparation of paper was funded by the of SuRE-FIT and grant – EIE/06/068/SI2.448123 and MVTS grant: "Sustainable Roof Extension Retrofit for High-Rise Social Housing in Europe as well as of "VEGA grant No. 1/3781/06 "European dimension of housing policy in Slovakia and the development of housing sector"

the present situation of this housing segment and the existing solutions for its further preservation.

The existing buildings are energy inefficient and often have unwanted homogenous occupation. There are certainly the differences between the older European countries and the newer ones. While in older countries the construction of large prefabricated housing stock continued to be built until the end of sixties, such mass construction was stopped in the new countries only at the beginning of Nineties. The different income situation in the old and new countries resulted into the difference in occupation of the housing units in the multiple family housing neighborhoods.

The removal of deferred housing maintenance and refurbishment problem is not easy to cope with. One of the partial solutions of this problem is to develop the rooftop extensions.

2. Urban renewal

Practically all prefabricated housing neighborhoods have to be renewed. It is necessary to start with the infrastructure that is in bad state. It is necessary to solve the parking problem. The designers of the neighborhood did not expect such growth of motorization. The sale of car grew rapidly after 1990. The parking lots have not usually been extended. The underground parking lots were constructed only in the limited numbers. As the result of that, the cars are often blocking the paths for the inhabitants, destroying the greenery, etc.

It is necessary to take care also to add additional services and shops in the neighborhoods, develop new greenery, rehabilitate the playgrounds for children, think about the colored facades, more modern lighting, building the rooftop extensions. The changes should be done in participation with the citizens and to facilitate the change of the lifestyle, increase the safety etc. The new owners of the housing units do not always value such changes in advance, although they bring not only more comfort into they life but also increase the value of the property.

It is also necessary to understand that there are hardly strong financial capacities and enough construction workers to realize the urban renewal fast enough. It is expected that if the construction of prefab neighborhoods took 30 years, their renewal will hardly be done let us say in 5 years.

The panel neighborhoods are today the mono-functional entities where the „life“ is missing, although in some of them lives quite a lot of inhabitants. Their size is often comparable to independent villages or towns, however growing decay make these „towns“ less attractive and the social problems have the tendency to cumulate. This is not so much problem yet in Slovak and Czech Republics as is in the Western countries; however the situation can change in future. There is the danger that the middle class would not like to live these neighborhoods. So the fast urban renewal is quite important problem to be solved.

The large housing estate in the Central and Eastern European countries appear to have greater problems regarding public space management, maintenance and use than those in other part of Europe. The housing privatization often did not solve the problem of the land property on which the buildings stand. That land often belongs to the third party (municipality, company, individual landlord, or even the unknown owner). Unclear ownership relations then complicate the care for the public space, such as greenery, parking lots etc. The existing situation is the legacy of the socialist past, when the land records were not kept properly. With the better registration of the property the situation should change rapidly, which does not mean, however, the solution of the problem. At present the public spaces are experiencing great pressure from the potential investors, who would like to develop the non-built-up spaces in order to make the profit. The original size of the public spaces is in such a way reduced. More new attractive housing units do not however mean that the area is becoming more attractive. Disappearance of greenery may create less attractive environment and the incentive for people to leave the area, which as the consequence leads to more vacancies in the stock.

The regeneration is an expensive and long term process and only a global approach will guarantee the solution of all problems in a logical time sequence and will ensure effective spending of financial means. The basic precondition is the integration of government and municipality investments. If we take into consideration the refurbishment of panel houses together with the improvement of open spaces, it is necessary to involve private investments too.

3. The refurbishment and rooftop extensions

The refurbishment became much more important in comparison with past. Approximately 60% of investment in the construction sector in Europe are in the fields of conversion, revitalization, restoring and rehabilitation Most projects try to involve important current topics, such as sustainability, material saving, increasing the supply of housing and enlarging the building itself.

Building the housing units on the roof of existing buildings can meet the modern era criteria for housing reconstruction. It enables to extend the housing space in the building, modernize the facilities, and adapt the housing units to the modern requirements, and to the segmentation of the housing demand.

The construction of the new housing units does not require the additional space, so it is sustainable from the point of view of saving the land. The new housing units do not need the new foundations, and thus a large quantity of materials is saved, and the amount of construction waste diminished. Related flow of materials is reduced. Roof toping also enable to solve the problem of the flat roofs that are not very suitable for the climate with frequent precipitation and icy winters. The leaking roofs then have to be repaired frequently. Sloping roofs on the contrary have the longer life span, can add the additional architectural value to refurbished building; the space under the sloping roofs is than effectively used for attics.

The really high effects from the rooftop extensions can be achieved when sustainability measures, the renovation of all building and energy efficiency measures are combined together with the housing market analysis. Situation in housing market can be the source of the new opportunities. For instance there may be the demand for the penthouses, high quality, non-standard elegant houses that may cover more than one floor, and may have the garden on the roof as well. The roofs of the houses are suitable for the construction of such housing units, especially if there are nice views from the top on the surrounding areas that is highly valued by many well-to-do families. Some of the solvent owners may prefer such apartments to single family housing units, especially when in such a way they are able to evade long commuting from the far outskirts of the town to their job places.

Refurbished buildings together with the revitalization of the surrounding areas have the important positive externalities for the area. As the result of it the local market value of the housing units grow, and more positive tenant mix can be achieved, although in some examples the effects of the gentrification may be expected. Surely enough the bank providing the mortgage credits for the clients in rooftop extensions should benefit from the rising value of the real estate that reduce their mortgage risk. Comprehensive refurbishment is also the opportunity to make more livable the existing housing stocks by for instance enlarging the balconies, rearranging the façade. Adding the additional housing units may help also to solve some of the problems of family life cycle. Older families may need less space for living, because they had already raised children, however they do not want to move out of their habitual neighborhood. Hence if they obtain the possibility to move to the new housing smaller units, on the rooftop, they may be quite satisfied.

Although many high-rise buildings need the renovation, they are often situated in the attractive areas of the town, for instance close to the center, or in relatively quiet environment. After their refurbishment, their value can substantially increase.

The new housing units on the top of the buildings may become the interesting source of revenue for the owners. From such revenues the costs of the refurbishment of the older part of the building can be partly offset. This moment is especially important for the social houses, but also for the condominiums. For instance in the Eastern European countries, the people often lack the necessary resources to pay the full costs of the renovation of the building. Revenues from selling the rooftop extension may become the additional source of financing such reconstruction, and so the financial burden is reduced.

4. SuRE-fit project

The important initiative in the area of the refurbishment of the panel housing is SURE-Fit project funded by the European Commission in the framework of Intelligent Energy program The project is oriented on the roof-top extension retrofit for high-rise social housing in Europe. Participants in the projects are Netherlands, France, Germany, Italy, Slovakia, Czech Republic, Poland, Sweden and Denmark.

The main goals of the project are defined as:

1. Consolidate the existing cutting edge technologies and best practices of roof top extension retrofit for high-rise social housing and develop process models and tailor-made guidelines for broader implementing the innovative solution in Europe.

2. Disseminate the knowledge and promoting the application of the integration of small-scale RES (renewable energy systems) installations, particularly PV panels, into the rooftop extension retrofit for high-rise social housing in Europe.

The rooftop extension as defined in the project may help to cope with several problems of the high-rise buildings. First of all it is the funding of their comprehensive refurbishment. Selling the additional housing units on the rooftop enable to create the additional financial sources that can be used for the refurbishment of the whole multiple- family houses, making the financial burden for the existing owners lower. The use of innovative technologies, such as better insulation materials, photovoltaic (PV) modules etc. enables to produce the energy neutral housing units on the top of existing houses.

The important moment of the retrofit scheme is intelligent flexible design (IFD) of the new housing units. IFD buildings approach includes:

- A smart, systemized approach to producing and delivering affordable and comfortable roof top extensions;
- A reduction of material use (by extending the lifespan of existing housing blocks, use of lightweight materials, optimized production conditions in factory);
- A reduction of waste production (re-use of existing building structures, possible re-use of demountable and modular IFD components);

- A reduction of on site nuisance for refurbishment and improved labor conditions for construction workers;
- A higher quality of delivered work;
- Less maintenance required over the building lifetime.

The refurbished building may stimulate urban area improvement as a joint effort between the local authority, housing associations, market parties, and the citizens. A dwelling with an increased internal flexibility will meet currently rising needs of – in particular - starters and elderly people. More diversity in population of urban areas is desired to enhance social cohesion. Along with building improvement the entire neighborhood will be upgraded. Rooftop extension retrofit will act as a strategic starting point for an area renewal strategy.

5. Technological aspects of the prefabricated housing stock in Slovakia

The beginning of mass flat building in Slovakia is dated since 1948 by building of brick apartment blocks from full burnt bricks with prefabricated elements as e.g. flooring plates, bresssummer, etc. Construction of apartment blocks was being accomplished by usage of element and volume standardization and by keeping of technical and economic indicators per a housing unit which were changing in particular time periods. Mass flat building of apartment blocks was accomplished in Slovakia in more than 20 types, construction systems and building systems which differ from each other by number of floors, shape, construction height, material of external cladding, different construction realization of balconies, loggias etc. The differences in the construction of apartment blocks built in particular construction systems or building systems we can see also from the point of the period of construction, carrying system (lengthwise or crosswise) as well as construction height of a floor.

In the appendix 1 the Table with the basic division of the number of flats built by mass flat building in Slovakia according to the building systems, construction systems and types in relation to their age, i.e. age until 10, 20, 30, 40 and 60 years. The table documents that more than 85% of total flat number was built in apartment blocks by applying of panel technologies. For reasons given we are focusing further on more on the problems of apartment blocks built by prefabricated technology. The table does not comprise apartment blocks built before the year 1946 and after 2003.

In the Appendix 2 the Table describing refurbishment costs according to building systems and professions for prefabricated housing stock are presented. The information is based on price analysis done in 1999 and appraised for price level of 2004 based on the statistical price indices.

6. Structure of permanently inhabited flats according to the material of carrying walls

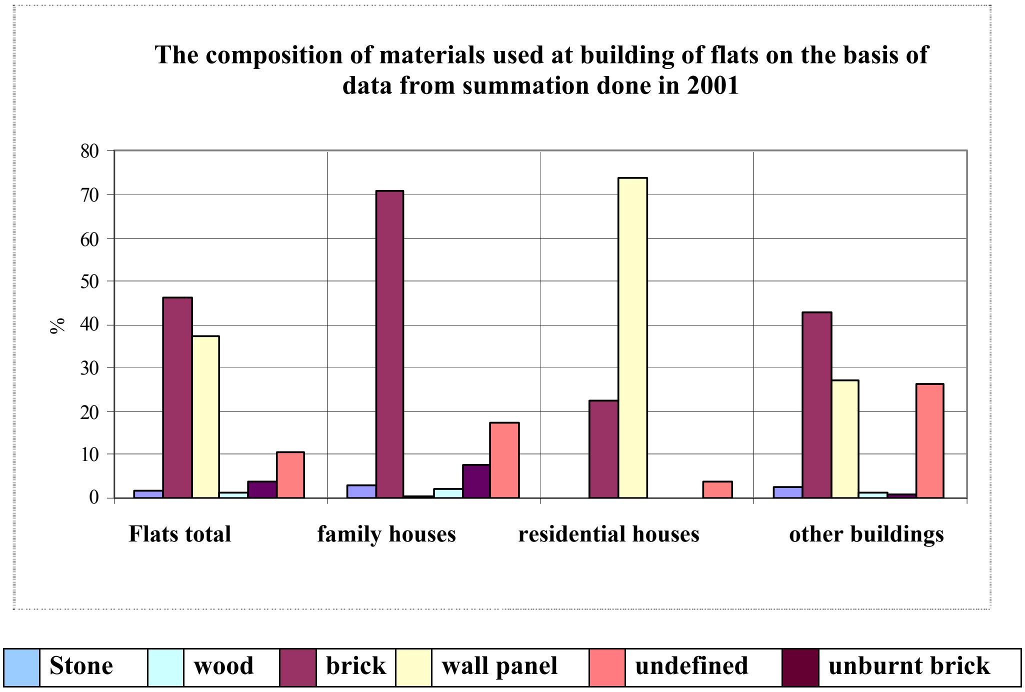
The quality of residential buildings pretty much depends on the structure of materials used for flat building, which determine the life, utilization of flats and requirements for their maintenance and repairs. The composition of materials used at building of flats on the basis of data from summation done in 2001 is represented in the following graph 1.

The physical condition of total residential buildings is necessary to characterize according to the particular types of houses in which flats are situated with selecting of those which are potentially suitable for heat-cladding as well as for a complete renewal. According to the importance and mainly according to the possible implications it is possible to divide the faults of apartment blocks into three categories:

- drawbacks endangering the safety of usage

- drawbacks which decrease the utility value, increase operating costs and in the course of time they can lead to incur of life-threatening defects
- drawbacks caused by the exceeding of useful life and wear and tear of building constructions and technical building equipment.

Apartment blocks built by mass forms of construction in years 1946 - 1993 (or later) at present do not comply with valid requirements regarding thermal insulation and energy efficiency. As a consequence building renewal has to involve also improvement of thermal-insulating properties of individual building constructions, which separate heated space from non-heated. The inevitable part of the improvement of energy efficiency is also linked to in-built in heat supply regulation and the hydraulic adjustment of heating system.



Graph 1 The composition of materials used at building of flats on the basis of data from summation done in 2001

7. What is the future of living in prefabricated houses?

This question should ask each owner of a flat himself/herself as well as each investor at investment objective preparation of its refurbishment. However in the majority of cases it is the question of money and decision between two possibilities namely:

1. *First possibility* is to do inevitable repair, removal of drawbacks by using of the cheapest materials, mainly without project documentation or missing of the majority of necessary project parts. The whole project realization is then managed by the empiric design of a supplier or project engineer. Negative but frequent phenomenon in the investor approach is his effort to have the cheapest realization and not technically correct and so the realization of building is performed without any calculations, expertise or supervising of a competent person. Realization of repair and heat cladding is commonly done in this way.

2. *Second,* but financially demanding, is comprehensive and high-quality refurbishment of apartment blocks, i.e. removal of systemic faults, complex repair of external cladding, roof, change of windows, doors and correct solving of all technical details while

meeting all new construction regulations and standards as well as prescribed technologies. It will subsequently influence:

- extension of lifetime of apartment block by 30 - 50 years,
- increase of energy efficiency by 30–60 %, which affects the reductions of related utility costs as well as maintenance and repair costs,
- prevention of occurrence of further panel construction defects, such as carbonization of prefabricated panels, corrosions of panel joints, etc.
- elimination of causes of mould occurrence in flats,
- improvement of architectural house design,
- increase of property market value etc.

Possibilities from the point of view of flat owners how to save financial resources and at the same time to have properly renewed apartment block are various. For example apartment blocks in the center of the towns rent the free space for advertisement placement, aerials or satellites for various media. Financial resources gained from renting are used for apartment blocks repair without charging significantly their maintenance and repair funds and thus the own financial resources of flat owners.

The other possibility is the sale of the roof space that is one of the common condominium spaces. As a result of it the share of common facilities is decreased and finally the contribution of each owner to maintenance and repair fund can be decreased as well.

There are several reasons that support the renewal of apartment block by realization of rooftop extension:

- quality realization has the influence on effective use of amortized roof as for example of kindergarten (Pic.1) by a rooftop extension of attic space for lodging at keeping untroubled running of original and new logical unit,
- revitalization and suitable incorporating of the building to original surroundings by creating of a new art-aesthetic face,
- interior layout, favorable economic indicators and short time of construction,
- gives the inspiration for similar application in rooftop extensions of objects of basic civic amenities,
- repair of old gas, electricity and water supply lines, change or reconstruction of lifts,
- a builder will repair roof without financial contribution of all owners of separate flats etc.

On the other side attic space and rooftop extensions have their drawbacks:

- space and floor losses in attic floor in case of small pitch of the roof, low backing or wrong disposition mainly in places with lower light height;
- leaning lower ceiling and changeable clear height over the part or whole floor limit the disposition layout of an attic floor;
- insufficient optic contact with surroundings at inappropriately chosen construction of roofing with low sloping of roof plane, inappropriate placement of windows and too big embedding of last under-roof floor into disposition can lead to the isolation of its inhabitants from outside environment;
- furnishing of space with chamfered lower ceiling by atypical furniture made-to-measure is usually financially more demanding;
- the investor at realization of rooftop extension is not always keeping the approved project documentation e.g. that by rooftop extension the number of floors of the house is increased only by one floor but in most cases he asks for change before finishing of the building. Without the consent and unknown to the owners thus he will increase the number of floors by one another floor or two floors which causes increase of number of cars and increased cost of cleaning and increased demand for parking which the investor at the end does not solve or he is not willing to solve it.

It is necessary to mention that not all apartment blocks allow realization of rooftop extension because they do not fulfil the fire-fighting requirements and they are not complying in the term of static or the general city plan does not allow the increase of the number of floors of apartment blocks etc.

The following examples illustrate the possibility to build new housing units over two types of buildings:

The first example is the realization of the rooftop extension over the existing kindergarten.

Picture 1 Kindergarten rooftop extension – 10 new housing units. Source: Photo from the 7th public non-anonymous contest PCDB 2004, Publication of Ministry of Construction and Regional Development

The interesting rooftop extension was realized on kindergarten in Moravany nad Váhom in Slovakia. The initiative came out from the municipality that wants to keep the low-income young people in the village. By rooftop extension the municipality decided to attain also other goals such as to renovate existing building, remove the leakages from the roof, and prevent the vandalism during the night. Ten new housing units were constructed (see the photo). The project obtained the highest price in the contest. Progressive and affordable housing (PCDB) in 2005. The contest was organized by Slovak Ministry of construction and regional development of Slovak Republic.

Basic construction data:

• Number of housing nits:	**10**
• Number of floors:	**Ground floor,**
	1 floor – the new one
• Category of housing units:	**2 three rooms units, 5 two rooms units,**
	3 one room unit
• Built area:	**859,04 m^2**
• Floor area of housing units:	**690.56 m^2**
• Housing living area:	**419.58 m^2**
• Built area:	**3,436.16 m^3**

Housing costs in SKK/ €	**11,578,980. - / 373,548. -**
Square meter costs in v SKK/ €	**21,000. -/ 677. -**
Construction period:	**11 months**

T***he second example*** (Pictures 2 and 3) is the reconstruction of the point apartment block of building system T08B in Košice built in cca 1970. There were four-floor houses with a basement and central communication core – stairs without a lift. In this case it is the redesigning of panel houses by the form of the simple rooftop extension whereby four new housing units were formed.

Picture 2 The nonrefurbished building

Picture 3 The new refurbished buildinf with the rooftop extension (Authors of the project: Ing. arch. Radoslav Novák, Ing. arch. Juraj Smieško

It is necessary to emphasize that the whole realization should be prepared by a project and controlled by an authorised person and his/her specialized skills are necessary to be checked at ordering of project work. The most common drawbacks are insufficient and unqualified preparation and control of realization, construction of heat cladding by a company without necessary qualification and trainings for work with heat cladding system (which is at present the reflection of catastrophic shortage of qualified building workers as well as project engineers for given field), self-willed replacement of materials in heat cladding and change of thickness of heat cladding etc.

8. Building certification

In accordance with the regulation of the European Union No. 2002/91/EC on Energy Performance of Buildings from December 2002 The parliament of Slovak Republic approved in 2005 The Law on energy performance of buildings as well as amendments of other related legislation. The basic goal of the law is to support better energy efficiency of buildings on the basis heat insulation related to the local climatic conditions. The expected consequence will be the reduction of the energy consumption in buildings without the need of the additional large financial costs and also the binding requirement to issue the energy certificate related to the consumption on the integrated energy for the new and renovated buildings.

More than 94 % of the housing stock in Slovak towns does not meet the contemporary recommended standards for housing efficiency of the external cladding. The housing insulation, the modernization of the heat supply can enable to augment the energy efficiency. The energy law that came to force from 1.1.2006 exerts the pressured on owners to refurbish the houses. The implementation of the law to practice was however postponed by two years due to the lack of qualified persons that are able to elaborate the energy certificate.

The precondition of the renovation is correct diagnostics of physical state of building, its structure. The documented results of the diagnostics must be realized before the start of the design work. On this basis it is possible to determine the scope of necessary renovation work. The problem is that such documentation is often missing.

Energy efficiency measures in the renovation project could be less or more successful depending on the correct diagnostics. This phase is often skipped or done superficially. In such a way it is possible to make the cost of renovation lower. Such approach is not systemic. The comprehensive diagnostics can show the need of other sequencing of the construction works, using other technologies and materials. That certainly augments the costs but on the other hands brings the economies but may augment more profoundly lifespan of the building and bring important economies because of stronger energy efficiency measures.

The demand for energy of existing dwellings built between 1960 and 1980 is about 250kWh/m2 per year. However, most of the buildings have been renovated before. The renovation works consisted of replacement of windows, addition of thermal insulation etcetera. Through various levels of renovation improvements in the energy performance of 25% up to 80% can be realized.

The negative but the frequent approach of the housing developer to housing refurbishment is to build with the minimum costs and to neglect some important aspects of the refurbishment. Often the refurbishment is being done without project, technical and economic analysis and even without the supervision technically qualified persons. Such approach is quite common when the roofs and facades are being insulated.

9. Realization of rooftop extensions with the support of project financing by commercial banks

The project financing area is at present the most spread possibility of financing of investment flat projects. For project financing it is characteristic that financial funds put into project are paid back from yields that the project generates. The condition for successful preparation and realization of investment project is the systemic application of principles and methods of project management – the set of activities and methods leading to a stated goal. Project management goes through time-spatial phases within which the individual processes and activities are performed. Project assets and generated cash flow preferentially create the collateral of the credit. In comparison with common forms of financing, preparation of the project is more time-consuming; it requires the synergy of professionals in the technical field, finance analysts and economists able to estimate development trends for the period of the credit providing. The financial institution involves into a project financing either as the only creditor or it enters into creditor relationship together with other financing institutions through syndicated loans. About its participation in project financing it decides on the basis of evaluation of project and credit risk. The crucial condition of a realization of such projects is their **economic return**. That is why at the assessment a lot of factors are taken into consideration and a project is assessed also from the view of estimated risks, which could influence its economy within the whole time of its economic return and at the same time especially in relation to the specific needs of an individual project.

The repayment schedule is related to prognosis of cash flow, which is fixed on the basis of technical and project analyses. Its purpose is to detect if the available future cash flow resulting from the project will be sufficient for covering of credit repayments including interests.

The secondary effect of the project financing is the fact that the commercial bank funding such a project willingly creates the package of favorable conditions for mortgages also for clients – natural entities who after its finishing will buy the space in rooftop extensions.

10.Potential of rooftop extension in Europe

The SuRE-fit team tried to estimate the maximum theoretical potential of the rooftop extensions in Europe. The methodological approach has been following. On the basis of the national statistics the number of low-rise building (the buildings with maximum eight floors) was found. From this number the buildings built between 1960 till 1980 were selected. According to the opinion of the expert team it does not make sense to build the rooftop extension on older buildings because their lifespan will be too short or they may be protected as the historical buildings. Roof topping on the buildings built after 1980 could be less efficient, because these buildings will need comprehensive refurbishment later, and they are also more energy efficient. Later the experts defined on how many low-rise buildings (built from 1960-80) the rooftop extensions could be mounted. The resulting appraisal of number of building suitable for rooftop extensions depended on the character of housing ownership in the different countries and the expert opinions. The resulting estimation of the potential is shown in the following Appendix 3. A total number of 7,369,763 dwellings belong to the theoretical potential of the rooftop extensions in Europe

11.Conclusion

There is the definite need to preserve the substantial part of the prefabricated panel housing stock in Central Eastern Europe while making it more energy efficient. The refurbishment is not cheap, and important part of the owners of housing units in the multifamily houses lacks the necessary financial resources. Also the sustainable energy savings solutions in housing sector have the growing importance.

One of the interesting partial solutions of the problem is the construction of adaptable, energy saving rooftop extensions, that may potentially trigger also broader aspects of the panel housing adjacent areas. The rooftop extensions and the comprehensive refurbishment of the older housing stock represent the sustainable ways of augmenting the housing offer, without the need of the additional land. The maximum potential for the rooftop extensions in Europe is quite impressive. The intelligent use of this potential is the challenge for the builders, developers, investors, architects, etc, since each potential building is situated in the different location that has its specifics.

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Appendix 1

	from	to	years	Total	T11 - T16	T01 B, T03B	BA	G 57	LB, MB	PV - 2	MS 5	MS 11	T06B - NA	T06B - ZA	T06B - KE	T06B - BB	T06B - BA	T08B - KE	ZT	ZTB	BA - BC	B - 70	PS 82 - TT	PS 82 - BB, PP	BA - NKS	P1.14	P1.15	Other built	Other prefab	undefined
building maintenance and refurbishment	1994	2003	**10**	**13,121**	219	168	0	76	48	34	0	0	363	62	118	116	114	0	0	0	0	706	332	100	0	4,141	2,857	1,494	1,204	969
	1984	1993	**20**	**182,047**	97	664	84	0	398	0	43	41	7,239	2,136	1,880	4,135	649	1,311	12	264	590	20,102	16,614	8,829	9,753	57,896	44,061	1,316	2,594	1,339
renewal	1974	1983	**30**	**290,599**	668	4,930	0	24	1,098	59	4	121	49,020	32,251	42,719	25,142	3,449	10,365	810	17,330	17,435	20,713	1,670	292	22,788	13,541	17,740	2,043	4,714	1,673
	1964	1973	**40**	**182,479**	3,724	14,802	3,923	939	13,546	5,144	3,625	2,367	27,529	19,353	32,858	10,321	7,060	10,494	7,817	3,703	2,279	580	0	20	944	112	32	4,636	4,640	2,031
	1946	1963	**60**	**110,040**	47,621	19,159	5,703	4,610	5,498	2,197	0	0	667	1,316	2,906	234	102	726	0	20	0	36	0	0	160	0	56	13,899	667	4,463
Total*				**778,286**	**52,329**	**39,723**	**9,710**	**5,649**	**20,588**	**7,434**	**3,672**	**2,529**	**84,818**	**55,118**	**80,481**	**39,948**	**11,374**	**22,896**	**8,639**	**21,317**	**20,304**	**42,137**	**18,616**	**9,241**	**33,645**	**75,690**	**64,746**	**23 388**	**13 819**	**10 475**

Appendix 2: The housing refurbishment costs according to prefab building systems and professions (price level 1999/2004)

The refurbishment costs of selected appartment (SKK/1 flat)

BUILDING SYSTEM		Number of the Floors	Number of the flats	Useful flat areaa	Thermal Insulation of the Siding	A B P - Price Level 1999 Roof	Coaming Construction	Remaining work	Sanitary technology	Central Heating	Electro	Elevators	Total In Sum - Price Level 1999	+complet. + SBC	index 2004/1999	+VAT (19%) in SKK	in Euro
		piece	piece	m^2	SKK/1flat	SKK/1flat	SKK/1flat	SKK/1flat	SKK/1flat	SKK/1flat	SKK/1flat	SKK/1flat		1	1	1	1€ = 31 SKK)
	terrace			55	74,250	21,175	75,900	38,115	77,110	33,990	65,945	0	386,485	413,539	454,893	541,322	17,462
				68	83,368	17,204	89,760	30,600	89,080	35,360	80,240	9,180	434,792	465,227	511,750	608,983	19,645
BA	tower	12 + 1	71	3,908	54,607	8,482	64,291	14,565	75,700	31,726	66,804	28,394	344,569	368,689	405,558	482,614	15,568
	terrace	7 + 1	28	1,632	50,177	12,014	65,942	19,241	75,700	28,094	61,586	29,286	342,039	365,981	402,580	479,070	15,454
	terrace	5 + 1	10	695	87,881	24,799	95,879	20,448	90,840	37,547	75,668	0	433,061	463,375	509,713	606,558	19,566
	terrace	8 + 1	32	1,738	60,348	10,659	91,975	23,053	75,700	27,885	62,583	25,625	377,828	404,276	444,704	529,197	17,071
	terrace	5 + 1	10	540	86,443	18,989	89,513	37,453	75,784	33,407	64,806	0	406,394	434,842	478,326	569,208	18,362
	terrace	5	19	1,106	73,062	18,451	75,936	35,151	75,784	30,350	63,599	0	372,333	398,396	438,236	521,500	16,823
MS 11	point	10 + 1	40	2,361	78,900	8,789	72,639	38,427	75,784	30,530	64,679	20,500	390,247	417,564	459,321	546,592	17,632
T06B Nitra	point	8 + 1	32	2,215	56,019	13,068	73,670	24,451	75,700	32,154	66,624	25,625	367,312	393,023	432,326	514,468	16,596
	terrace	8 + 1	23	1,425	44,721	11,601	79,221	18,470	75,700	27,239	60,379	35,652	352,984	377,693	415,462	494,400	15,948
T06B Žilina	point	8 + 1	32	2,069	85,867	12,194	77,146	29,353	75,700	29,240	63,046	25,625	398,171	426,043	468,648	557,691	17,990
	terrace	8 + 1	24	1,335	73,004	10,049	66,555	37,358	75,784	26,828	60,021	34,167	383,765	410,629	451,692	537,513	17,339
T06B Košice	tower	11 + 1	44	4,760	84,487	10,500	93,790	53,355	75,784	33,723	68,355	52,909	472,902	506,005	556,605	662,361	21,366
	terrace	8 + 1	16	1,034	92,861	12,347	95,544	44,446	75,784	34,886	67,843	51,250	474,961	508,208	559,029	665,245	21,460
T06B BB	point	8 + 1	24	1,293	89,113	9,849	68,910	35,772	75,700	26,536	60,021	34,167	400,069	428,073	470,881	560,348	18,076
	terrace	5 + 1	10	718	98,818	21,119	105,485	41,914	75,700	37,403	69,155	82,000	531,594	568,805	625,686	744,566	24,018
T06B BA	point	8 + 1	32	2,339	77,902	13,755	75,913	34,367	75,700	32,362	66,517	25,625	402,141	430,291	473,320	563,251	18,169
	terrace	8 + 1	23	1,257	65,296	10,951	63,792	31,560	75,700	26,950	60,057	35,652	369,957	395,854	435,439	518,173	16,715
	terrace	8 + 1	24	1,399	74,479	10,689	79,959	43,308	75,700	29,048	62,490	34,167	409,840	438,528	482,381	574,034	18,517
ZT	point			65	66,560	8,515	71,175	22,425	81,250	33,085	78,780	50,050	411,840	440,669	484,736	576,835	18,608
	terrace			68	89,080	14,008	74,460	33,252	87,040	35,020	80,580	7,820	421,260	450,748	495,823	590,029	19,033
	terrace			68	91,120	10,880	72,080	23,528	80,920	33,864	89,216	49,300	450,908	482,472	530,719	631,555	20,373
	terrace	9 + 1	27	1,435	58,983	9,570	70,159	23,946	75,700	28,478	62,328	30,370	359,534	384,701	423,171	503,574	16,244
B 70	point	8 + 1	40	2,814	78,642	12,441	89,138	41,779	75,700	32,024	68,096	20,500	418,321	447,603	492,364	585,913	18,900
	terrace	8 + 1	23	1,312	76,525	9,201	80,755	37,204	75,700	31,887	65,273	35,652	412,198	441,051	485,156	577,336	18,624
PS,82,TT	point	9	34	2,506	99,633	13,992	76,826	37,437	75,784	32,068	61,025	24,118	420,882	450,344	495,378	589,500	19,016
	terrace	8 + 1	16	1,104	98,364	13,955	92,055	40,857	75,784	34,449	67,843	51,250	474,556	507,774	558,552	664,677	21,441
BA,- NKS	point	12 + 1	71	3,015	43,494	5,474	46,248	14,677	75,700	21,595	55,714	32,789	295,692	316,390	348,029	414,155	13,360
	terrace	8 + 1	16	871	75,591	11,236	77,826	26,626	75,700	27,789	60,907	51,250	406,925	435,409	478,950	569,951	18,386
P1.14 , P1.15	point	12 + 1	47	3 085	84,114	9,008	72,544	24,965	75,700	28,570	62,638	49,532	407,071	435,566	479,122	570,155	18,392
	terrace	8 + 1	16	1,051	92,372	14,496	78,227	27,316	75,700	33,616	66,976	51,250	439,953	470,749	517,824	616,211	19,878

Appendix 3

Potential of rooftop extensions in Europe. (see POTENTIAL STUDY.. 2007).

	Total # Dwellings	Multi-family	Low-rise	Built '60-'80	Max. potential	Saved Energy [GWh]
AUSTRIA		52%	No data	*	6%	
	3,261,368	1,699,173	1,359,338	429,551	211,554	1,878
BELGIUM		25%			2%	
	4,097,125	1,028,378	984,158	245,165	87,397	776
FRANCE		43%			3%	
	28,668,114	12,413,293	7,855,063	2,694,287	987,456	8,764
GERMANY		54%			2%	
	38,709,853	20,864,611	1,9612,734	9,620,217	600,000	5,325
LUXEMBOURG		29%			4%	
	171,870	50,014	41,912	11,830	6,719	60
NETHERLANDS		31%			6%	
	6,634,647	2,063,375	1,925,129	965,928	391,201	3,472
DENMARK		39%			1%	
	2,540,543	985,731	883,215	282,756	35,000	311
FINLAND		58%			13%	
	2,548,043	1,467,673	1144785	585257	32,7744	2,909
SWEDEN		52%	No data*		7%	
	4,312,018	2,237,937	1,790,350	662,429	314,654	2793
GREECE	41%	No data	*		4%	
	5,467,049	2,219,622	1,775,697	783,083	214,565	1904
ITALY		74%			3%	
	27,300,961	20,311,915	1,5701,110	6566029	807153	13045
PORTUGAL		23%			2%	
	5,044,526	1,140,063	1,115,438	420,007	111,932	993
SPAIN		48%			6%	
	20,954,701	9,953,483	6,907,717	3,666,944	1,245,844	11,057
IRELAND		9%	No data	*	1%	
	1,281,840	110,238	8,8191	22,753	10,683	95
GR. BRITAIN		19%			3%	
	21,130,360	3,951,377	3,856,544	1,218,263	732,176	6,498
CZECH REPU.		57%			2%	
	3,826,042	2,161,714	1,431,055	65,8493	60,000	580
HUNGARY		34%			3%	
	4,313,887	1,449,466	1,113,190	535,094	145,813	1,035
POLAND		63%			6%	
	12,535,678	7,910,013	4,833,018	1,798,800	741,106	5,262
SLOVAKIA		52%			6%	
	1,667,631	858,830	536,769	281310	104,085	739
SLOVENIA		28%			5%	
	777,758	220,883	193,494	109281	35,626	253
ESTONIA		68%	No data	*		7%
	617,440	421,094	336,875	168775	43,881	312
LATVIA		71%	No data	*		8%
	958,085	679,283	543,426	219,544	74,645	530
LITHUANIA		61%	No data	*		4%
	1,292,554	791,043	632,834	202,507	55,487	394
Total	19,8583,985	95,049,225	74,778,852	32,191,958	***7,369,763***	***69,159***
		48%	38%		4%	GWh

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LABOR HOURS UTILIZATION ANALYSIS: A CASE STUDY

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Abstract

The unique nature of the construction process, together with exposure to outdoors conditions and other unpredictable events, increases the chance of spending more work hours for the project execution then initially planned. The achieved overall labor productivity is lower, which may consequently lead to a financial loss of the project at its completion. Several factors contribute to increase of actual work hours, or decreased performance when compared to initial estimates.
The paper discusses the major factors influencing the construction project performance. The emphasis is placed to the labor aspect. A case study is presented, where the analysis of the labor hours used for the project execution is carried out. The results show that thorough planning at an early stage of the project, which includes identification of all potential works and events, is crucial for the project completion within the planned budget, time and quality.

Keywords: construction project, performance, labor hours, bill of quantities

Introduction

Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment. Improvement of labor productivity should be a major and continual concern of those who are responsible for cost control of constructed facilities. (Hendrickson, 2003; Olomolaiye et al, 1998) Project plans have to be carried out impeccably in order to enable smooth execution and achievement of plans; if not, in addition to perceived time delays and additional consumption of resources, more labor hours can be spent as planned. Despite clear necessity of diligent project planning in theory, it can be observed that in practice, project planning stage is often carried out in hurry and superficially. When discrepancies from the plan are recorded during execution, plans are updated but the losses of labor hours and associated costs are sometimes irrecoverable. Labor costs can amount up to 40% of the total costs of the building structure construction, therefore their augmentation can significantly affect the total costs of this phase. For the general contracting company carrying out the construction works on the structure by itself and subcontracting the installation, electrical and mechanical works, this may mean the loss of a significant part of the project profit.
The purpose of this paper is to present analysis of a case study where more labor hours were spent as initially planned (which led to additional costs), to discuss the underlying causes and to propose solutions to identified problems. A turn-key contract was used in the case study.

The main point of this type of contract is to offer the opportunity to pass completion risks to the contractor, by making the contractor guarantee the performance of the subcontractors. It also avails the client the advantage of having a single entity to hold accountable for non completion (on deadline). Turn-key contract is also designed to make the contractor guarantee the integrity of the completion schedule. On the other hand, a turn-key contract comes with a higher cost, since the contractor charges a premium due to its higher risk exposure, as often cost estimates are expressed in overall terms without detailed breakdowns. (Aideloje, 2006)

Case study

Project under consideration deals with the construction of a combined business-cultural building. It is divided into several phases. Within the study, only the first two project phases, underground garages construction (phase 1) and two business buildings above phase 1 (phase 2) are analysed. Phase 1 consists of 3 underground floors with floor area of 1650 m^2 and 80 parking places. Phase 2 consists of two buildings with joint ground floor. The floor areas of the two buildings are 700 and 520 m^2, respectively. A turn-key construction contract was signed for both phases, which means that the project price was fixed and included costs of all works defined in the project documentation (including preliminary and preparation works), as well as the works not specified in the project documentation but required by legal regulations or required in order to achieve functional performance of the building.

The starting point for the analysis is establishment of a series of hypotheses which will be confirmed or rejected based on the evidence gained from the case study. This, of course, does not confirm the general validity of the hypothesis, however, it can result in better understanding of planning and execution of this particular project. By using appropriate knowledge management techniques, these results could be also be transferred to other projects within the contracting organisation under consideration.

Established hypotheses

The following hypotheses that will help to understand the discrepancies between the estimated and actually spent labor hours for the case study considered were established:

a) the construction workers do not fulfil the norms;
b) not all activities (required for project completion) are encompassed in the construction norms employed;
c) the quantity of works carried out is larger than the one specified in the contractual bill of quantities due to the superficially prepared bill of quantities;
d) construction works procured additionally (during the project execution) are the cause of the increase of actually spent labor hours;
e) climate factors adversely affect the labor productivity: the climate factors, e.g. extremely high or low temperatures, are influencing the actual on-site productivity. These influences are often not accounted for in the planning stage, therefore the discrepancies may occur between the planned and as.-built number of labor hours.
f) Uunskilled work force; some workers are considered to be qualified, however they can not perform basic construction operations such as formwork assembly for stairs.

Analysis

A detailed calculation of the labor hours required to complete the project was carried out in the preparation and planning stage of the project. The calculation was based on general construction productivity norms database (GNG, 1984) compiled and published in 1984 for Slovenia. Despite being old and often considered outdated, this database is still widely used in Slovenian construction industry.

The number of planned hours for each type of works is presented in Table 1. The calculation is based on a) contractual bill of quantities in the planning stage (initial estimate), b) updated scope of works (planning stage) and c) number of labor hours calculated after construction on the basis of in-built quantities and GNG norms. For all 3 alternatives, the number of labor hours for a particular task is determined as the product of the quantity (for a task) and the associated normative value taken from GNG norms. The data presented show that the difference between the initial estimate and the values calculated on the basis of in-built quantities is 6570 hours, or 10,5%.

Table 1. Number of planned (a) initial estimate, b) estimate based on updated scope of works) and c) labor hours calculated after construction on the basis of in-built quantities and standard norms.

	ACTIVITY DESCRIPTION	Number of labor hours		
		(a) (planned)	(b) (planned)	(c) (after construction)
		(initial estimate)	(based on updated scope of works)	(calc.based on actual quantities and GNG norms)
Phase 1				
1.	earthmoving works	3256	3256	2359
2.	concrete works	7649	7649	7827
3.	masonry works	505	386	404
4.	carpenter works	26358	26358	31235
5.	sewage and drainage	2403	2245	2554
6.	protection of the structure (ph.1)	319	319	257
7.	exterior planning	806	663	483
8.	construction works required for exterior connection for gas installation	92	92	122
9.	construction works required for exterior connection for water supply	328	244	96
10.	construction works required for connection to electrical network	85	85	125
11.	construction works required for connection to telecomm. network	273	273	333
Phase 2				
1.	demolition of the phase 1 protection	166	0	0
2.	concrete works	1983	1983	2305
3.	masonry works	2431	2431	1809
4.	carpenter works	15848	14293	19163
	TOTAL	**62502**	**60277**	**69072**
	Additional works			*4046*
	No.of hours not incorporated in the estimates			*10336*

In addition, during the execution, several additional works (where the major items were construction of a retaining wall, additional cores for phase 3 and repair works on the neighboring building), have been procured, for which a total of 4046 labor hours was estimated at the order.

The analysis starts with identification of various tasks for which a number of labor hours was spent however they were not incorporated in the initial estimate (and associated bill of quantites), neither in the plan at later stages. These tasks are site arrangement (an estimate of 100 labor hours), erection of the fence (estimate of 300 labor hours), snow removal on the site (the winter was colder and with more snow than usually; estimate of 1000 labor hours), execution of measures related to safety at work (protection fences, ...; estimate of 500 labor hours), drawing the positions for formworks (estimate of 300 labor hours), removal of water/ice in the basement (estimate of 150 labor hours), truck and road washing during earthmoving operations (requirement of the building permit; estimate of 500 labor hours), and several smaller items. In this category, we should also include the decrease of productivity due to the 30 minuts used for a break and a meal. According to Slovenian legislature, this break is paid, however it is not included in the construction norms. It means that in the planning stage, we plan for the worker to work 8 hours, however in the reality the worker works at maximum 7,5 hours, for the wage of 8 hours. The total number of hours spent for the paid breaks is 3759. Summing up the above listed items results in the total number of labor hours not incorporated into the initial estimates of 10336 (or 15% of the after-construction calculation, which is based on in-built material quantities and GNG norms).

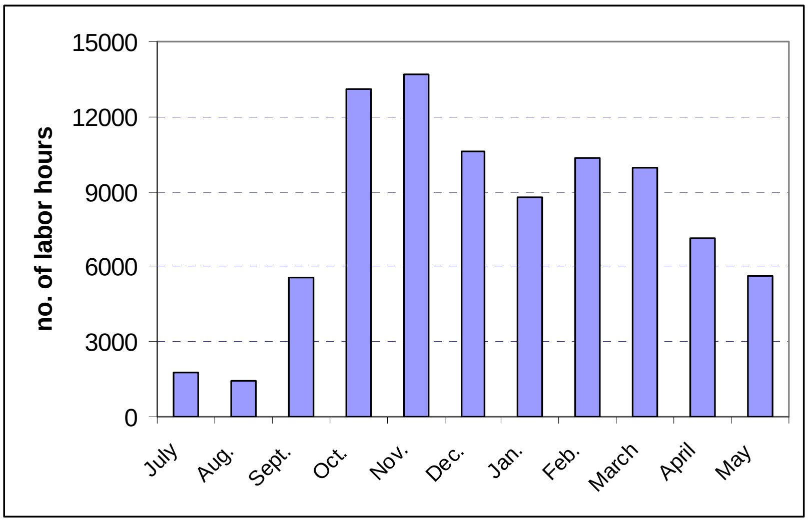

Figure 1. Dynamics of labor hours utilization

The actual number of labor hours recorded by the site supervisors is 87934. These hours are distributed over the course of the project as presented in Figure 1. Due to the contractual deadlines, it can be seen that the main part of the activities has been carried out between October and March.

The responsibility for the additional labor hours (i.e. the diffreence between the initial estimate and site-recorded number of hours) can be assigned to various project participants:

- the client, who ordered additional works while the project was already being executed,
- the designer, who did not take into the account all necessary items and their quantities in the preliminary bill of quantities; and
- the contractor for the inadequate assessment of the scope of works to be carried out.

Detailed analysis shows that the difference between the sum of initially planned hours and the hours spent for the additional works, and actually site recorded labor hours is 20947 hours. The analysis performed shows that the responsibility for 50% of this difference can be attributed to the contractor, 35% to the designer and 15% to the client.

Testing of hypotheses

The hypotheses established above were tested in order to confirm/reject them.

a) The construction workers do not fulfil the norms.

A comparison of total actually executed labor hours (87934) with the sum of the total number of calculated hours after construction (69072), number of hours for additional works (4046) and number of hours not incorporated in the bill of quantities (10336) shows that the number of actually executed labor hours is higher. Since the same bill of quantities was employed, it can be concluded that for the case study under consideration, the norms are not achieved. The hypothesis can be confirmed.

b) Not all activities (required for project completion) are encompassed in the construction norms employed.

A typical case of incomplete construction norms and associated description of activities is assembly of formwork; the activity description accompanying the norms consists of assembly, disassembly, site transfer, cleaning and greasing the formwork but not the drawing the formwork position. Based on careful observation of this site activities, it can be concluded that this is not a reason for the large discrepancy between the actual and planned labor hours. The hypothesis is rejected.

c) The quantity of works carried out is larger than the one specified in the contractual bill of quantities, due to the superficially prepared bill of quantities.

Comparison of the number of labor hours based on initial estimate, and the calculation based on updated scope and GNG Norms (first and second column of Table 1) shows that the difference is 8795 hours. This large discrepancy confirms the above hypothesis.

d) Construction works procured additionally (during the project execution) are the cause of the increase of actually spent labor hours.

The analysis shows that additionally ordered works required additional 4046 labor hours. The above hypothesis can be confirmed.

e) Climate factors adversely affect the labor productivity: the climate factors, e.g. extremely high or low temperatures, are influencing the actual on-site productivity.

Due to the contractual requirements, the majority of the construction works have been carried out during winter (Figure 1). The standard construction norms GNG introduce factors to be employed when a particular work is carried out at e.g. lower temperature. This factor ranges from 1,3 to 1,6 when the works are carried out at temperatures between -10 to -5 °C. This increase of working time for a particular activity was not accounted for during the preparation of the initial estimate. The hypothesis can be confirmed.

f) Unskilled work force; some workers are considered to be qualified, however they can not perform basic construction operations (such as formwork assembly for stairs).

The confirm or reject this hypothesis, a simple case of bricklaying was analysed. In the phase 2, cellular concrete masonry works were carried out. Table 2 presents the number of labor hours calculated on the basis of the general GNG norms (1984). It can be seen that according to these norms, 1943 labor hours should be spent in total for this particular activity. During the execution, the actual recorded number of hours for this task was 4206 hours, which creates the difference of 2263 hours compared to the initial estimate. The described analysis and some additional ones (Štrajhar, 2006) show that there is vast difference between the generally used norms and actual performance. The hypothesis that unskilled work force is one of the reasons for utilization of more labor hours than planned can be confirmed.

Table 2. Masonry works: calculation of initial estimate (required number of labor hours)

	no.of hours
Bricklaying with cellular blocks (dimensions 62,5x20x25 cm) (308 m^3)	622
Sealing of the joint between the wall and the slab	22
Assembly of 74 window beams (150 cm length)	30
Assembly of 178 window beams (200 cm length)	89
Cleaning (5529 m^2 floor area)	553
Production of 136 vertical reinfiorced concrete ties	495
Manual demolition and construction of new ties	132
TOTAL	1943

Conclusions

For the general contracting company that decided to bid for a particular project, it is extremely important to establish a realistic initial estimate, especially when the project is procured by a turn-key contract. The analysis of a case study, however, has shown a number of causes contributing to the difference between the initial estimate and actual recorded number of labor hours.

The results obtained show that the construction database employed may be outdated due to declining skillfulness of workers. Further, careful investigation of all available information regarding the project should be collected, and the initial cost estimate should account for the various circumstances, e.g. the season when the construction will take place. The project scope has to be carefully defined, and the bill of quantities and the accompanying list of activities necessary to complete the project should be complete. Only then, financial success of the project can be expected.

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BUILDING BETTER PUBLIC - PRIVATE PARTNERSHIPS IN ORDER TO ELIMINATE THE DILEMMA BETWEEN EFFICIENCY AND PUBLIC/DEMOCRATIC ACCOUNTABILITY

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Abstract (12 pt bold)

Public-private partnerships (PPPs) have received increasing attention over the last decade due to the fact that PPPs are portrayed as a vehicle of change as they are characterized by important determinants such as value-for-money and quality. However, partnerships also need to be accountable if they are to be desirable.

The aim of this paper is twofold. First, to explore the important component of accountability regarding how the interests of the involved parties could be better integrated into the process of establishing and managing partnerships. To do so, primarily it is vital to explain the notion of public accountability, then to present its principles and finally to specify the different kinds of accountability applied to public service provision. Secondly, it proceeds to an analysis of how "public" actors and those from the private sector, relate to, and are drawn into, the complex "web" of accountability emerging from such schemes based on a detailed study of the Copenhagen Metro and London Underground projects.

Keywords: Public Private Partnerships, public accountability, governance, London Underground project, Copenhagen Metro project

Introduction

This article analyses public-private partnerships (PPPs) as a new mode of governance which is principally characterized by shared public authority between public and private actors. Moreover, it focuses on the issue of how well the officials handle the vertical and contractual relationship with the private actors, given the requirement of democratic accountability according to the hierarchical, liberal model of representative democracy. The conclusions from the careful study of two complicated infrastructure projects, such as the London Underground and the Copenhagen Metro, therefore suggest that PPPs in even more complex policy areas need to be analysed carefully before any decisions on a partnership are reached.

There are basically two reasons for this. The first is that the general political goals for the partnerships are too general and have little impact on and contact with the day-to-day activities. It is the officials rather than the politicians that have influence over the PPPs. The second reason is that the private actors do not only run the programmes in an overall sense, they also make important decisions in their daily management. The private actors thus have influence within important public infrastructure but are not democratically accountable for their decisions.

Partnerships' Overview

In general, the term partnership belongs to a broader family of network concepts used in academic literature. More often partnership is defined as "cooperative ventures that rely upon agreement between actors in return for some positive outcome for each participant, which could be some economic or social goal or potential for synergy" (Carroll and Steane 2000). Also, in the literature, four sets of arguments in favour of partnership are commonly put forth:synergy, transformation, budget enlargement and capacity enlargement (Mackintosh, 1992; Bailey et al., 1995; Hastings, 1996; Elander, 2002; Friedrichs and Vranken, 2001). According to Mackintosh (1992), synergy is the additional benefit gained when two or more partners act together to attain a common goal. Synergy is realized in the form of an increased profit for the private sector participant and in producing new resources to advance the social goals of the public-sector partner. Combining different perspectives not only creates the potential to realize additional profit or added value, but also forges an innovative set of policies or solutions. The second argument is formed by Mackintosh's model of transformation; a process whereby partners seek to change or challenge the aims and operating cultures of other partners. Partnerships are vehicles through which the private sector can "shake up" the public sector, thus bringing about more streamlined decision making or a more entrepreneurial way of working, and a simultaneously mechanism whereby the public and voluntary sectors challenge the private sector to adopt more "social" objectives, less driven by short-term gain. The third argument is budget enlargement, which concerns the objective of raising more money by trying to obtain additional support from a third partner. Today, such arrangements are common, in both national and EU context (Elander, 2002). Thus, by showing a will to co-operate, two or more partners might gain additional support from central government or the EU, thereby making their budgets larger, unlike a situation where each of them would have acted in isolation (Mackintosh, 1992). Finally, capacity enlargement is related to an increase of challenges of governments, either local, regional or central, and a need of more capacity. In general, governments have more responsibilities in a narrower financial framework. To cope with this, responsibilities are spread among various intergovernmental, voluntary and private sectors. PPPs are formed to realize major development projects that would otherwise be unfeasible (Friedrichs and Vranken, 2001). However, the number and types of PPPs appeared over the years in practice are overwhelming, making the definition of a PPP difficult. Although there is no unified definition of PPPs, all definitions appeared in the literature have common features or characteristics. This has lead Peters (1998) to identify five general defining features of partnerships: PPPs are about a durable and a formal contractual relationship between two or more actors, at least one of which is public and another from the private business sector; the actors have clear goals and objectives with what they want with the partnership each of them bringing something to the partnership; finally, a partnership implies that there is some shared responsibility for outcomes or activities (Collin, 1998; HM Treasury, 2000). This differs from other relationships between the public and the private sectors in which the public sector retains control over policy decision after receiving the advice of organizations in the private sector. In contrast, actual partnerships produce mutual shared responsibility which can make accountability for these decisions difficult to ascertain.

The aforementioned accountability is closely linked to political and ideological underpinnings of PPPs, issues which have also been broadly discussed between practitioners, academics and scholars (Grimsey and Lewis 2004, Hodge and Greve 2005). Specifically, Linder (2002) argued that the bulk of features attached to PPPs reflect the neoliberal movement's quest for efficiency gains. As the states nowadays are regarded as overburdened, overextended and the governments are quite incapable of taking the control of the situation, partnerships can be seen as the vehicle of reducing the state of such a load, letting a more market-orientated management style thus resulting in government’s efficiency and bringing communities closer together. This is certainly the case in the UK, where PPPs have become an important key element of the Labour government strategy mainly regarding the social policy (Osborne 2000).

Also, the PPP formation and practice is related to the tradition of democracy. In young democracies, the idea of actively involving actors in public policy making, sharing responsibility and power is relatively new (van Boxmeer and van Beckhoven, 2005). Taking into consideration the latter, more can be argued on another important linkage affecting the formation and practice of PPPs, this of the distribution of power between actors. As it was already mentioned, the traditional adversarial relations endemic to command-and-control regulation can shift to a relationship based on trust and beneficial sharing of responsibility, knowledge and risk. A common understanding of the aforementioned is that all the involved partners should be seen as equal in terms of equally shared all the decision rights, costs and risks. However, this is not the case in most of partnerships’ practices as the actors involved have clear interests and goals of the partnership, although not necessarily the same ones. Therefore, bearing in mind Linder perception that PPPs focus on delivery and output specification and consequently they emphasize on efficiency and effectiveness, from a liberal democratic point of view, this is quite problematic. The dilemma that is raised is how accountability can be resolved in such situations in which the two partners share public authority within sectors that concern important public services? In this context, one of the main objectives of this paper is to explore the important component of public accountability in terms of its notion and concept, then to present analytically its principles and finally to specify the different kinds of accountability applied to public service provision.

Public Accountability

Accountability and in a more rationalistic framework public accountability is a crucial issue regarding its correct implementation on PPPs and therefore it has preoccupied the relevant literature (McQuaid, 2000) the recent years as it is claimed that no single partner feels fully accountable for the actions of the partnership. In a general sense accountability can be defined in terms of how an organizational body, which has been delegated authority, is accountable for his actions and performance. During recent years there has been a rather intense focus and research on accountability in European, as well as in global, politics which reveals that the concept of accountability is rather slippery (Przeworski et al. 1999, Schmitter 2000, Strom 2000, Behn 2001, Lord 2004, Grant and Keohane 2005, Koenig-Archibugi 2005). Therefore, it is argued that accountability can be best understood by its democratic or public dimension as this should be easily linked to the public chain of delegation and control. Hence, someone could immediately look on a clear authority relationship by public actors as the very essence of accountability (Thomas 2003). Indeed the aforementioned is a straight form of accountability. Also, accountability can be seen ex post in a principal-agent relationship. The principal-agent relationship is, however, only valid between the public actors - between the politicians and the officials. The situation becomes complex between public and private actors within various PPPs. Indeed, delegation of public authority does not seem to occur between the partners (Koenig-Archibugi 2005). On the contrary, public authority is shared rather than delegated. In such cases, the mechanisms for resolving public accountability are therefore highly complex. One of the ways of dealing with this complexity is to set up a public agency that has the responsibility to monitor the private actors (Majone 1996). This arrangement can still be regarded as problematic from a liberal understanding of democracy because the private actors are not part of the democratic chain of command and control.

As the private bodies or agents are not elected by the people and have no seat in the legislative bodies, the notion of delegation of powers to private bodies is directed to those control mechanisms and to investigation of methods and ways to hold them accountable to the principals – public sector. It is very crucial to make the private bodies be accountable to the general public as well as to make them accountable for the important decisions they make. In order this to be succeed, a process, a mechanism, a system, a concept, a something that not only permits public agencies - and their collaborators on the for-profit and non-profit sectors - to produce better results must be developed. For this reason, the regulatory arrangements and the mandatory legal mechanisms constitute a central theme in the literature on private authority and PPPs (Cutler et al. 1999, Hall and Biersteker, 2002). In line with the aforementioned literature, there exists the "pessimistic" scenario as well as the "optimistic" one debating on the regulatory implications of PPPs (Avant, 2005). On one hand, the pessimistic scenario states that PPPs substantially weaken public control and democratic processes; whereas the optimistic one strongly supports the perception that the private involvement can bring know-how, risks' mitigation and solutions' offer that the public sector has difficulty in handling. Although, there are extreme differences regarding the scenarios' baselines, yet, their common attribute is that the very idea of establishing PPPs has to do with its potential to be effective.

In order to see how the accountability mechanisms are designed between the politicians and the officials, on the one hand, and the officials and the private actors, on the other, the paper will now focus on the case of London Underground and the Copenhagen Metro.

The case of London Underground

In 1997, the London tube system was publicly operated and privately maintained. However, since then, the plans of the Labour Party for the London transportation system have been changed marking the division of the London Underground Limited (LUL) into a publicly owned operating company and three privately owned infrastructure companies (Infracos). Accordingly, under the proposed PPP scheme, train stations and services would continue to be planned and operated by the publicly owned as well as publicly accountable LUL, which would also retain responsible for safety on the whole of the Underground. Private companies were invited to bid for maintaining and upgrading the track, tunnels, signals, stations, lifts, escalators and trains under 30-year contracts to LUL. At the end of the contracts, the assets would return to the public sector. Thus, under the PPP, the Infracos would not have any operational responsibilities; they would essentially be responsible for maintenance work to the network while operations – including drivers, stations staff and responsibility for safety – would remain in the public sector. After years of protracted delays due to the Mayor of London's ongoing opposition to the proposed LU-PPP, the first PPP contract was signed with Tube Lines on 31 December 2002.

Tube Lines, a consortium of private sector firms including Amey, Jarvis and Bechtel, has agreed to spend £16 billion upgrading the ageing Underground's Jubilee, Northern and Piccadilly (JNP) lines over the next 15 years. The public-private partnership of the London Underground was completed on 4 April 2003 when private sector consortium Metronet (made up of shareholders Bombardier, SEEBOARD, Balfour Beatty, Thames Water and Atkins), promising investment of £17 billion, assumed contractual responsibility for the maintenance and upgrade of two major sections of the Tube; the Bakerloo, Central and Victoria (BCV) lines; and the sub surface lines (SSL) Metropolitan, District, Circle, Hammersmith & City and East London. Less than a week after the completion of the public-private partnership, lines of accountability were sorely tested when Metronet and Tube Lines blamed each other for a fire alert which temporarily closed a section of the Central line during the morning rush.

The case of the Copenhagen Metro
Following the loss of its industrial base during the 1970-1980s, the Danish government began to define strategies to revitalise the economy of Copenhagen by developing major infrastructure projects, principally the Ørestad bridge that now links Sweden with Denmark and its supportive Metro. The Copenhagen Metro PPP scheme is an example of a new approach to urban planning compared to traditional forms of decision making processes and fiscal support. Such forms of coalition have become popular throughout Europe over the past two decades, where cities are seen as sites of "strategic growth" – centres for economic growth and commercial competitiveness.

In order to integrate issues of growth, development and innovation with transport issues when developing the Ørestad/Metro project, a partnership was formed proposing the sale of land in the area near where the Bridge to Sweden would be built to fund local traffic investment. Two were the main identified factors regarding the aforementioned saleability of this land: its proximity to the bridge and to the city but also the development of a high-quality transport infrastructure. However, there were two potential obstacles; first, the land was listed as a nature reserve and, second, that the development of a transport infrastructure was in violation of the regional development plan which had not approved a new urban district in the area. The construction of the Ørestad/Metro project was officially launched by in March 1991. The proposal was popularly received by the Mayor of Copenhagen, the Danish Prime Minister and Parliamentary Opposition Leader for its tax-neutral status and potential contribution to strategic growth. However broader political and public knowledge of the proposal was lacking. Less than two months later, in May 1991, a Bill pertaining to the Ørestad (including a light-rail system) was introduced to the Danish Parliament without first being subject to a public hearing and minus any consideration of viable alternatives, as stipulated by the Planning Act. Non-governmental organisations led by Danish Society for the Conservation of Nature submitted complaints to the Danish Parliament in relation to the nature conservation of the area, where the Ørestad was to be built. The Parliament however voted to reject all pending conservation cases including that of Amager Commons. In June 1992, the Ørestad Law was passed paving the way for the establishment in March 1993 of the Ørestad Development Company (ØDC) comprising members of the Copenhagen City Government and the Danish State. The ØDC announced in 1994 that it had chosen a driverless Metro as its preferred "light-rail" option. The basis for this choice was not explained. Stage one of the Copenhagen Metro was officially opened in October 2002, two years behind schedule.

Accountability Analysis of the LUL and the Copenhagen Metro
From a relatively careful study of the aforementioned case studies, both schemes are characterised by relatively low levels of transparency and openness, main components of

public accountability. In particular, the LUL-PPP, involves a “complex web of accountability” characterised by a relative lack of publicly visible, accessible or comprehensible accountability mechanisms. The highly technical and legalistic nature of the LU-PPP contracts and related partnership documentation limited opportunities for publicly engagement and scrutiny of the PPP relationship, its terms and financial viability. It was mainly through the very public intervention of the Mayor of London himself during the PPP negotiation process that brought elements of that process into the public arena for wider public scrutiny and debate. Arguments regarding the safeguarding of the “public interest”, the conditions for public safety, the use of public monies and the future of public transport in London featured in the public debate led by the Mayor of London and the media, which acted not only as a vehicle for public debate but as campaigners as well. Furthermore, a lack of direct and clear lines of accountability in the implementation of the LU-PPP was high on the list of public criticism.

A similar sound feature of the Copenhagen Metro case is the complete absence of the public from the decision making process. Only after decisions had been taken and in the implementation phase did critical public debate and protest activities emerge. But due to the widely perceived political and economic importance attached to the project, opportunities for public mobilisation were severely hampered by a lack of available arenas for public debate and critique. The “private” component of the PPP was, however, criticised for its ability to hide behind the “commercial-in-confidence” clause on aspects that should have been open to public scrutiny.

Another similar key issue in both projects that shows the extended lack of public accountability is the continuous increase of the projects’ budget during their implementation phase and their constant completion delays. It is estimated that the Copenhagen Metro’s budget increased substantially by 5.6 billion DKK following a delay of two years to the project and a National Audit Office report criticised the narrow focus of the public sector comparator regarding the LUL agreement which did not consider the wider costs and benefits, and risks of the aforementioned. Hence, both the UK and Danish PPP schemes have also failed in proving that their independent financial analysis resolved the correspondent “value for money” tests. In general, accountability can be reached by using further means to avoid the lack of transparency like the establishment of effective mechanisms of public scrutiny. An important mechanism is the conduct of proper cost and benefit analyses whereby facts and figures are made publicly available. While certain cases demonstrate the value of open parliamentary enquiries, at the same time powers should be extended to National Audit bodies to examine specific cases of value for money.

Procedures must be put in place that guarantee the safety and security concerns are met in public private partnerships. It is not sufficient to issue new procedures,there must also be a commitment to their implementation. According to the United Nations Economic Commission for Europe, governments need to establish bodies that can scrutinise the safety aspects of PPPs. They need to be independent and include experts. The companies as well must demonstrate their awareness of the increased importance of safety in PPPs and must show that they are implementing new standards in their current commercial practices. Another key concern is that the private sector while improving efficiency by cutting costs, may in addition seek to cut costs available for maintenance, control etc of important services. Above all else, citizens value the improvement of security and safety of the service over efficiency and better services. The LU-PPP, the world’s largest PPP, is unusually complex in that its structure is a desegregation of integrated networks and bid processes involving multiple parties on three separate deals. Surprisingly, issues of safety and security have been completely absent from the debate surrounding the implementation of the Copenhagen Metro project.

Conclusions

Both the UK and Danish PPPs are characterised by the prevalence of formal public accountability procedures in the administrative domain, whereby decision-making processes are conducted behind closed doors in the absence of any salient public participation. Informal mechanisms involving public engagement through social mobilisation and related bottom-up procedures of accountability were of little or no effect to the outcome in either case. Rather public accountability was formally applied through the top-down approach of representative democracy. However, the unavoidable transfer of some risk/responsibility from the public to the private sector in PPP schemes continues to pose a serious challenge to transparency and the wider issue of public accountability whereby access to publicly-relevant information including processes of decision-making was constrained by "commercial-in-confidence" clauses and highly-technical language.

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MODERN ORGANIZATIONAL STRUCTURES IN CONSTRUCTION COMPANIES

MODERNE ORGANIZACIJSKE STRUKTURE U GRAĐEVINSKIM PODUZEĆIMA

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Abstract

Research in present construction companies in Slovenia has shown a characteristic hierarchical organization mostly shown as functional or departmental organization chart.

Our paper presents possibilities for formation modern organizational structures in middle sized construction companies. Our research in present construction companies in Slovenia has shown a characteristic hierarchical organization. The most spread form is functional or departmental organization chart which deep and wide branching depends on company's size, type of production, product assortment, dislocation of work units, etc. Normally, business processes flow within several organizational units (sectors, departments) and through division among functional units such as production, marketing, sales, administration etc. However, when business is organized around individual functions, the company cannot be successful. There is a need for treating company within processes. Therefore, the paper represents possibilities for structuring the organization along processes. The presented organizational chart will introduce a formal support for decentralized organization where operations are performed at the operative level within core process. Interpersonal cooperation and communication flow will increase respectively.

Keywords: Organizational Structure, Process-based Organization, Construction Management.

Sažetak

Istraživanje trenutnog stanja organiziranosti građevinskih poduzeća u Sloveniji je pokazalo uobičajene hierarhijske oblike organiziranosti najčešće kao funkcionalni oblik organizacije.

U radu su prikazane mogućnosti oblikovanja modernih organizacijskih struktura za srednje velika građevinska poduzeća. Istraživanje trenutnog stanja organiziranosti građevinskih poduzeća u Sloveniji je pokazalo uobičajene hierarhijske oblike organiziranosti. Najčešće je upotrebljena linijsko-štabna shema organizacije, njena razgranatost po širini i dubini pa zavisi od: veličine poduzeća, vrste proizvodnje, asortimana proizvoda, dislociranosti radnih jedinica itd. Poslovanje u takvim organizacijama se odvija kroz više organizacijskih nivoa sa raspodjelom po funkcijskim sektorima (npr. marketing, razvoj, proizvodnja, prodaja, servis). Međutim, poduzeća u kojima se poslovanje vrti samo oko radnih zadataka unutar pojedinačnih funkcija, ne mogu biti uspješna. Poduzeće je potrebno razmatrati kroz procese. Rad predstavlja mogućnosti oblikovanja procesno usmjerenih organizacijskih struktura kao formalnu potporu za sposobnost decentraliziranoga djelovanja na nivou temeljnih poslovnih procesa. Moderan oblik omogućava sudjelovanje zaposlenih bliže mjestima unutar organizacije te optimalni protok komunikacija.

Ključne riječi: management u građevinarstvu, organizacijska struktura, procesno usmjerena organizacija.

1. INTRODUCTION

Modern construction companies are confronted with the need for modernization of management and more efficient organization of work in order to cope with increasing complexity and dynamics of the economic environment. These changes have clear implications for the organizational structure. A considerable number of studies have argued that traditional organizations structured in a functional way cannot be successful. There is a need for treating company along processes and their impact on the organizational structure.

This paper deals with two types of organizational structures appropriate for construction company: functional and process-based. First, a functional or departmental form is typically hierarchical with several levels. It is distributed into basic functional units such as production, marketing, sales, administration etc. while its deep and wide branching is adapted to company's activity. Second structure is convenient for process-based organizations. A company is organized around core processes while supporting processes were added and included according to requirements. The work is done in different department and is beyond the traditional, narrow minded functional departments.

2. CLASSICAL ORGANIZATION STRUCTURES

Modern organizations have been organized according to the idea of Adam Smith's labour specialization. This idea argues that processes have to be fragmented into specific jobs which are normally preformed by a group of employees that work together based upon the specific functions. Therefore, organizational structure reflects this functional approach.

According to research of organization structure in middle sized Slovenian construction companies it is perceived that functional form is prevalent (Pšunder et al. 2008). The form is hierarchical, centralized and divided among functional units. Its deep and wide branching depends on company's size, type of production, product assortment, dislocation of work units, etc. In spite of different variations and modifications of functional structure all of them should include production or technical function, commercial function, financial and accounting function, and administration function. A typical functional organizational structure in Slovenian construction company is presented in Fig. 1. Each level in the scheme is meant as a general frame within a range of variety is allowed. General department could include administration function, legal function, human resources function, ect.

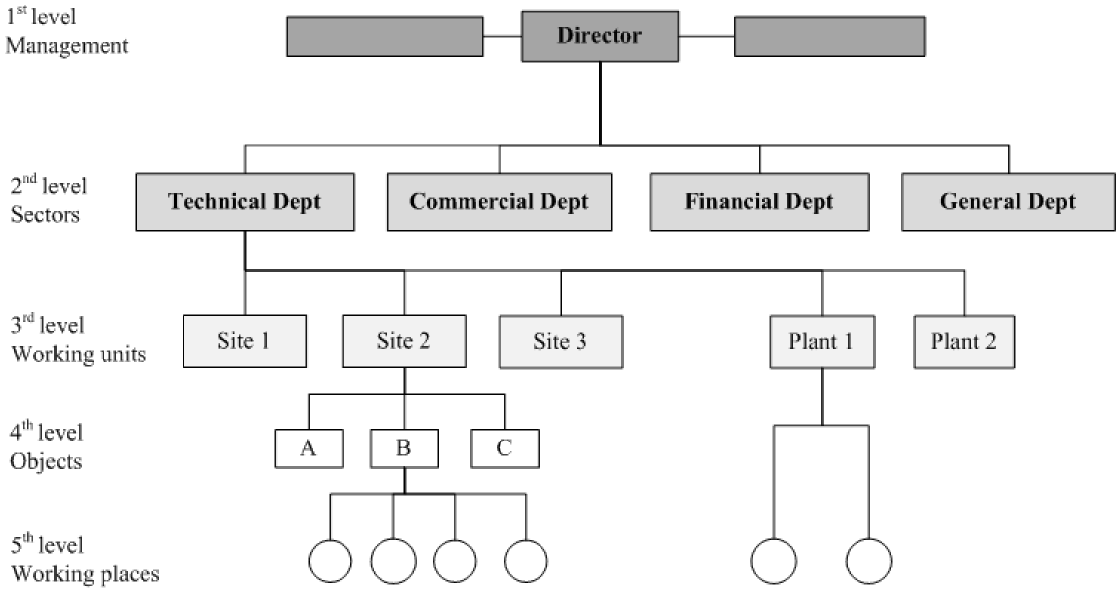

Fig. 1. Functional organizational structure in Construction Company

The advantages of functional structure design are distinct fixed boundaries of hierarchical level and direction to specialization of labour (Kovačič, 2005). Hence, higher range of specialization causes difficulties by performing complex tasks. Another disadvantage is that employees are oriented into their own unit/department. They work independently of other parts of organization. Interpersonal communication and coordination are not effective because work is organized around tasks instead of processes.

3. PROCESS –BASED ORGANIZATION STRUCTURES

The fast changing demands of the business environment create an urgent need for organization to break away from the traditional organizational model. Companies have tried out different strategies such as Total Quality Management, Business Process Reengineering, Empowerment, Benchmarking, where processes are central element of an organization. But within the existing organizational paradigm there were almost no comments in the change management literature about interaction between these efforts to realign a company along processes and their impact on the organizational structure. Therefore, in this paper a process-based organization structure is summarized (Vanhaverbeke and Torremans 1999).

3.1. Understanding process-based organizations

In order to distinguish process-based organizations one has to start with the definition of business processes. There are several definitions that all define business process as a structured, measured set of activities designed to produce a specific output for a particular customer of market (Davenport 1993, Hammer and Champy 1993). Setting up process-based organization always starts with the identification of core processes in company. Usually firms can draw a process map with 5 to 15 core processes.

Normally, in construction companies three core processes can be identified: production, operation and market-oriented processes. A major operation process almost always flows across several departments while a market-oriented process exceeds the external boundaries of the company.

3.2. Structuring the organization along processes

A process perspective necessarily entails cross-functional and cross-organizational change. Unlike to traditional organizational forms, in which formal communication is vertical, a process perspective implies horizontal view of the business that runs across the organizational departments.

The basis for redesigning a construction company towards a process-based organization implies that all activities, which logically belong together, are grouped in the process. First, this means that the core processes are defined as the basis for an organizational unit. Second, supporting processes were added such as accounting, supply, logistics and service, development, human resource management, ect. They are included according to requirements. New multi-dimensional flat organization structure is created. We can speak of a decentralized form with fewer hierarchical levels where operations are performed at the operative level within core process. Fig. 4 presents proposed process-based organizational structures for construction company.

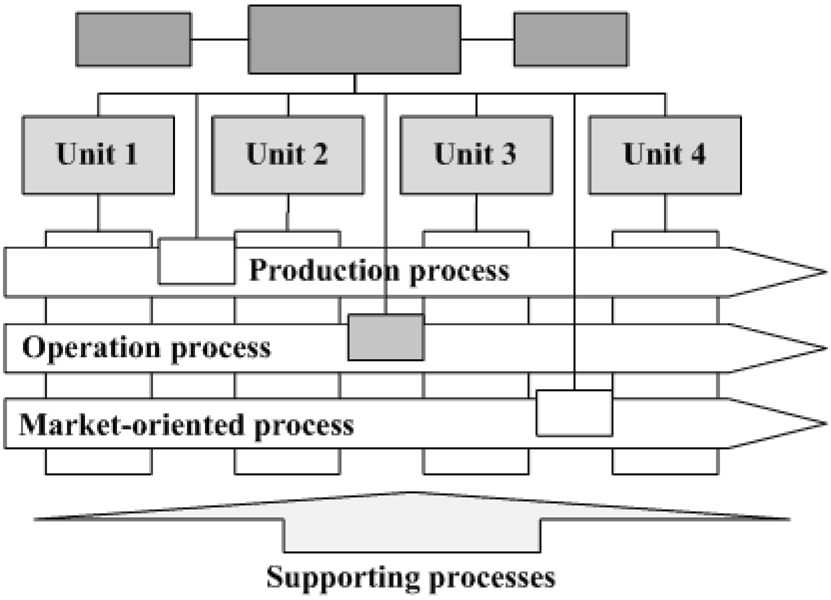

Fig. 2: Process-based organizational structures in Construction Company

Within the core process, temporary project process teams are organized in addition to constant process teams for supporting processes. Hence, teams perform process tasks at the operative level of the organizational pyramid. The organization is therefore based on knowledge of operative experts who must also have the authority to decision-making.

In organization that puts processes into foreground, efficiency and effectiveness of organization depend on connections between individual processes that are carried out by different departments/units. It is therefore important that flat form of organization allows decentralized decision-making while fluent inter-process coordination is achieved within the framework of daily process-team work. Communication flows within the organization when required. Consequently, the middle management loses the role of the controller and takes on the role of a mentor.

4. CONCLUSION

To sum up, a functional organization is rigid and therefore not applicable for response on increasing complexity and dynamics of business environment. For that reason, process-based companies have become fashionable during recent years. They are a powerful answer to the problems of functional oriented structured companies. In this paper, we illustrate how process-orientation can be translated into construction company. We suggest a multidimensional process-based structure where companies work is organized around the core processes. It allows decentralized cooperation and decision making while it is formed upon expert knowledge at the operative level.

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CALCULATION OF OPERATING COSTS OF NEW BUILDINGS

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Abstract:

The probable amount of the sources to be devoted to the running of the future buildings is an important point of view both in the case of private and public investments, that should be taken into consideration. The author has worked out a simple method for the calculation of the majority of the operating costs, based on the building as a whole. The method is based on the particular classification of the operating costs and on the directive 2002/91/EC about the energy-output of the buildings, released by the European Parliament. Dealing with the cost turned on the heating, boiling water, ventilation, cooling and light is made together, and by the help of this method the number of the uncertainty factors and the amount of the job can be decreased.

Keywords: construction costs, operating costs, calculation, CAD, energy

1 Introduction

Not just the construction, but the running costs too influence, how economical a building is. According to Meier[1] the effect of the running costs of the completed building is more significant than the value of the investment. His consequences are the following:

- Established decisions about an investment can be made only if one knows the running costs too.
- The decrease of the running costs is necessary, because they overweight the capital costs significantly.
- Not taking the running costs into consideration generates financial difficulties in the future.

This article studies the operating costs of a building, that are parts of the running costs,

- because the measure of the operating costs is at great importance in the running costs,
- because to decrease the operating costs later is possible only by further, large investments (for example better heat insulation, new heating system, etc.),

[1] Claus Meier: Investitions- und Folgekosten bei Bauvorhaben, 1988, page 49

- because the operating costs depend on the energy prices considerably, that are getting more expensive for decades, and recently the rise in prices is more intensive.

A method to calculate the operating costs is presented below, that ascertains exact results ever in the early stage of the planning. The method can be well applied in case of planned buildings and in case of renovation, if keeping the new energetic requirements is a consideration.

2 Classification of the operating costs

The operating costs used to be considered in the running costs. There are many methods to classify the running costs. A possibility is to use the classification of the bookkeeping. Another possibility is to use the German standard DIN 18960. The standard creates four main groups for the running costs[2]:

1. capital cost,
2. administrative cost,
3. operating cost,
4. building maintenance cost.

The standard divides the costs above into three levels. The standard points to the fact, that the different groups can be merged in certain cases.

It is practical to create a classification adjusting to the level of the preliminary designs in the phase of the selection of the plans. Thus can be created such classes of costs, that are possible to be ordered to data available in the early phase of the planning or easier to be calculated. The heating, hot water supply, ventilation, cooling and lighting gets bigger importance in the operating costs because of the continuous rise of the energy prices. So we have created a classification of the operating costs, in which the primary energy consumption is a separate class. The primer energy consumption of the planned building can be calculated with the help of the integrated energy consumption of the building.

The integrated energy consumption of the building is the annual consumption of the installation systems assuring the normal use of the building according to volume unit, in primary energy (kWh/m2,a). The integrated energy consumption includes the consumption of the heating, ventilation, hot water supply and (except block of flats) lighting systems, including the efficiency and self-consumption of these systems. The energy gained by active solar/photovoltaic systems and by connected energy production operated as the self system of the building can be subtracted from the total cost.

The integrated energy consumption does not include the consumption of:

- the technological heating,
- the technological ventilation,
- the technological hot water,
- swimming pool technology,
- balneology systems,

[2] BKI Handbuch, 2003, page 75

- outdoor lighting.

The classification of the operating costs in the investment phase of the preliminary design creating:

- *primary energy consumption*
  - *heating*
  - *hot water supply*
  - *ventilation*
  - *cooling*
  - *lighting*
- *water and sewage*
- *cleaning of the building*
  - cleaning staff
  - cleaning agents
  - fee of rubbish
- *services*
  - computer-network
  - installation equipments
  - information flow (intranet, internet, cable TV, etc.)
- *reception, supervision, operating*
  - installation systems
  - telephone
  - alarm system
  - porter, service.
- *operating of traffic and green surfaces*
- *others* (for example the replacement of the expendable material)

3 The theoretical basics of the calculation

3.1 Primary energy consumption

In the directive 2002/91/EC about the energy-performance of the buildings published by the European Parliament, the requirements of the maximal energy consumption of the buildings is defined. This directive must be kept in Hungary since 01.09.2006 in case of buildings built with newly released building permission or in case of substantial renovation of buildings with a basic area greater then 1000 m2. The energy requirements are regulated in Hungary by the 7/2006.(V.24.) TNM decree.

The classification of the operating costs makes possible that the energy consumption of the building does not need to be calculated from the components, and then summarised, but it can be defined directly from the integrated energy consumption according to the proper building. The integrated energy consumption of the building must not be greater than the value defined in the energetic decree. Building permission can be given for a building only if the planned energy consumption of it does not surpass the prescription or the decree.

For the calculation of the primary energy consumption the requirements of the decree above are used. The table below contents the letter, percentage and textual characterization of the classes determined by the decree 7/2006.(V.24.) TNM.

A	< 60	energy-sparing
B	61 - 90	better than requirements
C	91 - 100	meets the requirements
D	101 - 120	near to the requirements
E	121 - 150	better than average
F	151 - 190	average
G	191 - 250	near to average
H	251 - 340	weak
I	341 <	bad

Fig. 1: Energetic classification of buildings

The percentage of the classification means the ratio of the integrated energy consumption of the building and the value of the requirement. The primary energy consumption is defined by the decree by the types of buildings. The maximal value of the integrated energy consumption can be calculated by the formula below.

Dwellings (does not include lighting energy consumption):

$A/V < 0{,}3$	$E_P = 110$	kWh/m^2a	(3.1.)
$0{,}3 < A/V < 1{,}3$	$E_P = 74 + 120\times(A/V)$	kWh/m^2a	(3.2.)
$A/V > 1{,}3$	$E_P = 230$	kWh/m^2a	(3.3.)

Officies:

$A/V < 0{,}3$	$E_P = 132$	kWh/m^2a	(3.4.)
$0{,}3 < A/V < 1{,}3$	$E_P = 94 + 128\times(A/V)$	kWh/m^2a	(3.5.)
$A/V > 1{,}3$	$E_P = 260$	kWh/m^2a	(3.6.)

Educational buildings:

$A/V < 0{,}3$	$E_P = 90$	kWh/m^2a	(3.7.)
$0{,}3 < A/V < 1{,}3$	$E_P = 40{,}8 + 164\times(A/V)$	kWh/m^2a	(3.8.)
$A/V > 1{,}3$	$E_P = 254$	kWh/m^2a	(3.9.)

Where: A = the cooling surface of the building; calculated by inner sizes (m^2)
V = heated volume; calculated by inner sizes (m^3)
E_P = integrated energy consumption (kWh/m^2a)

The average lighting energy consumption of dwellings is 8,0 kWh/m^2a. The energy consumption needs to be expressed in primary energy. If the calculation is not made in primary energy, than the result needs to be multiplied by a primary energy transformation coefficient plotted against the used energy. This coefficient is 2,5 in case of electric power, and 1,0 in case of natural gas and heating oil.

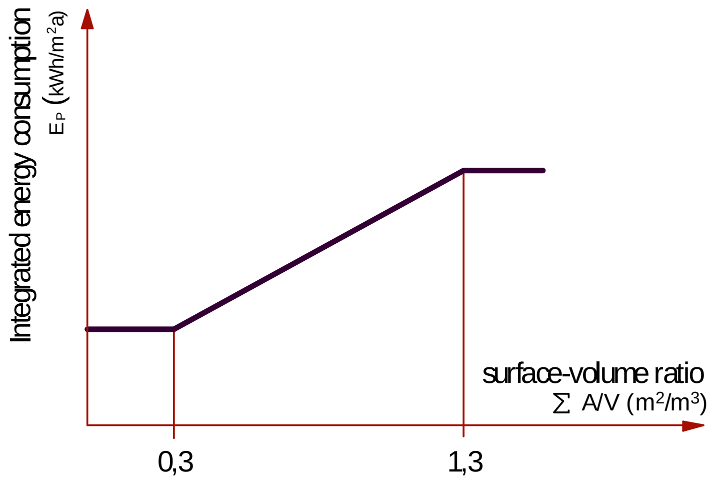

Fig. 2: The value of requirement of the global energetic feature

The figure above presents the theory of the value of requirement of the global energetic feature. The value of requirement depends on the ratio of the cooling surface and the heated volume of the building. The value of requirement follows the rise in surface-volume ratio only till 1,3 over this value to meet the requirements causes greater difficulties and additional charges.

If the geometry of the building is known, the surface-volume ratio is able to be defined, then the proper formula can be chosen from above. The definition of different standards for different building-classes is in progress, so there may be further formulae[3] beyond the three above. After calculating the integrated energy consumption (E_P) related to the studied building, the cost of the primary energy consumption can be calculated, this way:

$$K = E_P \times P \times 3{,}6 \times A_N \text{ (Ft/a)} \qquad (3.10.)$$

where:

- K = cost of the primary energy consumption (Ft/a)
- E_P = integrated energy consumption (kWh/m2,a)
- P = unit price of the natural gas: 2,50 Ft/MJ (energy price)
- 3,6 = constant: 1 kWh = 3,6 MJ
- A_N = net heated area (m2)

3.2 Water, canals

It can be calculated based on the expected consumption of water and the known water and sewage prices. The calculations relating to the water-consumption must be defined in Hungary based on the authoritative values of *MI-10-158-1:1992 Technical Directive*. The average daily water-consumption of one person can be calculated with the following formula:

[3] Zöld A: Az új épületenergetikai szabályozás, 2006, page 18

$$V = a \circ f \frac{1}{1000} \quad [m^3 / day]$$

where:

V = average daily water consumption (m^3/day)
a = daily ration per head (litre/person,day)
f = number of staff, ration or number of workers

The ‘a’ value for households, based on the manner of the building up and on the type of the settlement, public buildings and workplaces is defined by the Technical Directive. The number of staff can be defined with the help of the planning program. The amount of sewage is equal to the water-consumption in the calculation, because the account for sewage is made based on the water-consumption. The amount of the sewage needs to be calculated only in special cases, if it is measured by a counter. Then the operating costs must be calculated with different water and sewage price. Both operating costs must be calculated for a one-year interval.

3.3 Cleaning of the building

The sum appropriated to the operating cost depends on the shape of the building, the place and material of the building units, and on their surface formation (for example it is plain or rough, it gets dirty easily or hardly, it is made from smaller or greater elements, to how many parts it is divided, how many objects there are, that make cleaning difficult, etc.). To make a more exact calculation, it is reasonable to list the surfaces, which must be cleaned, then categorize them and define a unit price for each category. In case of a more simple calculation it can be defined with the help of the data of realised examples referred to useful basic area or volume. The cleaning of the building as operating cost, need to be calculated for a one-year interval.

3.4 Services, facility management

More information about the level of expectations can be acquired form the planning program or from the investor. It is reasonable to calculate the cost factor separately for each building. To realize that, there are the following methods:

- with the help of data bank, using the data of realized buildings (benchmarking),
- with the help of estimated or planning values,
- with the initiation of the participants of the market (quotations, prices of services).

4 Summary

The calculation of operating costs with the classical method requires very much labour. The main part of the operating costs is the price of the energy appropriated to the heating, hot water supply, ventilation and lighting that is getting more expensive. In case of a new building, the requirements defined by the directive 2002/91/EC, referring to the maximal energy consumption of a building must be met at the planning. The amount of maximal annual consumed energy can be defined if the values of requirements are known. Naturally investor may decide to establish a more energy-sparing building. Then the calculation can be made with the energy consumption of more favourable class. The building needs to be formed at the planning with taking the energetic requirements into consideration. With the method above the operating costs can be defined more exactly and simply at the phase of preliminary design.

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DOCUMENTATION CONTROL IN BUILDING COMPANY WITH SUPPORT OF SIMPLE WEB APPLICATION

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Abstract

Documentation for the construction envolves many interested people and need a lot of changes during the life cycle. The usage of traditional document management systems and usage of e-mailing can cause a lot of problems in the communication between project team members.

The basic problem for construction documentation is to share the documents between all project team members. These project teams usually consist of internal members of contractor, designers, customers, subcontractors, etc. The article is focused on describing simple modern tool – the web applications for sharing documents. These applications enable to share the construction documents on common internet page of the project and use all the technical advantages of this solution.

Keywords: construction documentation, documents control, web application

Introduction

We can see today the increasing pressure on the speed of communication and availability of information in general overall. Of course, these requirements are also reflected in construction companies, which usually manage large volume of documents, especially in the management of construction contracts. The characteristic features of the activities of construction firms from this perspective are at first cooperation with external entities (investor, designer, subcontractors) and also the remote communication between the employees of own the company (site manager, trader, material department, overhead departments ensuring quality control, safety, etc.).
As the basic information holder transferred between the involved parties we consider the documents to the construction contracts, both text and graphics. Large companies use for the management of documents some of the electronic documentation systems configured according their internal needs. In addition to these robust traditional database systems we see currently on the market new flexible web-based systems, which have many advantages. These are reflected especially when managing various projects, which involve a variety of internal and external partners.

Document management systems

Document Management Systems („DMS“) can be defined as the computer systems used for saving, storage, archiving and sharing of electronic documents. These could be a text or image documents, which have been created already as electronic or have been converted into this form. These systems include basic functions:

Insertion of documents – all DMS systems provide the possibility to insert documents to the system, mostly in the form of a simple upload formsheet, in some you can also upload files via FTP, respectively. FTPs.

Security - one of the most important parts of DMS systems. Good security is usually very expensive and not every company can afford it. Certain standard should be get by encrypted transmission (SSL) between the user's computer and server.

Setting right of access to documents - this function is dependent on the complexity of the system, and of course of the needs of the organisation. DMS systems allow to the users to allocate the rights to the file, ie. who has the right to read, edit, delete and approve this file.

Organizing documents - the aim of any information system is always to find what you need, usually due to the organizing the documents to the folders and the ability to search, espesially the full text.

Document Versioning - this feature allows the system to impose and save any changes to the document, including the date and user that change. Whenever in the future is possible to return to some of the earlier versions.

Workflow - the passage of each document through the certain information flow, which allows DMS to define who can edit the document, who and at what level the document is approved, possibly on where and when to issue a number of other functions. This feature is one of those already rather advanced and sophisticated and is adapted to the specific business needs of concrete company.

Archives - digitization and storage of documents in electronic repositories.

Backup - and possibly their migration to other more perspective formats to follow the continuity of access to them.

Of course, each of the DMS can provide these functions in different levels. Currently we can see two groups of DMS, which are in the following text referred to as classic electronic documentation systems and web-based documentation systems.

Classic electronic documentation systems

Classic electronic documentation systems were originally developed for internal purposes and only internal workers had the access to this system within the intraplant computer network. These systems are based on the database solution of the specific requirements and needs of users. These systems are commercial systems, which are usually traded by their creators with standard manners as other software. The requirements of current practice have forced out in many cases the possibility of external access to these internal systems through a web interface for selected users. Then the system looks like a web-based application, but is still limited by its original purpose. Common problem particularly for small and medium-sized businesses is the high price of the DMS, and sometimes their complexity. This practice leads to a situation where small and medium-sized firms don’t find the courage to do anything with such systems. The situation in the construction companies is very similar: there is very difficult to apply such classic DMS here because it can very hard to fulfil mentioned essential requirements, such as low cost, simplicity of the system, the speed of communication and access to information for remote operators.

Simple Web documentation systems

More recently, new product - simple web applications – has appeared on the market. These applications usually contain above defined basic functions for DMS, so in next we call them „web documentation systems“ (for short „webDMS“) . WebDMS are created with the aim to share the documents on the web by unlimited quantity of users and they are not linked only to an internal company staff. Their aim is the simple and effective work on electronic documents that are shared by different users. For example, they can be used very efficiently for projects of various types which are entered by various partners.

These systems can be broadly characterized as a systems for sharing documents. And they are characterized by the following characteristics:

- low price,
- simplicity,
- flexibility,
- availability outside the company on the web.

Most of these systems are offered in a basic version for free, so they are available not only for businesses but also for non-commercial purposes. It is clear that in this free version the ability of such system is also limited. From a certain level may, however, these systems meet the above characteristics of DMS.

Practically, this means:

The easier webDMS offer only storage space, either for single sending large documents or as a permanent shared space (for example, www.rapidshare.com). More advanced systems offer more features of the classic DMS, and with their other modules (Address Book, Calendar, Task list) are suitable for coordinating work teams and management of the entire project (www.docs.google.com, www.capsa.cz).

<u>Use of webDMS in practice</u>

The authors of this article have practical experience using these WebDMS for construction firms in the following areas:

- Management of the documentation for the realization of construction contracts - contracts, budgets, drawings.
- Cooperation between the construction company and external consulting firm in implementing the quality management system under ISO 9001.
- Management of the company's internal documentation (usually according the quality management system with compliance to ISO 9001)

In the next we describe in detail the practical examples of the use of webDMS those areas.

Administration and management of construction contract documentation

WebDMS can help to realize these challenges in the management contract documentation:

- Transmission of documents for the construction realization (contract documents, budgets, planning, drawings).

  Sales manager or project manager will store contract documents on the web site agreed for the contract. The site manager has the contract documents on this web address available for his disposal. In addition, more advanced webDMS can automatically generate an e-mail information about the new document/ on its update, so the site manager receives the information immediately after updating the document on web.
- Monitoring the course of the contract.

Site manager can store new documents and update on this web address already existing documents relating to the contract flow and organization (the planning of human resources for the contract, material supply planning, budget „consumption“, and others). Here on certain web address they are at disposal to the building professions (purchasing officer and others).

- Document control „against“ subcontractors (contracts, budgets).

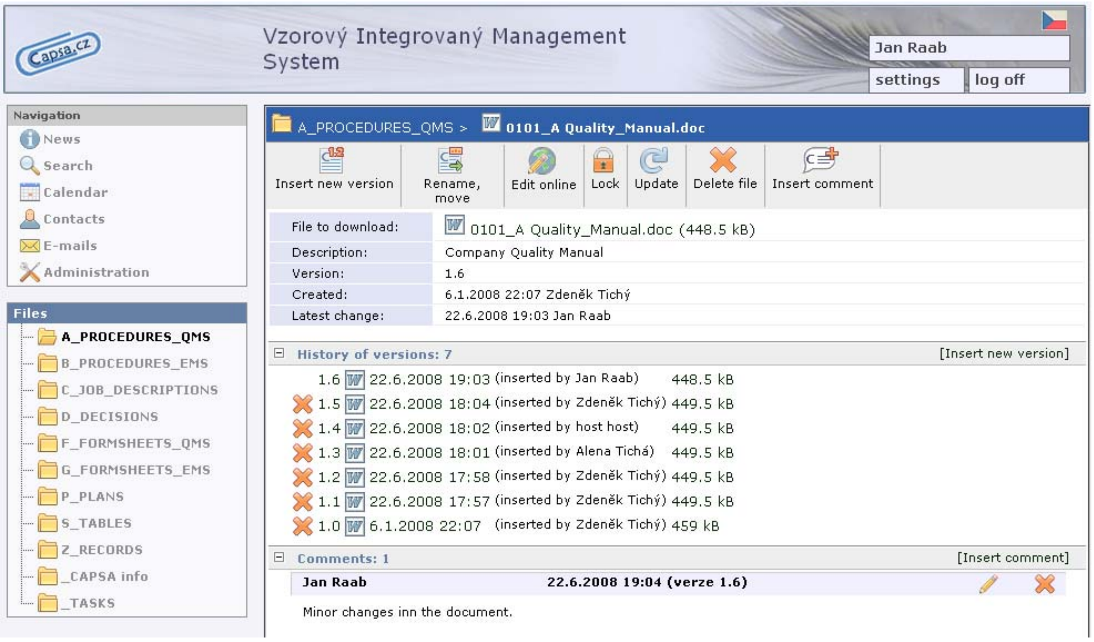
  Site manager or project manager can share the documentation for communication between the site and subcontractor on this address.

- Document change management.

  This ability is one of the most features of the advanced webDMS. These systems allow "versioning" of the documents, which means that such system keeps all stored versions, and depicts the „historical“ development of the document. This ability fundamentally differs such system from the current sharing of documents on corporate servers or in classic DMS.

- Sharing (availability) internal documents.

  All employees have all the necessary business documents, templates, forms, ... on the appropriate web address for the processing of the necessary documentation for different contracts.



Obr. 1 – Screenshot from webDMS Capsa.cz

Sharing documentation between the construction company and an external consultant

All functions of webDMS can be very effectively used in projects whose output is to be any documentation. A typical example is a project to prepare the company for certification according ISO 9001 standard using an external consultancy company. Advantage of webDMS advantage in such a project I see especially in the transmission of documents during the implementation of ISO 9001 to the customer. Each adviser certainly knows a situation when he needs to cooperate on some document with the customer. But it is very difficult to control both version – the version handled by adviser and that one controlled in parallel by customer. It can lead to the collision of such two or more versions. Because this situation is directly typoval one we will describe here how webDMS can be used in this case.

The adviser creates, in cooperation with the customer, the common web site of the project, according to the instructions, which is usually located as the part of the home website of the webDMS. On this project web address the adviser and the customer can work together with a help of simple tools of this system as follows:

- Adviser as the project administrator creates a normal directory structure for the common project, while the "creation" is working intuitively, as you would on your computer.
- Gradually, the adviser will fulfil this structure by template documents, in accordance with his ongoing consultations with the customer.
- The customer then can edit these documents (Word, Excel) directly on-line on this website. It is therefore no need to save the documents in parallel on the disk and the like. Of course, this option can use only those customer employees who are entered into the system with relevant rigths.
- The current state of the file is always stored on the web site, including its history, it means including the date and authors of each version.
- The return to the previous versions is essential for complete function of webDMS.
- Each authorised user of the file can lock this file to other users at the time when he needs to work on it outside web (for example, at the weekend, or when being outside the web).
- WebDMS can usually generate automatic e-mail notice to the optional users after the dokument has been updated or after embedded news. It will eliminate to the users the need to watch the work on the project actively.

The result, after the implementation of quality management system, is a situation where the company has saved the current controlled documents on given web site. The company may therefore continue to use them for the daily communication and sharing of documents with its employees. This is especially effective for those employees who spend most of the time outside the company (sales persons, construction site managers and others).

Management of the company's internal documentation
This is the basic possibility of use of webDMS and results from the above description. Therefore this possibility is not described further.

Conclusion

The current requirements for project management and company management lead to the use of simple and flexible tools for communication between members of work team through the Internet. „WebDMS“ applications for sharing documents and projects can be one of the approaches how to deal with this communication. We can therefore predict a big future for these webDMS applications, not only in corporate practice, but also in other areas of life. And for companies operating in the construction market we can consider this allegation from the above mentioned reasons as doubly presumable.

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"*DESIGN AND BUILD*" IN COMPARISON WITH THE TRADITIONAL PROCUREMENT METHOD AND THE POSSIBILITY OF ITS APPLICATION IN THE CROATIAN CONSTRUCTION INDUSTRY

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Abstract

A considerable part of construction projects in developed countries are executed by method of procurement known as *"design and build"* which is the main member of the integrated procurement systems.
These methods of procurement appeared as an alternative to traditional, separated methods where the client endeavours to ensure the single-point responsibility for the design and construction of the project. The direct contact between the two contracting parties, enabling misunderstandings to be minimised and procedures to be simplified, is considered as one of the main advantages of *"design and build"*.
Research carried out at the end of the year 2007 indicates a low development of the Croatian construction industry regarding the implementation of modern, alternative procurement methods, emphasising the need for improvement of this area of project management.
The paper describes the basic characteristics, the project phases and the possibility of implementing *buildability/constructability* concept in projects being conducted by *"design and build"* procurement method.
The possibility of application of *"design and build"* method in the Croatian construction industry is explored.

Keywords: *design and build*, traditional procurement method, procurement, buildability, constructability.

Introduction

A considerable body of opinion within the construction industry has suggested over many years that the traditional separation of the design and production functions within the construction process has been primarily responsible for a general lack of consideration given to the necessary and vital integration between project phases. Too often the propensity for improvement is lost because construction is thought of as little more than a routine production function almost deliberately separated from project planning and design. Fundamentally, the philosophy, systems and approaches traditionally in use do not lend themselves to the consideration of alternative design, construction and managerial procedures (Griffith and Sidwell, 1995).

Many of today's construction and engineering projects are very costly and highly complex, employing new materials and technologically advanced construction methods. Typically, demands are being made upon the construction process not just in terms of time, cost and quality, but also in those of project organisation, management and procurement. Prior to the mid-1980s the mainstream of the construction industry in developed countries has followed traditional methods of procurement. Many clients today, however, are increasingly dissatisfied with the traditional approach and its operational characteristics and actively seek alternative methods of procurement, organisation and management to meet their increasingly complex demands.

One consequence of the above has been the global development of new, alternative procurement methods, which can be categorized, by the way in which the interaction between the design and construction of the project is managed, to integrated procurement systems, management-oriented procurement systems and, in more recent times, partnering.

Main characteristics of *design and build* procurement model

The category of integrated procurement systems incorporates all of those methods of managing the design and construction of a project where these two basic elements are integrated and become the responsibility of one organisation, mostly, but not always a contractor.

The *design and build* procurement system is the main number of the group. The principal variants are *novated design and build*, *package deal*, *develop and construct* and *turnkey* methods of procurement.

We can define the *design and build* procurement method as:

"An arrangement where one contracting organisation takes sole responsibility, normally on a lump sum fixed price basis, for the bespoke design and construction of a client's project." (Masterman, 2002)

The project organisation structure for *design and build* is shown in Figure 1.

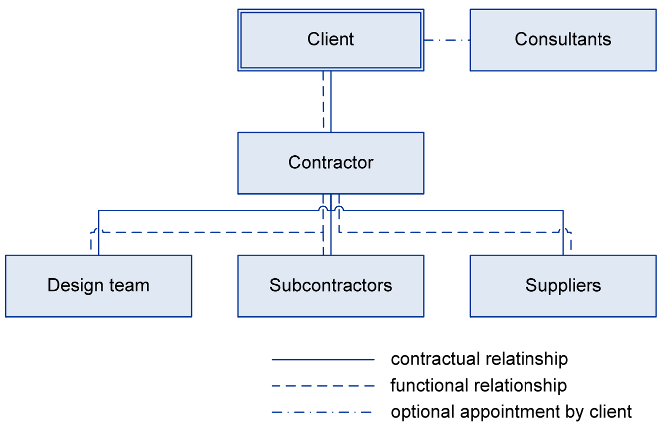

Figure 1 *Project organisation structure for the design and build procurement system*

Research has suggested that *design and build* contractors organise their activities in three different ways (Rowlinson, 1987):

- Pure *design and build* - here, the contractor strives for a complete and self-contained approach where all the necessary design and construction expertise resides within one organisation that has sufficient resources to complete any task that arises. In such organisations, all aspects of design and construction have the capacity to be highly integrated.
- Integrated *design and build* - in this form, a core of designers and project managers exists within the organisation, but this type of contractor is prepared to buy in design expertise whenever necessary. Although more effort is needed to integrate the internal and external members of the *design and build* team, in-house project managers are employed to co-ordinate these functions.
- Fragmented *design and build* - many contractors, both large and small, and including national builders, operate a fragmented approach to *design and build* projects, whereby external design consultants are appointed and co-ordinated by in-house project managers whose other main task is to take and refine client briefs. Under this regime, many of the integration and co-ordination problems of traditional approach are likely to manifest themselves along with some role ambiguity among the professions as they come to terms with the builder as leader of the design and construction team.

Advantages and disadvantages of the method

Advantages

1. The single point of the contract between the client and the contractor means that the client has the advantage of dealing with one single organisation that is responsible for all aspects of the project. Accordingly, the need to commit resources and time to contracting with designers and contractors separately is significantly reduced.
2. Provided that the client's requirements are accurately specified, certainty of final project costs can be achieved and this cost is usually less than when using other types of procurement systems.
3. The use of integrated procurement systems enables design and construction to be overlapped and should result in improved communications being established between client and contractor. These two characteristics enable shorter overall project periods to be achieved and project management efficiency to be improved.
4. The strategy enables an integrated contractor contribution to the design and project planning. Traditional procurement has often been criticised for its inability to integrate the separate design and construction functions and impossibility of the contractor becoming involved sufficiently early in the procurement process to make any significant contribution. *Design and build* provides the necessary multi-disciplinary approach and integration because it forms designer-contractor team at early stage in the process, bringing all the participants onto the same side.

Disadvantages

1. Difficulties can be experienced by clients in preparing an adequate and sufficiently comprehensive brief. As a result of insufficiently defined client's

brief which does not communicate his precise wishes to the contractor, great difficulty can be experienced in evaluating proposals and tender submissions.

2. The client is required to commit to a concept design at an early stage and often before the detailed designs are completed.
3. The absence of a bill of quantities makes the valuations of variations extremely difficult and restricts the freedom of clients to make changes to the design of the project during the post-contract period. Bids are difficult to compare since each design will be different, the project programme will vary between bidders and prices for the project will be different for each different design.
4. Relatively fewer firms offer the *design and build* service so there is less real competition. The performance of *design and build* contractors is subject to considerable variation dependent upon whether they are pure, integrated or fragmented organisations.
5. Although well-designed and aesthetically pleasing buildings can be obtained using this method, the client's control over this aspect of the project is less than when using other methods of procurement.

Design and build **project phases**

The project life cycle defines the phases that connect the beginning of a project to its end. In the literature we can find different approaches to the project life cycle model. On the basis of a comparative analysis of seven different approaches to project life cycle models, W. Hughes (Hughes, 1991) has made the suggestion of dividing the project into seven phases which are differentiated by separate decision points:

1. Inception stage (Label I)
2. Feasibility stage (Label F)
3. Scheme design (Label S)
4. Detail design stage (Label D)
5. Contract stage (Label T)
6. Construction stage (Label C)
7. Commissioning stage (Label G)

The specificity of Hughes's identification phases in terms of carrying out the project is that it is possible to implement them in a different sequence, depending on the project procurement method. The sequence of the phases in construction projects using traditional and *design and build* procurement methods is shown in Figure 2. The basic difference between these two procurement methods is that in the *design and build* method the contractor is chosen earlier. In this case, the documentation used for selecting the contractor is very different. The phases are divided decisions in the project which present the results of individual phases.

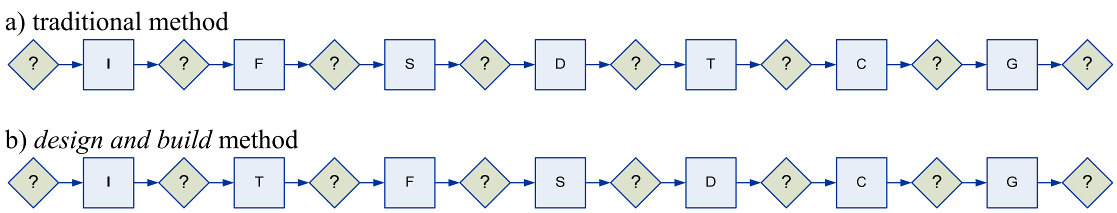

Figure 2 *The sequence of the phases in construction projects using a) traditional method, b) design and build method (Hughes, 1991)*

Implementation of ***buildability/constructability*** concept

Constructability (term used in USA) or *buildability* (term used in GB) are terms specific to the construction industry and they represent a management concept which has been developed by the construction industry in the past 30 years.

Construction Industry Institute Australia defines *"constructability"* as:

"a system for achieving optimum integration of construction knowledge in the building process and balancing the various project and environmental constraints to achieve maximisation of project goals and building performance"
(Griffith and Sidwell, 1995).

It is clear that the method of procurement has a profound influence upon the potential for constructability in modern construction projects. It is frequently suggested that bringing the whole construction process under a single point of control that is directly responsible to the client can achieve greater overall effectiveness and integration as well as better constructability. *Design and build* is one form of procurement directed explicitly towards this objective.

From the client's viewpoint, constructability, in practical terms, is concerned with reducing project uncertainty and risk through increasing efficiency in the design and construction processes, simplifying contractual arrangements and improving project organisation and management. Constructability, as a concept throughout the total building or engineering process, has a number of functional aims and *design and build* procurement has the functional ability to fulfil some of them (Table 1). Viewed from this perspective, *design and build* procurement can certainly make a positive contribution towards improving constructability (Griffith and Sidwell, 1995).

Table 1 *Design and build: functional ability to fulfil aims of constructability (Griffith and Sidwell, 1995)*

Constructability: functional aims	***Design and build*: functional ability**
Simplified contractual arrangements	Simplifies contractual arrangements: the contract is between the client and the contractor, with total responsibility given to the contractor; and the contractor is responsible for all subcontractors and suppliers.
Integrated design and construction	Promotes an integrated design and construction team in the form of the main contractor. Encourages professionals to work towards the real interests of the client.
Improve communication	Client-contractor single link and integration of design and construction improve communication between building or engineering team members.
Increased operational efficiency	Client knows at any time who to contact, i.e. the contractor. Contractor can respond quickly to client needs.
Reduced project duration	Significant savings in project time are possible through overlapping design and construction aspects. Pre-construction procurement time greatly reduced and earlier start on site is possible.
Reduced cost	Client knows, within a reasonable degree of accuracy, the total financial commitment before commencing work on site. More rapid procurement also makes cost saving.
Increased performance	Detailed brief (employer's requirements) and contractor's proposals set out the detailed specification for design workmanship, materials and performance.
Minimal project changes	Detailed brief reduces likelihood of project changes. If variations occur, contractor can respond quickly and directly to client.

The application of the construction project procurement methods in the Republic of Croatia

The Croatian construction industry also faces a similar problem of there not being enough connection between the different project phases. Traditional methods *(design–bid–build)* are mainly used when negotiating construction projects and the contractor is usually not involved in the design phase. This results in their specialist knowledge and experience not being used as much as it could be. The weak integration of the main stakeholders and project phases has a negative influence on the successful outcome of the project.

Research which was carried out in 1996 in the Republic of Croatia on a sample of 150 construction projects demonstrated that 66% of the projects went over the planned deadline, and 17% went over the starting budget (Radujković, 1997). Further research in 1998 did not show any improvement – on the basis of a sample of 333 construction projects, it was noted that in 78% of the projects an average went over the deadline for 60%, and that in 81% of the projects an average went over the budget for 32% and this solely in the construction phase (Burcar, 2005).

Considering that construction projects are carried out in the Republic of Croatia mainly according to the traditional method, we can relate these aforementioned results to this particular procurement method. According to research that has been carried out on risk sources in the Republic of Croatia, it is visible that dominant part of the internal construction project risks make those related to management, design documentation, human factors, supply and logistics and contracts (Radujković, 1999, Car-Pušić 2004). A possible way of responding to these risks is the proper choice of procurement methods in construction projects.

At the end of 2007, academic research in the form of a case study about construction project procurement methods was carried out in the Republic of Croatia. Research was carried out on five construction projects, which were elaborated in detail through the carrying out of interviews with all the main stakeholders involved in the construction – the client, the designer, the main contractor and the supervising engineer. The method of semi-structured interviews was used. The questions were aimed at providing an account of project development throughout the phases, with a special focus on the relationships and problems associated with the aforementioned participants.

One of the main results of this research and qualitative analysis was the conclusion that the dominant procurement method used in construction projects is the traditional method. This demonstrates the tardiness of the Croatian construction industry in terms of implementing new, contemporary procurement method which would positively influence the integration of the phases and participants in the project. It would also result in the possibility of realisation of the *buildability/constructability* concept, as has been suggested by global research and practice.

However, in recent times investors have an increasingly visible need for changes to be made to the traditional method, and also that a part of the risk, responsibility and especially the organisational work and financing of the design is taken on by the contractor. This is one of the main features of the *design and build* procurement method.

At the moment, this mainly involves the contractors taking on the burden of financing and communications with the designers, whilst responsibility for the design and determining the conditions for the design contract remains a question that is solved directly between the client and the designer. Nevertheless, it is visible that clients have become aware of the advantages of a greater connection between the client and designer in the construction phases, thus enabling them a reduction in their work-loads as well as easier communications.

As an initial step towards the use of an alternative procurement method, the improved traditional method in two variants is suggested (for private or for public clients). Afterwards the general improvement measures are also suggested. These measures would have the aim of influencing the wider environment in order to improve procurement procedures.

One of the suggested general improvement measures that relates to the *design and build* method includes making changes to the existing legal regulations, and the development of autonomous regulations that would create a legal framework for the application of new procurement models. These measures would arise from key element of the tender documentation - a form of contract. Globally, a number of systematic autonomous regulations have been developed that proscribe the standardised forms of contract, whose use has become normal practice. In the Republic of Croatia autonomous regulations in the field of construction are very weakly developed, which presents one of the hurdles that are faced in the successful use of different procurement methods.

Changes to the legal regulations relate to the restriction of the use of a pure type of *design and build* model according to the new *Spatial Planning and Construction Act* (in Croatian: *"Zakon o prostornom uređenju i građenju"*, NN 76/07). In article 179, item 3 it writes that "*the designer cannot be an employee of the person who is the contractor in the same construction.*" It is suggested that this legal regulation is changed in order to enable the implementation of the project according to a pure *design and build* method.

The results of the research suggest the weak development of the Croatian construction industry in terms of using contemporary, alternative procurement methods and the need for this area of project management to be developed. Research into a sample of selected construction projects in the Republic of Croatia has confirmed the significant influence that the choice of procurement method can have on the integration of the phases and the participants, and as a result, on the ultimate success of the project (Turina, 2008).

Conclusion

This article has outlined the *design and build* procurement method, which has become a popular alternative to traditional procurement methods in developed countries thanks to its significant advantages. A comparison of the life cycle of *design and build* method with traditional method has been carried out, as well as an evaluation of the possibility of implementing the constructability concept.

It then continues by questioning the possibility of applying this method in the context of Croatian construction industry, based on the conclusions from research about procurement methods in the Republic of Croatia.

Whilst in developed countries significant experience has already been gained in the realisation of construction projects using alternative procurement methods, and these areas are further developing in the direction of implementing new philosophies such as partnership, Croatian construction remains in the phase of almost exclusively using traditional methods.

However, the trend of the faster development of the Croatian construction industry in terms of increasingly complex projects, and the search for quicker and cheaper solutions and achievement of value for money will influence the need for new organisational and management methods. This will have a positive influence in terms of the integration of main project stakeholders and phases, as well as the ultimate success of the entire construction project.

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Zakon o prostornom uređenju i gradnji, Narodne novine broj 76/07

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LAYING SIEGE TO F//C^{max} FLOW-SHOP PROBLEM – IS 'RANDOM' THE LIKELY WINNER?

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Abstract

One of the most famous and challenging set of problems of Operations Research is the family of so called Flow-Shop Problems, where n pieces of products are to be scheduled for production using uniform technology on m pieces of machines for to achieve e.g. the shortest overall production time, or the minimum of waiting times, or some other target functions. Analogy in construction can be set when considering series of buildings or of construction elements (products) to be built in cooperation of series of (sub)contractors or of teams of resources (machines). Differing feature is that action of machines can be overlapped in time at processing the same product (building). The paper reports some interesting trials of finding solution for the problem, testing series of algorithms, such as Johnson's (1954) algorithm, variants of enumerations, pair-wise exchanges, and random sampling. Revealing conclusion of examinations has driven attention of researchers into direction of strict estimates on theoretical minimum of target values functioning potentially as criterion of optimum.

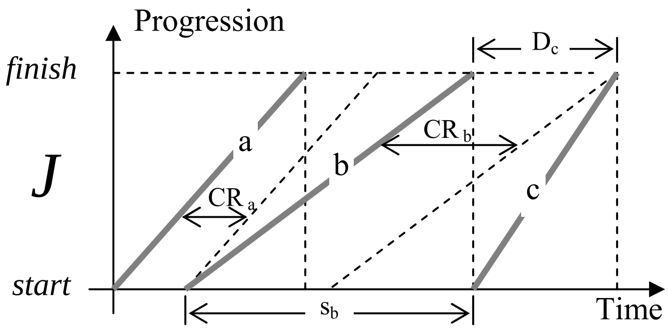
Keywords: operations research, flow-shop problem, construction modelling

PREFACE

For graphical representations of ideas to be discussed on following pages instead of using one-dimensional graphics of schedules (known as Gantt Charts), that is usual at discussing scheduling (mean: sequencing) problems, we indicate our thoughts on two-dimensional „time-route" diagrams known as „progression curves", „cyclograms" or as „linear schedules", as seen below. Horizontal axis of the diagrams is Time, while along vertical axis Progression can be read in any proper dimension such as m, m^2, m^3, ton, %, €, etc. that is a common characteristic of all processes (jobs) scheduled.

Figure 1.

Two-dimensional representation of timing processes (a,b,c) on project („workpiece") *J*



Processes are represented by individual lines (See: line „a", „b" and „c" above) slopes of which can be read as intensity of progression, while durations of processes (D_a, D_b, D_c) and timing of them (e.g. succession times between either at start: s_a, s_b or at finish: f_a, f_b) can be read as horizontal (time) views of their linear representations.

For succeeding processes with or without overlapping in time, minimum succession times (called „technology breaks", denoted as „CR_i" – read as „critical approach after process *i*") are set, defining expected minimums of non-overlapping periods.

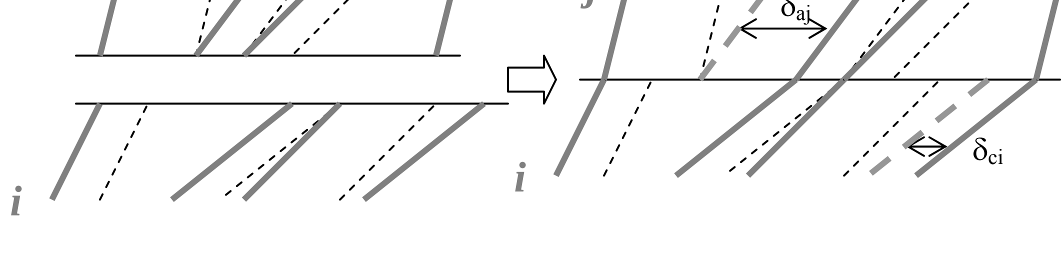
Ranges/values of critical approaches can be defined/selected tipically by considering technical-technological needs, such as needed time for hardening, cooling, drying, consolidating, etc. as constant values or can be predicted as functions of progression (processing times) due to needed manipulation area or safety zones or on-site storage capacities etc. regarding the manner of operation under consideration. Guiding relative timing of succeeding processes this way any relative time position, „lead" or „lag" time, can be set. Expectation of non-overlapping in time also can be considered as a special case of „overlapping", with succession time equal to minimum of durations of processes linked to each-other. (See process „b" and „c" in Figure 1. above – and CR_b between them. $CR_b=\min\{D_b, D_c\}$)

Minimum succession times (s_i, f_i) between succeeding processes (*i*, *i*+1) can simply be calculated using durations (D_i, D_{i+1}) and critical approach (CR_i) as input values:

$$s_i = \max\{CR_i,\ D_i+CR_i-D_{i+1}\};\quad f_i = \max\{CR_i,\ D_{i+1}+CR_i-D_i\}$$

In our context lines of processes in a schedule of a project (or of a workpiece) must not coincide or cross each-other, otherwise it would mean a partly differing (turning) technological order, that we exclude from our investigations. A project (workpiece) is complete, when the last process is completed. The schedule of a project in which all the succession times between neighbouring processes are at their minimum, set by „CR" values predicted, we do refer as „Own Schedule" or „most compact" schedule of the project/workpiece (as if it would be processed in its own). These most compact own-schedules of projects will be released by need (succession times between neighbouring processes can and will be increased if needed) when combining/linking more of them in a „Master Schedule". (See: Figure 2.)

Figure 2. Releasing Own Schedules of projects/workpieces (i, j) for linking them up in a Master Schedule with expectation of breakless performance of processes/machines. (Detail of Master Schedule is right to the arrow.)



Thus the problem of forming a Master Schedule and finding optimal sequence of projects for to achieve the aim preset is derived back to the problem of matching pairs of succesion vectors (succession times „$\underline{f}_i$" at finish on preceeding project/workpiece and succession times „$\underline{s}_j$" at start on succeeding project/workpiece).

INTRODUCTION

For testing and demonstrating effect of „Sequence" (of projects) on minimum overall execution time of a Master Schedule comprehending execution of numerous building projects („multi-project management") a small **software** has been developed by the author. Principal aim was to bring attention of students (future managers) on extended considerations of construction management especially at executing large-scaled and complex development works.

Due to standard technologies and to specialization of resources (subcontractors) also in Construction Industry some aspects of the problem of harmonyzing preferences of Clients and those of Contractors can be demonstrated by the challenge of Flow-Shop Problems. Expectation of completing products (buildings) as individual deliveries in the shortest times of execution (Clients' interest) is not necessarily coinciding the endeavour of contributing firms in completing series of products in the shortest overall execution time (Contractors' interest). Sometimes changing conventional/traditional order of operations in a technology may result in significant savings in time (that is in costs and in series of other efforts).

In a basic Flow-Shop Problem (mostly referred in manufacturing industry) n pieces of products are to be scheduled for production using uniform technology on m pieces of machines for to achieve the shortest overall execution (completion) time (C^{max}), or the minimum of sum of waiting times ($\Sigma\Sigma\delta_{ij}^{min}$) or some other target functions. The only differing feature in construction is that action of „machines" (subcontractors) can be overlapped in time at processing the same product (building).

Analogy between manufacturing industry and construction industry – from this later aspect – is trivial when considering numerous product-series to be manufactured and/or more buildings/structures to be built using the same „general" technology.

Main challenge is that for to solve most of the Flow-Shop Problems there exist no any close formula. For to find real optimal solution some type of enumerative algorithm is needed, which may/would take enormous run-time. Computations of those kinds are referred as „NP-hard" in technical literature, that is time (steps) needed for solution is „non-polinomial", it can not be defined as n times something, or n^2, n^3, etc., where n represents the number of products to be scheduled.

To demonstrate the difficulties with these calculations you can imagine a computer calculating one million master schedules – as permutations (sequence variants) of 20 projects – in a second. Well, to examine all possible permutations that computer should work for more than 77 thousand years ($20!=2.43\cdot10^{18}$; $2.43\cdot10^{12}$ sec > 77,000 years). So long a time for to solve a single problem usually we do not have. ...

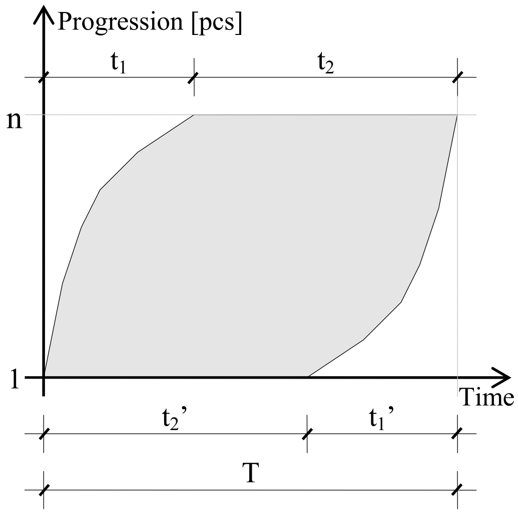
PROBLEMS TESTED

Modelling the problem

As indicated in the Preface linking up series of projects in an overall master schedule can be derived to the problem of matching pairs of succession vectors originated from most compressed „own schedules" of individual projects. Tracking necessary releases of own schedules during matching them in a master schedule estimates can be made on still available shortest overall execution time (and on minimum sum of necessary releases) avoiding the need of building up the sequences (permutations) totally for judgement. Thus huge sets of possible solutions can be eliminated from examinations.

Figure 3.

Constant (t_1) and variable (t_2) parts of overall time of completion (T) in a master schedule



$T = t_1 + t_2$

$T = t_1' + t_2'$

$t_1 = const$

$t_1' = const$

$T_{min} \Rightarrow t_{2\ min}$

$T_{min} \Rightarrow t_2'_{min}$

Before discussing data and algorithms some general recognitions (remarks) are worth to be explained highlighting common manners of variants of problems examined.

- Overall execution time of any master schedule can be divided in two segments:
  1., overall duration of processing on the first machine (t_1), that is sum of processing times on the first machine, which is constant value, not varying by the sequence of pieces;
  2., time span between finishing the first and finishing the last process on the last workpiece, that is actually effected by the sequence.

- Building up a master schedule from the very last or from the very first workpiece is a symmetrical problem, so the division of above can also be made as overall duration of processing on the last machine (t_1') and time span between starting the first and starting the last process on the first workpiece (t_2'). Due to didactical reasons we choosed the former division. (See: Figure 3.)

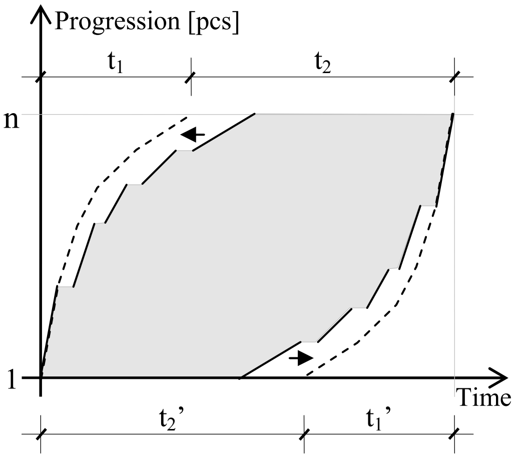
- In an optimal sequence (master schedule) the t_2 and t_2' values are at their minimum so these are the quantities the examinations should focuse on. Thus calculations are dealing with succession times, while processing times (durations) do have less or indirect importance.

- Expectation of non-overlapping can be handled as special case of overlapping as described in Preface, so overlapping is a more general expectation. (See: Figure 1.)

- Expectation of breakless performance of processes on the first and on the last machine has no significance from the point of view of the overall execution time, hence moving item lines (linear representations of processes) to the direction of start (on the first machine, in case of a broken performance) would have no effect on the overall execution time, while the performance can be made breakless. Similar can be said in case of broken performance on the last machine, moving item lines to the direction of the finish. (See: Figure 4.)

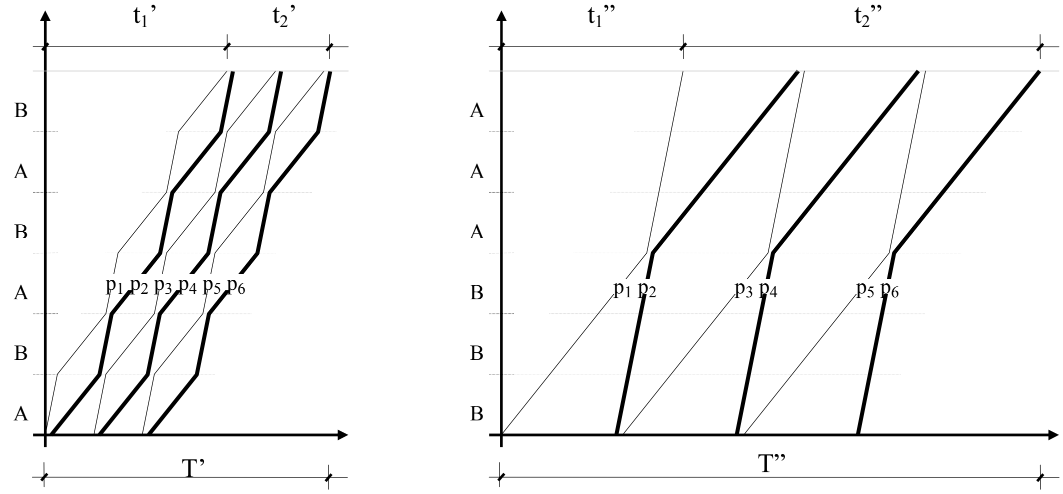
Figure 4.

Broken performance on the first and on the last machine can be made breakless without disturbing the overall execution time



Before paying more efforts to the problem we were interested in the range of effect of sequence on the overall execution time. For example, measuring theoretical schedules against each other when breakless performance of machines is expected we concluded that rate of overall execution time in an advantageous („best”) schedule (T’) and that in an unsuccessfully selected („worst”) schedule (T”) may even tend to zero(!) when increasing number of workpieces and that of machines. (See: Figure 5.)

Figure 5. Measuring effect of sequence on overall execution time with expectation of breakless performance of machines. (Sequencing *m* pieces of projects of type „A” and *m* pieces of projects of type „B” – all produced by *n* pairs of machines. On project typed „A” each second process has the duration of D_a, while others do have D_b. On project typed „B” the values of durations are the opposite. Values of critical approaches are CR. … Let D_a be significantly larger than D_b and CR! → $D_a >> D_b, CR$.)



$$\frac{T'}{T''} = \frac{t_1'+t_2'}{t_1''+t_2''} \approx \frac{m\cdot D_a + (n-1)\cdot D_a}{m\cdot D_a + m\cdot n\cdot D_a} = \frac{(m+n-1)\cdot D_a}{m\cdot(n+1)\cdot D_a} = \frac{m+n-1}{m\cdot(n+1)}$$

Based on overall durations of processes (on minimum timespan of all jobs assigned to each individual machine) and on most compressed own schedules of workpieces (projects) we also elaborated an algorithm for to estimate „theoretically" possible minimum (optimum) of target value (C^{max}). This later proved to be far more useful than expected at judging if a sequence (permutation) of larger number of workpieces (projects) produced or found is optimal or not.

The input

Data set
- number of workpieces (projects): 2 – 20 pieces (pcs)
- number of machines (processes): 2 – 20 pcs
- processing times (durations): 0 – 20 time unit (t.u.)
- critical approach (technological break): 0 – 10 t.u.
- number of random samples: $10^0 – 10^{10}$

For to generate basic set of data random generator is built in. Durations and critical approaches can further be edited (modified) graphically, while edition of set of data (such as adding, deleting, copying projects and processes, and arranging data base) is provided via menu commands and hot-keys.

Target functions
- C^{min} („C^{max}" – minimum of overall execution time)
- D^{min} („$\Sigma\Sigma\delta_{ij}^{min}$" – minimum of sum of releases of own schedules)

Primary target function of the two above can be choosed optionally, while the other – as secondary target function – can be used for further filtering of optional solutions

Shop options
- overlapping (in time on a workpiece) allowed or not
- break of performance (of machines) allowed or not
- missing processes (on individual workpieces) allowed or not

Run options
- filter value (for enumeration) set manually
- filter value (for enumeration) adopted from random sampling
- run until first match (run until first sequence fitting the preset filter value is found)

Track options
- footprint of job (tracking graphically the run of enumerative algorithms along the combinatorical tree, and/or tracking pair-wise exchanges)
- distribution (tracking distribution of target values and/or progress of calculations)

Graphical options
- size and scale of graphical representation (cyclogram) of individual projects and consequently also that of the master schedule (for to provide best and overall view)
- indicating bottlenecks (succession times at their minimum), such as critical path at network techniques. (Here we name it as „knotwork" due to appearance of graphics resembling the hand-made artycraft decoration widely known as „macrame".)

The algorithms

Variants of enumeration
- total enumeration: testing all possible permutations
- partial enumeration: testing all permutations fitting preset filter value
- implicite enumeration: testing permutations fitting the actual filter value which is updated when better target value then actual filter is found

Variants of pair-wise exchanges
At pair-wise exchanges pairs of projects within the actual sequence (permutation) are tested for exchange systematically if the target value could be improved.
- exchanges generated by primary target function (if decreasing can be gained)
- exchanges generated by secondary target function (if primary target value is unchanged but decreasing can be gained in secondary target value)
- exchanges generated by secondary target function (if primary target value is unchanged but increasing can be gained in secondary target value)

Arranged Branch & Bound
Similar to implicite enumeration, but with no initial filter and with pre-testing and pre-arranging options/choices (branches of decision/combination tree) each time when proceeding downward along the decision tree (when adding newer and newer member to the sequence/permutation under construction).

Johnson's (1954) algorithm
Johnson's famous algorithm for to solve $F2//C^{max}$ problem (scheduling on two machines) published in 1954, adapted and tested for more than two machines

Random sampling
Numerous random-generated permutations tested and evaluated

Estimating optimum
Based on overall durations of processes (all jobs for each machine) and on most compact „own schedules" of projects (workpieces) „theoretical" minimum of target value (C^{max}) is estimated. Finding any permutation (either random-generated or gained via pair-wise exchanges) matching the estimates optimality of solution can be taken as granted for sure. Feature of estimating optimum is associated with random sampling.

EXPERIENCES

Enumerative algorithms (with apropriate filter values) are surely serving an or all the optimal solutions. First of main key-points is if there exists any optimal solution with target value fitting the filter, while choosing a filter value significantly worse than the real optimum may result in either exponentially increased run-time. Thus any failure in choosing/setting real and proper initial filter value has great significance. Second key-point is verification of optimum. It is an age-old experience of working with enumerative algorithms that solutions later proved to be optimal may appear quite fast during the calculations while to prove optimality of them (to be sure of not finding better ones) may take significantly longer run-time. It is the key-point where a proper estimate on the real optimum (as theoretically proved lower bound) can help much.

Nevertheless, run-time of enumerative algorithms are desparately determined by the data themselves under examinations. The higher the level on the combinatorical tree the algorithms (filters) can bound (stop) examination of improper branches the shorter the run-time is. This later proves to be in close relation with span, median and modus of distribution of target values of all the permutations. (How outstanding the optimum is, what proportion of all the permutations are optimal, etc.)

Pair-wise exchanges are fast and clear procedures and may result in a quite acceptable solution in an almost unmeasurably short run-time. Main disadvantage of them is that they may run to a local optimum. Thus initial sequence (permutation) the exchanges are started from has great significance. Combining these algorithms with random sampling for to set or choose initial sequence is a promising trial. Pair-wise exchanges raise a theoretical question too: It is admitted that any sequence can be transformed to any other one via pair-wise exchanges. The question is, if there exists any optimal sequence could be originated from a given non-optimal one via series of pair-wise exchanges while target values are monotonously improving. (If some secondary target function could help avoiding local optimum and could help finding global one.)

Arranged Branch & Bound suffers no risk of non-existing target value set as filter. It always starts from and results in existing solutions. Effort of arranging (pre-selecting) choices for building up sequences on each level downward the decision tree however consequences in a significantly increased run-time, while in finding the real optimum (either the first one) in a shorter run-time it hasn't proved. It may keep searching on branches (on subsets) later proved to be not optimal for long. (It was one of the most unexpected and unpleasant experiences of all the examinations. We assumed and expected more of that. Locally advantageous matching – pairing or building sub-sequences – of own schedules does not necessarily mean advantage in global.)

Johnson's (1954) algorithm for to solve two machine flow-shop ($F2//C^{max}$) problem surely results in optimal solution (for two machines), optimality of which can be theoretically proved. With some slight modification the algorithm can be adapted for overlapped situations too. The problem with the logic of the algorithm is that it proves to be false, even more counteracting, when applying for problems with more than two machines. Researches are going on to elaborate some rules and/or preferences to adapt it for more machines but one should pay not too much hope of success. (Contradiction of applied logic and of aimed target can also be proved theoretically.)

Random Sampling is the least developed – even more, it could be said, the most primitive – way of finding acceptable or hopefully optimal solutions, but it works suprisingly well. Main question is how representative the sample of trials can be considered. Increasing the number of pieces (projects) to be scheduled even seemingly huge numbers (either millions or billions) of samples tend to be less and less in proportion compared with the number of all possible sequences. But, does it really mean, as objective law, that sampling is less representative? To assist answering – or at least judging – this later question was the primary reason for features of Tracking Footprints and Distributions (together with routines of Estimating Optimum) had been built in the **software**.

Routines of Estimating the optimum has been developed originally for to cool over-heated expectations against time-savings via finding a proper sequence of pieces to be scheduled. Later it proved to be a useful „benchmark" to judge optimality of any solution (sequence/permutation) found or produced. Main idea of estimate is that „t_2" segment of overall execution time of a master schedule on one hand can not be less than sum of succession times either at finish (Σf_i) or at start (Σs_i), respectively, on the most compressed project (t_2 value on the own schedule of which is the smallest). On the other hand, t_2 segment of total execution time (C^{max}) of a master schedule also can not be smaller than t_2 value of a fictive „overall" project (workpiece), durations of processes of which are calculated as overall time-span of processing on each machine, and considering the smallest approach times (CR) between succeeding processes.

This later has been improved to a test of selecting projects/workpieces systematically to the first and to the last position of the sequence using their actual critical approach values for calculating succession times, while durations were calculated from overall processing times for each machines – considering actual expectations of breakless performance. These estimates may include some errors (inaccuracy) anyway due to actual variancy of time values and of successions times. But during test-runs they proved to be correct so many a time that it drove our attention and interest to pay more efforst for searching ways of estimating optimum as correctly as possible. The bounty is alluring: establishing a „criterion of optimum". Though trials are promising in case of estimating C^{max} (t_2^{min}) values, similar „accuracy" still had not been achieved at estimating minimum of sum of necessary releases ($\Sigma\Sigma\delta^{min}$).

Window of displaying Footprints of calculations had been integrated into the software mainly for testing random generator routines (if the sample spans the whole range of possible sequences) and for to evaluate effectivity of enumerative routines (what percentage of possible sequences have been excluded from the examinations). The feature proved to be useful also for to cool expectations against enumerative approaches. Huge figures may be glamorous but misleading. Having the proper filter value not rarely we got the result of excluding more than 99.99999999 % of possible sequences. That is, the algorithm had to examine less than 0.00000001 % of all the permutations. But how long a time would it mean in case of sequencing let's say only 20 pieces (projects/workpieces)?

Another return of footprints were the ability of tracking the positions of individual pieces within the sequence while improving target value(s) via pair-wise exchanges. It was also good for destroying any preliminary assumptions and expectations or any theoretical rules we guessed.

Tracking Distributions of target values during run-time and after the calculations was also useful and awakening. On one hand the shape and extents of frequency-diagram furnished us some kinds of intimate information about behaviour and progress of calculations, on the other hand it warned us that limits of displaying result may obscure even huge numbers. Sometimes to an optimum value of a target function with a seemingly faint chance of finding (occurence) associated enormous number of alternative solutions. That is: a target value with relative frequency of seemingly zero may be achieved in huge number of cases (instances/permutations). It gives us some hope of random samples might prove to be representative in cases of larger number of projects (workpieces) too, and combined with other routines of improvement, they may lead us to find the real – or at least „acceptable sub-" – optimum.

SUMMARY

The problem of sequencing – and within that the so called Flow Shop Scheduling Problem – got into our view at the dawn of age of more and more spreading and available micro computers nowadays called PC-s. Historically the question we faced was if micro computers could be used for bringing still unavailable tool of sequencing closer to practice for to assist resolving some contradictions of interest of clients and that of contractors in a way of finding proper arrangements/sequences of contracts. (If each building could be delivered in an acceptably short period of disturbing the sites and performance of contractors contributing could also be managed on an „effective industrialized" way – in times of serious lack of building capacities and of mass and urgent need of (re)constructions.)

After modelling and testing potential effects of sequences on total execution time of a master schedule we tested five principal ways of building/finding optimal sequences:

1. For to gain certain optimum, and to check any other trials, enumerative algorithms had been developed, later improved and accelerated by some methods of filtering (Total-, Partial- and Implicite Enumeration);
2. Building sequence as a kind of string of optimal matches of individual schedules with the hope of deriving the problem back to a kind of Assignment Problem that can be solved either by Linear Programming („Arranged" Branch & Bound);
3. Finding partially optimal solutions for simpler cases and extending/combining them for more complex situations. That is, adapting some similar and theoretically provable algorithm to our purposes (Johnson's Algorithm);
4. Producing an initial sequence and improving it gradually via series of consecutive modifications (Pair-wise Exchanges).
5. Finally, for testing/measuring return of all our efforts against, a pure and primitive way of finding optimal sequence – „by chance" (Random Sampling).

Due to our principal aim of testing sequencing/scheduling as a tool for resolving some contradictions in Construction Industry and to get „provably sure" optimum, manyfold heuristics had been deliberately excluded from our investigations.

After long times of examinations, after numerous trials and hypotheses falling apart as leaves from the trees none of the principal ways above proved to be either the only or the best way of constructing/finding „the optimal" sequence. None of the „advanced" techniques and/or approaches proved to be either deliberately or more outstandingly better or effective for our purposes than the most primitive way of Random Trials. But the same time we found that elaborating a proper estimate on likely optimum is more promising a challenge. Having it, we can judge optimality of any sequence found or produced, and we can judge likely return of our efforts to find an even better solution if the one present did not seem to be optimal. ...

Construction Management, in general, avoids the „flow-shop problem" anyway. There are individual clients with diverse interest, there are contracts determining sequence of buildings and there are age-old traditional orders of processes within wide-spread and applied technologies. Sequences may be dictated by practical reasons of logistics and/or availability of resources of any kind. Risk of any changes in durations during

execution is also high, that may vanish all the results of our efforts spent for finding the optimal sequence. The question of sequencing emerges in case of – 'Thank God' – rare situations of need of mass reconstruction and/or in case of serious lack of capacities for delivering in a proper time. Main yield of dealing with it may appear rather in manufacturing construction materials and prefabricated elements, but most of all, in bringing attention of managers on the phenomenon that changing age-old traditions in technologies and/or selecting a proper sequence of jobs may result in unexpectedly considerable savings in time and/or in any other efforts. ...

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ANNEXES

Figure 6. Found optimum and Distribution of target values at Scheduling 20 projects (Schedule displayed with option of Show Knotwork on)

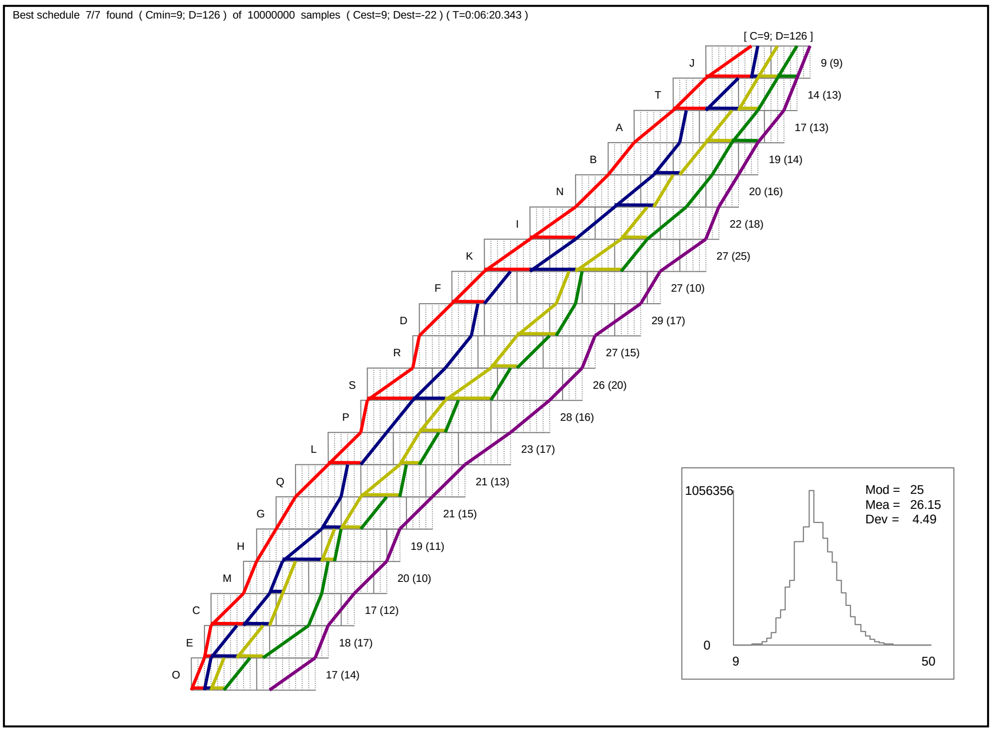
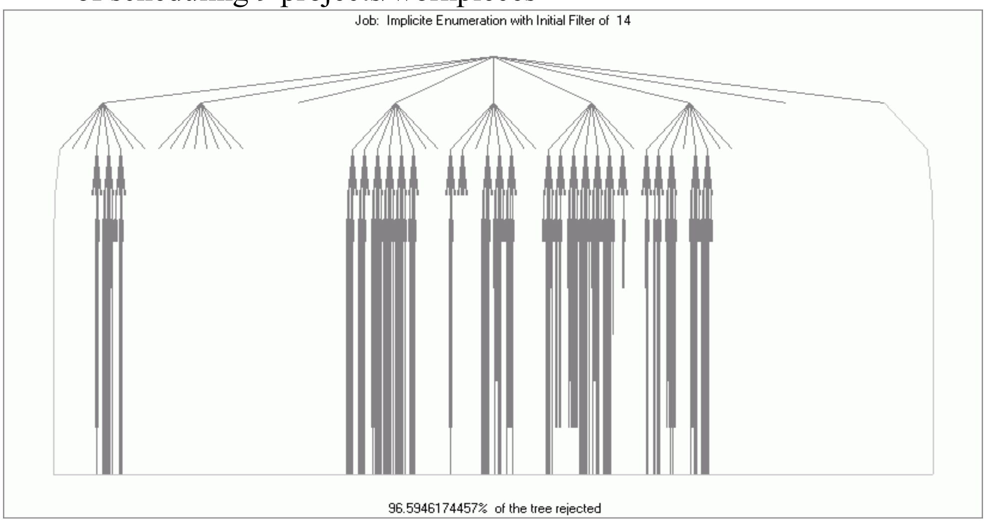


Figure 7. Footprint (on the decision/combinatorical tree) of an Implicite Enumeration of scheduling 9 projects/workpieces



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TEROTEHNOLOGICAL BUILDING MANAGEMENT

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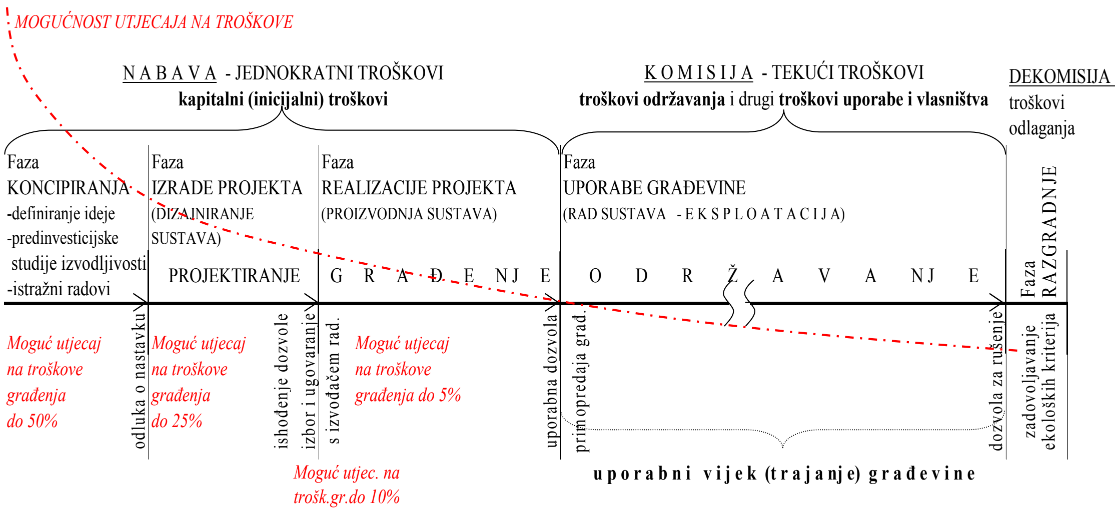
Abstract
Terotechnological management concept implies optimization of lifetime incomes and expenses in a system with a large share of long term possession. This is why it is appropriate for buildings, especially those buildings whose owner does not change over their life.
Cost effectiveness of investment is in correlation with the time of building's exploitation. Described here is an iterative approach to determination of planned service life, according to ISO 15686, in concept and design phase. Greatest influence on expenses over building's life is possible in these phases. Every project with regard to its specifics requires special analysis of the sources of costs and risk. Categorized groups of sources help when planning and identifying costs.
In the usage phase it is necessary to adequately monitor building state, activities taken and the costs tied to them. To that end, it is desirable to formulate appropriate type system documentation. Management requires computer support which encompasses databases and appropriate methods to help in decision making.

Keywords: terotechnology, planning, cost, service life

UVOD
Upravljanje građevinama ovisi o njihovoj namjeni i vlasništvu (državno ili privatno –s jednim ili više vlasnika). Radnje koje se poduzimaju tijekom vremena uporabe, poglavito u svrhu održavanja, ovise o značaju građevine i njenom stanju koje je posljedica starosti, kvalitete projekta i izvedbe, te dosadašnjeg održavanja.
Građevine kroz svoju uporabu trebaju vratiti uloženi kapital ili ostvariti društvenu korist, a projekti izvođeni po modelu javno-privatnog partnerstva (JPP) i jedno i drugo. Različite građevine na različite načine mogu ostvarivati prihode, dok tijekom njihove uporabe nastaju raznorodni troškovi (*Facility Management Costs*). Uvijek nastaju neki troškovi korištenja i održavanja, a postoje i određeni troškovi upravljanja građevinskim objektom. Kod nekih vrsta (namjena) građevina dolazi i do troškova proizvodnje, troškova povremenog moderniziranja, u nekim slučajevima i zaštite okoliša [10].
Osnovni cilj upravljanja je da kroz dobru organizaciju minimalizira troškove. No, nije dovoljno troškove promatrati izdvojeno, već ih treba analizirati integralno, na razini svih faza životnog ciklusa građevine (slika 1.). To podrazumjeva njihovo sveukupno planiranje prije izvedbe i kontrolu tijekom građenja i za vrijeme uporabe. Posebno je naglašen interes cjeloživotnog sagledavanja troškova kod građevina koje cijelog svog životnog vijeka ne mijenjaju vlasnika (investitor = korisnik, vodi projekt od izbora projektne ideje do rušenja na kraju).
Pokazalo se da troškovi korištenja i održavanja i troškovi razgradnje u konačnici često bivaju veći od inicijalnih (kapitalnih) troškova građevinskih sustava.
Trgovine i uredi obnavljaju se približno svakih 10 godina, a prema izvješću BMI iz 1996. god. troškovi obnove u UK iznose 54% od početnog kapitalnog troška za banke

i 82% za stanove. Troškovi održavanja zgrada godišnje iznose 2-3% početnog kapitanog troška. ¨Ako se uzmu u obzir i poboljšanja radovi na postojećim zgradama mogu doseći svake godine 5% kapitalne vrijednosti zgrada na nacionalnoj razini [1]¨. U zemljama razvijenih ekonomija približno 50% troškova gradnje odnosi se upravo na održavanje (uključujući obnovu). Ukupni izdaci za održavanje zgrada imaju tendenciju rasta i u Velikoj Britaniji samo za zgrade iznose 5% bruto domaćeg proizvoda [1].

Neke inozemne analize za slučajeve JPP-a ukazuju da od sveukupnih troškova građevine na projektiranje i građenje otpada 30 -35% (inicijalni troškovi), a na uporabu i održavanje, tzv. fazu komisije, 60 -65% gledano za razdoblje od 25 -30 godina [8] (koje se uobičajeno računa za povrat kapitala kod građevina visokogradnje).

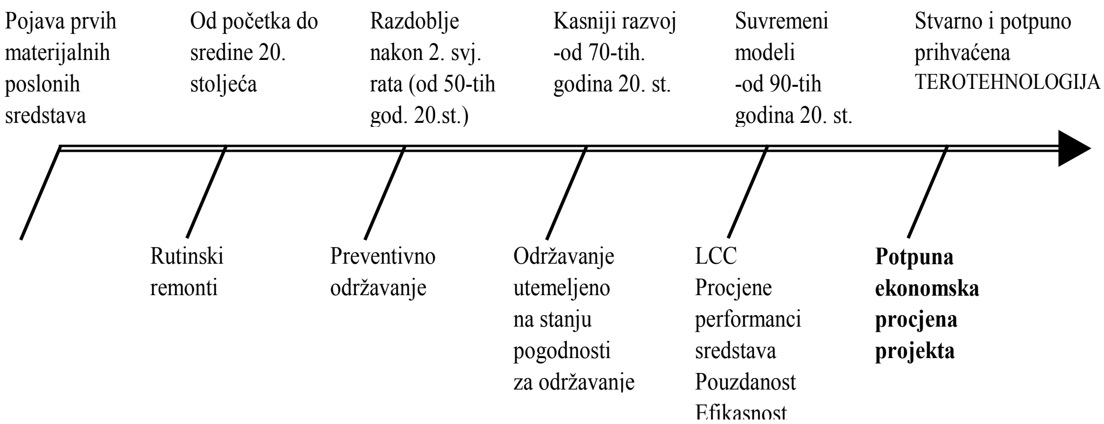


Slika 1. -Osnovne faze životnog vijeka građevinskog projekta, troškovi građevine kao poslovnog sustava i mogućnost utjecaja na njih [9, 10]

CJELOŽIVOTNO PLANIRANJE TROŠKOVA

Kada je nakon Drugog svjetskog rata nastala potreba za ubrzanom proizvodnjom, a uslijed značajnog tehnološkog napretka stvorena je mogućnost izvedbe mnogo naprednijih tvornica i zgrada, došao je do izražaja problem odgovarajućeg upravljanja nekretninama. Veliki, sofisticirani sustavi imali su visoke troškove održavanja, a obzirom na njihovu veliku vrijednost svakako se trebalo dobro paziti da se ostvari dovoljna iskorištenost [2]. Menadžeri zaduženi za upravljanje funkcijama održavanja u poduzećima u Velikoj Britaniji i SAD upozorili su na potrebu izbora sustava ne samo prema kriteriju visine troškova projektiranja i građenja, već na temelju procjene svih troškova do kojih dolazi tijekom cijelog vijeka korištenja nekog sustava.

Za sustave s velikim udjelom dugotrajne materijalne imovine, kao što su različite vrste građevina, pogodan je terotehnoški koncept upravljanja. Terotehnologija je primjenjiva za građevinarstvo i druge tehničke djelatnosti, kao i na uslužne poslovne sustave (stambeno-poslovne zgrade, škole, bolnice, hoteli itd.) koji su rezultat (proizvod) djelovanja sustava građevinskih poduzeća.



Slika 2. -Razvoj održavanja materijalnih poslovnih sustava prema terotehnologiji [5]

Teratehnologija (grč. ¨terein¨ znači ¨briniti se¨) je disciplina koja kombinira menadžment, ekonomiju, inženjering, pravo i znanja građenja kako bi se osigurali optimalni troškovi životnog ciklusa razvoja i upotrebe opreme i poslovnih sustava. Stoga obuhvaća upravljanje sustavom od njegovog stvaranja do razgradnje ili preraspoređivanja [2, 3]. Terotehnološki sustavi kao standardne elemente imaju:

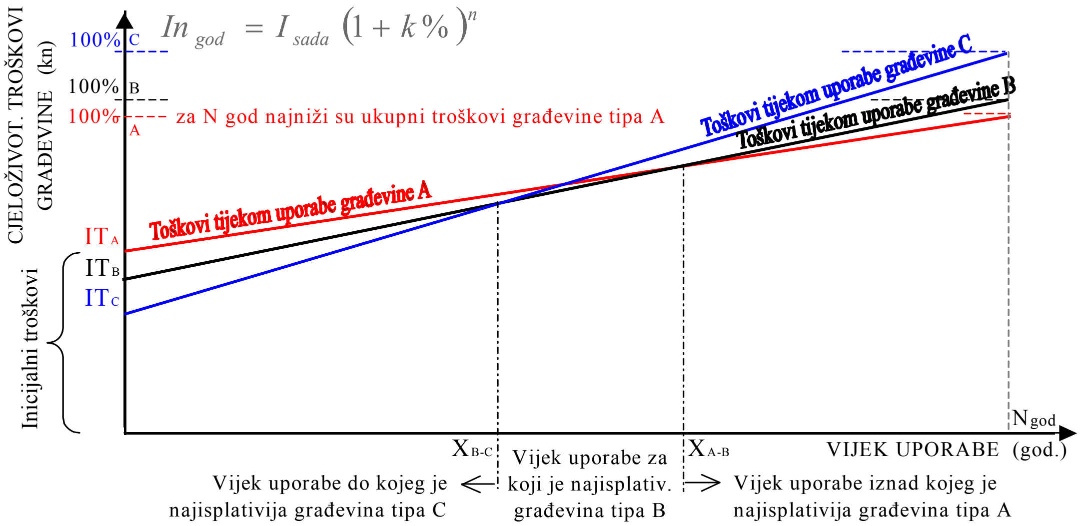
- upravljanje dizajnom sustava (tako da je pogodan za održavanje), što podrazumjeva izbor i projektiranje najpogodnijeg tipa građevine,
- upravljanje nabavom, odnosno izbor najpovoljnijeg (ne nužno i najjeftinijeg) izvođača projekta, moguće i više njih, te tehničko-financijski nadzor realizacije,
- upravljanje projektima, uključujući pribavljanje sredstava sa željenim operativnim i održavateljskim karakteristikama, upravljanje operacijama za skrb i smanjenje zastoja sustava, upravljanje financijama (kontrola troškova i odlučivanje na temelju povratnih informacija) i upravljanje ljudskim resursima (izbor i usavršavanje operativnih djelatnika) [2].

Ovakav način upravljanja zahtjeva da se u svakom trenutku upravljanja bude svjestan opsega svih troškova sustava, kako prošlih, tako i sadašnjih i budućih. Za građevine (npr. hoteli) kod kojih je uz funkcionalnost posebno važan njihov dizajn (unutarnji i vanjski izgled), nužne su periodične promjene čije troškove također treba predvidjeti. Tijekom dugog vijeka korištenja građevina mijenjaju se propisi u svezi sigurnog korištenja, pa im se oni da bi ostali u funkciji moraju prilagođavati [10].
Isto tako treba računati i prihode koji nastaju uporabom sustava, kao i gubitke do kojih dolazi zbog zaustavljanja proizvodnog procesa ili smanjenja njegovog obima (npr. u slučaju nekih kvarova, redovitog remonta i dr.). Kod zgrada, osim neke proizvodnje unutar njih, prihodi mogu biti od iznajmljivanja stambenih i poslovnih prostora, parkirališta, danas sve više postavljanja reklama i odašiljača, od prodaje nekih prostora, kao i od vrijednosti koje ostaje na kraju, nakon rušenja (zemljište).
Ipak, u usporedbi s menadžmentom dobiti, mogućnosti utjecaja na nastajanje troškova kod poslovnih nekretnina su u načelu veće [9].
Mnogo principa teratehnologije sadrži metoda *Life Cycle Costs* (LCC) za upravljanje troškovima sredstava cijelog životnog vijeka sustava. LCC daje podlogu za usporedbu i izbor između različitih mogućih varijanti (opcija dizajna) sustava na temelju svih troškova kojima će biti izložen tijekom cijelog svog životnog vijeka, ali za razliku od teratehnološkog koncepta zanemaruje priliv financijskih sredstava od korištenja sustava.
Planiranje cjeloživotnih financija treba početi već u fazi osmišljavanja projekta, tj. u predinvesticijskim studijama izvodljivosti, pa uz uobičajene sudionike u izradu

projekta valja uključiti i specijalista za održavanje građevina da napravi dio dokumentacije za to područje [4]. U fazi uporabe nastaje velika grupa troškova održavanja od kojih mnogi jako ovise o odlukama koje se donose prije početka građenja. Empirijski podaci pokazuju da se u pripremi odlučuje o 80% troškova, a za preostalih 20% je razmjerno mala mogućnost upravljanja.
Veličine utjecaja na troškove građenja mogu se grupirati na one uvjetovane:
- okolinom (ekonomski, politički, pravni, društveni i ekološki čimbenici),
- mjestom (klima, gradilište i iskorištavanje)
- oblikom (geometrija, statički i konstruktivni uvjeti i građevinsko-fizička zaštita),
- proizvodnjom (način, vrijeme i cijena gradnje),
- korištenjem (vrsta, stupanj i trajanje korištenja)
- menadžmentom (snaga pregovaranja i organizacija) [9].
Poznato je da su u početku razvoja projekta, dok se još nije počelo s izgradnjom, utjecaji na ukupan iznos i dinamiku troškova najveći. Kada se jednom dobije dozvola i potpiše ugovor s izvođačem radova, kako se gradnja bliži kraju mogućnost utjecaja na troškove je sve manja.
Suprotno tome, kumulativna krivulja nastajanja troškova u fazi planiranja raste sporo, za vrijeme građevinske izvedbe ima nagli rast, a nastavlja se neprekidno povećavati i tijekom uporabe, najdugotrajnije faze životnog ciklusa.
Iskustva u nekim državama EU ukazuju na moguće uštede u ukupnim, cjeloživotnim troškovima građevina do 20% vrijednosti [8, 9].
Vrijeme i napor uloženi za izbor optimalne varijante građevinskog projekta, budućeg sustava za eksploataciju, kao i bolji nadzor i veći troškovi (jednokratni) za kvalitetniju realizaciju, u pravilu bi trebali osigurati da budu potrebna manja financijska sredstva tijekom uporabe (tekući troškovi), odnosno minimiziranje investicijskih izdataka dovodi do većih troškova korištenja. Generalna procjena je da tzv. ¨jeftine građevine¨ koje ne uvažavaju kasnije troškove mogu biti povoljnije najviše za 10 –20% investicijske vrijednosti, dok povećanje zbog ušteda u budućnosti (npr. omogućavanje fleksibilnosti građevine, izolacije, lakše održavanje itd.) može iznositi cca. 2 -3% [9].
No, tu je važno biti svjestan koliko se svi ti troškovi znatno razlikuju od regije do regije, jer direktno ovise o cijeni ljudskog rada. Zato je uvijek potrebno napraviti posebnu analizu s odgovarajućim vrijednostima utjecajnih parametara [10]. Kada se ima pouzdane podatke jednostavno je iznalaženje modela građevine s optimalnim ulaganjima u odnosu na kasnije troškove i vrijeme uporabe. Na slici 3. prikazana je situacija s tri varijante građenja (s različitim inicijalnim troškovima i različitim troškovima korištenja). Dani grafički prikaz s pravcima je pojednostavljen usvajanjem prosječnih troškova, istih za sve godine eksploatacije (u stvarnosti troškovi imaju skokoviti prirast, uobičajeno sve veći kako raste starost građevine. Na grafikonu nisu uzeti u obzir niti troškovi razgradnje, a nisu prikazani ni prihodi. Granično trajanje uporabe za izbor određenog modela građevine prema minimalnim ukupnim troškovima može se izračunati iz izraza koji se dobiva izjednačavanjem pravaca na grafikonu:

$$X_U^{A-B}[god] = \frac{IT_A[kn] - IT_B[kn]}{UT_B\left[{kn}/{god}\right] - UT_A\left[{kn}/{god}\right]}$$, gdje su:

IT - inicijalni troškovi (ulaganja u planiranje, izbor varijanti, projektiranje i gradnju),
UT - troškovi tijekom uporabe,
$_B$ - označava građevinu s manjim inicijalnim, a većim troškovima za vrijeme uporabe,
$_A$ - označava građevinu s većim inicijalnim, a manjim troškovima za vrijeme uporabe.

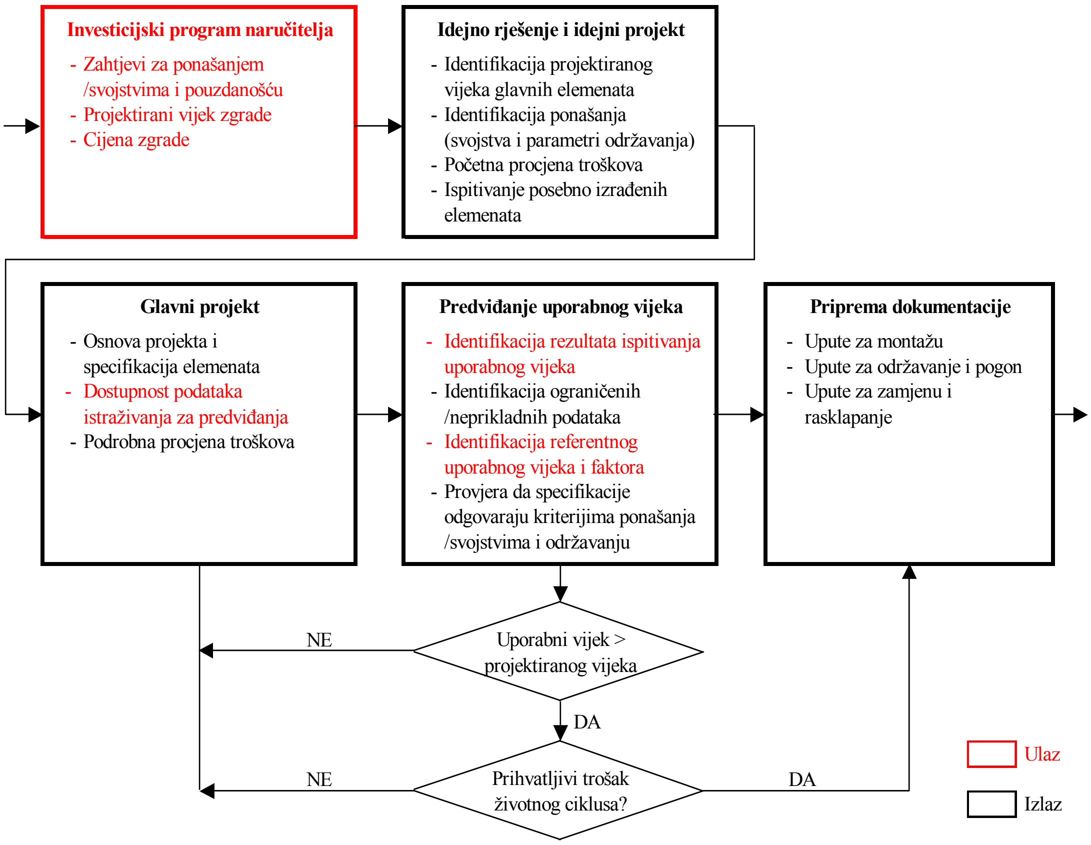


Slika 3. -Prikaz odnosa inicijalh troškova i troškova tijekom uprabe građevina [10]
(I = vrijednost investicije –sadašnja i nakon n godina, k = kamatna stopa)

U financijskoj analizi treba uzeti u obzir i utjecaj vremena na vrijednost financijskih sredstava. Kako bi se svi troškovi tijekom nekog dužeg razmatranog perioda mogli zbrojiti i međusobno uspoređivati primjenjuje se metoda njihovog diskontiranja na sadašnju vrijednost preko neke usvojene kamatne stope.

PLANIRANJE UPORABNOG VIJEKA

Da bi se cjeloživotni troškovi građevine mogli optimirati, već u ranoj fazi projektiranja potrebno je odrediti trajanje buduće građevine i njenih dijelova. Osim planiranja održavanja i dinamike troškova i dobitaka, te određivanja rentabilnosti, analitičko predviđanje uporabnog vijeka građevina u razvijenim zemljama sve se više traži i zbog sigurnosnih zahtjeva, procjene djelovanja na okoliš i razmatranja utroška energije za cijeli životni ciklus građevine.
Zadatak planiranja je što je više moguće osigurati da procijenjeni uporabni vijek zgrade ili elementa (*estimated service life*) bude najmanje toliko dug koliko je projektirani vijek (*design life*). Predviđanje uporabnog vijeka treba biti uključeno u proces projektiranja zgrade s iterativnim postupkom da bi se ¨ustanovilo kako se prikladno postižu istodobno zahtijevana svojstva, održavanje i prihvatljivi troškovi [1]¨. Uporabni vijek zgrade planira se tako da se u investicijskom programu zada projektirani vijek, a zatim u idejnom i glavnom projektu definira trajnost svih elemenata zgrade i njihovih sastavnih dijelova, kao i periodi (raspored) njihovih popravaka, obnove ili zamjene s ciljem da se zadrže na početku postavljeni zahtjevi. Taj proces definira ISO norma 1586 što za tipičan slučaj pokazuje slika 4.
Neograničeni projektirani vijek zgrade treba rabiti vrlo rijetko jer on znatno smanjuje mogućnosti projekta. Kod zgrada neograničenog vijeka uporabe za nedostupne konstrukcijske elemente potrebna je također neograničena trajnost. Ako je uporabni vijek bitnog elementa kraći od projektiranog uporabnog vijeka zgrade, on mora biti zamjenjiv ili mora postojati mogućnost održavanja. Za lako zamjenjive elemente predlaže se projektirani uporabni vijek od 3 -6 godina .
Važno je identificirati minimalno prihvatljivu razinu kritičnih svojstava za sve važne elemente građevine. ¨Ta svojstva određuju pitanja ponašanja koja mogu inicirati zamjenu elementa ako element više ne zadovoljava prihvatljivu razinu [1].¨



Slika 4. – Postupak predviđanja uporabnog vijeka u fazi projektiranja [1]

U okviru planiranja uporabnog vijeka razmatra se ponašanje građevine u okolnostima okoliša koji će na nju djelovati i uključuje se predviđene rizike. Pri tome treba težiti korištenju podataka poznate kvalitete, a inovativni materijali su problematični. Općenito je prihvatljiva granica povjerenja od 80% za elemente koji se mogu održavati, dok nedostupni elementi, koji su predviđeni da funkcioniraju bez održavanja tijekom cijelog uporabnog vijeka građevine, zahtjevaju još višu razinu pouzdanosti. Procjene uporabnog vijeka stalnih elemenata ili sklopova zato trebaju premašivati projektirani uporabni vijek zgrade za iznos koji predstavlja pogrešku [1].¨
Stručna literatura, Narodne novine i ISO norma 1586 daju dosta slične podatke o očekivanom uporabnom vijeku za brojne, različite elemente građevina. Faktorska metoda procjene te referentne periode još množi s nizom faktora čija veličina (može biti i veća i manja od 1,00) proizlazi iz posebnih uvjeta za konkretni slučaj (kvaliteta elemenata, razina projekta, razina izvedbe, unutarnji okoliš, vanjski okoliš, uporabni uvjeti, razina održavanja) [1].
Planiranje uporabnog vijeka primjenjuje se na nove, još neizgrađene građevine, ali i na postojeće. Kod postojećih ocjena elemenata načelno će se primjeniti na preostali uporabni vijek onih prije ugrađenih, a izbor elemenata i pojedinosti raditi će se samo za popravke i nove radove.
Koliki će zaista biti vijek trajanja građevine ovisi o materijalima i kvaliteti izvedbe, ali i načinu održavanja i vrsti građevine. Uz funkcionalnu i tehnološku zastarjelost treba voditi računa i o ekonomskoj zastarjelosti do koje dolazi kada održavanje postane previše skupo i kada postoje prihvatljive jeftinije alternative održavanja. Uz sve to utjecaj mogu imati i razni estetski, pomodni, socijalni, psihološki i komforski faktori.

UPRAVLJANJE TROŠKOVIMA TIJEKOM UPORABE

Upravljanje građevinama nije isključivo tehničko održavanje, premda se u našoj praksi često samo na to svodi. Zapravo se radi o multidisciplinarnom području s gospodarenjem usmjerenim na očuvanje, pa i povećanje vrijednosti građevina.
Uz tekuće troškove u ovoj fazi se javljaju i troškovi građevinskih izmjena koje produljuju trajanje uporabe. Uključivanje troškova održavanja i modernizacije u planiranje budžeta poduzeća obično se bazira na iskustvu, pa se za to, prema njemačkim izvorima, za zgrade uzima postotak od 1,5% vrijednosti vlasništva nekretnine [9]. S većom mehanizacijom i automatizacijiom kod instalacija zgrada i troškovi poslovanja se povećavaju.
Zbog uspješnijeg planiranja i praćenja (evidentiraja) troškove je poželjno razvrstati u srodne grupe kako se kategoriziraju u nekim zemljama EU (V.B., Njemačka) [7, 9].
Svrha održavanja prema *Zakonu o prostornom uređenju i gradnji* je očuvanje bitnih zahtjeva za građevinu tijekom njezinog trajanja. Preventivno održavanje sve više zamjenjuje rutinske remonte i prediktivno održavanje (pregledima ili mjerenjem ustanovljena potreba zamjene ili popravka), a pogotovo korektivno održavanje do kojeg dolazi tek nakon pojave kvarova (slika 2). Za građevine je najpoželjnije preventivno održavanje jer im produljuje uporabi vijek, ali ono zahtjeva stalno vođenje brige o njima.
Kod održavanja je važno je postići povoljan tajming održavanja jer prekasno, kao i prerano popravljanje povećava troškove. Ako se mjere održavanja i modernizacije provode rjeđe ti troškovi će u prosjeku za to razdoblje biti niži, ali s produživanjem tih ciklusa u pravilu rastu troškovi korištenja.
Da bi upravljanje bilo što efikasnije treba primjenjivati suvremene, transparentne metode analize, a na raspolaganju treba imati odgovarajuće baze ažuriranih podataka.
Tijekom vijeka uporabe potrebno je ustrojiti dobro organiziran (pod)sustav održavanja s komunikacijskim kanalima koji omogućuju povratne informacije jer je zbog očuvanja bitnih svojstava građevine potrebna kontinuirana usporedba stvarnog stanja građevine s planom i početno postavljenim zahtjevima. Za to je pogodno standardizirati dokumentaciju koja će upućivati na uočavanje i evidentiranje relevantnih, tekućih podataka u svezi stanja građevine i aktivnosti održavanja, a svakako je neophodna programska računalna podrška.
Kod donošenja odluka pri upravljanju održavanjem posebno je važno određivanje prioriteta mjesta djelovanja na građevini ili prioriteta između više građevina pod istim menadžmentom. To se može obaviti nekom od varijanti višekriterijske analize (matrične). Da bi se ona primjenila prethodno je potrebno na osnovi analize predmetne građevine odrediti kriterije usporedbe i njihovu težinu. Više kriterija će doprinjeti vjerodostojnosti odluke, a svi kriteriji se ne moraju moći izraziti u istim mjernim jedinicama (zapravo se većinom mogu vrednovati kroz neku ocjenu). Za standardne kriterije kod zgrada predlaže se: status objekta (značenje u odnosu na druge), fizikalno stanje elementa (trenutno stanje i mogućnost većega oštećenja), značenje elementa (tj. funkcionalnog dijela zgrade gdje se nalazi) za uporabu, utjecaj na korisnike i utjecaj na objekt (kako može oštećenje jednog elementa izazvati oštećenja na drugim dijelovima) [4].
Slični postupci mogu se primjeniti i kod građevina niskogradnje (ceste, mostovi i dr.) koji su u vlasništvu države Aktivnosti njihovog održavanja obavljaju se prema godišnjem planu, te strategiji razvitka i programu građenja i održavanja. Da bi se uspješnije optimiralo troškove treba analizirati kriterije važnosti i prioritete održavanja (sagledavati objekt i pojedinačno i njegovu važnost u prometnoj mreži). Pregledima (redovito ophođenje) se ustanovljuje stanje objekata (prema ¨Katalogu oštećenja¨ -za

grupe elemenata i u cjelini), a onda bi trebalo napraviti scenarije djelovanja koji uz postojeće uvjete osiguravaju zadanu razinu uslužnosti, sigurnosti i trajnosti. Troškovi se mijenjaju ovisno o vremenu kada će se izvrši popravak oštećenja, pa scenariji predviđaju stanja za različite starategije održavanja, s proračunom njihovih troškova, kao i troškova (štete) do kojih će doći ako se neka strategija ne primjeni [6].

ZAKLJUČAK

Građevine su trajna kapitalna imovina, ali i složeni, tehnički sustavi koji traže odgovarajuće upravljanje u interesu vlasnika i korisnika, kao i društvene zajednice.
U našoj praksi se često građevinski projekti realiziraju isključivo prema kratkoročnim ciljevima (najmanjoj cijeni gradnje), a pri upravljanju njima izostaje sustavni pristup i dokazane metode analize. Ne postoji neki opći, troškovno optimalni model građenja, nego je za svaki konkretni slučaj potrebno posebno razmatranje.
Uvijek se teži smanjenju sveukupnih troškova posjedovanja, pa je zato o njima potrebno voditi računa tijekom svih faza životnog ciklusa građevine. Da bi pozitivni utjecaj bio što veći s cjeloživotnim predviđanjem treba početi još kod osmišljavanja projekta i s tim u skladu ga dizajnirati. Dugoročno planiranje prije gradnje i dobra organizacija upravljanja tijekom uporabe može dovesti do velikih financijskih ušteda.
Čak i ako je građevina već duže u uporabi, a nije prethodno napravljen odgovarajući plan za njen cijeli životni vijek, korisno je odrediti preostali uporabni vijek i za njega definirati plan održavanja. I tada se još donekle može utjecati na dinamiku i ukupan iznos troškova, pogotovo ako se planira neka rekonstrukcija, dogradnja, promjena namjene, veće poboljšice zgrade i sl.
Rušenje zgrade treba biti uzeto u obzir već u fazi projektiranja kako bi se smanjio otpad i olakšala ponovna uporaba materijala i elemenata.

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GALA 2008 – Construction project management software

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Summary

Project management has a low reputation in construction. Only 33% of projects meet their time objectives and 66% have issues with meeting their cost objectives. This paper elaborates on a tool – GALA 2008 - for integrating cost and time in construction projects which managers can use to achieve higher project management success. The application consists of more than 20000 norms of material, work and machines, and more than 9000 analysis of cost. It has been tailored for construction markets similar to the Croatian. This software helps construction professionals generate: bills of quantities (BoQ), work diaries, invoices, project schedules, histograms and S-curves (material, work, machine and cost) and manage procurement on site. We have validated its use in practice and came up with guidelines for further development; such as collaboration abilities on an enterprise level.

Keywords: project management, cost, time, integration, application, construction industry

1. Introduction (A brief overview of the software development)

1.0. Introduction

Competitive pressures within construction industry have forced companies to reexamine their management techniques and to improve their *"modus operandi"*. The industry has been accused of being the worst, wasteful, inefficient and ineffective (Nicholson, 1999). Every project is a combination of many events and interactions, planned or unplanned, with changing participants and processes in constantly changing environment, throughout the lifetime of the project (Sanvido et. al., 1992). Project management should always achieve success which is often viewed trough cost, time and quality. Projects, managed trough MS Project, Fast track, Super Project, Primavera, or any other PM solution, represent a model of behavior of a project. Still, some divergences exist and are shoving the downsides of the model. Thus managers must try to minimize them and insure a higher level of performance. Such divergences are never completely explained because of the nature of construction work and uncertainties associated (Al-Jibouri, Saad H. 2003). Only in 2003, private companies have spent more than 1.5 billion £ on tools for performance measurement (Beatham et al., 2004).

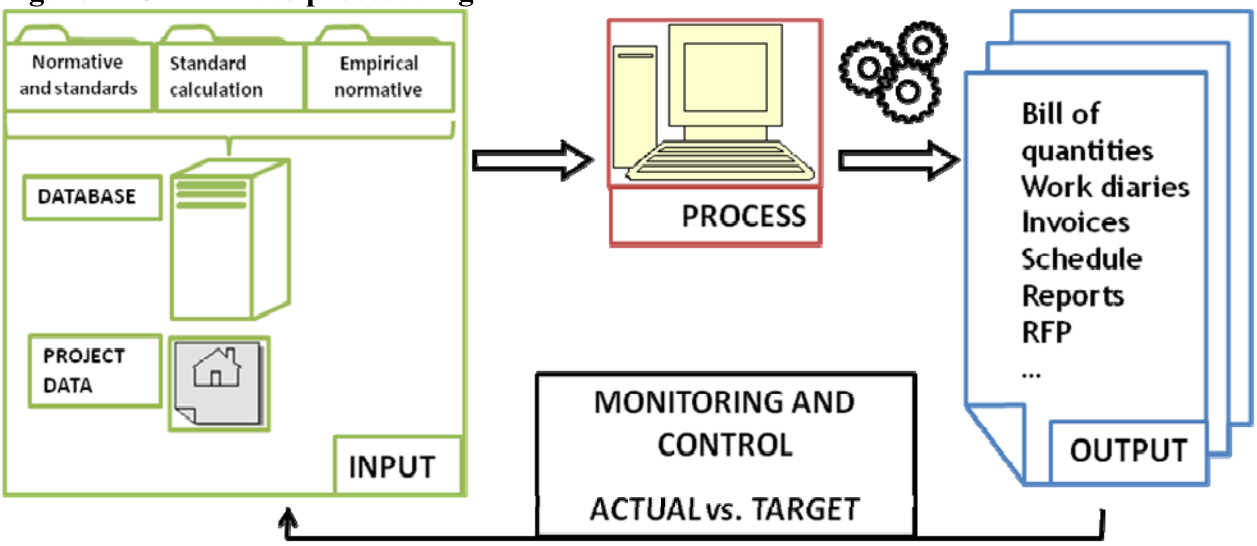
Only closed-loop and holistic system will ensure continuous improvement, crucial to achieving better goals. Ideally such systems should be stable, respond quickly to changes and be robust to small amount of noise (Al-Jibouri, Saad H. 2003). Time lags are very malicious, and can degrade performance significantly (Ogata, K., 1967). Project managers should view construction projects in the holistic manner and try to integrate and balance all phases and objectives in achieving PM success. Unfortunately, many are still managing in intuitive and "*ad hoc*" fashion and try to allocate resources across various project areas (Freeman, M. and Beale, P. 1992). Many authors criticized present performance measurement methods as time and cost consuming (Navona, and Eytan, 2002). Recent research, on 1500 world project, showed the lack of systematic performance measurement (Navona, and Eytan, 2002) and poorly adjusted control systems (Simons, 2000). In this context, we have tried to design a software application – GALA 2008 – that will integrate cost and time in construction projects and enable managers with the ability to control PM success.

Gala2008 is a software application which was placed on market in 2001. In the beginning the application was developed as a tool for one Construction Company, but thanks to extremely positive reactions to its use it was quickly placed on the market. Through cooperation with its users the application keeps developing, it uses new technologies (SQL Server) and establishes cooperation with Faculty of Civil Engineering, University of Zagreb, which speeds up its development over the last three years.
The application develops toward establishing and maintaining control over cost, time and resources in construction projects. By applying this software on the market of the Republic of Croatia and outside its borders as well, we have gathered additional guidelines and have implemented to make the application more user-friendly.

This paper presents concept of Gala2008 and its implementation to operational phases of construction projects.

2. The concept:

Figure 1: GALA 2008 process diagram



The application has been designed in accordance with common phases of a construction project and has been adjusted to the construction industry practices in Croatia and related industries of the neighboring countries.

Figure 1 shows schematic data flow within GALA. The application uses normative and standards in civil engineering, combines them with empirical normative and project information as the input to the process. Process generates output information, such as: bills of quantities, analysis of costs, invoices, project schedules, histograms, S-curves (material, work, machine and cost), etc. Managers can then proceed with the monitoring phase (actual vs. planned) and if there is a need, conduct control.

Application functions in four phases:

2.1. Quotes and Contracting Phase
- 2.1.1. Projects
- 2.1.2. Bills of quantities

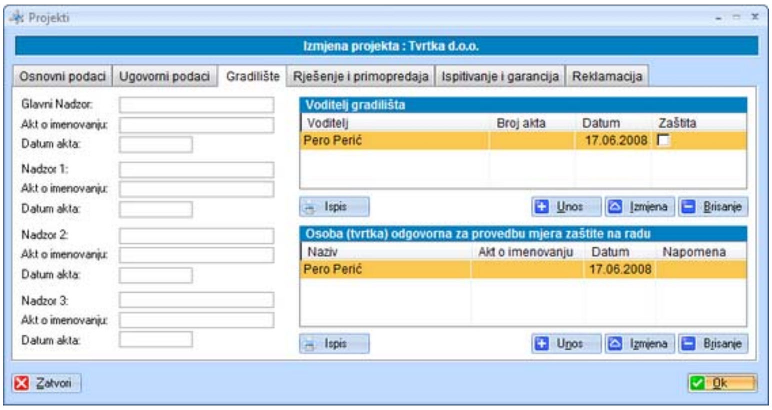
2.2. Scheduling phase
- 2.2.1. Drafting an schedule on operative level
- 2.2.2. Work process and Work Breakdown Structure (WBS)
- 2.2.3. Drafting a project schedule

2.3. Application Phase
- 2.3.1. Realization
- 2.3.2. Warehouse operations

2.4. Invoicing and surveying phase
- 2.4.1. Log book
- 2.4.2. The situation report
- 2.4.3. Surveying

2.1.1. Projects

Figure 2: Producing project documentation



In "Projects" (see figure 2), managers can generate a number of documents related to the 'Projects' which are common to construction project management practice. These are: Decision on founding of the construction site, Appointment of the Project Manager, Appointment of the Construction safety officer, Delivery request, Delivery records, Certificates, Guarantees, Complaints, Correspondences, incoming documents. All documents are easily accessible and of uniform design.

2.1.2. Bills of quantities

The concept of the application is such that enables an unlimited number of bills of quantities for a single project (see figure 3). Each BoQ can have its resources price lists (work,

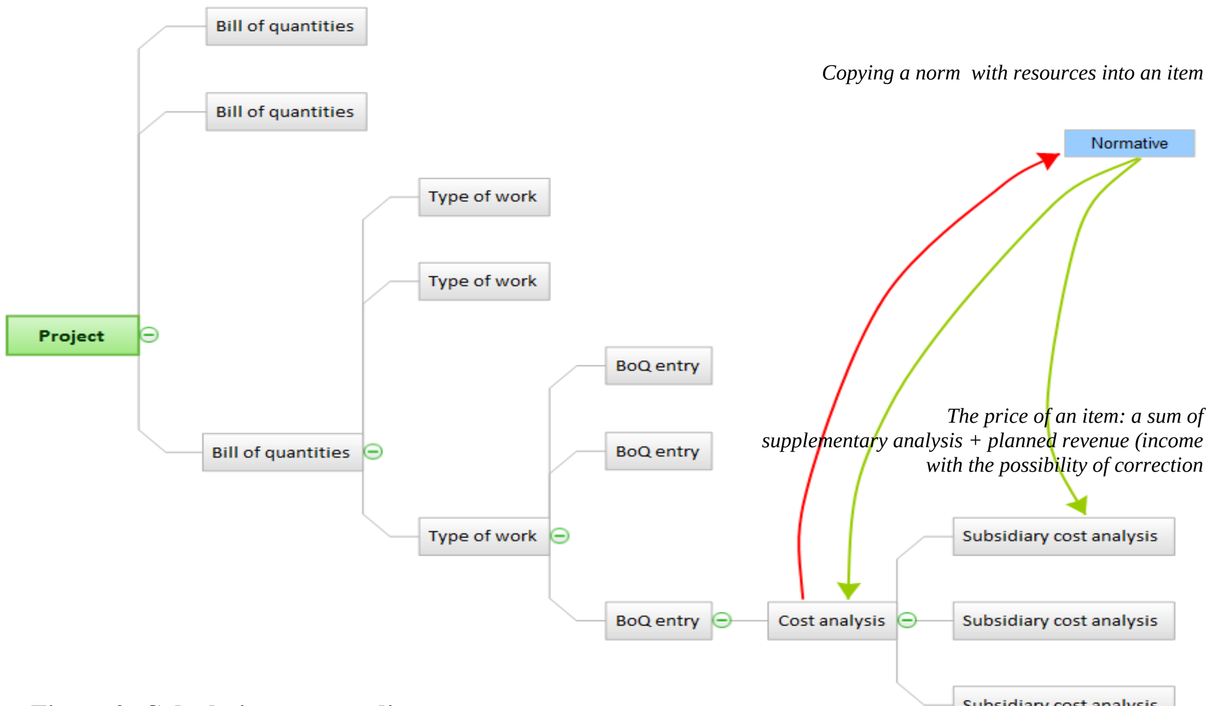


Figure 3: Calculation process diagram

material, machines) as well as different factors of work, materials and machines. By producing and calculating items in the bill of quantities, the user receives information on necessary resources for each particular item as well as the cost and profit of each of the items. Cost analysis (see figure 4) is made in such a way as to allow an unlimited number of supplementary analyses at an unlimited number of levels.

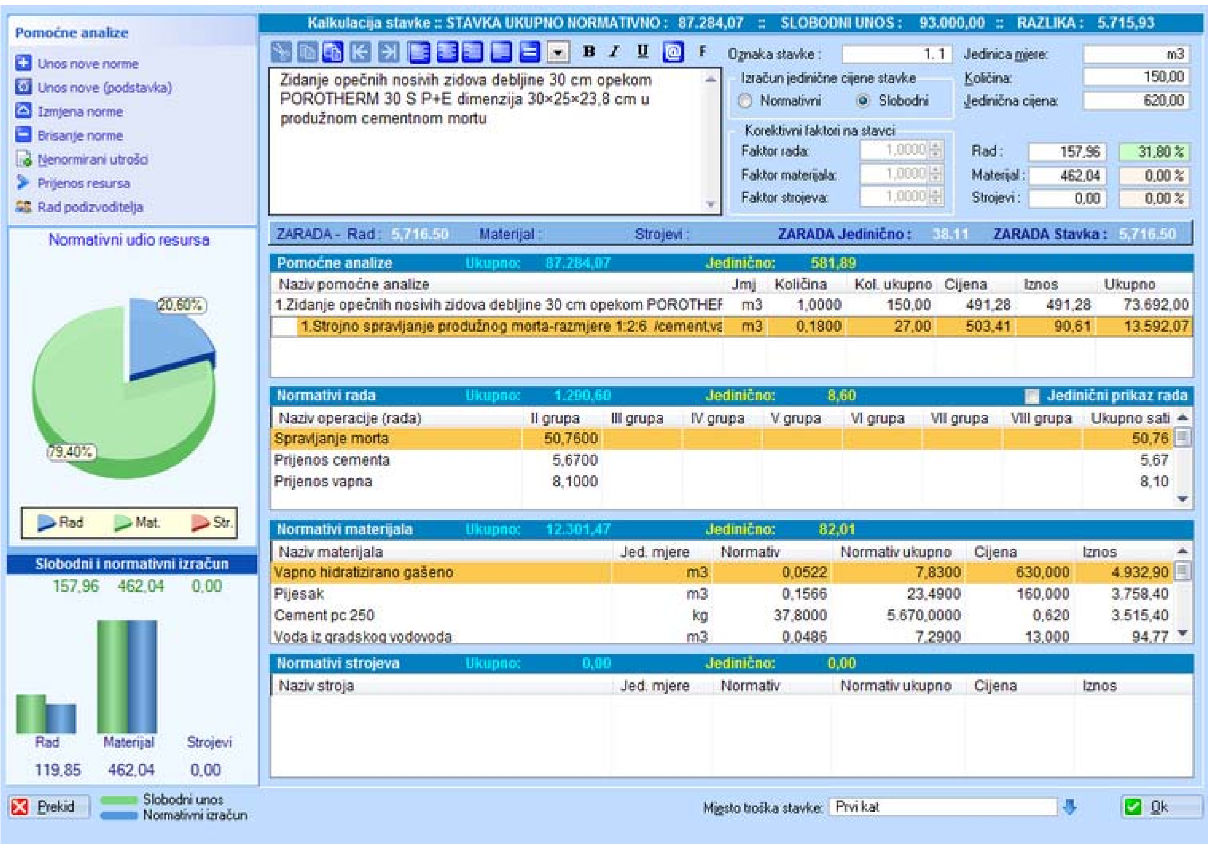


Figure 4: Calculation of an item by an unlimited number of analysis

Norms of work, materials and machines include 21 work types, 9750 groups and over 25,000 normative. They contain norms for building constructions (preparatory works, ground works, prefabricated elements, bricklaying, roofing, armoring, concrete works, carpentry, facade works, transport of materials, pre-stressed concrete); civil engineering (ground works, civil engineering, preparatory works, bricklaying, concrete works, bracing, concrete works, external waterworks, sewage, drainage, scaffoldings, wooden bridges and ducts, iron bridges, foundation engineering, melioration works, tunnel works, road maintenance, macadam roads, cobbled roads, bitumen roads, railways) and final works (tiling, artificial marble, terraces, flooring, glass cutting, house-painting, waterproofing and insulation works, plumbing and locksmith works, carpentry, electrical fitting, waterworks, sewage, sanitary equipment, air-conditioning, central heating).

The database is open for updating, so the users can enter new data (norms based on experience) or change the existing ones. The total cost of the Project can be reached by calculating on the level of the bill of quantities, by changing factors of work, material or machines as well as by applying different price lists which enables recalculations of the whole bill of quantities or one of its parts. Users can change price or particular items in the bill as well as by giving special discounts or bonuses on the whole bill. Since subcontractors have a respective share in construction projects, managers can create bills of quantities, export them in MS Excel and deliver it to the subcontractor. By importing data and comparing items of subcontractor's bill of quantities, the user can conclude on the most favorable subcontractor.

In this way, managers get an overview of necessary resources, materials and machines for the given task. Moreover, it enables recalculating the prices of particular resources for the whole bill.
The ratio between expected income and expenses for the whole bill of quantities and its control in each of the items is crucial for defining the total amount of the offer.
The calculation of income is based on the calculation of the required resources for each of the items in the bill. The calculation of each item or the whole project is done by using price lists (unlimited number of price lists) of work, materials and machines multiplied by factors of work, materials and machines. The labor factor can contain the profit factor, and the selling price of an item can be changed (so can the price of each of the resources). The information on the planned profit, i.e. income and costs are always presented either at an item level or the BQ level.

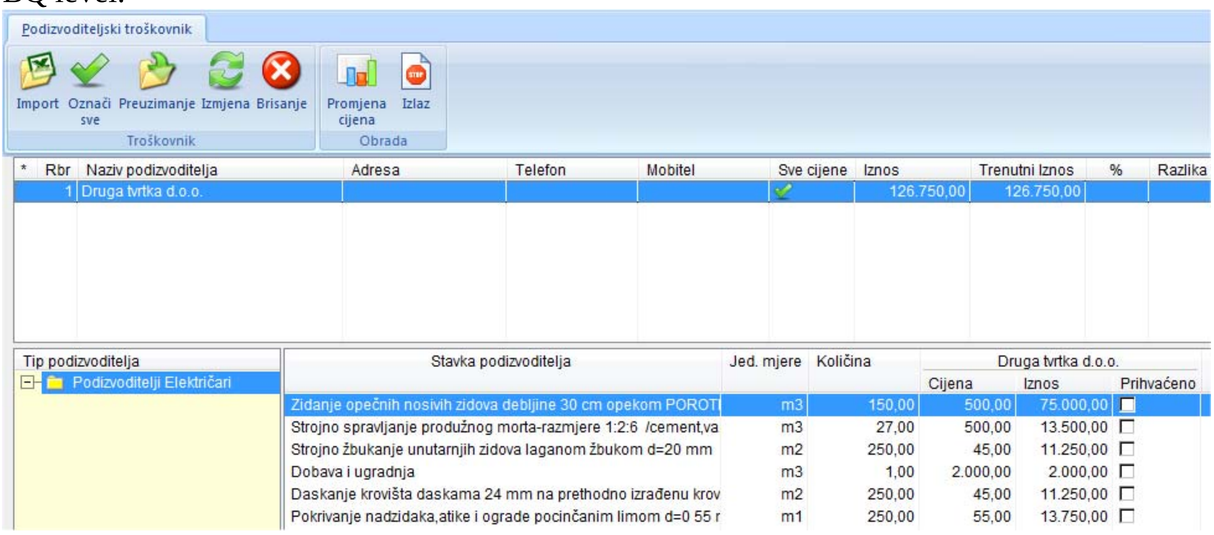
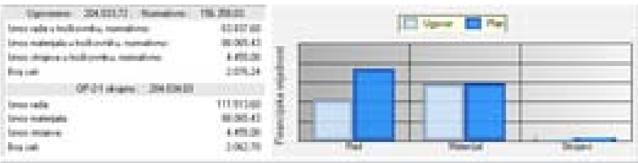


Figure 4: Taking over subcontractor's bill of quantities and conducting comparison

2.2.1. Schedule on operative level

Figure 3a: Resources bill of quantities – operative plan



GALA directly transfers cost analysis and associated resources as activities of project schedule. They can be linked into one or divided into more activities for further use in different items of the WBS structure. It is possible to delete an activity or add a new one and change the technology, resources or their prices.
Managers can effectively use charts and numerical data on requested resources for different technologies and for particular items for decision making and the selection of the most appropriate technology and most favorable supplier.

2.2.2. Work processes and WBS structure organization

Activity duration is calculated by using the norm of an optimal group. Activities can be distributed within WBS. It is also possible to produce more work plans, where the user calculates based on different calendars and assigned activities to different WBSs (see figure 5). Estimated duration is calculated by using one of the following formulas:

$$Ta = (Q * Nv) / (N * t) \quad (1)$$
$$Ta = (Q *) / (Up*N * t) \quad (2)$$

Q = Amount of work
Nv = Time norm
Up= Effect norm
N = Number of work groups
t = Working hours

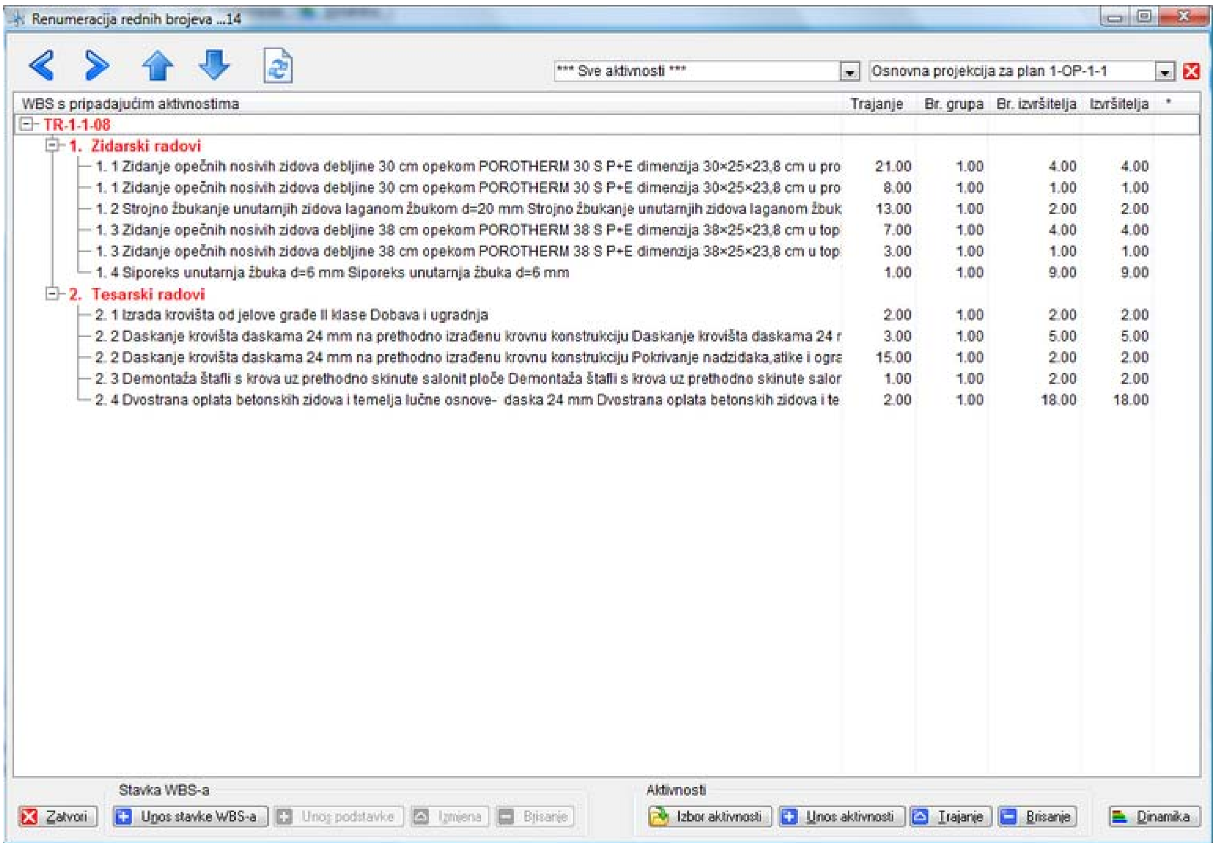


Figure 5: Item organization according to WBS with the calculation of duration

Critical value in formula (1) or (2) is Nv. Nv us calculated by leveling respective norms of it resources within a group with the highest ratio of 5.

The Table 2 shows an example of calculating activity Nv which is then used for calculation of activity duration.

Table 1: Calculation of Nv for a working group I

Work group	NS/Groups	Group II	Group IV	Group V	Group VII
Norm		0.15	0.17	0.6	1.22
Number		1	1	3	6
Duration norm (number of workers)	0.20	0.15	0.17	0.20	0.20
The time norm of the work group					**0.20**

Table 2: Calculation of Nv for a working group II

Work group	NS/Groups	Group II	Group III	Group IV	Group V	Group VII
Norm		0,15	0,01	0,17	0,6	1,22
Number		1	1	1	3	6
Duration norm (number of workers)	0.20	0.15	0.01	0.17	0.20	0.20
The time norm of the work group (Nv)						**0.20**

Table 2 shows that in order for a group to have a norm Nv = 0.20 application added 6 workers of group VII and 3 workers of group V. Thus the norm of the whole group is 0.2 h (according to the longest duration of 1.22/6). The change in the number of workers within a group changes the duration of an activity. Picture one demonstrates an example of activity duration calculation. Manual change of the number of people within the group is possible as well. In that case the application performs a new optimization of an ideal group and adequately calculates duration.

The biggest ratio between the groups is 5. Therefore, (Table 1) one would need a worker from the group III with the norm of 0.01, the calculation would be like the one shown in the Table 1. Since the ratio of Group II and Group I (0.15/0.01>5) is bigger than 5

WBS structure is formed automatically on the structure of the BoQ, but a separate one can be also designed.

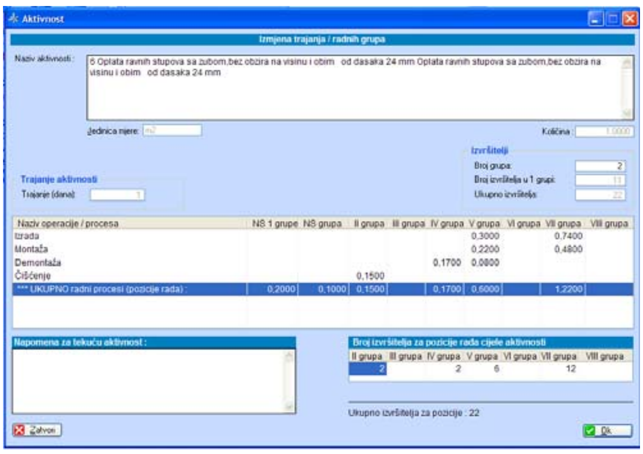


Figure 6: The change in the number of groups or workers within a group results in a change in the duration of an activity

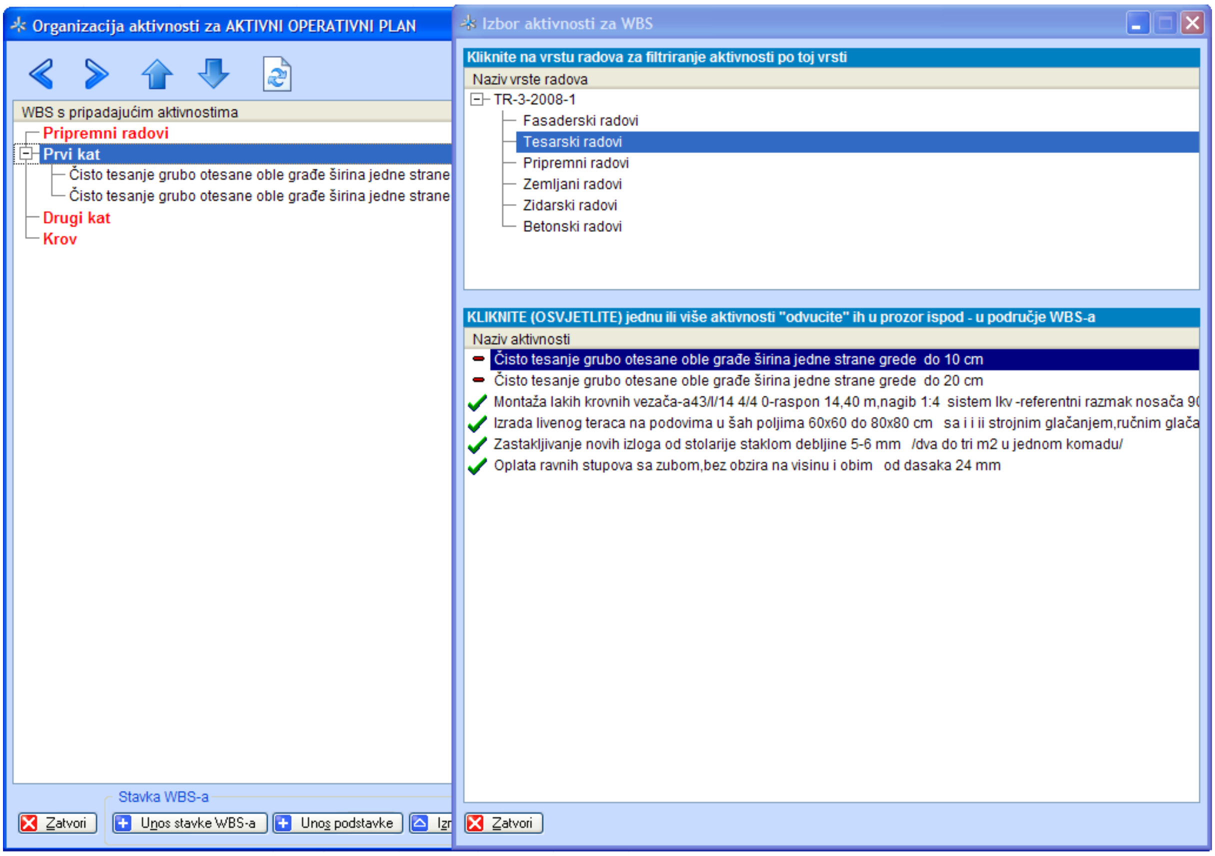


Figure 7: Drag and drop method in assigning activities to WBS items

2.2.3. Drafting a project schedule

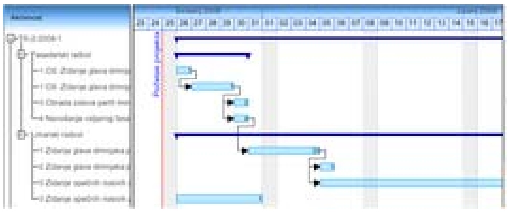


Figure 8: Linking of activities

Having created the schedule draft, a final project schedule can be created. Activities can be linked by four forms of connection (Start-Start, Start-Finish, Finish-Start, Finish-Finish) and a delay can be added (see figure 8). Precedence diagramming method (PDM) is used to calculate the duration of a project, whether from the beginning or the end of the project depending on the selected method. In planning the sequence of the activities, a great assistance plays the histogram of work force. Automatic calculations of critical activities as well as late dates for performing individual activities are of great use to the project manager and can be included in the view. The S curve of late and early beginnings in the realization phase can be supplemented by the third, green, line (see figure 9).

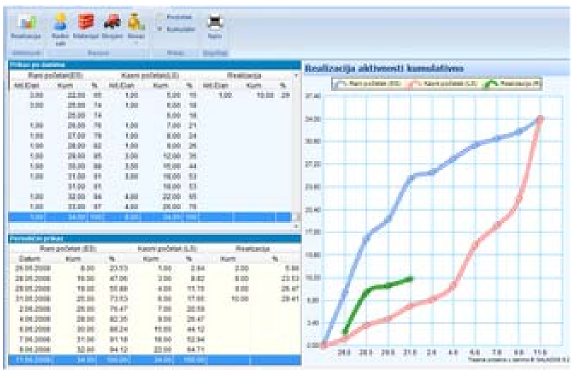


Figure 9: Realization line

Project managers can create more projections of the project schedule by using different calendars. In correlation with it one receives the requirements concerning the work force, material and machines as well as the expected income and expenditure. All the data are relevant for the continuance of the process of acquiring the material and equipment or for the decision making in the divisions for human resources management.

A schedule for certain subcontractor GALA will display only the activities pertaining to him. The schedule can be obtained in the form of a table, a Gantt chart, a table and a Gantt chart, and networks, and the reports are, along with the numerical data, obtained in forms of a histogram and an S-curve. A simultaneous overview (see figure 10) of a Gantt chart and histograms is especially interesting and there are 10 predefined forms: the number of activities, the type of workers, the number of workers, the selected material, and the chosen machine – early and late dates:

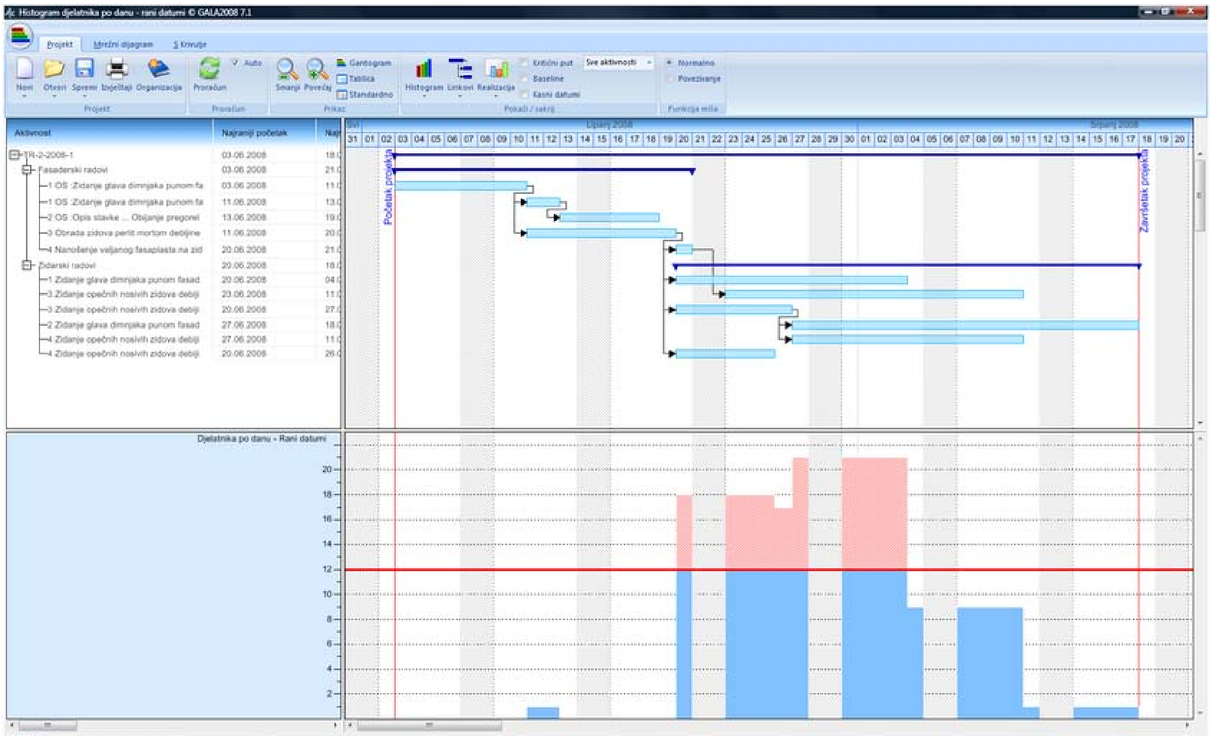


Figure 10: A Gantt chart and histogram

2.3.1. Realization

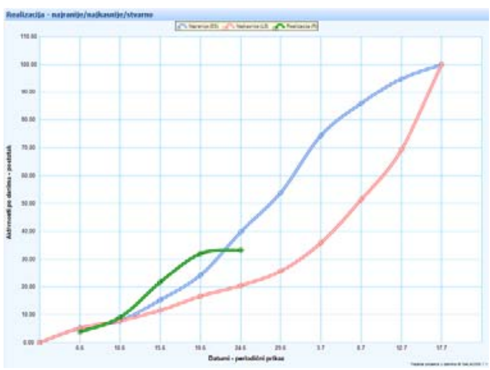


Figure 11: S-curve of activities or resources

Through the concept of logging the realization of planned activities and expended resources one creates tables of working hours, warehouse documents (requisition slips or internal delivery notes), work orders, a daily project log and final measurements for the construction book. Data are obtained on the condition of resource expenditure on the principle *planned – spent – should have been spent*.
The state of the dynamic plan through a Gantt chart, as well as the automatic correlation of the activity

duration based on the data on the duration of the activities that have already begun. With the dynamic plan, the “S curves” of all resources are obtained (of workforce, material, machines and money) in form of early and late curves and the realization curve (green curve, figure 11). Project managers are thus enabled with resources control and can make proper decisions as well as revise the plan.

2.3.2. Warehouse activities

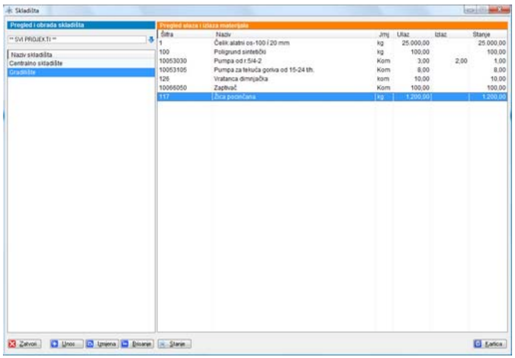


Figure 12: Warehouse overview with the table of materials

Warehouse activities are a part of working processes on a construction site (see figure 12). By logging and making of receipts, requisition slips, internal delivery notes and delivery orders, each project manager can control the warehouse condition and the expenditure of materials.
By entering the realization (on the daily base or for a period) the user can create a requisition slip from the work order and thus affect the warehouse, which makes it easier to monitor the warehouse condition.

2.4.1. Construction log book

Based on agreed cost estimates, the sheets of a construction log book are created automatically. Final measurements of completed work can be entered into the book sheets or data from logged realizations can be taken over. The authors have recognized this kind of adjustment as critically needed for as simple and as fast operation as possible.

Each sheet of the book has an unlimited number of final measurements, which have an unlimited number of calculation formulas. On site mangers can add pictures or schemes which definitely represent a detail necessary for fulfilling the book (see figure 13).

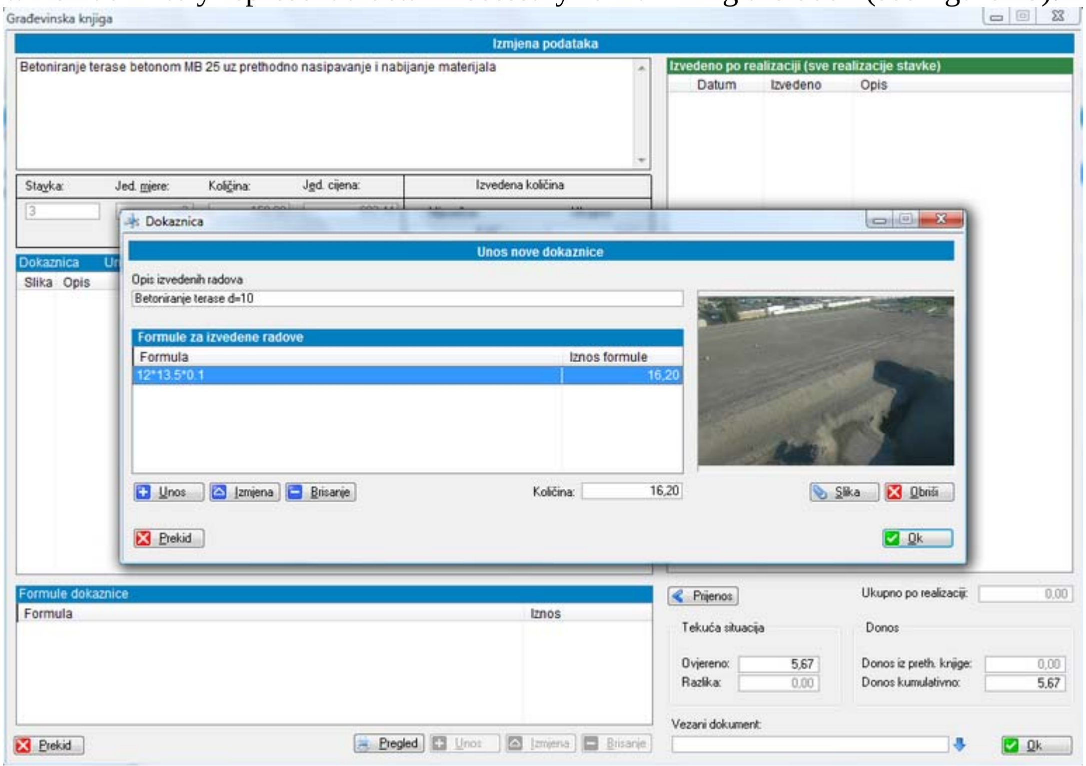
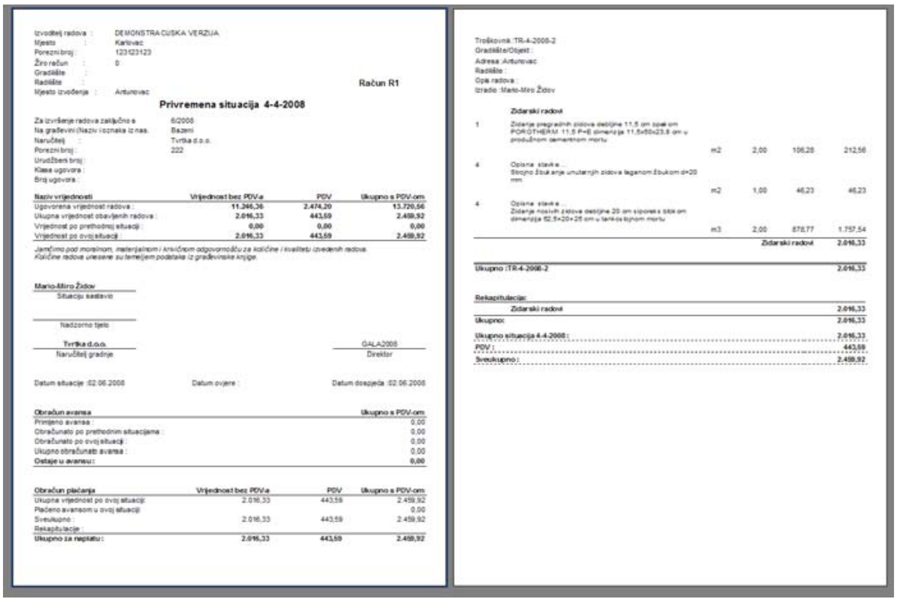


Figure 13: Entering final measurements with a formula

2.4.2. “Situation” – construction invoice report

Figure 14: Situation printout with a cost estimate



Izvođelj radova : DEMONSTRACIJSKA VERZIJA
Mjesto : Karlovac
Porezni broj : 123123123
Žiro račun : 0
Gradilište :
Radilište :
Mjesto izvođenja : Arturovac

Račun R1

Privremena situacija 4-4-2008

Za izvršenje radova zaključno s 6/2008
Na građevini (Naziv i oznaka iz nas. Bazeni
Naručitelj : Tvrtka d.o.o.
Porezni broj : 222
Urudžbeni broj :
Klasa ugovora :
Broj ugovora :

Naziv vrijednosti	Vrijednost bez PDV-a	PDV	Ukupno s PDV-om
Ugovorena vrijednost radova :	11.246,36	2.474,20	13.720,56
Ukupna vrijednost obavljenih radova :	2.016,33	443,59	2.459,92
Vrijednost po prethodnoj situaciji :	0,00	0,00	0,00
Vrijednost po ovoj situaciji :	2.016,33	443,59	2.459,92

Jamčimo pod moralnom, materijalnom i krivičnom odgovornošću za količine i kvalitetu izvedenih radova.
Količine radova unesene su temeljem podataka iz građevinske knjige.

Mario-Miro Židov
Situaciju sastavio

Nadzorno tijelo

Tvrtka d.o.o.
Naručitelj gradnje

GALA2008
Direktor

Datum situacije :02.06.2008 Datum ovjere : Datum dospijeća :02.06.2008

Obračun avansa	Ukupno s PDV-om
Primljeno avansa :	0,00
Obračunato po prethodnim situacijama :	0,00
Obračunato po ovoj situaciji :	0,00
Ukupno obračunato avansa :	0,00
Ostaje u avansu :	**0,00**

Obračun plaćanja	Vrijednost bez PDV-a	PDV	Ukupno s PDV-om
Ukupna vrijednost po ovoj situaciji:	2.016,33	443,59	2.459,92
Plaćeno avansom u ovoj situaciji:			0,00
Sveukupno :	2.016,33	443,59	2.459,92
Rekapitulacije :			
Ukupno za naplatu :	**2.016,33**	**443,59**	**2.459,92**

Troškovnik :TR-4-2008-2
Gradilište/Objekt :
Adresa :Arturovac
Radilište :
Opis radova :
Izradio :Mario-Miro Židov

Zidarski radovi

1	Zidanje pregradnih zidova debljine 11,5 cm opekom POROTHERM 11,5 P+E dimenzija 11,5x50x23,8 cm u produžnom cementnom mortu	m2	2,00	106,28	212,56
4	Opisna stavka ... Strojno žbukanje unutarnjih zidova laganom žbukom d=20 mm	m2	1,00	46,23	46,23
4	Opisna stavka ... Zidanje nosivih zidova debljine 20 cm siporeks blokom dimenzija 62,5x20x25 cm u tankoslojnom mortu	m3	2,00	878,77	1.757,54
				Zidarski radovi	2.016,33

Ukupno :TR-4-2008-2	2.016,33
Rekapitulacija:	
Zidarski radovi	2.016,33
Ukupno:	2.016,33
Ukupno situacija 4-4-2008 :	2.016,33
PDV :	443,59
Sveukupno :	2.459,92

Based on entered quantities in the book sheets and the agreed price from the cost estimate, the value of the “situation” is calculated (see figure 14). Such concept enables managers to control costs in cumulative fashion and estimate future payments. The authors have also recognized this kind of adjustment as critically needed for as simple and as fast operation as possible.

3. Discussion: practical application and acceptance in practice

During GALA 2008 implementation in practice we found very positive feedback from its users. The application has been used in companies dealing with building construction, civil engineering and final works in construction. Due to its simple usage and user friendly working interface, the application has been well accepted in practice. We have also found suggestions of the users very helpful and the application is daily perfected and updated.

The program has been also used in educational facilities, high schools and faculties (Faculty of Civil Engineering in Zagreb). By implementing the application in educational purposes we have gained precious advice, as well as the assistance in tackling with new issues.

The application correlates with the ISO standard, and therefore respective documentation is included. Printouts of these documents are easily adaptable to look exactly the way it is set in the standards.

We have also conducted market analysis. We couldn’t find any similar product that integrates bill of costs, resources with project schedule and thus enables construction managers with ability to have a holistic view. In that way we hope that we have produced a unique and effective tool for successful construction management.

4. Conclusion, assessment of the application and recommendations for further advancement

This paper presented has presented the concept of Gala2008 – software application for project management in construction. The concept has been divided into bidding and contracting phase, scheduling phase, realization phase and payment. We have integrated cost, time and resources and thus have enabled construction managers with more holistic tool. With it, project managers can generate: bills of quantities (BoQ), work diaries, invoices, project schedules, histograms and S-curves (material, work, machine and cost) and manage procurement on site.

Also, documents produced by the application are in accordance with ISO standards. As consequence, complete documentation about the construction site is created including the necessary record-keeping. GALA is fully compatible with Croatian construction market and with similar ones in the region.

By its use project managers gain full control over project process and can manage working processes and cost in more efficient and effective way and therefore make more rational decisions. The software still needs improvement, i.e.: moving GALA onto enterprise level, collaboration initiatives, communication with other applications (4D visualization) and its use with mobile devices (PDA).

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Critical success factors and criteria in construction projects

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Abstract
During its lifecycle, the scope of constructions projects constantly differs due to the changes, boundaries and risks that are imminent to the industry. The most important objective and criteria upon every project should be assessed is its success. From 1960's, researchers are trying to find critical success factors and criteria upon which project success could be evaluated. This paper gives a comprehensive review of various success factors and criteria within the academe and the profession. The review brings a critique of modern approaches of measuring and evaluating success. It defines difference between project criteria and project success and explains their role in construction projects. Survey, taken within Croatian construction industry, shows the diversity among different management's perceptions of critical failure factors. Investors (Clients) ranked "isolation of project objectives from overall business policies" as number one, Contractors preferred "precarious optimism" and Project managers (Consultants) gave "insistence of clients on realization of project without adequate documentation" the greatest importance. The paper concludes with the final set of sucess factors and criteria upon which success of construction projects can be evaluated and assessed.

Keywords: project success, review, critical success factors, success criteria, construction

Sažetak:
Tijekom životnog ciklusa građevinskih projekata, obuhvat projekta se konstantno mijenja zbog sveprisutnih ograničenja, promjena i rizika. Najvažniji cilj i kriterij prema kojem bi se svaki projekt trebao ocjenjivati je postizanje uspjeha. Još od 60-tih godina prošlog stoljeća istraživači pokušavaju pronaći najbolji način njegove evaluacije. Ovaj rad prikazuje pregled primjene kritičnih faktora i kriterija uspjeha u građevinskim projektima unutar profesionalnih i akademskih krugova. Članak daje kritiku na trenutne metode mjerenja i procjene uspjeha. Nadalje, definira razliku između faktora i kriterija te objašnjava njihovu ulogu u građevinskim projektima. Istraživanje provedeno u građevinskom sektoru Republike Hrvatske pokazuje različitosti u percepciji ključnih faktora neuspjeha između pojedenih menadžerskih uloga u projektu. Investitori su rangirali "izolaciju projektnih od strateških ciljeva" kao broj jedan, Izvođači su preferirali "prevelik optimizam", a konzultanti su dali "inzistiranju klijenata na realizaciji projekata bez primjerene dokumentacije" najvišu ocjenu. Članak zaključuje s konačnim skupom kritičnih faktora i kriterija uspjeha prema kojem menadžeri mogu ocjenjivati projektni uspjeh.

Introduction – the approach for defining success

Construction projects are being carried out for many reasons, for example: to erect a building or an infrastructural project, to set a production process, improve existing products, introduce change… No matter what the goal is, its final criteria should always depend on success. Motivation and reasons for a project are irrelevant when it comes to project success. The question is closely linked with organizational effectiveness and benefits in long-term aspect (Sehnar et al., 1997) and therefore it can be observed as a concept of strategic management. It is crucial to create strategic demands for success from the highest levels of management onto the project team and project activities. Since the 1960s, project management researchers have been trying to discover which factors lead to project success. Despite of columns of words that have been written, decades of managing projects experience, the rapid growth in membership of project management professional organizations and dramatic increase in the amount of project working in industry, project results continue to disappoint stakeholders (Cooke-Davies, 2002). The topic is still in development, but some authors, nevertheless, have defined the criteria. Identification of project success attributes has an unquestionable importance for every project stakeholder. Their understanding can benefit the effectiveness of construction projects (Kog et al., 2002). Nowadays, the challenge lies in insufficiently standardized approach (Sehnar et al., 1997). Traditionally, construction industry has accepted classical criteria of project success: cost, time and quality (Kerzner, 1992) – iron triangle – which could not satisfy all aspects of success. Some authors have even concluded that the measuring of success is "mission impossible" (de Wit, 1988). The following example justifies doubts:

Example 1: Classical example of project cost overruns was the famous Sidney Opera House. The project took 15 years (since 1958 to 1973) and estimated cost increased fourteen times (from 7 million A$ to finally 102 million A$). However, today the project stands not only as a symbol of Sidney, but also as one of the Australian symbols represents an engineering masterpiece.

Example 2: Maksimir stadium in Zagreb was built in 1912. He was renovated and reconstructed many times since then. The last reconstruction, in which 25.000,00 square meters were planned, started in 1998, but stopped in 2000, because of financial and political reasons. Investors are searching for the best model to finish the stadium since then. Many solutions were recommended and right now PPP model is under the consideration. Accordingly the stadium should be given to a concession for 15 years. Until now, the stadium consumed more than 70 mil. EUR and it is estimated that the final cost will take 130 million more. The end of the project is not yet in sight.

In these examples both the developer and the contractor suffered losses. From their perspectives, the project has failed. However, from the perspective of the other parties, it was a big success. We can conclude that projects should not be judged upon classical measures (time, cost and quality), which are more suitable to management practice. Project stakeholders will have different expectations from projects; and so their criteria of project success will also vary. Therefore, success criteria should be agreed upon appreciation among all project stakeholders. **Can one with certainty conclude that the project was a failure or that it didn't succeed before its use began?**

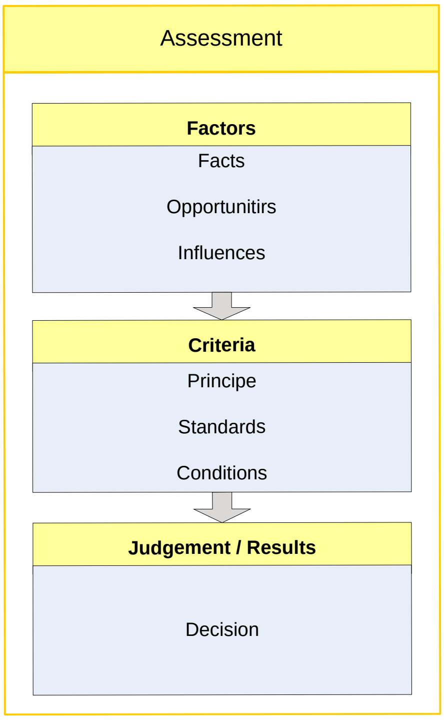
Genesis of defining success

In the early stages, project success was closely connected with project main objectives; time, cost and quality (Chan et al., 2004; Navare et al., 1990). The terms nowadays serve as basic criteria for project success and were identified and interpreted in almost every study (Chan et al, 2004, Belasi and Tukel, 1996, Hatush and Skitmore, 1997). Chan's (1997) success overview initiated a number of studies which tried to define project success. Atkinson (1999)

named them as a the criteria of «The Iron Triangle». While definitions of success are changing «The Iron Triangle» is always included only in different variants. **Pariff and Sanvido (1988)** defined success as: *An intangible perceptive feeling, which varies with different management expectations, among persons, and with the phases of project.* **Baker et. al. (1983)** showed subjective factors in defining project success in spite of its measurement inability. After analyzing 650 projects they came with the definition: *If the project meets its technical specification and/or defined mission, if there is a high level of satisfaction within key participants of the contractors' organization, clients, project team and investor, project has achieved overall success.* **Pinto and Selvin (1988)** concluded: *Project success is complex and often illusionary attempt, but still it is of great importance for effective project performance … project success comprises two components: problems with project management and problems with investor… that's why it is important to set up adequate system for appropriate definition of project success.* **Jaselkis (1999)** defined project success as: *A construction endeavor that is perceived by the project manager, and hence, by his organization, to have "outstanding" results for all parties involved in the project.*
The project success can mean different things to different people, and so to different industry, company, project team or an individual. Every party has its own goals and different evaluation success criteria. I.e. architects often take esthetics more important than cost criteria. However, the users can appreciate some other criteria more, like; heating index. Even more, success criteria can change throughout different phases.

Distinction between success and project management success, and success factors and criteria

Figure 1: Decision making model based upon factors and criteria



Source: Lim and Mohamed (1999)

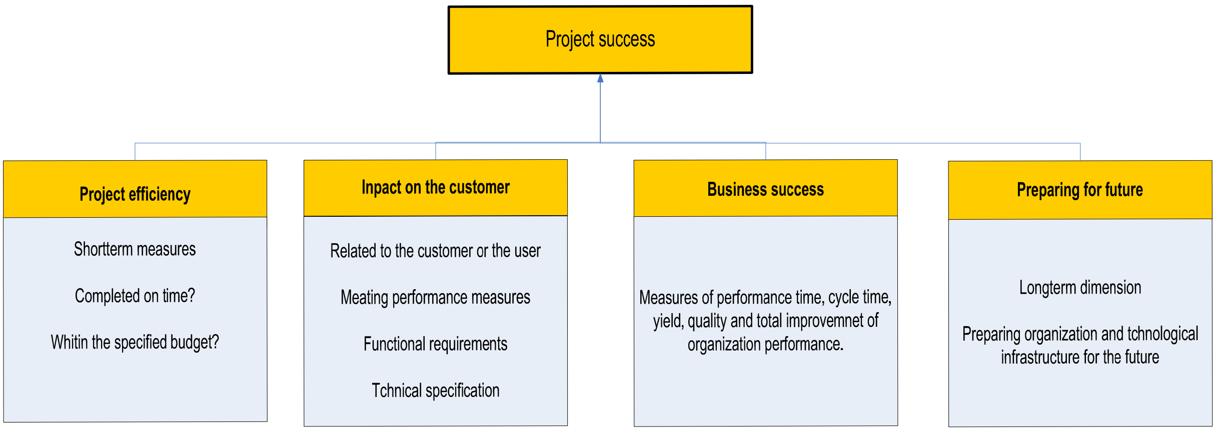
The project success is measured against the overall objectives of the project and **project management success,** on the other hand, against the widespread of traditional measures, like: cost, cost increase, time, time increase… The second distinction is also important. **Project success criteria** are measures by which success of a project will be judged and **success factors** are inputs to the management system or critical areas that lead directly or indirectly to the success of the project or business (Cooke-Davies, 2002). The similar distinction was presented by Lim and Mohamed (1999): *Principle or a standard based upon something will be assessed. Factor is a circumstance, a fact or an influence which can contribute to the final result.* Oxford dictionary defines criteria as: *Standard or a judgment or a principle used for critique or assessment.*
To be more illustrative we will explain the distinction in sequent example (see figure 1). A construction firm is trying to get a contract on a public bidding process. Capability and selection criteria represent the overall criteria of the bidding process. By accomplishing capability criteria, competitors can step in the second round where they will be evaluated by selection criteria. The main criterion is usually the cost and so the cheapest will get the contract. On the other hand, there is a whole set of factors which influence the selection process, like: number of competitors, cost-efficiency, references, experience… These factors can be important, but do not directly influence the final assessment score.

When these two definitions of criteria and success are joined we can easily define success criteria as: *The set of principles or standards by which favorable outcomes among interested parties can be completed within a set specification***.**

Project success criteria

Pinto and Pinto (1991) interpreted that project success measures should contain psychological effects, such as user's content and communication within team, usually known as «the soft measures». **Wuellner (1990)** also supported implementation of psychological content under the project success measures. Further, **Pockok (1996)** mentioned an absence of

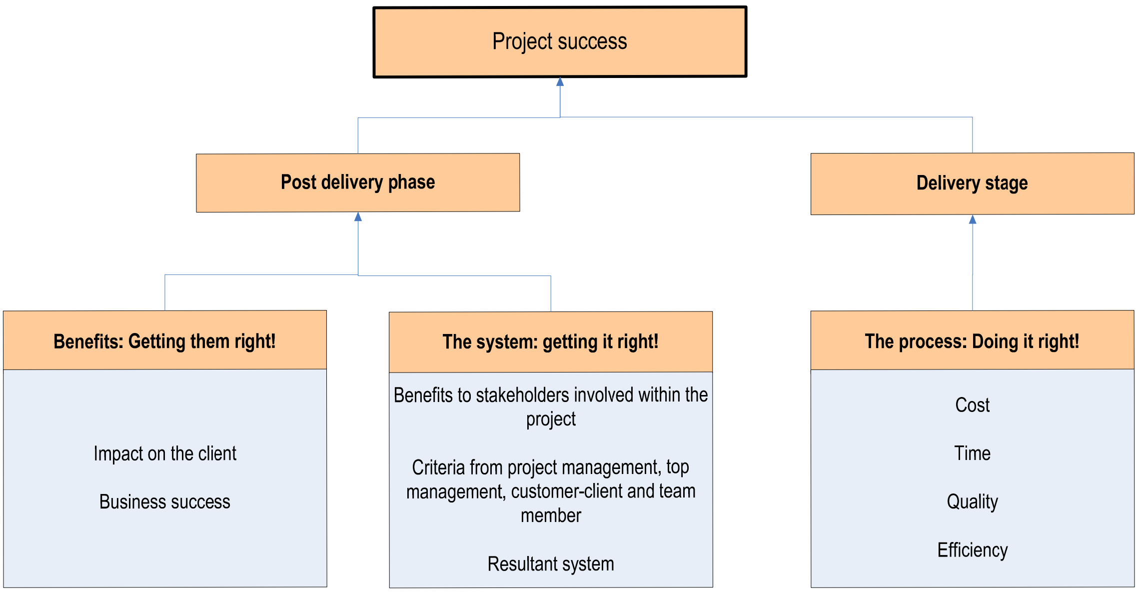
Figure 2: Four dimensions of project



Source: Sehnar et al., (1997)

legal disputes as a project success indicator. «Safety at work» was introduced as a success indicator, since it was realistic because of the legislative. **Kometa (1995)** used comprehensive

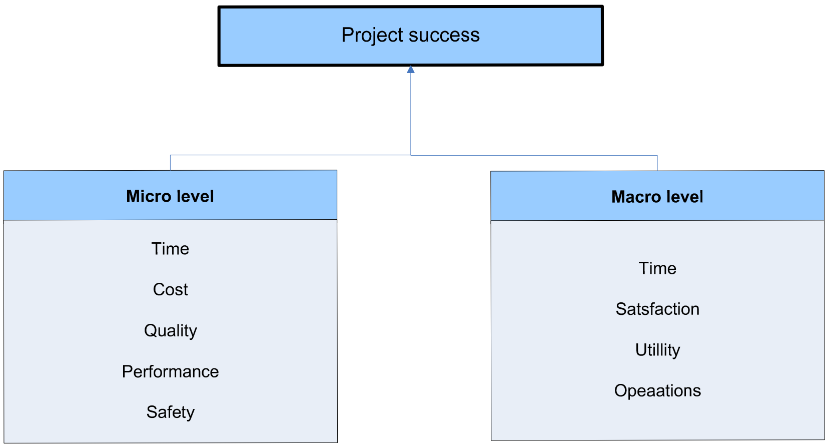
Figure 3: Atkinson's model for measuring project success



Source: Atkinson, R. (1999)

approach for defining project success criteria where he included: safety at work, expenses, maintenance cost and flexibility of project for ultimate users. **Songer and Molenar (1997)** considered project successful if it is done according to budget, time, satisfying user's demands, under specifications, retain work quality and decrease construction deterioration. **Kumaraswamy and Thorpe (1996)** included different criteria in their studies: project manager's content, technology transfer, gratitude of surrounding, health and security. Shenhar **(1997)** suggested that project success should be developed in four dimensions, as shown from figure 2, which all are time related. First dimension is project schedule. Second dimension can be used right after the final construction. Third dimension comes after 1-2 years of usage. Finally, fourth dimension is applied 3-5 years after the construction. **Atkinson (1999)** developed a similar project success structure in three phases. First phase during the construction: *«Doing it right!»*. Second phase right after ending the construction: *«Getting it right!»*. Third phase observes project benefits: *«Benefits from: Getting them right!»*. Figure 3 explains project success point of view. Lim and **Mohamed (1999)** stated that project success should be viewed from the different perspectives of the individual developer, contractor, consultant, users and so. Authors are suggesting project success evaluation from macro and micro point of view (see figure 4). **Sadeh et. al. (2000)** developed project success in four dimensions. First dimension is to fulfill specifications according to signed contract. Second dimension is benefit to final user. Third dimension is benefit for organization in progress as direct construction profit. Final dimension is benefit for national technological infrastructure and companies (see table 1).

Figure 4: Macro and micro levels of project



Source: Lim, C.S. and Mohamed, M.Z. (1999)

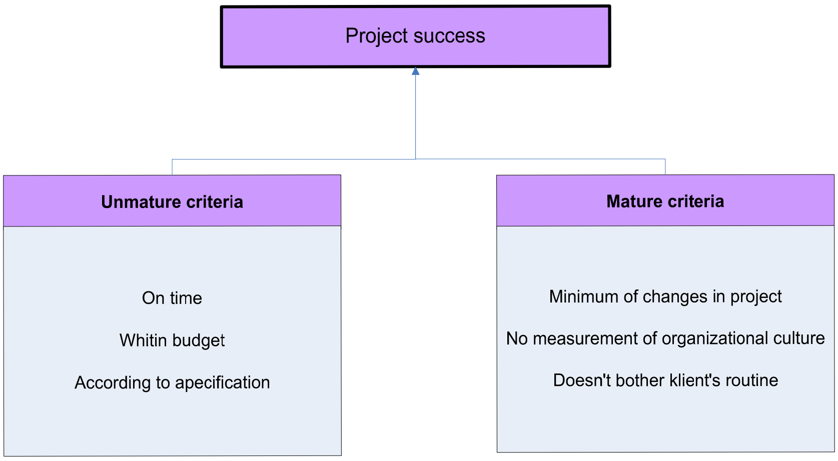
Table 1: Project dimensions and criteria

Success dimension	**Success measures**
Meeting design goals	Functional specifications Technical specifications Schedule goals Budget goals
Benefit to the end-user	Meeting acquisition goals Answering the operational need Product entered service Reached the end user on time Product has a substantial time for use Meaningful improvement of user operational level User is satisfied with product
Benefit to the developing organization	Had relatively high profit Opened a new market Created a new product line Developed a new technological capability Increased positive reputation
Benefit to the defense and national infrastructure	Contributed to critical subjects Maintained a flow of updated generations Decreased dependence on outside sources Contributed to other projects
Overall success	A combined measure for project success

Source: Sadeh et al. (2000)

Nicholas (1989) in his study concluded that content of crucial stakeholders including users and final product quality were main measures of project success evaluation.
Kerzner (1992) defined project success criteria as mature and immature (se figure 5).

Figure 5: Success criteria



Source: Kerzner, (1992)

Turner (1997) defined project success criteria as: the facility is produced to specifications, on time and within budget, the project benefits to user, project benefits to business, project fulfills all specified goals and project satisfies needs of the user and benefits the stakeholder. **Wateridge (1998)** defined project success criteria as: carried out under specifications, project fulfills its business intentions and defined goals, fulfills default quality, profitable for the investor, project team satisfaction during project and with its outcome, profitable for the contractor, stakeholder's satisfaction with project during its construction and exploitation. **Baccarini (1999)** included: on time, within budget and according to specified quality, satisfaction of project interest parties demands. He defined product and project success as meeting quality thresholds on schedule and within budget. **Ling et al. (2004)** researched an influence of several factors on project success. They defined a set of criteria for measuring project success such as: cost, cost increase, cost increase intensity, time, time increase, time increase intensity, quality during delivery project to user, continuous quality, equipment quality, and value of investor's administration and satisfaction of investor. **Baker et al. (1983)** suggested that project success should be judged by following criteria: time, cost and quality. During the last ten years researchers were suggesting different criteria for measuring project success. The union of all studies is shown on the figure 6.

Figure 6: Research union of project success criteria

Critical success factors

Veen-Dirksand (2002) defined CSF as: *The number of areas for any business system, in which, if they are satisfactory, will ensure competitive performance for the organization.* **Sinclair (1995) defined CSF as:** *The limited number of areas in which will the results, if they are satisfactory, ensure the competitiveness of the organization.* **McCabe (2001) defined CSF as:** *… are statements which are explaining in what way to improve business performance, and in what way to achieve the mission.* **Chua et al. (1997)** studied factors' influence on estimated cost support as a project success achievement. They concluded with 8 CSFs: number of organizational levels between project manager and craftsmen, project manager scope experience, level of project documentation preparedness at construction start, construction plan, cost of project team, project team frequency of meetings, frequency of amending budget, cost management system. Using this information, they extracted another 5 project affecting factors and added one more dimension to project success, such as: frequency of meetings, project manager time devoted to project, project manager scope experience.

Rubin and Seeling (1967) evaluated impact of project manager scope experience on project success. They were using technical project success and measured it by following criteria: project manager experience has a low impact on project success and size of previous project affects on following project success. **Martin (1976)** deducted following set of project CSFs: defined goals, rightly chosen organizational philosophy, management support, organizing and delegating, project team selection, defined resources, system control and tracking, scheduling and dynamic scheduling. **Baker et al. (1983)** concluded that different CSFs are affecting on criteria: defined goals, team dedicated to project goals, project manager presence on construction site, remarkable financing, project team competence, proper initial cost evaluation, minimal time of running in, planning and control technique application, social orientation, bureaucracy absence. **Cleland and King (1983)** presented following CSFs: project abstract, construction concept, management support, financial support, logistic support, market information, construction plan, project manager education, organizational structure, commission, transparent information and communication system. **Locke (1976)** identified following CSFs: the identified interest parties, clear hierarchic structure, competent project manager, set control mechanism, schedule control meetings. **Chan et. al. (1997)** presented six critical project success factors. They were: the project team devotion to project, contractor

Figure 7: Research union of project success

competence, risk evaluation, investor competence, user's requirements and restrictions. **Morris and Hough (1987)**, in their study, singled out following factors: human factors, project abstract, politics and sociological factors, finances, legal arrangements, planning and design, tense project schedule, schedule time. **Munns and Bjeirmi (1996)** also formulated a set of CSFs: human factors, client relations, politics, legal arrangements, contracts, project administration, efficiency, benefit and goals. **Belasi and Tukel (1996)** form following set of project success factors: usage of manager abilities, control and tracking, technology usage, preliminary estimations of activities duration, planning, and external factors related to: the project manager, project team, resources, environment protection, and business system. **Pinto and Selvin (1988)** formed the following set of critical project success factors: new member's employment, conflict number, consulting a client, communication, politics, technical complexity, and tracking and return information, client verification, top management, project manager characteristics, environment protection and problems. Currently, we couldn't find any relevant study that supports the nature and all generally accepted measures. Figure 7 shows present achievement of researches in area of critical success factors.

The survey across Croatian construction industry

Croatian construction industry has emerged on open market and accordingly aligned during last 15 years. These changes are now implemented in almost every company, and so construction sector is largely restructured, specialized and aligned with European regulations (Radujković and Parova, 2005). There was also a huge amount of capital purred into the sector, market has opened to foreign investors and so companies now face more demanding clients – and thus higher level of success is expected from them. During the risk-oriented survey (Radujković, 2004) in Croatia, participants were asked to rank five key attributes that will lead to project failure – as the opposite of critical success factors. Responses were collected from 332 professionals that were at executive positions (table 1). It is obvious, from the table 2, that all of respondents put the emphasis on management. An attempt was made to make an agreement among groups, but unfortunately few agreed, only on some particular phases. Our key results were very close with suggestions, related to project assurance function (Tilk, 2002).

Table 2: Key failure project factors on Croatian construction projects

Clients (Investors)	Contractors (Engineers on site)	Project managers
1. isolation of project objectives from overall business policies	1. precarious optimism	1. insistence of clients on realization of project without adequate documentation
2. lack of stakeholder support	2. poor planning	2. client-generated late changes in project scope
3. lack of clear project scope	3. inadequate communication	3. unrealistic client/contractor goals
4. no life cycle criteria	4. underestimation of fragmentation	4. lack of knowledge about PM techniques
5. lack of risk analysis	5. lack of procedures for changes	5. contract award mainly based on bid price

Source: Radujković (2004)

The integration of project success criteria and factors

With success criteria managers can make a judgment about something, in this case about project success and with success factors can influence it outcome. If an achievement of continuous flow of benefits can be identified, during the project lifecycle, success is inevitable (Radujković and Parova, 2005) and these kinds of benefits can alter success in quantitative and qualitative way. Entire scheme of factors and criteria is shown on figure 8. The system represents the steering wheel of project success. Managers can use this tool as a mean of focusing their energy and resources on the critical issues and thus try to accomplish the one, true, goal – project success.

Conclusion

We can conclude that success should be the ultimate goal of every project. By measuring its accomplishment we are able to assess the whole project. Today, there is no unified definition of project success. Chan's review (1997), initiated huge avalanche of studies and thus success is defined in different manners, but authors are mainly circling around "the iron triangle".

Figure 8: Influence of project success factors and criteria on project

Every project has its own characteristics and constraints and thus has different factors and criteria of success. Figure 8 shows the diversity of success criteria and factors which should be taken into consideration in every project. Since 1960's, regardless of their industry, researchers are trying to define the factors which contribute to success and the criteria upon it can be assessed, even though some did not recognized the distinction in their models. Acknowledging the fact that stakeholders can have different interests and so the criteria of success, some concluded that the success can't be measured and defined and that the quest is a "mission impossible" (de Wit, 1988). The success shouldn't be treated just through financial dimension, but through harmoniously balanced business perspective. It is important that project stakeholders understand these facts, so they could approach the problem accordingly.

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COMPETITIVENESS ANALYSIS OF CROATIAN CONSTRUCTION INDUSTRY

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Abstract

The paper is discussing the meaning and importance of competitiveness in general, same as the methods of its expression and measurement. The data on competitiveness of total economies of countries in environment and of interest will be presented. Some aspects of competitiveness of Croatian construction industry in comparison with other industries will be discussed. The problem of evaluation of competitiveness at the corporate level, particularly in construction industry will be pointed out, and preliminary results of its estimation will be shown.

Keywords: Construction industry, Corporate management, Competitiveness, Croatia

1. Meaning and Importance of Competitiveness

The competitiveness is defined by many authors and institutions, but we will select some of the most relevant among them. The definition of OECD from 1992, characterizes competitiveness as a tool for providing as good as possible position at international market with aim of better standard of living for citizens, providing open economy and minimizing restrictions in trade and free market. The UNCTAD's documents say that the goal of the politics that promotes the competitiveness is to increase the quality of production factors, provide the adequate macroeconomic management and solid economic policy, create the competitive transparent and easy accessible market and apply development policy for strengthen the entrepreneurship, promoting of technology and opening of commercial opportunities. Both of mentioned expressions point out primarily the macroeconomic dimension of competitiveness, related to national economies, and the welfare of people.

Michael E. Porter, the leading theorist and consultant in the field of competitiveness is discussing the related term of competitive advantage as characteristic of good or service that brings to its provider the market advantage among the competitors. This Porter's formulation can be apply to entire economy, but is primarily meant in the context of corporation.

Competitiveness obviously has the broad and long term effect on the prospect of single corporation, but also on all industrial branches, same as the total economy, what imply the living of every individual.

The measurement of competitiveness

There are several methodologies of the measurement of competitiveness, but mostly created for it's analysis and expression on macroeconomic level focused on national economies. Two the most relevant among them are the methodology of World Economic Forum (WEF), and the methodology of IMD.

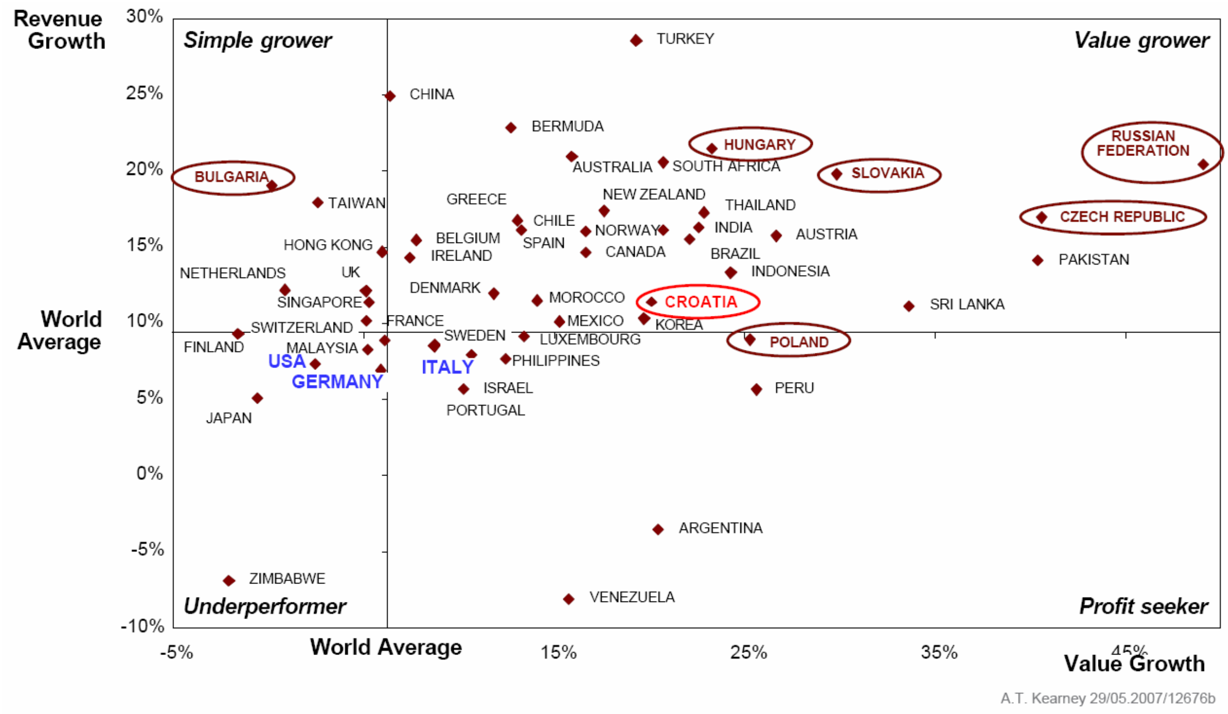
The WEF does rank more than one hundred and thirty national economies each year according to estimated competitiveness expressed through Global Competitiveness Index (GCI) that is based on more than one hundred variables. Important groups of them are on quality of public institutions, efficiency enhances and innovation and sophistication factor. The same source is also producing the Business Competitiveness Index (BCI) that consists of two sub-ranks, sophistication of company operations and strategy, and quality of the national business environment. The both presented rankings are based on relevant and measurable data collected from respected institutions, but also based on the opinion survey from the experts across the world.

The IMD is one of the leading global business schools located in Lausanne in Switzerland, that is publishing the World competitiveness yearbook (WCY) since 1989. The yearbook is listing fifty-five countries and methodology is based on more than 300 variables. Important groups of criteria are economic indices, efficiency of governmental institutions, business efficiency and infrastructure.

As a difference from macroeconomic level, there are no broadly recognized and applied methodologies for the expression of the competitiveness on the microeconomic and corporate level. One of the aims of this paper is to begin the process of definition of the methodology for the measurement of construction industry competitiveness level.

2. Competitiveness of Croatian industry

Both of mentioned globally recognized methodologies of evaluation of competitiveness list also the Croatian economy. In the GCI's yearbook for 2008 Croatia is listed as 58th. As the GCI yearbook of WEF is listing about 98% of world economy by production, the 58th place among one hundred and thirty one countries positions Croatia in better half of the world.



Picture 1. *Benchmarking of Croatian industry in the world with focus on SEE countries, source [Kearney, 2007]*

At the same list among the countries in the region Austria was positioned on 15th place, Slovenia 39th, Bulgaria 79th, Greece 65th, and B&H 106th. That shows Croatia is still far from the best in the region, but still better than most of others. The BCI listed Croatia as 60th among all one hundred and thirty-one countries listed for the year 2008.

WCY of IMD is listing Croatia since few years. Its position for the year 2008 is 49th, and a year ago it was 53rd. Such result is reasonable since the list is covering just better part of the world economy, and position at the list can be taken as a kind of success by itself.

Apart from data presented previously captured from the WEF and IMD, the potentials of Croatian economy is highlighted in a broad global study done by A.T. Kearney that encompasses 32 thousands of enterprises that carry 98 percent of global market capitalization. The Picture 1 shows Croatian industry in its environment with other SEE countries highlighted. Croatia is, as most of SEE countries positioned in quadrant of value and revenue growth as intensive development phase occurs due to transition process. Other SEE countries benchmark the unused potential.

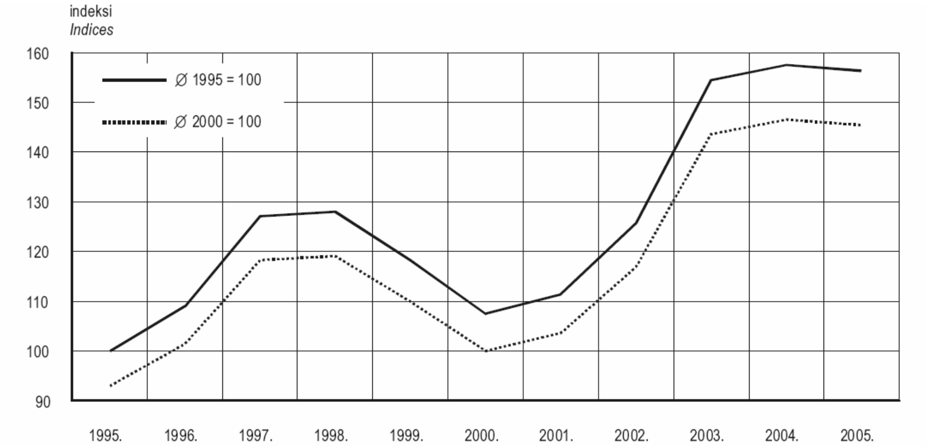
3. Competitiveness of Croatian construction industry

Construction industry is of relevance for Croatian economy as it provides more than 11% of employment directly and according to some estimations further 15% of employment indirectly. As it is shown in Table 1, the participation of construction industry in term of employment with 11,4% is even higher than European 10 %.

Description	Year 2007	Index of construction industry	Index of total economy	Participation of construction industry in total economy
Number of companies in construction and civil engineering	9.063	111,4	106,4	10,8
Number of employees	102.328	109,0	106,1	11,4
Total income	57.951	111,3	113,6	8,8
Pretax profit	3.295	102,6	119,8	7,5
Net profit	1.618	79,9	124,5	6,5

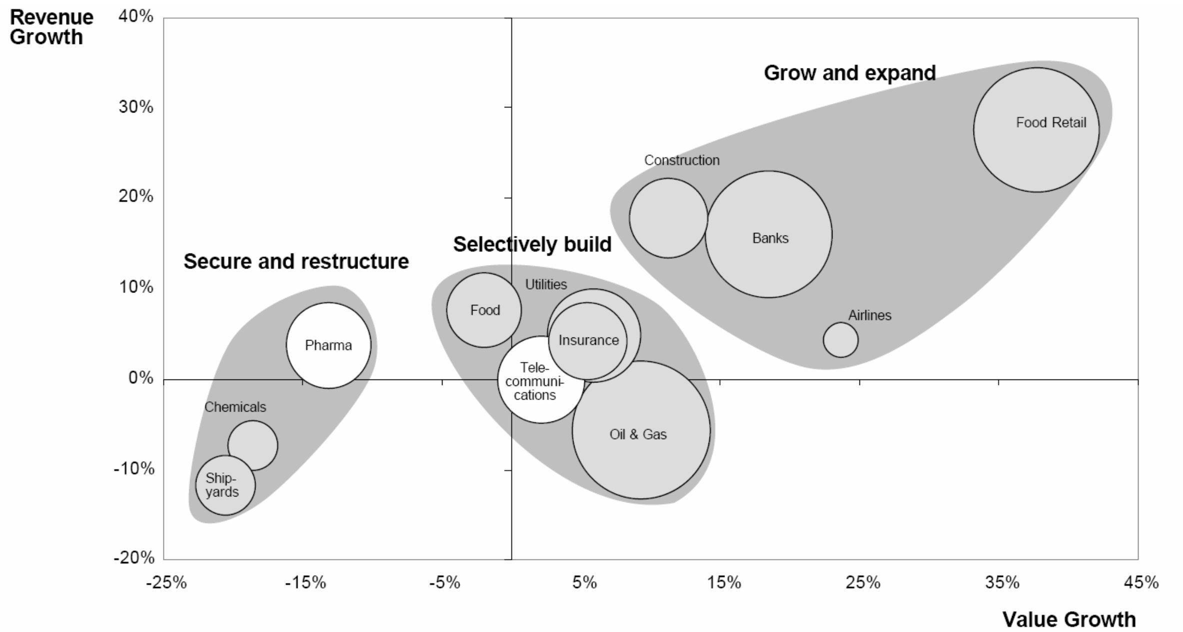
Table 1: *Indices on position of construction industry in total economy*

Watching the indices of growth of GDP in construction in Croatia, shown at Picture 2, we can see the constant appreciation since year 2000.



Picture 2: *Indices on GDP in construction growth, source: [State biro for statistics, 2007]*

Picture 3. is showing the growth of Croatian construction sector in comparison with other industries. Axes represent world value and revenue growth average Construction industry, which is located in 1st quadrant, and is characterized by higher value and revenue growth comparing to the industry world average. Comparing the growth of Croatian construction sector with the growth of other industries presented at Picture 3, it is possible to differentiate three groups, first one that is characterized by slow growth of revenue and growth (in Croatia these are shipbuilding, chemical industry and pharmaceuticals) and that group encompasses companies that are within intensive restructuring process. In the second group, characterized by medium revenue and value growth are food industry, telecommunications, insurance industry and oil and gas. Third, most attractive group, consisting of banking, retail and construction, brings high revenue and value growth.

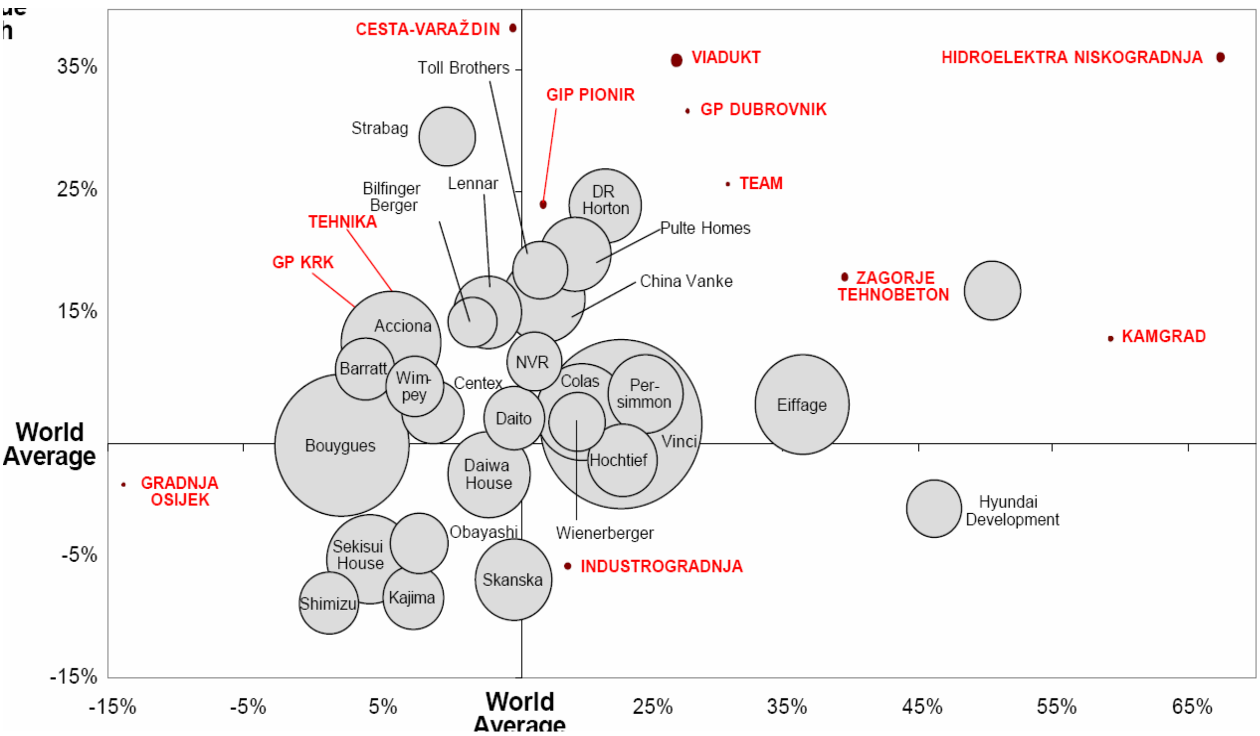


Picture 3: *Croatian industry breakdown according to value and revenue growth, source [Kearney, 2007]*

After we have seen evaluated distribution potential we can conclude that Croatian construction industry is one of the most profit increasing industries in Croatia at the moment. As Croatian market is rather small, we can expect in near future that construction firms will reach market limits. This could lead the industry back in the first group of above discussed graph, the group that needs restructuring. To avoid recession in the industry, which would effect the whole domestic economy it is important that consolidation and restructuring process starts when the industry is on its peak with goal to sustain its market volume and ability to resist much stronger competition on domestic or foreign markets.

3.1 Competitiveness of Croatian construction companies

The competitiveness of Croatian construction companies expressed in terms of value and revenue growth in comparison with globally respectable construction companies is shown in Picture 4. It is important to stress that two biggest companies Konstruktor inženjering and Dalekovod are missing in analysis. However the results shows the most of Croatian construction companies are positioned in the 1st quadrant, what means they are in the phase of appreciation of both, value and revenue. Such situation is correspondent with the state of total Croatian construction industry as presented at Picture3.



Picture 4: *Benchmarking of value and revenue growth of Croatian construction companies with industry global players, source [Kearney, 2007]*

Regarding the results related to size of the companies, first ten by income biggest Croatian construction companies produce 21,5% of total income of construction industry, that is much more than 11,6% what is average in total economy. At same time first ten by profit biggest construction companies participate with 15,9% of total profit of construction industry, what is less than 19,3% what is the contribution of ten best by profit in total economy.

4. Conclusions

We can conclude that Croatian economy in total belong to better part of the world, and is slowly but steady increasing the position by time. The Croatian construction industry by most indices belong to better part of Croatian economy. However it is to be aware of the limitations in market development within the country, and of necessity of increasing the competitiveness in comparison with industries in environment, at least for two reasons. Firstly, to enable to local companies the continuous, stabile and sustainable prospect at national market in global environment among international competitors, and second, to make possible and real to operate at international market. To do it is necessary to define the methodology for estimation, analysis and increasing of competitiveness of Croatian construction industry and corporations.

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SIMULACIJSKI MODEL GRADILIŠTA TEMELJEN NA SUSTAVU SIMULACIJE DISKRETNIM DOGAĐAJIMA: ISKUSTVO IZ NASTAVE

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Sažetak

Članak opisuje nastavno iskustvo s dodiplomskog studija Zavoda za organizaciju i ekonomiku građenja Građevinskog fakulteta Sveučilišta u Zagrebu. Studenti se upoznaju s modeliranjem tehnoloških procesa građenja uz pomoć sustava simulacije diskretnim događajima na stvarnom projektu gradnje gdje je svakom studentu dodijeljen različit simulacijski zadatak. Osnovna ideja ovakvog pristupa jest da se integriranjem ovih parcijalnih simulacijskih modela može dobiti potpunija slika stvarnih procesa građenja, a istovremeno studenti dobivaju priliku sudjelovanja na stvarnom građevinskom projektu kao promatrači - nakon čega simuliraju promatrane procese. Prvi dio članka daje općenit pregled sustava simulacije diskretnim događajima i razloge za njihovu primjenu u kontekstu organizacije građenja. Drugi dio članka opisuje izradu nepotpunog modela procesa građenja jedne građevine u smislu edukacije. Dan je kratki opis građevinskog projekta uz objašnjenje sustava dodjele zadataka studentima, s ciljem simulacije složenog procesa građenja. U zaključku su predstavljene neke razlike između dobivenih rezultata uz pomoć simulacijskog modela i stvarnih procesa na gradilištu.

Ključne riječi: sustav simulacije diskretnim događajima, projektiranje procesa građenja, organizacija građenja, nastava.

A DISCRETE-EVENT SIMULATION BASED MODEL OF A CONSTRUCTION SITE: A TEACHING EXPERIENCE

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Abstract

This paper presents a teaching experience from the Construction Management Graduate Programme held at Faculty of Civil Engineering, University of Zagreb. The students are taught discrete-event simulation based modeling of construction processes through a real-world test case where every student team is given a different assignment. The main idea of this approach is that integration of these partial tasks/individual assignments - would eventually provide a more complete picture of the actual processes taking place at the construction sites, and at the same time - the students are given an opportunity to participate in an ongoing construction project by observing it and subsequently simulating the observed processes. The first section of the paper gives an overview of discrete-event simulation systems and motives for their application in the Construction Management context. The second part of the paper depicts an experience of creating a partial simulation model of a large building project – from a teaching perspective. A description of the test-case project is given, along with explanations of how individual assignments were chosen in order to simulate complex reality taking place at the jobsite. In conclusion, differences between the results obtained from the simulation model and the actual processes are given.

Keywords: discrete-event simulation systems, construction processes design, construction management, teaching.

1. Introduction

Modeling and simulation

A simulation is an imitation of a subject or process existing in the physical reality. The main types of simulation are as follows:

- Physical simulation
- Interactive simulation
- Computer simulation

Modeling is the basic form of representing complex systems and phenomena.

Simulation is used in many contexts, including the modeling of natural systems or human systems in order to gain insight into their functioning. Other contexts include simulation of technology for performance optimization, safety engineering, testing, training and education. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Key issues in simulation include acquisition of valid source information about the referent, selection of key characteristics and behaviors, the use of simplifying approximations and assumptions within the simulation, and fidelity and validity of the simulation outcomes[1].

Discrete event simulation[2]

In discrete-event simulation, the operation of a system is represented as a chronological sequence of events. Each event occurs at an instant in time and marks a change of state in the system. For example, if an elevator is simulated, an event could be "level 6 button pressed", with the resulting system state of "lift moving" and eventually (unless one chooses to simulate the failure of the lift) "lift at level 6".

Components of a Discrete-Event Simulation:

- Clock
- Events List
- Random-Number Generators
- Statistics
- Ending Condition

Simulation Engine Logic:

1. Start
    - Initialize Ending Condition to FALSE.
    - Initialize system state variables.
    - Initialize Clock (usually starts at simulation time zero).
    - Schedule an initial event (i.e., put some initial event into the Events List)

2. “Do loop” or “While loop”
    - While (Ending Condition is FALSE) then do the following:
    - Set clock to next event time.
    - Do next event and remove from the Events List.

[1] http://en.wikipedia.org/wiki/Simulation, accesed June 25, 2008
[2] All data from http:// http://en.wikipedia.org/wiki/Discrete_event_simulation, accesed June 25, 2008

- Update statistics.

3. End
   - Generate statistical report.

Simulation of Construction Processes[3]

Construction Engineers deal with the production aspects of realizing a facility (e.g. dam , high rise building, or an interstate highway) much in the fashion that an industrial engineering deals with the problems inherent in manufacturing a product. The major difference between production of a product and production of a facility is the length of the product run - the number of repetitions. In construction we normally build a unique facility which is a one-of single copy. In manufacturing, product runs vary from small batches to long runs - say of a particular model of T.V. set or lawnmower.

Possibly due to the uniqueness of constructed facilities and the perceived lack of repetition, the concept of studying work processes did not receive much attention until the late 1960s. At this time, work sampling and various graphical techniques related to bar charting were considered. It was recognized that although projects are typically unique, many construction processes are repetitive (e.g. earth hauling, tunneling, road construction, glass installation on a tall building, etc)and amenable to closer investigation. Due to the comparatively short "half life" of construction processes, sophisticated analytical methods were viewed as being too complex for most situations.

With the advent of simulation methods in construction, simple networking concepts were introduced as a modeling framework for studying construction operations. The earliest of these methods was the so-called "link node" model adapted by Teicholz (1963). After that, Halpin (1973) developed the CYCLONE format at the University of Illinois that has become the basis for a number of construction simulation systems. CYCLONE simplified the simulation modeling process and made it accessible to construction practitioners with limited simulation background.

[3] All data from https://engineering.purdue.edu/CEM/People/Personal/Halpin/Sim, accessed June 27, 2008

The Case Study

After a brief introduction to most widely used simulation systems in the construction practice, it becomes evident that any meaningful simulation-enabled-analysis of construction operations on jobsites should take place on a realistic test case. The authors therefore decided to apply a simulation based approach for analyzing construction operations in their teaching practice. The experiment was conducted as part of Construction Machinery Systems, a course held at Construction Management Graduate Programme at University in Zagreb.

The test case project was chosen based on the following criteria:

- Complexity: adopting a discrete-event-simulation based approach makes sense only if the operations comprising the construction process are complex enough (see Hartmann, 2008).
- Machinery work – driven: Machine-work-driven processes can produce a consistent modeling output as they are modeled more easily than manual-work–driven processes. Also, experience on this project has shown that these processes can be accurately measured and subsequently put together in the form of a logical model (see Izetbegović et al., 2007).
- Variety: The idea of the experiment was to eventually integrate the obtained partial models and thus, create a more complete picture of the interdependencies between construction operations in a complex construction process. Hence, different portions of the process were chosen for the assignments.

Class assignments were formed for teams of students based on their individual skills and previously gained knowledge. Given the fact that not all students were comfortable with computer programming, the tasks were assigned to the students as follows:

- The first member of a team was responsible for conducting process measurements on the jobsite,
- The second member was responsible for creating a corresponding process model,
- The third member was responsible for structuring the actual simulation model.

The authors decided that Stroboscope simulation system is the most easy to use tool for the purpose of this teaching experiment, because of its convenient graphical user interface, elaborated user manual and availability of a brief tutorial (see Martinez, 1996).

The main observed process was jobsite transport and installation of a heavy structural element. The process was mainly driven by construction machinery (two mobile cranes), but also included a portion of manual work during the installation phase. The building structure consisted of a number of such structural elements, so it was convenient to model this operation, as it is repeated many times during the construction process (Martinez, 1996).

Simulation output gives information about duration and productivity of a modeled cycle (Ioannou, 1990). Figure 1 demonstrates two simulation models from the final phase of transport and installation of a single element. A complete picture of the process could be reconstructed from the models by measuring average duration of transport for all structural elements and incorporating it in the initial model. Transport durations differ for each element, and average duration value can be calculated from the data obtained at the construction site. A relatively accurate model for the complete construction process can be obtained, by incorporating average duration value in the model, and setting a correct value for a given number of cycles, thus providing help for site engineers.

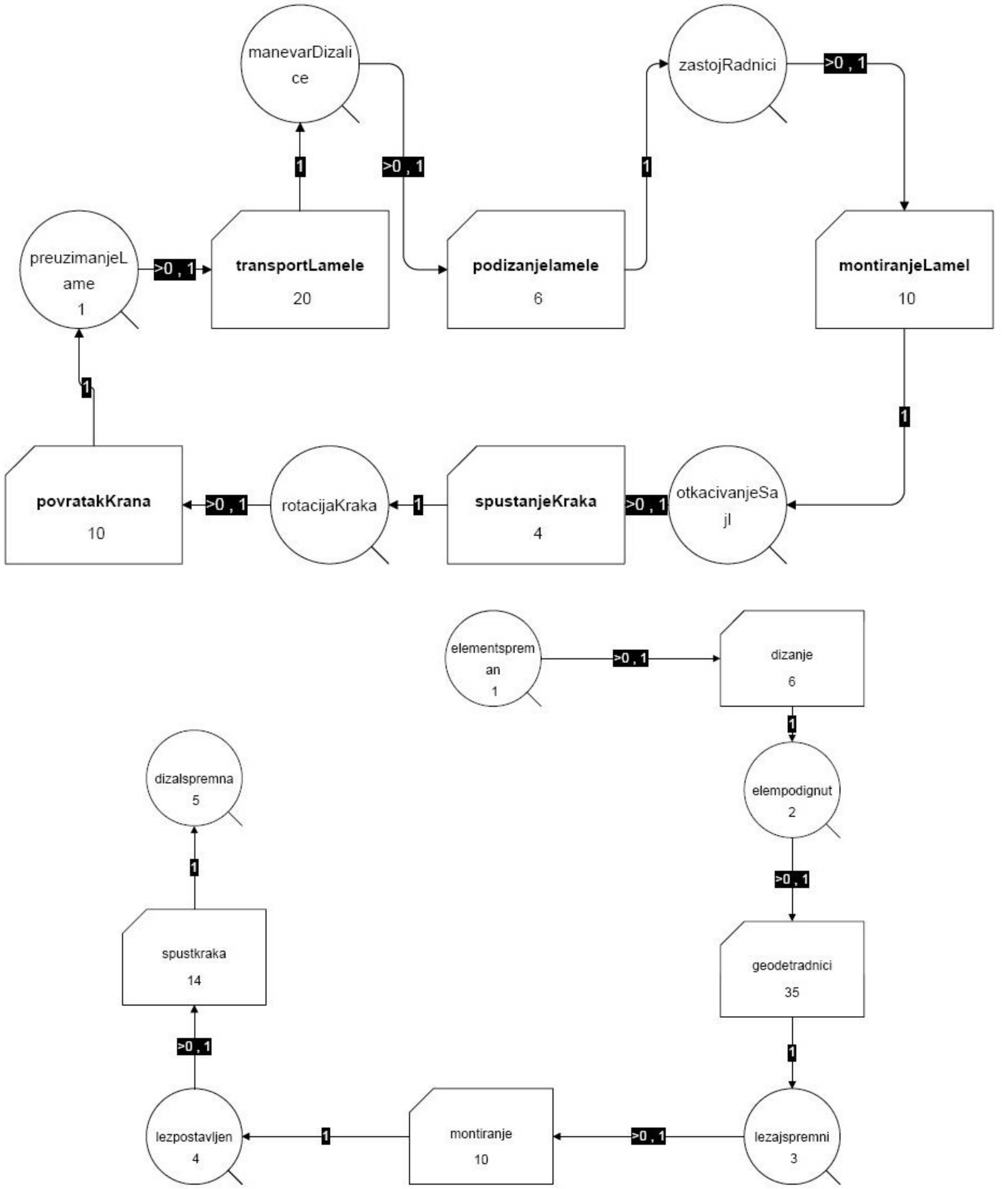

Figure 1 – The Stroboscope model for jobsite transportation and manual installation of a single heavy structural element.

The obtained model can further be expanded by integrating the obtained separate models into a single model encompassing a wider range of construction operations on the jobsite. This model would give a realistic representation of more processes taking place at jobsites, thus playing a decision support role in site managers' practice, when properly used (see Halpin and Martinez, 1999)

Concluding Remarks

The test case has shown that simulation based modeling of construction operations on jobsites can be successfully integrated in teaching practice, and interpretable results for further analysis can be obtained from this effort. Interpretation of obtained results was the final part of every student team's assignment to ensure validation of their effort. Authors' opinion is that students will find this modeling experience useful, regardless of positions they will eventually be holding in their future professional careers. Construction operations design is a valuable feature not only of the planning process, but also for construction professionals on jobsites. Using a discrete event simulation system could help construction professionals in making the right decisions on jobsites, and creating accurate predictions of progress for the actual construction process.

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MACEDONIAN CIVIL ENGINEERS AS CONSTRUCTION PROJECT MANAGERS

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Abstract

In Republic of Macedonia, so far the process of licensing Construction Project Managers has not started.

Who are construction project managers? How are they chosen? What are the problems about their education? What are the problems about their licensing? Do they have an impact on the Macedonian civil construction engineering as a whole? What are the problems connected with the construction project management regulations?

To get answers for the mentioned and many unmentioned questions, the authors of the paper did some investigations about the construction project management situation in Republic of Macedonia. The results of that investigation are presented in this paper.

Keywords: Civil Engineers, Construction, Project Managers

INTRODUCTION

The need for proper project management in the Republic of Macedonia has been acknowledged in the past. However, project management application and development was mainly based on the application and development of contemporary planning methods and techniques. The individual researches in important areas for quality construction project management are fairly small and the licensing process in the area of project management has not been established to date.

As a result of the described situation, the Macedonians construction practise is facing various problems. In order to perceive the major problems and reasons for occurrence, the authors of this article carried out an analysis of previous and present condition in the managing of construction projects in the Republic of Macedonia.

The results from the research are presented in this article. They have been systematised into several key group issues and problems. They refer to the following:

- Appointment of Construction Project Managers

- Education in the field of construction project management
- Certification and licensing of project managers in Macedonian civil construction engineering
- Construction Project Managers' impact on Macedonian civil construction engineering
- Regulations relevant for construction project management

ANALYSIS OF KEY PROJECT MANAGEMENT PROBLEMS IN MACEDONIAN CONSTRUCTION

Appointment of Construction Project Managers

The process of licensing staff and Companies in the field of construction project management in Republic of Macedonia has not started yet. As a result, it is very difficult to identify staff and Companies that are competent in that field.

The analysis of the practical construction work in Macedonia indicates a great diversity regarding education and professional experience of project management staff, as well as the types of companies they work for.

Depending on the participants employed in the realisation of construction projects, the project managers are classified into two groups: 1. project managers participating in international projects 2. project managers participating in national projects.

1. In the Republic of Macedonia, project managers participating in the realisation of *international projects* are being chosen by each participant in the construction independently. In this fashion, each participant applies one's individual criteria and procedures for selection of such staff. The staff selected by international participants are usually foreign persons having appropriate certificates and licences, but the disadvantages of selecting such staff is the insufficient awareness of the actual situation by the staff, when carrying out construction works in Republic of Macedonia.

   It should be mentioned that the foreign participants in the construction of buildings, pursuant to the Law on Construction can undertake all the positions as the domestic participants.

   Many times, national staff work as project managers for foreign Companies. The majority are civil engineers having experience with construction of buildings at home and abroad and are familiar with the planning, regulations, technical specifications and negotiations in the construction business, construction management and IT and have a good command of English.

   It happens that Macedonian Companies take part in international projects abroad. However, it should be noted that in such cases not having a procedure of selecting certified and licensed project managers in the Macedonian civil engineering, creates large problems concerning their appointment and realisation of working tasks.

2. Project managers participating in the realisation of *national projects* are chosen by the Project Sponsor. As there is no established procedure for selection of project managers, the Project Sponsor is in a position to choose staff in line with one's own procedures. In most cases, Project Sponsors select project managers from their own category, who will be available in the period of project realisation. Depending on the type of project product/produce (usually construction building), the managing of the project is carried out

by civil engineers. Sometimes, architects, economists, mechanical engineers or other workforce is appointed. Normally civil engineers having practical experience in construction, who have been previously involved in the realisation of similar projects and have some know-how from the principal areas of project management, are appointed. Unfortunately, workforce without prior necessary experience in project management is also selected. In rare cases are staff members not employed with the Project Sponsor appointed as project managers. If that happens, this is usually international staff, hardly ever Macedonian staff, predominantly civil engineers.

Concerning the responsibilities given to the Macedonian civil engineers as project managers, it can be assumed that there isn't any distinction with regard to the responsibilities assigned to project managers, regardless of whom they work for and who makes the selection.

These managers coordinate and supervise the construction process from the initiation of the construction project through final construction, making sure that the project gets done on time, within the project budget and the planned resources.

Construction managers direct and monitor the progress of project activities, sometimes through construction supervisors or other construction managers. They also work 'on call' 24 hours a day. Sometimes they work on several projects. In that case, they often work out of office. Usually they work under pressure because of the rapidly changeing construction project environment, so most decisions are made at the job site.

For large construction projects which are divided into many segments, construction project managers may plan, direct and coordinate the whole project or may be in charge of one or more of these segments.

Education in the field of construction project management

Although Macedonian construction companies and also the Macedonian construction public have recognized the necessity and importance of developing construction project management in Republic of Macedonia, there isn't any university which deals with graduate and post graduate programs of construction project management. During the studies, students acquire minimal education about the mentioned field of construction. Owing to that, graduate and post graduate students lack the necessary knowledge and practical experience. The only possibility for the students to direct their education in the field of construction project management is to write their M.Sc. or Ph.D. theses in the mentioned field. Needless to say, there is a possibility for students to continue their education at universities abroad.

To create a better situation for education of construction project managers in Macedonia the Faculty of Civil Engineering in Skopje is in the initiation phase of creating a new master curriculum program in the field of Construction Project Management.

It may be pointed out that adequate attention had not been paid to the other forms of education and training in the area of construction project management in the Republic of Macedonia.

This indicates that the number of seminars, symposiums, congresses, conferences, workshops or similar forms for exchanging experiences in the field of construction project management in Macedonia is at a low level.

In addition, there have been neither activities on the part of the Chamber of Engineers and Authorised Architects for harmonosing and standardization of expressions and the knowledge fund compared to other countries, nor developed methologies for application of construction project management and no guidelines and defined standardised educational programmes for education and training in the mentioned area.

As a result, Macedonian staff, especially civil engineers working as project managers has the minimum necessary knowledge, and use foreign concepts, models and standards for construction project management and their work is based on their own experiences, education and intuition.

Certification and licensing of project managers in Macedonian civil construction

In accordance with the Law on Construction [1] " The investor can determine a person for construction management, who will on his/her behalf carry out all organisational works for monitoring the construction process, from idea, project, and building until obtaining approval for use, with financial and material supervising of means in the construction of buildings from first to third category..." "...The construction manager can be a person registered in the trade register for performing such activities, if s/he holds a license and has at least one person employed with authorisation in the architectural or civil engineering profession."

The aforementioned has not been achieved in practice. The main reasons for such situation are various problems that emerged with the beginning of the process of selecting construction managers. Due to this, the process was stopped and the Law on Construction is currently being amended.

Another problem is that fact that the Republic of Macedonia lacks National Certification Program in the area of construction project management that would be in line with similar international programs. As a result, Republic of Macedonia does not have stages of competences and qualifications, as well as phases of the certification process. Furthermore, there is lack of manuals and training courses for candidates' preparation and Companies for the process of certification and licensing.

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. It may be noted that the individual research in the specific field is fairly small [2].

Hence, it should be emphasised that in the Macedonian construction practice there are different kinds of foreign concepts, models and standards used by foreign project managers, and also Macedonian employees working as project managers.

Many years ago, there was a Macedonian Association of Project Managers, but currently it does not exist. The main reason for that situation is the lack of licensed Macedonian Construction Project Managers.

It should be underlined that there are project managers in Republic of Macedonia with foreign licence. The majority of managers are also foreign managers, who have modest knowledge of the real construction situation in Republic of Macedonia.

Construction Project Managers' impact on Macedonian construction

In complex and dynamic conditions for realisation of construction projects, the civil construction engineers working as project managers have positive and negative impacts on the situation and the development of the Macedonian construction as a whole.

The engagement as project managers has allowed civil construction engineers to become aware of the significance of education and licensing in the field of construction project management. The work has also enabled them to acquire experience in the construction project management area, to develop team spirit, to obtain other competencies, skills and practices particularly important for the good quality of construction project management. However, the majority of civil construction engineers, especially the ones that have gone through a positive experience from managing the realisation of projects, believe they can successfully manage all kinds of construction projects regardless of their nature and that they have become indispensable. They “keep” the acquired knowledge to themselves and rarely exchange know-how with other employees. Such employees have a negative impact upon the reputation of the Macedonian civil construction engineers, especially when participating in international project at home and abroad.

On the other hand, the competition on the international construction market is increasing day by day. Investors are searching for competent individuals and licensed Companies to manage projects, so that the investor can depend on and be confident in their performance. Therefore, the lack of project licenses in the Republic of Macedonia that would be internationally recognised has an impact upon the finding of work for the Macedonian construction Companies abroad, thus directly affecting the Macedonian civil construction business.

Legal regulations relevant to construction project management

Numerous domestic and foreign participants are included in the realisation of construction projects, especially the projects related to strategic investment buildings. The vast majority are technically equipped and staffed, possessing knowledge and experience related to project realisation. They are also capable of adjustment to the ever changing project realisation conditions. As a result, the experience to date from the realisation of construction projects in the country, point to the fact that well designed legal regulations, and in within its framework the Law on Construction is the basic prerequisite for efficient and cost-effective realisation of construction projects.

The present Law on Construction has been in effect since 2005. The analysis results indicate that there are significant paragraphs in almost all articles of the Law, concerning the management of construction projects realisation. However, insufficient attention has been paid to crucial issues relating to the management of construction projects. In order to improve the situation a *“Manual on the manner of issuing, extending and withdrawing of license to managers of constructions from first to third category”* was adopted, but, soon after the *Manual* was removed from practise because of the numerous problems emerging in the construction practise.

Additional problems in the Macedonian construction practise occur because the terminology, expressions and levels of project documentation used in the Law on Construction are not harmonised with the contemporary EU regulations terminology. Such a situation results in occurrence of frequent problems in management of international project.

As to the remaining relevant Macedonian legal regulations, they are also not focusing enough on the key issues concerning construction project management.

CONCLUSION

The situation analysis of construction project management pointed to the fact that the practical application of project management in the construction practise began in the 1960s. However, its development and functionality, especially after Macedonian independence was not progressing with the anticipated and required intensity.

The process of certification and licensing of staff and Companies has not been established so far. 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 the fact that the expressions and the levels of project documentation and its scope are not harmonised with the contemporary EU regulations in the relevant field. Consequently, the Republic of Macedonia falls behind many European countries in terms of construction project management.

Some of the realised construction projects, among which are strategic construction projects have been managed inadequately. This had its effect on increasing expenses for project realisation and postponement of realisation deadlines. On the other hand, the problems caused by project management affected the finding of work for Macedonian civil construction engineers abroad, thus directly affecting the Macedonian civil construction business. Such situation in the Macedonian practise was a result of many subjective as well as objective reasons.

However, the fact that the public concerned with the area of construction is becoming aware of the need to take practical steps in order to improve the situation regarding education and licensing of Macedonian workforce especially civil engineers is encouraging. Furthermore, the inevitability of paying more attention to other significant issues and problems concerning construction project management was acknowledged. Their resolution will create conditions for eliminating the causes for many other problems emerging during realisation of construction projects in Macedonia. Condition will also be created for quality, cost-effective and efficient construction of building at home, and the possibilities for international cooperation of the Macedonian civil construction engineering aboard will be increased. All this will allow faster integration of the Macedonian civil construction engineering within the EU civil construction.

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PRIMJENA „TIME-COST“ MODELA U UPRAVLJANJU GRAĐEVINSKIM PROJEKTIMA

Vahida Žujo*, Diana Car-Pušić†

SAŽETAK

„Time-cost“ model za brzu procjenu vremena građenja prisutan je u svijetu već 50-ak godina. Jedno od njegovih obilježja jeste ograničenost primjene isključivo na područje istraživanja, zbog gospodarskih i drugih razlika. U ovom radu se prikazuje postupak procjene vremena građenja za objekte visokogradnje na području Federacije Bosne i Hercegovine. Predloženi model je primjenjiv u uvjetima kada se ne očekuje djelovanje faktora rizika intenzivnije od uobičajenog. Model je testiran na bazi podataka za osam objekata visokogradnje izgrađenih na području Hercegovine u periodu od 2006.-2008.godine.

Ključne riječi: vrijeme, cijena, ugovoreno, ostvareno, procjena, pokazatelji, modeli

1. UVOD

Dosadašnja praksa ukazuje na veliku prisutnost problema probijanja ugovorenih rokova građenja. Brojna znanstvena istraživanja potvrđuju ovu tezu [1, 3] .
Svijest o ovom problemu prisutna je, kako u građevinskoj praksi, tako i u znanstvenim krugovima. Cijeli niz istraživača bavio se u svojim istraživanjima ovim problemom [11,13].
„Time – cost“ model koji ima za cilj što točniju procjenu vremena građenja već u ranim fazama projekta, utvrdio je 60-ih godina prošlog stoljeća, australijski istraživač Bromilow [2]. Kako je model određen kao funkcija cijene građenja, razumljiva je ograničenost njegove primjene samo na područje istraživanja. Nakon prvog istraživanja, kasnije je u više navrata potvrđena je vjerodostojnost modela i u Velikoj Britaniji, Kini, Texasu, Maleziji, Hrvatskoj itd. [9, 4, 6, 5, 3] .
Često se vode dugotrajni sudski sporovi između investitora i izvođača radova čiji je glavni predmet neopravdano probijanje ugovorenog roka. Uobičajeno je da sudionici u projektu paušalno određuju vrijeme građenja, ne vodeći računa o stvarnim mogućnostima izvođenja u tom roku.
Imajući u vidu sve navedeno, a u cilju reduciranja problema može se reći da postoji realna potreba za određivanjem matematičkih modela za brzu procjenu vremena građenja i na tlu Bosne i Hercegovine.

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2. BAZE PODATAKA

Predmet istraživanja su objekti visokogradnje izgrađeni u periodu od 1995.-2006.god. na području Federacije BiH. Metodom anketiranja i intervjuiranjem odgovornih inženjera u građevinskom firmama prikupljeni su podaci za ukupno 53 objekta podjeljena u dvije skupine:

1. Nova gradnja 29 objekata
2. Rekonstrukcija 24 objekta.

U tablicama 1 i 2 prikazani su podaci s terena s izračunom osnovnih statističkih pokazatelja. Kod objekata nove gradnje je zabilježeno nepoštivanje ugovorenog roka u prosjeku veće za 14,80% i istovremeno nepoštivanje ugovorenog roka i ugovorene cijene za 25,29% veće nego kod objekata rekonstrukcije.

Tablica 1. Baza podataka sa statističkim pokazateljima za objekte visokogradnje - nova gradnja

objekat	Godina izgrad.	Vrijeme građenja [dani]			Cijena građenja [100.000 KM[‡]]		Prekoračenja [%]	
		ugovoreno	Ostvareno	Razlika	ugovorena	ostvarena	vrijeme	cijena
1	2	3	4	5	6	7	9	10
1	2003.	180	255	75	20,460117	24,595769	41,67	20,21
2	2002.	120	130	10	2,407934	2,648727	8,34	10,00
3	2003.	360	412	52	1,394748	1,483098	14,44	6,33
4	2004.	60	69	9	1,647091	1,773811	15,00	7,69
5	2004.	90	100	10	1,660224	1,776380	11,11	-9,09
6	2004.	20	18	-2	2,858531	2,598736	-10,00	-9,09
7	2004.	60	68	8	1,349080	1,547134	13,33	14,68
8	1998.	510	510	0	6,510000	6,510000	0,00	0,00
9	1998.	30	30	0	0,246080	0,246080	0,00	0,00
10	1996.	150	150	0	2,168688	2,168688	0,00	0,00
11	2001.	180	180	0	6,631256	6,631256	0,00	0,00
12	2005.	60	60	0	1,551802	1,551802	0,00	0,00
13	2006.	90	120	30	3,000000	3,134900	33,34	4,48
14	2006.	180	230	50	10,000000	11,100000	27,78	11,00
15	1998.	165	201	36	2,807577	2,807577	21,82	0,00
16	2001.	300	300	0	2,790000	2,790000	0,00	0,00
17	2002.	30	30	0	0,235000	0,235000	0,00	0,00
18	2002.	360	360	0	18,840083	18,840083	0,00	0,00
19	2003.	150	150	0	9,319828	9,319828	0,00	0,00
20	2005.	120	135	15	3,420079	3,572128	12,50	4,45
21	2003.	150	220	70	5,905552	6,836758	46,67	15,77
22	2003.	90	110	20	2,325000	2,502410	22,22	7,63
23	2003.	90	95	5	1,351375	1,444357	5,56	6,88
24	2003.	210	223	13	0,559007	0,692821	6,19	23,94
25	2005.	320	380	60	9,487900	12,255340	18,76	29,16
26	2003.	60	70	10	1,426504	1,612504	16,67	13,04
27	2005.	120	132	12	1,702218	1,870098	10,00	9,86
28	2005.	90	100	10	1,500000	1,698350	11,11	13,22

[‡] Konvertibilna marka – valuta BiH-e

29	2002.	60	65	5	3,815300	3,899891	8,33	2,22
						Prosjek	11,55	6,84
						Median	10,00	6,33
						Minimum	-10,00	-9,09
						Maksimum	46,67	29,16
						Prvi kvartil	0,00	0,00
						Treći kvartil	16,67	11,00
						Interkv. odst	16,67	11,00
						Stand.dev.	13,30	8,41
						varijansa	176,92	70,78

Tablica 2. Baza podataka sa statističkim pokazateljima za objekte visokogradnje - rekonstrukcija

objekat	Godina izgrad.	Vrijeme građenja [dani]			Cijena građenja [100.000 KM]		Prekoračenja [%]	
		ugovoreno	Ostvareno	Razlika	ugovorena	ostvarena	vrijeme	cijena
1	2	3	4	5	6	7	9	10
30	1999.	540	600	140	46,500000	46,500000	11,11	0,00
31	2001.	40	40	0	0,373233	0,373233	0.00	0,00
32	2005.	120	300	180	0,774229	0,979230	150,00	26,47
33	2005.	120	300	180	1,976019	2,664238	150,00	34,83
34	1997.	240	390	150	34,300000	57,8200000	62,50	68,57
35	2003.	210	240	30	6,789324	7,462610	14,28	9,92
36	2007.	180	180	0	11,002138	11,002138	0,00	0,00
37	1995.	180	199	19	4,124046	4,704000	10,56	14,06
38	2003.	120	120	0	4,115297	4,115297	0,00	0,00
39	1995.	165	212	47	4,012238	5,049891	28,48	25,86
40	2004.	180	220	40	7,248037	7,823260	28,48	7,94
41	1998.	90	90	0	1,396330	1,582330	0,00	13,32
42	2006.	150	300	150	4,238900	4,603341	100,00	8,60
43	1995.	90	90	0	2,124391	2,124391	0,00	0,00
44	1998.	60	60	0	0,159142	0,159142	0,00	0,00
45	1999.	180	180	0	33,320892	33,320892	0,00	0,00
46	2002.	60	60	0	1,877204	1,877204	0,00	0,00
47	2002.	60	60	0	2,063693	2,063693	0,00	0,00
48	2001.	200	180	-20	4,988687	5,301000	-10,00	6,26
49	2002.	120	110	-10	4,406739	4,533711	-8,34	2,88
50	2004.	180	150	-30	3,812765	3,917015	-16,66	2,74
51	2003.	150	148	-2	4,481149	4,481149	-1,33	0,00
52	2001.	150	150	0	4,278000	4,278000	0,00	0,00
53	2002.	120	120	0	2,585000	2,585000	0,00	0,00
						Prosjek	21,36	9,23
						Median	0,00	1,37
						Minimum	-16,66	0,00
						Maksimum	150,00	68,57
						Prvi kvartil	0,00	0,00
						Treći kvartil	17,83	10,77
						Interkv. odst	17,83	10,77
						Stand.dev.	46,71	16,02
						varijansa	2182,15	256,80

3. PROCJENA VREMENA GRAĐENJA

Određivanje modela za procjenu vremena građenja T bazira se na primjeni Bromilowog „time-cost“ modela

$$\boldsymbol{T = K*C^B}$$

Gdje su:

C – cijena građenja
K – pokazatelj potrebnog prosječnog vremena građenja za jediničnu novčanu vrijednost
B – pokazatelj zavisnosti promjene vremena građenja o promjeni cijene građenja

To podrazumjeva određivanje pokazatelja K i B koristeći logaritamsku transformaciju eksponencijalne jednadžbe u linearni oblik

$$\ln T = \ln K + B * \ln C$$

Poznatom metodologijom [2, 3, 8, 10], uz pomoć jednog od kompjuterskih programa[§] određuju se glavni pokazatelji jednostruke linearne regresije, uz prethodno izvršenu revalorizaciju ugovorenih i ostvarenih cijena u odnosu na razmatrani vremenski period, tj. V/07 [7].
Vizualnom ocjenom dijagrama „ln$T$-ln$C$“ ustanovljeno je da pojedini objekti znatno umanjuju pogodnost linearne aproksimacije. U cilju dobivanja većih koeficijenata korelacije i determinacije ponovljen je postupak linearne regresije s reduciranim uzorcima na način da su iz I grupe izuzeti objekti pod rednim brojevima 3, 6, 8 i 14, a iz II grupe objekti pod rednim brojevima 32 i 33.
U tablici 3 je dat uporedni pregled pokazatelja linearne regresije na cijelom i reduciranom uzorku.

Tablica 3. Pokazatelji linearne regresije na cijelom i reduciranom uzorku

Grupa objekata	Pokazatelj	CIJELI UZORAK		REDUCIRANI UZORAK	
		Ugovorene vrijednosti	Ostvarene vrijednosti	Ugovorene vrijednosti	Ostvarene vrijednosti
nova gradnja	R	0,579	0,621	0,829	0,860
	R^2	0,336	0,386	0,688	0,739
	AR^2	0,311	0,363	0,674	0,728
rekonstrukcija	R	0,835	0,717	0,856	0,848
	R^2	0,698	0,514	0,732	0,719
	AR^2	0,684	0,491	0,719	0,705

R – koeficijent korelacije
R^2 – koeficijent determinacije
AR^2 – korigirani koeficijent determinacije

Model je ocijenjen kao prikladan i usvojene su regresijske jednadžbe

[§] U ovom radu je korišten kompjuterski program SPSS9

1. Za objekte nove gradnje ***T = 70*C^0,52***
2. Za objekte rekonstrukcije ***T = 79*C^0,41***

gdje je C izraženo u 100.000 KM.

Dobiveni rezultati ukazuju da će se objekt nove gradnje vrijedan 100.000 KM graditi u prosjeku 70 radnih dana, odnosno objekt rekonstrukcije 79 radnih dana.

4. PRIMJENA DOBIVENIH REZULTATA NA NOVOJ BAZI PODATAKA

Novi modeli su testirani na novoj bazi od ukupno 8 objekata i na samo jednom objektu je zabilježeno značajno odstupanje što je prikazanao u tablici 4. Ostali rezultati su ocijenjeni kao zadovoljavajući. Objekt pod rednim brojem 5 ima odstupanje od 49 % što se može objasniti činjenicom da maksimalna ugovorena cijena u glavnoj bazi podataka za objekte nove gradnje iznosi 2.200.012,58 KM, što je 2,27 puta manje od ugovorene cijene razamtranog objekta.

Tablica 4. Rezultati primjene modela na novoj bazi podataka

r.b.	Objekat, lokacija, god. izgradnje	Ugovorena cijena [KM]	ostvareno vrijeme T_{OS} [dani]	Procjenjeno vrijeme $T = 70*C^{0,52}$ $T = 79*C^{0,41}$ [dani]	T/T_{OS}
1	Osnovna škola, nova gradnja, Šuškovo selo, općina Stolac 2006.	169.980,34	**90**	**92**	1,02
2	Gimnazija jezička, rekonstrukcija, Sjeverni logor, Mostar, 2006.	710.000,00	**180**	**176**	0,98
3	Javna ustanova „Konak“, rekonstrukcija, Mostar, 2007.	500.000,00	**150**	**153**	1,02
4	Objekti viskogradnje – rekonstrukcija, Počitelj, općina Čapljina, 2007.	377.008,31	**126**	**136**	1,08
5	Poslovno-stambena zgrada „Dolina sunca“, nova gradnja, Mostar, 2006.	5.000.000,00	**360**	**535**	1,49
6	Poslovna zgrada „MIK“ , nova gradnja, Mostar, 2007.	180.304,00	**60**	**66**	1,10
7	Stara gimnazija, rekonstrukcija, Mostar, 2008.	1.300.000,00	**210**	**226**	1,08
8	Poslovno-stambena zgrada „Mukoša“, rekonstrukcija, Mostar, 2007.	700.000,00	**180**	**175**	0,97

5. ANALIZA I USPOREDBA S INOZEMNIM REZULTATIMA

U usporedbi sa dostupnim međunarodnim rezultatima [12, 9, 5, 4, 3] , vrijednost dobivenog pokazatelja K veća je, što ukazuje na manju produktivnost u Federaciji Bosne i Hercegovine. Npr.u Hrvatskoj je dobiven podatak da se za 79 dana može realizirati projekt vrijedan milion hrvatskih kuna[**], dok je u ovom radu dobiven podatak da je za realizaciju projekta od 100.000 KM potrebno 70-79 radnih dana [3]. Drugim riječima, to znači da se ista zgrada u Federaciji Bosne i Hercegovine gradi u prosjeku cca 2,5 puta duže nego u Hrvatskoj.
Pokazatelj B u Hrvatskoj za objekte visokogradnje iznosi 0,60, što znači da je nešto veći utjecaj složenosti projekta na produljenje vremena. Općenito, i dosadašnja su istraživanja pokazala da je pokazatelj K veoma podložan promjeni u ovisnosti o gospodarskim prilikama, dok se B kreće u granicama od cca 0,40-0,60.

6. ZAKLJUČAK

Bitno je istaknuti da je dokazana, nakon što je više puta potvrđena u svijetu, vjerodostojnost Bromilowog „time-cost“ modela i na tlu BiH - e. Ovo je tek prvo istraživanje takve vrste, te predstavlja samo uvod u detaljnija istraživanja za određivanje modela za brzu procjenu vremena građenja.
Dobiveni matematički modeli su primjenjivi samo na području Federacije BiH, u uslovima kada ne postoji realna pretpostavka za pojavu i negativno djelovanje rizičnih faktora.

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HISTRIA REAL ESTATE FUND – CASE STUDY

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Abstract:

This paper demonstrates real property (real estate) fund as a modern trust capital investment strategy.

Real estate fund investment policy demonstrates rather new organized form of profitable and secure investment strategy. The transparent and efficient land development through essential real estate phases allows the project to be attractive to private and public investors. Such project inevitably involves contribution of various participants such as: community, professional contractors, developers, urban and spatial planners, architects, builders, real estate agencies, etc. A case study of Histria Real Estate Fund Ltd. demonstrates rules in a single cycle project within private equity fund. It illustrates how an opportunity investment meets public sector interest in frame of global region development.

Keywords: Real Estate, Equity Fund, Investment

1. INTRODUCTION

Real estate funds with their unique operating nature and special business characteristics serve as a modern alternative to traditional capital funds. It has some crucial advantages in comparison to other investment opportunities. Real estate funds are becoming important subject on real estate market and relatively profitable and secure investment possibility for small and institutional investors. Significantly the real estate funds deliver long term and above-average return. Due to well known risks at real property investing the Fund portfolio has to be diverse and well dispersed. In any case the real estate market price fluctuation has true influence on risk level, loan and tax policy changes. The Fund's aim is to build the portfolio, that is enough diverse according to type of real property, ownership and geographical region. Deciding which investments judge among the most profitable within the Fund it is necessary to consider both real estate market and capital market development.

2. HISTRIA REAL ESTATE FUND SIGNIFICANCE

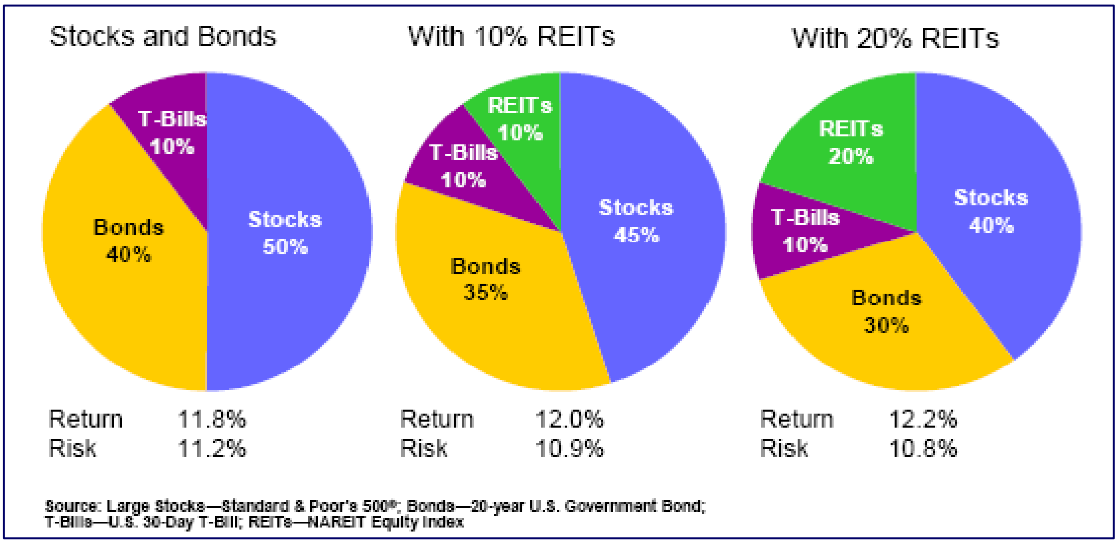
Histria Real Estate Fund plans to be a private equity real estate fund investing capital mainly in land development on Croatia coastal location and Istria region generally. It is intended for high net worth individuals and institutional investors. The objective of the Fund is to ensure the investor’s above average return on real estate investment by establishing controllable risks. For the purpose of managing the portfolio and any separated real estate investment the SPV (Special Purpose Vehicle) company is established. The Fund has its formal settlement on Cyprus, which allows the ultimate performance within taxation incidence. The Fund involves credit leverage what increases the return.

In the period of the real estate fund foundation it is of utmost importance carefully to monitor the investment opportunities in real estate. The Fund’s investment policy should be flexible and should enable the Fund Consultants quick response time at the estimation of individual real estate projects. In the time aspect so called Single Cycle approach is intended to be used, so the capital assets are to be disbursed among investors in term of SPV final sale. The Fund is supplemented by Investor’s Committee which assembles five acknowledged experts in the field of real property management. During the operation the Fund company should invest any asset surplus at subscription into deposits or other instruments of the money market with fixed yield and credit standing A or higher. The company shall invest in the primary region (at least 50 % of assets), represented by the area of Istarska županija and the coastal region of Croatia. Possible secondary target region for investment is the remaining part of the Republic of Croatia and eventually Republic of Slovenia.

Istria is a well perspective area from the point of location, admission, traffic network, climatic feature and natural beauty. Yet, lineament of the region is a down developed real estate market and cross information field, what both requires a provident operation. Nevertheless, the involvement of important investors is more or less expected. An additional achievement when plunging the Fund is relatively high interest of local community in consecutive region development. Last but not least urge of the Fund success is the fact that Croatia is well approaching to EU which has on the other hand a significant demographic situation, set to absorption in scarcity zones such as Istria.

3. MARKET OPPORTUNITY

The first real estate fund company in Croatia is known as Terra Firma. Company has shown good perspective for investors soon after entering stock exchange in 2005. After some successful investment realization in non-improved land, Terra Firma has increased internal share value for approx. 10 % of gross sum, operated by management company Agrippina from Pula. Opportunities after share registration have exceeded Founds starting capital, where planned yield has amounted between 12 to 15 %. The result was significant because of real estate component advantage in investment portfolio. General rise has been notoriously characteristic up to year 2000. (Picture 1)



Graph 1. Stock and Bond Investors 1972 -2000

The principle of added economic value to the real estate investment is following the sequent step process:

I. Land purchase
II. Project development
III. Project sale in the intermediate stage or further improvement of the land
IV. Final improvement sale

The key competitive vantage in performing capital investments in real estate, respectively land development, rather than other investment opportunities, is grossly a string of following items:

- Inside knowledge of domain circumstances and local market behaviour
- Fast response on market opportunities and optimal purchase price achievement
- Proverbial habit comprehension and strong involvement in local municipalities
- Real property intermediary service network
- Coexistence of grade planners, architects, appraisers, lawyers, etc.
- Optimal output strategy assurance

4. CASE STUDY ON TERRA INVEST FORMER FUNDS

Terra Invest is a Croatian company that has managed formally to elaborate two real estate fund projects with similar terms to Histria Real Estate Fund. This knowledge serves as goodwill to the superior managing process. Within the second one, the Terra Mediterranea Real Estate Fund, there are some successful examples of making the surplus profit in managing the land use and proper improvement development.

Life cycled projects:

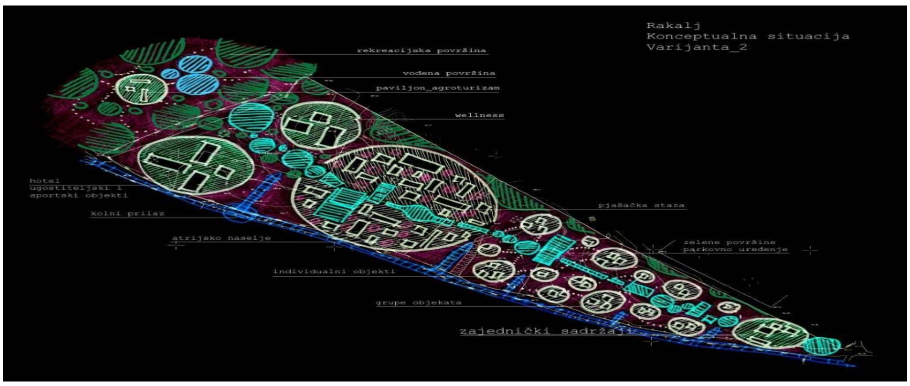
- Kaštanjer – land improvement in housing (purchase at 72 EUR/m2, project costs approx. 10 EUR/m2, sold for 230 EUR/m2),
- Vodnjan - land improvement for tourist capacities (land purchase and documentation cost 42 EUR/m2, sold for 120 EUR/m2).

Projects in process:

- Loborika – land improvement - housing purpose
- Rakalj – land improvement - vacation purpose
- Škicini – Istria typical stony houses settlement

Slide 1. Loborika – Residential vicinity master plan

“Rakalj” presents Land improvement for tourist capacities – 60 000 m2 land - villas with functional buildings



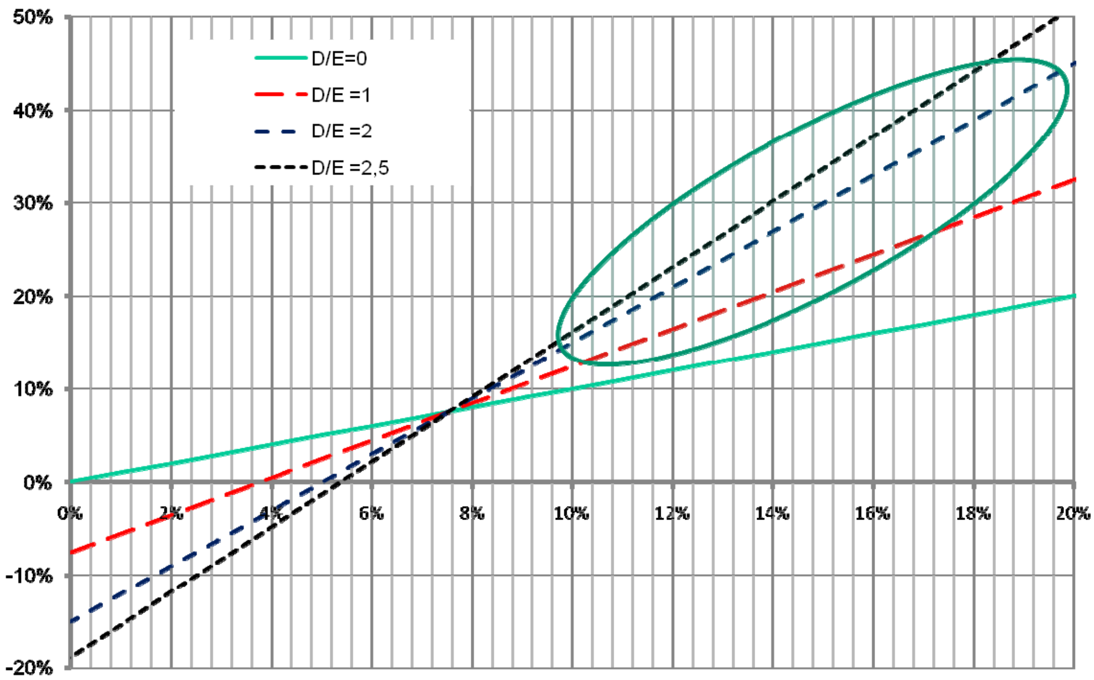
Slide 2. Rakalj – Land use study

“Škicini” presents Land improvement for typical stony house construction on vacant land approximately 5.000 m2

Slide 3. Škicini – Architectural design study

5. FINANCIAL ANTICIPATION AND CREDIT LEVERAGE ROLE

The competence of Fund finance treatment is on managing company Genevra Ltd. The management company should charge approximately 2% of yearly provision fee upon the Fund financial assets. When yield exceeds 6% the managing company is entitled to share the profit in relation 20/80 in favour of shareholders. Prospective return is expected on 15% of capital invested. Involving financial leverage we can predict a higher return for the investors, what is seen on Graph 2. However, the expected return for the investors is estimated within 25 to 30% p.a., what is reasonably high yield in comparison to alternative investment opportunities.



Graph 2. Debt/Equity ratio (D/E)

6. INVESTMENT ADVANTAGES CONCERNING ASSESSMENT

In case the Fund was established in some of the countries of EU the assessment would have consequences on income. For that reason the Fund shall have the residence on Cyprus, which is the only member of EU without any assessment condition on capital return for institutional companies so far. The Fund shall not govern a direct investment policy in real estate but plans to purchase the property through SPV companies. The profit regarding the sale of SPV company is likewise not the case of assessment. Fund investments are divided into base capital deposit of 10.000 EUR limited and capital overplus (i.e. agio) which is not rateable. The accountant aspect implicates the use of IAS standards, validating the book value as a fair value. Investor's withdrawal is feasible with selling the stock share or in case of Fund liquidation.

Histria Real Estate Fund Ltd. is an investment example with high interest in portfolio diversification through a real estate investment strategy. Professionally the Fund is therefore acquiring and managing properties by pooling together financial assets with other investors. The real estate investment business in such form is making it possible for investors to be able to indirectly own income-generating real estate. In case the Fund's Company is not indebted, this introduces a credit involvement under relatively advantageous loan qualifications.

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