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INTRODUCTION

Dear Colleagues,

It is our great pleasure to welcome you to the 11th OTMC international conference on organization, technology and management in construction. This conference is another in the series of meetings we have organized during more than thirty years with the aim to get together the experts who are dealing with the discipline so important for the success of every construction activity.

The most essential resource needed for the development of construction industry is new knowledge. Nowadays, it can be created only with cooperation among the people and the teams that share their vision, creativity and passion. Working together has never been of the essence like today. Conjunction between the people and institutions has also never been so possible. Information technologies enable communication like never before. However, personal acquaintance remains still the most important and also the most enjoyable foundation of any networking. We are sure that more than 100 authors from 13 countries participating at the Conference share the same awareness of the importance of getting together.

We are convinced that innovation can only be created and successfully applied with participation of all the social partners. For that reason our wish has always been to attract the attention of scientists, professional practitioners, owners and policy makers participating in construction process. This time we have again prepared a series of activities to encourage the cooperation between the academia and the industry in identifying and discussing the possibilities for acting together to achieve better performance and meet the needs of clients more successfully. You are invited to take a part at two workshops with actual topics on legislation, same as at the technical session with presentations of case studies of successful projects and innovative products.

One of our main concerns is related to education of students, as well as professionals. Traditional Academic forum with participation of academics from 19 universities will give the opportunity to the participants for the exchange of information and experience on study programs, teaching practice, new trends and demands in education in construction organization, technology and management. Hopefully, the forum will encourage the participants to create the possibilities to use some of numerous programs for students and teachers mobility within the European academic area and make the education process more dynamic and exciting.

The venue of this conference is the city of Dubrovnik. We sincerely hope that the unique heritage of this city and the beautiful environment will contribute to pleasurable atmosphere during both the conference working and social activities for all participants.

Finally, on the behalf of the organizing committee I want to thank to the authors, reviewers and the members of the international scientific committee for their contribution in preparing the conference. I wish 11th OTMC conference to be successful and pleasurable for all the participants.

Prof. Ivica Završki, Ph.D.
President of Scientific Committee

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INTERNATIONAL SESSION

SPATIAL PLANNING AS POTENTIAL RISK MANAGEMENT TOOL IN HERITAGE PROTECTION*

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Abstract

The paper will provide the analysis of the Croatian spatial planning practice in respect to the built heritage protection with the presentation of its scope as a tool in risk management. Results presented will follow the examination process considering basic structure of the spatial planning documents in relation to the building heritage and their possible impact on its protection. Research presented will cover context analysis that use selection of spatial planning documents as a materialization of general attitude towards heritage. Results will present weaknesses (lack of understanding or formal approach to the protection principles) and strengths (formal guiding of the preservation process in practically sound and sustainable way) of spatial planning in relations to the heritage protection within Croatia (considering planning principles, legal and administrative framework together with operational repercussions). External trends that define possible threats (devastation or even complete destruction) and opportunities (reconstruction, revitalization and in final complete preservation) towards building heritage will be presented in this study. As a conclusion paper will suggest how they have possibility to be enabled or disabled with and within the planning procedures and documents.

Keywords: spatial planning, building heritage, preservation, risk management, legal framework, Croatia

* The complete text is available on CD-ROM / Arbutina, Alfirević Arbutina, Ževrnja

Spatial planning – the meaning, scope, participants, tools and objectives

Spatial planning as a term that emerged in recent European practice include what is today in the practices around the world known as physical or regional planning. When we discuss the planning phenomena that deals with the features presented in space, it is now much more often described as process that is included within the spatially determined features of different planning sectors. In that term, the spatial determination and regulation of different human, social functions and at the same moment protection of the original natural features still present are the main objectives of the planning process featured within this article.

Main feature in many strategic documents on international, national or even regional and local level emphasize the development as their prime objective. Development is in some cases described as a process that leads to more desirable and prolific state of economic and social state of some particular society through set of government or nongovernment policies, plans and management activities. That process inevitably alters the broad scope (if not all) of spatial features and the change is deeply embedded within its nature. In the case of development process spatial planning have to provide the spatial determination of development strategy and within that a set of incentives together with the limitation and restrictions. Spatial planning have to be one of the instruments that will provide the set of operational guidelines and some kind of instruments in dealing with the spatial features for international, national, regional or local structures of government. That instruments or guidelines have to allow providing the significant data to prevent the start of processes which could lead to the deterioration of some of the positive spatial attributes or even to block already started processes. In the scope of the heritage protection, the role of the spatial planning would be to provide the tools for preservation through economic, social, political and technical approach in particular national surrounding.
Discussing the spatial planning as a partial tool for enabling sustainable development than the term preservation or conservation will be in great antithesis to the notion that development and the change have to be priority. It can be the case if the development is based on non restricted change without taking into the perspective many of the social features that some society covered within its fundamental attributes. The position of the spatial planning will be providing the set of those limitations and restrictions considering the heritage that will not block the development but will curb it to the line that will in positive fashion involve the heritage as integral part of society foundations and will embed that heritage within the foundations that will enable the process of change and development. It will have the possibility to include within the formal structure of spatial planning documents set of operational policies, plans and management activities designed in a manner that will as a result have to decrease in deterioration of heritage in general or in the cases of documents on the local level even to prevent deterioration of one targeted sample of heritage.

Planning problems

- integration of different sector oriented plans or schemes
- integration of historical structures with development trends or growth potential
- tendencies to create the structure and not to follow detected and appreciated historical structures
- conflict between the tendencies to provide open structure that will correspond with the changes in the economy or society and tendencies to preserve detected heritage values
- definition of mono-functional zones that do not provide integration of activities within some society (where protection often becomes just the excuse for lack of decisive action in planning)
- often do not provide the notion of multidimensional effects that the plan can have on the space effected
- formal approach that tends to fulfil the legal obligations more than practical purpose of planning as coordination of activities and interests in space
- lack of heritage protection sensitiveness among those directly involved in the operational

planning process

Croatian spatial planning legislation and general practice

The structure of spatial planning in the Republic of Croatia, is a series of obligatory plans regulated at this time by one law* that deals with planning and construction. Plans that are defined by law as obligatory are made for administrative areas regulated within a special law. Spatial structures that are covered within those plans correspond to the administrative division of the national territory through countries as a regional self-government bodies and cities as well as municipalities in the local self-government level. Certain plans have their area determined without leaning on the administrative borders of regional or local governments. In those plans the boundaries are defined through reconnaissance of natural, technical, social, aesthetic or other common characteristics of a given territory and those plans could be determined on the national or regional level.

Among the planning documents, whose scope is defined by a formal administrative division the spatial plan area is emphasized by quite impressive special features, as well as urban and detailed plans. Spatial plans for special areas at the national level include the whole national park whose physical characteristics include significant portions of extremely valuable features preserved and unchanged ecosystems or parts of the cultural landscape of exceptional quality values. Their propagation and regulation may be the subject of planning at the regional level also. This is the case when there are no rigid qualities for the national degree of protection. At the local level, zoning and detailed plans include smaller spatial units that are generally found within the boundaries of cities and villages, and are minutely regulated relations within such a small geographical units.

The structure of spatial plans in Croatia:

- The Strategy and program of spatial development of the Republic of Croatian as documents that within have the covering of the entire national territory.
- Spatial plan of areas with special features that are focused mainly on the national parks and natural reserves, but could include the areas that are within the Strategy or some of the regional plans or even government decisions defined as territories with special features.
- Spatial plan of the county and the city of Zagreb that deals with the regional territorial context.
- Spatial plan of the larger city, town or municipality is document that covers the area of all local self-governing structures.
- Urban Development Plan deals with the particular and spatially restricted urban areas within the administrative borders of cities, towns and municipalities.
- Detailed plan as the most detailed spatial document that will cover the smallest portion of the territory, but with the scope that will deal with each particular building plot or any other land plot.

All those plans are governed with the two main principles that are described with terms of vertical and horizontal integration and harmonization. It means that all of the spatial attributes and phenomena within formal plans of all levels and areas must be in compliance with each other. It means in short that vertical integration and harmonization will provide that the plans with the smaller areas will obligatory include all features that are defined in the higher level plans. On the other hand, within those lover level plans there is the possibility to tackle the spatial issues with much more precision and to define the standards stricter than in the higher level plans. The second principle of horizontal integration and harmonization will have to provide the spatial continuity in present and planned infrastructural or other spatially determined features within their area scope.

* Act on Physical Planning and Construction (Official Gazette Narodne Novine 76/07, 38/09, 55/11, 90/11, 50/12)

As a special feature of the whole planning process in Croatia the participatory nature off the procedures must be emphasized. The involvement of the representatives (councilors of the different regional or local governments) is the first stage of that participation. In the final stages of the planning process the pubic presentation (as dissemination of the information about the plan) and the public debate (as a meaning of acquiring the direct citizens input to the planning issues) must be conducted as a legally obligatory element of the planning procedure. It is the case where the citizen have the possibility to participate within the planning process.

Heritage protection within Croatian Act on Physical Planning and Construction

Among the first articles of the Act on Physical Planning and Construction the issue of heritage protection is defined as a prime objective[*]. In the following articles[†] Act defined the historical and cultural areas as a places of special national interest and within that notion the legal framework in applying the particular documents to preserve them within the spatial planning process. In several other articles of the Act for the protection of the cultural heritage are defined as obligatory guidelines that have to be embedded within the scope of the planning documents[‡]. Unfortunately the scope of the particular guidelines and obligatory elements within the definition of physical planning documents is in the Act itself still left quite indecisive and while the protection of the coastal areas is defined quite elaborate the protection of the heritage is rather vague.

Spatial planning and the principles of heritage protection

Actual practice

Actual practice in the spatial planning and heritage protection is in one hand the story of complementary steering the development process through the formal instances in the government that will include offices for physical planning on the regional and local levels, Croatian Ministry of physical planning and construction and regional conservation offices of the Croatian Ministry of culture. On the other hand there is quite antagonizing attitude from civil engineers and even architects with the notion that direction is not the case but just the limitations and restrictions in the same development process. The third side is the planning practice and practitioners itself, where urban and regional planners had become in many cases almost only the administrators without the clear and vigorous attitude towards the heritage issue within the spatial planning. That situation just enables and do not solves the conflicts that occur in space between the local and external interests on one level, or between economic and preservation interests on the other level. To provide even more complication in the entangled relationships within the space and society itself one must be aware that conflict between the planning and execution will intensify all antagonisms that are possible in the relations within the limits that spatial planning will tend to tackle.

One particular problem in considering the spatial planning and heritage preservation is the antithesis

[*] Act on Physical Planning and Construction, Article 7.

[†] Act on Physical Planning and Construction, Article 48.

[‡] Today in the Act on Physical Planning and Construction there is no explicit definition of obligatory study that will define the heritage inventory and the basis for the heritage protection guidelines within the area that is in the scope of the plan. The structure of documents that have to be defined considering the planning issues and heritage conservation issues are today the scope of different Act. The Act on the Protection and Preservation of the Cultural Properties in the section 4 define the scope of the documents that have to be done during the planning procedures. The articles 55, 56, 57 and 58 define the need, scope and responsibilities within the planning process considering the cultural heritage, especial built heritage as part of the tangible heritage.

between the ideas of speed of development that embed the notion in it and that planning have to enable, and idea of conservation that will tend by its definition to restrain and slow up all processes that will occur in space. That antithesis will further aggravate the position of heritage itself in the social context as a personification of the development retardant.

Weaknesses in planning process

In the practical sense the plans that are adopted do have the conservation study as one of the foundation for the planning process itself. Within the studies that are done, the level of inventory listings are quite precise and substantial and the set of guidelines are in general precise and competent. Problem occur in the planning process when those studies become the part of the plan that is not in full embedded into the formal document structure and just acts as a complement paper that is nominally part of the plan but without practical significance. The particular guidelines are incorporated within the formal structure of the planning document but often without of the conservation study authors' direct involvement. That urban and regional planers arbitrariness in those cases often the source of possible defects in the planning guidelines and possible implicit source of heritage deterioration.
The particular problem within issue is present in the structure of the planning documents where the special national interest is in legal form defined for the heritage assembles (especially urban or rural historic settlements with great heritage values), but it is not executed in a way that will provide efficient protection and further more rehabilitation or restoration. The plans that are defined for those complex structures are often done in the very same fashion and by the same not so in heritage conservation competent structure of participants as this was the case of green field investments. It also means that the major coordination in the cases of valuable heritage assembles is left to the local governments that do have the direct relation to the space and the life within it, but often define economic development as priority above all else. That fact disrupts the possibility to achieve the needed level of coherent heritage protection within the plan that will supposedly have to enable it.

Positive achievements

Among the positive effects of current planning practice on the heritage protection is the fact that it provides the fundamental spatial inventory of heritage that had been registered or recognized by the experts as valuable. With the overlapping with the other features of the planning documents (for instance as zoning, infrastructure or natural resources in its present or planned form) it provides the first instance in protection by recognizing its presence and defining it as part of routing tool in the process of development. Within the set of rules and guidelines that will enable certain building design and construction minimal limitations considering heritage are embedded as obligatory.

General guidelines for the heritage protection within the spatial planning

As a simplification of rather complex theme the set of rules that could apply to the heritage conservation processes in large scale (that will deal with heritage on some of the larger areas included in the scope of spatial planning documents) will obligatory include the following postulates:

- In the certain area inventory of all heritage must be done
- Inventory must be provided with the minimal set of information that will include the physical character of the heritage (considering nature and the formal status of the each particular example of heritage)
- When the inventory list of the heritage will be prepared the first task is to provide adequate documentation (that will include detail architectural and other kind of surveys, photographic material, historic data and as much separate specialist studies as possible such as structural, material and other)
- Using inventory of heritage and documentation about it, set of guidelines for preservation and conservation must be devised. That set of rules must provide the direction of the development

process that will include the heritage without the possibility to endanger it. It must not be just the set of restraints and limitations (but some will have to be included and those must be defined on the level that will prove to be sheer necessity).

- Protection of the particular heritage must not be restricted only to the location of that particular example, but have to be in some degree extended to the surroundings of the heritage concerned

Conclusion

Potential of spatial planning in heritage protection

Heritage protection depends on the acquiring information that will provide accurate identification of particular heritage and areas with the heritage values. That identification can be done and it is done by numerous researchers in the field of archaeology, art history and architecture. The problem with such heterogeneous body of researchers is that the information that they will prepare has to be processed and spatially determined in the uniform fashion. With the spatial planning process that unification of the information about the heritage and most of all its spatial determination and overlapping it in correlation with the other spatial features and future spatial developments provide the basic tool in predicting and repositioning of possible threats. Future practice must be able to respond to that issue in positive fashion. Furthermore the planning practice must be legally defined in a way that heritage protection will be incorporated within the legal act that deals with the physical planning directly (what is not the case at the moment).

Special feature of the future considerations about the heritage protection within the spatial planning process must be definition of the particular spatial planning documents that will deal with the valuable heritage assembles (urban and rural) in the manner that will have the conservation component of the plan as basic and leading element in practice. That means that in the structure of the documents that are defined within the legal framework must be explicitly defined the structure of the plans that have to be done for such valuable heritage areas. Those plans must not be the plans of general nature that are done in the fashion and with the tools that are sufficient for all other spatial situations. Their features and their tools must be heritage oriented and participants highly sensitive and motivated to ensure that heritage preservation will be the prime rule in the plan inception.

And as a final conclusion the planning process in the case of heritage must provide few general items of great importance:

- The first objective is to provide the tool for identification of heritage areas and particular elements.
- The second objective will be to develop the guidelines for safeguarding of preserved heritage, restoration of heritage in danger or deteriorated heritage and the possibilities of development of the adjacent areas without the impairing the heritage itself.

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MODERN MATERIALS IN THE PROTECTION OF BUILDING HERITAGE*

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Abstract

Paper will discuss the conservation principles that are foundation for preservation of built heritage in correlation to the modern construction practice and within the usage of modern materials in the preservation techniques. The paper will provide the inside in the development of the theoretical approach to the building heritage conservation and preservation with the main focus on the introduction of the repercussions that each of the theoretical principles will feature in entangled living practice of construction and heritage preservation. Special consideration within the paper will be done to define the crucial problems in the legal framework within the modern building practice (as highly regulated activity) considering materials that had to be used within the process (describing the paradigm of modern or traditional materials in the conservation theory). Materials and their qualities or limitations will be analyzed within terms that define modernity or tradition in their preparation or usage and in that respect the attitude towards them from the heritage protection specialists or officials. The results will provide the basic theoretical framework in respect to the possible way of using modern materials within the modern conservation practice considering obligatory technical regulations and standards as part of the regulatory status of the complete construction profession.

Keywords: modern materials, conservation theory, building heritage, preservation, legal framework

1. Theoretical principles of heritage conservation

Within the heritage protection few issues dominate the field of theory and therefore practice. Those are the question of authenticity, heritage values (Feilden, 1982-2003, p.6) and accordingly ways how to approach preservation of heritage through conservation of its main attributes. Those issues were determined as basic fundaments for conservation activities and are based on the multitude of particular theoretical models. All those heritage conservation theoretical models had been devised through the last little more than 150 years as personal contribution of few important theorists and practitioners in the field of heritage conservation.

* The complete text is available on CD-ROM / Arbutina, Dunović, Alfirević Arbutina

1.1. History of Heritage conservation - defining the theoretical model of heritage conservation

Heritage conservation as a scientific and practical discipline is present only from mid of the 19th century. Although present in one or the other form through the history only in little more than 150 years heritage conservation came into the focus of legislators and general public. Within that period of time, theories had been working around the basic ideas that developed notion of the heritage importance and need for its preservation.
Through the history of heritage conservation ideas had been changed quite a bit. It is from notion that all things must "die", as Ruskin said in the 19th century, that idea of heritage that will inevitably perish eventually is derived. It is concluded with the Ruskin motto that all we can do is to keep the heritage in a way that certain death will come with some degree of dignity and nothing more. But in the same period of time heritage and the quest for its protection was defined in a way that will have to enable preservation and heritage duration in time as long as it is possible. That idea drives the activities even today and it is the basis of all actions that are done through the history till present day.

The idea was in the start defined from the notion that heritage can and must be completed and even rebuilt if we know the right set of information from the historical or even practical point of interest. Such way of thinking in terms of heritage conservation was at first preached and practiced by Prosper Mérimée and Eugène Emmanuel Viollet-le-Duc (Jokilehto, 1986, p.277-284). One was as intellectual involved in heritage administration and other as practitioner was involved in great medieval heritage conservation and even reconstruction projects. Their conservation principles are in the best way materialized in the examples of Carcassonne and Abbey of la Madaleine in Vézelay. In terms of materials those restoration are kept in compliance with the historic techniques that are identified on the particular locations, but the way how to use them is left to the discretion of an architect in charge of the restoration. It was such approach that enabled much of the designer imagination within the process and less compliance with the objective historical information. Restoration of the period was idealistic in a way that provided the possibility to complete the unfinished or to restore deteriorated without much of the questions about the authenticity were raised. On the other hand, principles for maintaining the heritage was by those two pioneers defined in a way that anticipated much of the modern heritage conservation theory principles and even modern principles of construction management and fire safety or even safety at work (Špikić, 2006, p.103-136).

During the years the theory of heritage conservation was complemented by the work of Italian Camillo Boito that perpetuated development of principles (Špikić, 2010, p.63-72) that had been the basis for much of the modern conservation theories. Those principles rather simplified among other defined actions that are proper for the heritage conservation (Arbutina, 2010) considering particular materials and techniques. Principles that are devised under the leadership of Boito demanded clear conciseness about the authenticity of the physical structure within the particular heritage building. Principles that are defined include for the first time clear notion about original structure and additions or alterations: one of the principles defined the need of clearly distinguishing genuine and reconstructed parts of the building; other stated that difference between authentic and reconstructed parts in the project of reconstruction must be clearly reported with the use of different materials.

Gustavo Giovannoni was another Italian (after Boito) that was instrumental in defining the theoretical principles of conservation (Jokilehto, 1986, p.351-356). Within his work new Italian charter was prepared in year 1932nd (Jokilehto, 1986, p.465-466) that dealt with much more elaboration with the particular conservation issues. Among the principle within the charter we must emphasize following: primary interventions on the heritage buildings are consolidation and maintenance (they define prevention as prime action); recovery of the original shape (called repristination) is admissible if it is based on accurate data, and if the original elements are prevalent; new additions (if they are necessary due to consolidation or practical use of the monument ...) must be kept to a minimum and executed without decoration; the restoration of historic buildings should be such that modern technical achievements can apply; all work on the architectural heritage must be accompanied by detailed scientific and technical documentation.

Before the Italian charter of 1932nd Max Dvorak defined the set of rules that specified commencement of the work on conservation before the extent of the devastation became large (what defines the presumption of maintenance as in Italian charter of 1932.); but contrary to the Italian charter defines obligatory use of the old and original materials and rejects the use of cheap substitutes (what on the other hand almost rejects modern materials as readily available and therefore cheaper than original ones); but defines the interventions that deal with the monument substance as compulsory cases for essential professional help.

After the World War II Venice charter of 1964 defined the theoretical model that is basis for much of the recent intervention on the built heritage. The main principle that deals with construction works as the technical basis for the preservation and conservation emphasize the need of using traditional materials and building techniques. The use of the modern technology and materials is restricted to the cases here where traditional techniques prove inadequate. In such cases consolidation of the monuments can be made by using modern techniques of conservation and therefore construction and in doing so all those modern techniques and materials must have effectiveness proven through scientific data and confirmed by experience.

After the Venice charter much of the ICOMOS documents, declarations and charters deals with the particular aspects of conservation theory and some of them provide certain theoretical principles considering modern materials and techniques but with much constraints and reserves. Among those are Principles for the Preservation of Historic Timber Structures, Charter on the Built Vernacular Heritage both from year 1999 and especially ICOMOS Charter - Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage from year 2003.

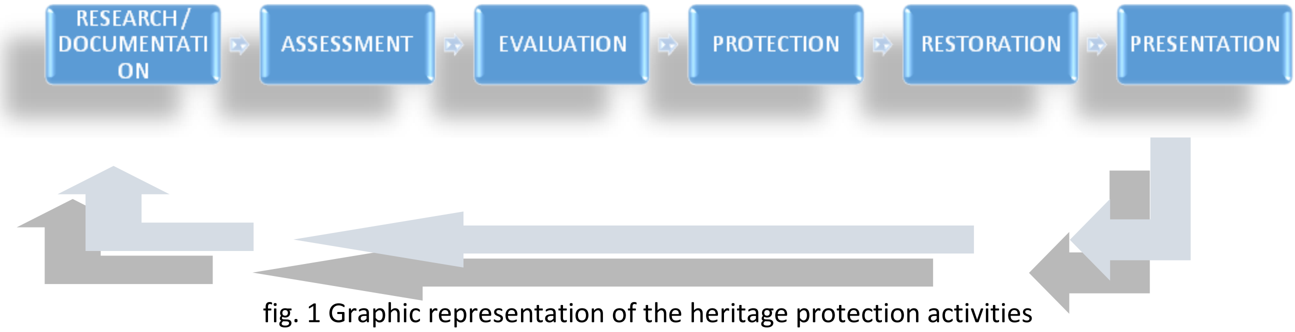

fig. 1 Graphic representation of the heritage protection activities

1.2. Authenticity

Main issue in the heritage preservation and conservation is question of authenticity. Within that topic are considered two main attributes that define most of the heritage and with it also the models and methods within their preservation. The first that have to be dealt with is the form of the built heritage and the second is the substance of whom it is made or it authentic physical structure.

To the general public visual appearance will be equated with the form of the heritage. That visual appearance will be then identified with the heritage and will provide basis for most if not all of the authentic attributes apprehensible to the general public. As a visual sensation it is quite acceptable to the process of simplification that is often manifested within the general public in the form of a symbol embedded in the most recent socially accepted conventions. Since that symbol was simplified than the meaning of a symbol, what heritage became is also simple to maintain. Therefore actions that will have to be undertaken to provide protection and conservation will be kept to the extent that will have the interest just in keeping the physical appearance and the rest of the heritage attributes could be easily neglected. In that case the question of material, techniques or technologies is out of scope from any little more profound heritage rethinking.

Contrary to the general public opinion, form of the building heritage is in reality quite a complex theme. Complexity of the building heritage is on the theoretical basis dealt mostly by the art and architectural historians. Their analyses tackle the values of particular building heritage through its visual and stylistically oriented definition. They often provide the theoretical model for possible intervention. Particular (and therefore rather variable) model that is devised especially for the particular building heritage is formed upon all theoretical models that are presented by the important expert individuals (as such mentioned before) or the expert organizations (as ICOMOS). That model considers the form as an authentic constant that can't and must not be deteriorated in any way. Considering that principle all the interventions on heritage will have to have the preservation of the form authenticity as their primary law of conduct.

fig. 2 Structure of heritage conservation activities

On the other hand, the question how to maintain the authenticity of the physical structure makes quite a problem to the experts that are dealing with the practical aspects of building heritage conservation. That problem of preserving the authentic physical structure within certain part of the world is present more than in the other. In the western world authenticity is derived from the emphasis on the original material that was touched not just by the greater idea that provided the conceptual basis for heritage creation, but by the physical involvement of the builder or artist, or the physical person as creator. Personal involvement of the human within the process of heritage forming through the physical contact with the material involved in the heritage creation makes huge portion of the western perception of the heritage value. That personalized approach derived theories that emphasize the authenticity that is downgraded each time somebody else than its original creator tend to entangle in heritage physical structure.

On the contrary, in the many eastern civilizations and cultures the authenticity is derived from the greater idea itself and is embedded completely within that idea, so if any interference in changing the material due to its natural decay occurred it will not affect authenticity as long the basic idea is maintained. Within that primary idea for creation one can find embedded technique and technology together with the particular materials that represent integral and almost crucial aspect of heritage value. All that depersonalized approach to the heritage creation play significant part in defining the possible conservation activities. Such eastern philosophical approach to the question of authenticity makes possible to even completely rebuild some of the examples of the building heritage with no negative connotation on their perception considering authenticity as long materials and techniques that had been originally designed are thoroughly applied.

If we have the form of the building heritage as an unalterable attribute than its substance will have to adapt to all interventions that could be done upon it to enable its subsistence. After defining the model of conservation, particular method of interventions should be devised upon this model. With each intervention the physical structure of the heritage will be altered more or less. Alteration of the physical structure therefore ultimately leads to the loss of earlier defined heritage values, especially those considering the authenticity of material used for the original construction.

Within the substance that makes the physical part of the heritage one can find problems with dealing with the material itself, together with the technology that will incorporate such material in the building heritage. In contemporary heritage conservation that issue of material and ways how to use it make the significant part of the heritage perception and according to the most of the theorists huge part of the heritage values in case of each particular example.

The question of the authenticity is moreover enhanced with the notion that each and any kind of contemporary intervention within or upon the heritage will ultimately change part of its authentic physical substance and therefore decrease authenticity. In that respect most of the preservation and conservation theories deal with the rules of minimizing the impact of recent activities on the heritage.

With the activities that will provide the technical basis for the heritage preservation the question of authenticity comes to the light as quite important part of defining the heritage conservation theories.

2. Legal framework of modern construction practice

Today all actions on built heritage have the new imperative that makes the task of sustainable preservation and conservation even more difficult. The legal frame within all construction activities must be compliant with the principles that define the functional and structural (mainly physical) restraints to the applying of original material and original construction techniques on the building heritage but do provide quality assurance safe and secure using of the buildings or their particular parts.

Modern building regulation within EU, and within the most of the world, provides the formalized set of rules, regulations and standards that must be applied. In the EU it is imperative that with the design, construction and in the final stage using of the buildings all aspects of the basic requirements for the buildings are maintained. Even procedures for determining the compliance with those basic requirements for the buildings are standardized.

Considering the level of those standards that are today defined as obligatory, historic buildings will be in quite difficult position to be compliant even with their minimal features. Standards that are today defined as minimal for the built heritage will pose great deal of problems to comply within their original set of spatial, functional and constructional features. Those basic requirements defined in the EU regulations as mechanical resistance and stability; safety in case of fire; hygiene, health and the environment; safety and accessibility in use; protection against noise; energy economy and heat retention as well as sustainable use of natural resources within the historic buildings is difficult to achieve without great deal of technical and financial input. In many cases even pursuit for the achievement of those standards will be difficult without deteriorating the authenticity of the heritage. There in jeopardy will be even the form of the heritage and not just the particular material or part of its physical structure.

The position of using modern materials and modern techniques and technologies will be and must be in enabling compliance with those basic requirements in the fashion that will not jeopardize the authenticity of the heritage in any aspect or any of its attributes and values.

3. Materials, techniques and technology in heritage conservation

When we discuss actions of heritage conservation on physical structure of the building heritage than application or implantation of certain materials is almost always the issue (except when there is the case of removing some of the alterations throughout the time of the heritage existence). In the theoretical models that are supposed to provide the basis for any kind of interventions and also the necessary priority in doing so, original material and original building techniques are the imperative. That imperative was defined through the historical development of the heritage conservation theory and is accepted in most modern conservation charters that provide the theoretical basis for recent conservation activities

It is important to note that terms techniques and technologies within this paper will differ substantially. Their meaning will be defined in consideration to the way how certain material is applied during the construction process. To apply the traditional material within modern technology is possible in the same way similar to that of the traditional one. On the other hand historic materials could be applied using modern techniques and within modern technological systems.

Even the terms modern or traditional material, technique or technology must be carefully used because clay brick definitely had many thousand years long history of using within the construction throughout the world, but modern brick blocks and even modern brick dimensions will not correspond to the traditional way of making them and definitely using them and the same is with the masonry as construction technique.

When we describe the usage of materials, techniques and technologies than must be the question of authenticity put to the test and with the answer to that question all further actions will comply.

It is possible to use modern techniques of construction with the traditional and even authentic material, or to use modern technologies with traditional materials as well (where one example is the case of consolidation of the particular building structure using the lime mixtures by injecting those to the bearing walls or other parts of the structure with the use of pressure tools and other sophisticated apparatus without jeopardizing the authenticity of the whole building in doing so). The prime postulate is to use original or traditional and authentic material and original or traditional and authentic technique or technology through the process of conservation and preservation as much as possible.

1.3. Modern materials

The question of acceptance of modern materials in the conservation of the built heritage is for the construction practitioners more than just the theoretical issue. It is the question not just of modern materials as genuine novelties in the field of construction (as using the epoxy resins or other polymeric compounds), but also the using of traditional materials produced and certified in the fashion that include their contemporary industrial manufacture. That is the question of using prepared materials in a way that will exclude traditional ways of producing them and will be compliant with the requested standards of certification according to the rules and regulations that in full determine acceptance not just the materials, but the actions of acquiring them and using or applying them on the construction site.

Acceptance of the modern materials in the heritage conservation theory is of great importance in recent years when the possibilities of new materials and technologies and their application in the heritage conservation is more increasing. In using the modern materials some of the issues stand out in the overall picture. It is their economical attributes that will make them cheaper and readily available. The second issue is way in whom they will be applied in the construction process, because today workmanship is provided with training and is accustomed in using modern materials (to the contrary their preparedness for using and adequately applying traditional materials is quite unsubstantial and that today becomes question of great importance in the heritage protection even through the need to protect from oblivion traditional techniques and not just the result of their efforts).

More recent theories on building heritage, as much as those that are now more than hundred years old, are often reluctant in accepting the modern materials as suitable for in heritage conservation. At first such approach seems as quite anachronistic and do not perceive any possibility for progress. It would be so if one will forget that conservation is by the definition there to conserve the past and present that will become the past and not to enable novelties of any kind. In respect of primary goals of heritage conservation, what is to preserve and conserve the heritage that we already have, all further actions must be undertaken. It is of the most importance even when from the past is known that application of the novelty materials and technologies without much of the experience can produce quite harm to the heritage and cause great deal of material and financial costs to maintain such heritage in future as it was with the 1930-ies restoration work on the Acropolis in Athens.

Using of the modern materials in the heritage conservation on the other hand is not strictly forbidden, on the contrary, in some cases it is today even encouraged (as it is the case in the detachable carbon reinforcements used for the structural consolidation of the built heritage). In heritage conservation using of those modern materials is the question of their endurance during time at use and the question what kind of consequences on the original heritage structure after some period of time. The novelty in construction, especially novelty construction materials often do not have the benefit of experience and using them must be thoroughly considered because the consequences after some time for the heritage could be severe.

To define the basic requests for the modern materials that will enable them to be used in the contemporary heritage conservation activities one has to have in mind following:

- Constancy and stability of the modern materials must be tested and confirmed if they tend to be used in heritage conservation.
- Application of the modern material must be such that removal must be kept as a possibility that will not produce consequences on the original physical structure of the heritage

1.4. Modern techniques and technologies

In definition of modern technologies one can note that two separate elements are embedded within their definition. First part of those technologies is modern material itself, where even application of modern material within traditional technique and technology (for instance application of glass bricks in masonry) will define some aspects of the modern construction techniques and technologies. The second element in defining modernity within techniques and technologies is the procedure itself. Those procedures are often characterized by the using the sophisticated apparatus (sometimes just in the case when that will enable masonry work to be executed in perfect lines and sometimes in application of injection compounds during the structural consolidation) or just the tools that are perfected using the contemporary technological solutions (that provide the perfection in visual and other perfection of the executed construction).

Using the traditional materials within modern technological principles is one approach that will be perceived as possibility in heritage conservation. It is much more so if there is possibility that such approach will comply with the theorists' principles.

fig. 3 Graphic interpretation of the theoretical structure in the heritage conservation

Principles of heritage conservation will have to be compliant with the certain theoretical model that is usually complex, tends to be comprehensive and systematic, with the scope that had to be treated as universal. Within any of the theoretical models one can find much more than one method with whom the conservation would be attained. Those methods are partial and localized on certain problems or certain elements of the heritage and are much closer to the practical application. Within each of the methods certain highly localized actions are embedded and those within have the planning, design and execution processes and at the end the results.

Traditional materials and their use within the modern technological principles is possibly in the way that it will be possible to reconcile the need to preserve authenticity in using the traditional materials (with whom comes the structure, texture, color and even some of the nonphysical sensations that will define the human perception of the built heritage) with the principles of monitoring and certifying quality and performance (Teutonico, 1988) with compliance with the contemporary rules regulations and standards (Alcantara, 2002). It is the way to secure attaining quality of particular part of the structure as much as to assure the quality of the building as a system. It is important that this will provide the basis for the certifying the conformity with the basic requirements for the buildings that are imperative in today construction practice.

The principles that govern today construction practice have as imperative strict control in every aspect of producing or using construction material. In that respect the manufacture could be perceived as a sort of modern technology itself. Today those standards of manufacture are often such that the average product is prepared in way that can even be defined as to perfect in a term of color, shape and texture. Such products will than after construction will be in sharp contrast with the most of the historic materials that constitute the built heritage. It is often problem when the products are done in such way that they have to emulate the authentic building material used on some of the particular historic building. Than implementing the material that has the basic elements molded according to the traditional principles will note have the effect off the original material in many of its attributes. In that case principles of authenticity will prove to be main obstruction in using the modern materials and modern technologies during the conservation activities. Those obstacles can be overcome if the use of the materials and technology is done in a way that will comply with the prime rule of authenticity preserving.

fig. 4 Amphitheatre of Pula, Croatia. Within the building concrete with Portland cement was used for the reinforcements with the consequences that include large amount of damage caused by the salts resulted from the chemical reaction within the structure of the cement and original stone fabric.

4. Conclusion

Using the new and modern materials within modern technologies is in the recent heritage conservation often a need when the rules and regulations demand certain extent of conformity with their demands. In that respect using of modern materials and modern technologies in today conservation practice is not as restricted as one can imagine. Modern materials and technologies that are today readily available provide the plenty excellent ways of solving quite difficult tasks in the field of built heritage conservation. Those technologies are often the most common in the field of moisture protection, structural consolidation or providing the needed fire safety.

The use of such materials and technologies must be compliant with few basic rules that will provide necessary expert backing in their application:

- Interventions must be kept to a minimum and newly applied materials shall be in minimal quantity and form needed
    - What it means is that even when the more substantial actions will provide even more effect considering safety or any other aspect of basic requirements for the buildings, the action must be such that the minimal impact on the authentic physical structure and visual attributes will occur. It is question of maintaining the level of authenticity as much as possible for as much as possible.
- During the conservation activities there have to be a possibility that intervention and the application of new material could be reversible
    - Principle that will govern the reversibility of the actions must be tackled not just with the usage of materials, but with the selection of the technology that will provide the basis that materials used could be dismantled form the heritage in question without the grieve consequences. Such interventions could provide the basis for the structural repair and consolidation or functional enabling of certain new (or even old function within the new and modern circumstances) usage for the heritage.
- During the conservation activities on the heritage must be achieved that if the interventions are not reversible they must be at least repeatable
    - The setting for repeatability of certain intervention will be in the case of construction the question of martial used for the task. Durability and mainly the strength of the material used and applied must be such that in the case of damage or deterioration of certain reasonable scale that new intervention (and with it the material) will deform and deteriorate first, so that the original and authentic physical structure could be saved during repeated repair of damaged new layer of material. In the case that the new material is stronger than the original the deterioration and destruction will first emerge on the authentic structural layer of the built heritage. Repair of that authentic layer will diminish its authenticity and with application of more modern and stronger material in the future all damage will increasingly appear in the authentic physical structure. With the increase in percentage of new materials within the heritage structure the degradation of the authenticity as a complex concept will be rapid.
- Interventions and application of the new materials should be such that they will not impair the aesthetic or any visual attribute of the heritage in question
    - Visual or aesthetic qualities of the material used in the conservation intervention must be such that it does not provide complementary visual or tactile sensation that will be able to alter the perception of the authentic heritage structure.

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TRANSPORT MANAGEMENT SYSTEM AS RISK MANAGEMENT CONTROL LEVER IN CONSTRUCTION PROJECTS*

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Abstract

Large infrastructure construction projects suffer from schedule delays in 84% of cases, resulting in 28% of cost overruns. Similar situation is found in all projects. Common progress monitoring using budgeting and percentage of completion failed to reduce the risk of delays and cost overruns. It became evident that no single project may be tracked solely by budget, as numerous risk sources reside in other departments of the contractor and outside factors. This resulted in an eruption of Risk Management research efforts, which imposes new requirements in field data gathering to enable measurable performance monitoring. Traditionally, data is gathered by single or few field supervisors or project manager, who input the quantities or percentages into one of standard software packages for project control. This situation mandates data verification through other departments whose software packages are in no correlation with the project control software. A study conducted by NIST showed that this lack of interoperability of software packages increases total project costs by 3.7%. As BRE report 2003 shows, transport accounts for 10%-20% of total construction costs which makes auditing transport data mandatory. This paper describes a Transport Management System which enables such audit and provides a lever of accountable control against construction site data, mitigating risk of delays and cost overruns proportional to the transport costs. Common areas in both systems are discussed, as well as their interaction.

Keywords: project management, cost control, enterprise coordination, multi project management, interdepartmental integration

* The complete text is available on CD-ROM / Bačun

Introduction

According to a recent survey of 290 companies (Aberdeen Group, March 2012) in attempt to evaluate and compare the challenges of project-based firms in a two year time span, it was found that among five business drivers, only one registered increase, namely, “Increased competition forced us to lower or freeze prices” from 27% to 33%, coming second as Top Business Drivers. “Lack of available skilled resources needed for projects” at 36% was still first although decreasing by 1% from two years before.

In identifying top project pressures, “Need to use project resources more effectively” was first at 34%, but close third was “Too many late projects” at 31%. Best-in-Class registered on average 3.5 weeks of schedule overrun, while the bottom 30% in the class 4.5 month of average schedule overrun.

In another analyst insight, researching Operational Risk Management (Aberdeen group, March 2013) as the top pressure driving executives to focus on risk, almost half the participants (49%) selected “Need to reduce impact of operational risks on financial goals”.

It is evident that avoiding cost overruns is the top priority of project oriented firms management.

How do cost and schedule overruns ocurr?

In a research led in 2002 (Flyvbjerg, 2003) on 258 large infrastructure projects in 20 countries worth US$ 90 billion, it was found that nine out of 10 transport infrastructure projects fall victim to cost escalation (84%), average cost escalation is 28% in USA and Europe and 64% in developing countries.

On a further analysis (Flyvbjerg, 2004) it was found that cost escalation is highly dependent on the length of the project-implementation phase and at a very high level of statistical significance, which means that schedule overruns result in cost overruns.

In an empirical study of constructions delays in Florida (Ahmed & all, 2003) the most significant construction related delays were found to be: Inspections, Material/Fabrication Delays, Material Procurement, Lack of Qualified Craftsmen, Poor Subcontractor Performance and Construction Mistakes. Contractor was identified as most responsible for delays (44%) out of which about half (48%) were Excusable Compensable, while a little less (44%) were declared Non-Excusable and therefore Non-Compensable.

Cost increase is not only due to visible schedule overruns. Projects that seem to be finished on time, upon analysis may show unwarranted cost overruns.

A Stanford University Workshop (O’Brien, 1999) there was mention of two instances where resource availability (capacity constraints) and poor site conditions incurred real costs and limits on subcontractors and suppliers, bringing the Supply Chain Management as a significant factor of project cost overrun.

The example of Durand Centre, a US$150 million shopping mall project built in London was completed on time and placed second in a national project manager competition. But, there was a delay to steel fabrication that resulted in a six-week delay to steel erection on-site. The delay was not anticipated and did not become apparent until it occurred on-site. The contractor ordered acceleration of work at the cost of £231 thousand. Although on time, the project has shown cost overrun due to disruption of supply chain.

The other example is the Buchhaugen project which utilized a Just-In-Time style delivery system, a rolling three-week unit reorder, with 3 week lead time for the supplier to prepare the lot for delivery. In practice, the project management had great difficulty to predict the demand, resulting in more than half units deviations from the planned three week order period. Those disruptions resulted in difficult quantifying saving in production lines, and a cost increase in at least one subcontractor.

O’Brien suggests improved coordination, costing, and control offered by construction supply-chain management as means to cost control.

Operational disruptions and delays are not the only factor of avoidable cost increase in construction project. A cost analysis about inadequate interoperability in capital facilities industry (Gallaher, 2004) showed that the total costs for insufficient connectivity of programme support is 1,11% for designers, 0,86% for Contractors, 1,24% for suppliers of special products and 2,84% for Investors and managing companies.

In the study, only verifiable and quantifiable costs were considered. Those costs were the costs for supply, maintenance and training for redundant CAD/CAE systems, costs for manipulation of maintenance for a redundant paper system, costs for employing third companies, investing in establishing internal programme sections in order to solve the non-connectivity and costs for participating in forums dealing with non-connected programme solutions. The delay costs considered were the costs for non-productive work/waiting time on site due to delay of activities, lost profit due to delayed payments (discounted income) lost profit for the Client due to delay of the availability of services /products and non-productive time, because the object is not in normal functionality.

In a construction site operation, the supply chain disruptions can cause costly delays (O'Brien, 1999). In a Sector Insight research about Chief Supply Chain Officer's pressures for supply chain cost (Heaney, 2012), the two main pressures highlighted were "Growing complexity of global operations" and "Rising supply chain management costs". In order to confront those pressures, the focus CSCO has shifted towards internal / external collaboration, and they highlighted two courses of action: "Improve internal cross-departmental systems and process collaboration and integration" and "1.15 times as likely to increase B2B collaboration / visibility into supplier-side processes with suppliers, trading partners".

It is evident that cost overruns in construction projects, which are quite frequent and global (Flyvbjerg, 2004), are not a product of a single or a few catastrophic events, but a result of numerous small disruptions and delays across all the departments of the enterprise. That is why project management of isolated construction projects give such disappointing results. Standard tools of project management of a single project, fail short as the best approach to control construction costs. A new approach of integrated multi-project interdisciplinary interdepartmental effort should be the path to control and manage project cost and resources.

Whenever there is an interdepartmental or multi-project situation to manage, the problem of information visibility and coordination arises.

In an analyst insight research (Permenter, 2013), the top two business pressures for mid-size companies (i.e. companies with revenues between US$ 50 million and US$ 1 billion) were "Lack of business integration leading to poor communications" and "Rising business complexity". The research states that poor communication between partners can lengthen the time it takes to get the right information to key decision makers in the supply chain, which increases the number of delays and buffer time and decreases the overall supply chain agility.

Traditional collaboration tools, like email, meetings, online conferencing, autocratic top down directive enforcement are not effective in new business circumstances. A new approach, one of business or project "social networking" should be adopted. The proposed model of internal Multidimensional Preemptive Coordination (Bacun, 2013) should be extended to allow participation of external selected subcontractors and suppliers, so that the effort to meet the project goals can be achieved with success.

Although the transport accounts for significant 10%-20% of total construction costs (BRE, 2003) it would seem that the role of transport is much more significant. Transport is in the midst of numerous business processes which places it in a unique position to act as a control lever for different segments of construction management. It is the nerve system of construction site supply chain, so its timely functioning is of paramount importance to successful project completion. Among top risks that have biggest impact on business, the executives stated "Failure of Critical Assets" as being the most important (Paquin, 2013). Careful management of Vehicle Reservation Subsystem introduces a control lever in multi project situations. The transport logs data has consistence and auditable authenticity as quantities transported can easily be verified in both Inventory Management and Site Daily Log, as well as external supplier's delivery documentation.

2. The tranport fleet problem in a construction company

The vehicle fleet in a construction company has to fulfil numerous business needs. It has to provide the transport infrastructure for internal supply chain management for company's projects. It provides profit to the company by means of transport services for external customers. It is a valuable company asset whose utilization has to be carefully optimised. In a recent survey about improving operational performance, it was found that the best in class companies are performing at 18% higher Overall Equipment Effectiveness (OEE) than the bottom 30% of performers (Aberdeen Group, September 2012).
But, in a multi project situation, the company never has enough resources and exactly the right ones, so the company's fleet has to be complemented with subcontractors. As subcontractor engagement is in scope of work of Procurement, it is evident that the vehicle reservations and scheduling is closely embedded into supply chain management. More to the point, the supply chain needs to coordinate suppliers' delivery capacity with the each project schedule so that delays and disruptions can be avoided.

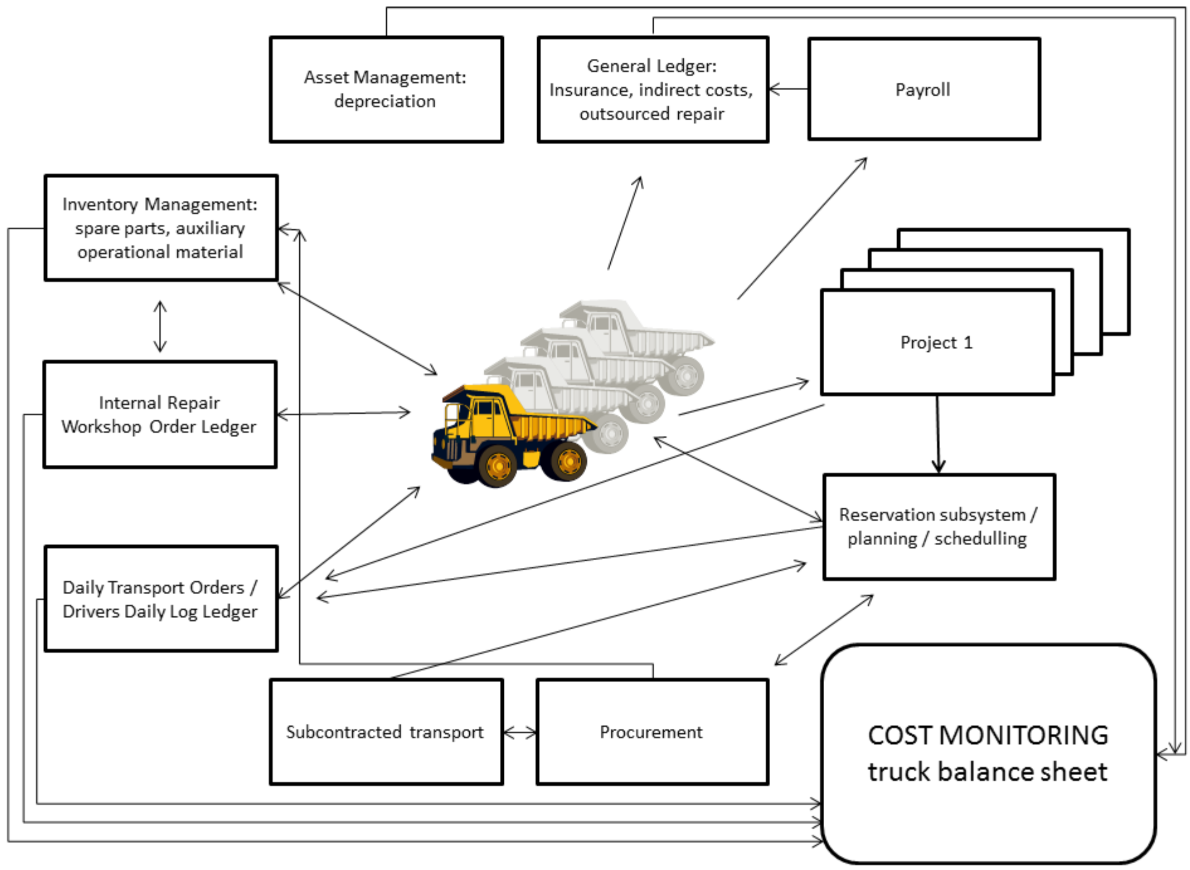

Figure 1 Transport cost problem monitoring

The vehicle scheduling further has to be coordinated with regular and preventive maintenance, which is done either in the Internal Repair Workshop or outsourced externally, for specialized work.
The vehicle fleet represents quite a substantial value for the company, and as such, close cost monitoring is mandatory. The operational costs, fuel consumption, miles travelled, drivers hours, load and unload time is gathered from the Vehicle Daily Transport Order/Drivers Daily Log data. Repairs costs, hours and spare parts are taken from Internal Repair Workshop Order Ledger. Depreciation for each vehicle is gathered from Asset Management in Accounting. Outsourced services, special repair work, insurance, indirect costs and such, are gathered from the company's General Ledger data. The value of inventory items issued as operational costs for each vehicle is gathered from the Inventory Management System. The hours logged in the Drivers Daily Log are used as time sheet data for Payroll.

Any disruption in the described relations will result in disruption and delays of the scheduled activities at the construction site, so special consideration should be dedicated to coordinating different participants from different departments. Traditional coordination practices via meetings, telephone calls, faxes or online conferencing fail short of providing stable uninterrupted flow of activities necessary for delivering projects on time.
It is evident that the vehicle fleet performance is in the middle of a complex interdisciplinary business problem, whose intelligent planning and adherence to plans will have great influence in operational risk mitigation.
The Transport Management System (TMS) consists of several modules whose purpose is to provide a closed loop of cost control and performance monitoring data and total cost of ownership insight in real time. It consists of Vehicle Reservation and Scheduling, Vehicle Transport Order Ledger, Bill of Landing Ledger and Internal Repair Workshop Order Ledger.

2.1. The Vehicle Reservation Subsystem

The Requests for Transport are posted into the Vehicle Reservation System. The project managers, construction site supervisors or other authorized personnel should use the Project Schedule to generate the Request so that the system links the Request details to the scheduled activities. The Request can further be supplemented with additional vehicles manually, but those will not have an activity link, so they will be logged as not scheduled. The Request should have a header (date and time frame needed, destination, partner ID, project ID, a note) and variable number of items identifying the type and quantity of vehicles needed and eventual preference. The requestor doesn’t know which actual truck will be available, will the truck be from company’s internal fleet, or subcontractor asset, so there is enterprise wide vehicle group or type classification which enables consistent data manipulation across tender bidding, project scheduling, Vehicle Reservations Subsystem and construction site resource utilization reporting.
Each requestor is presented with Request he/she made and will monitor the status of the Request which is set by transport planning personnel, but isn’t aware of other participants requests.
The vehicle scheduling staff works with Requests for Transport by type. They select the period and vehicle type. The system displays all the requests for the selected type and the available vehicles. The system will suggest the closest match. The operator will either confirm or manually approve or deselect the reservation. If there is shortage of company’s resources, a Request for Action will be issued to Procurement, so that proper subcontractor can be engaged. If there are subcontractors with approved yearly contracts, the operator might have permission to issue a Transport Order to the subcontractor directly.

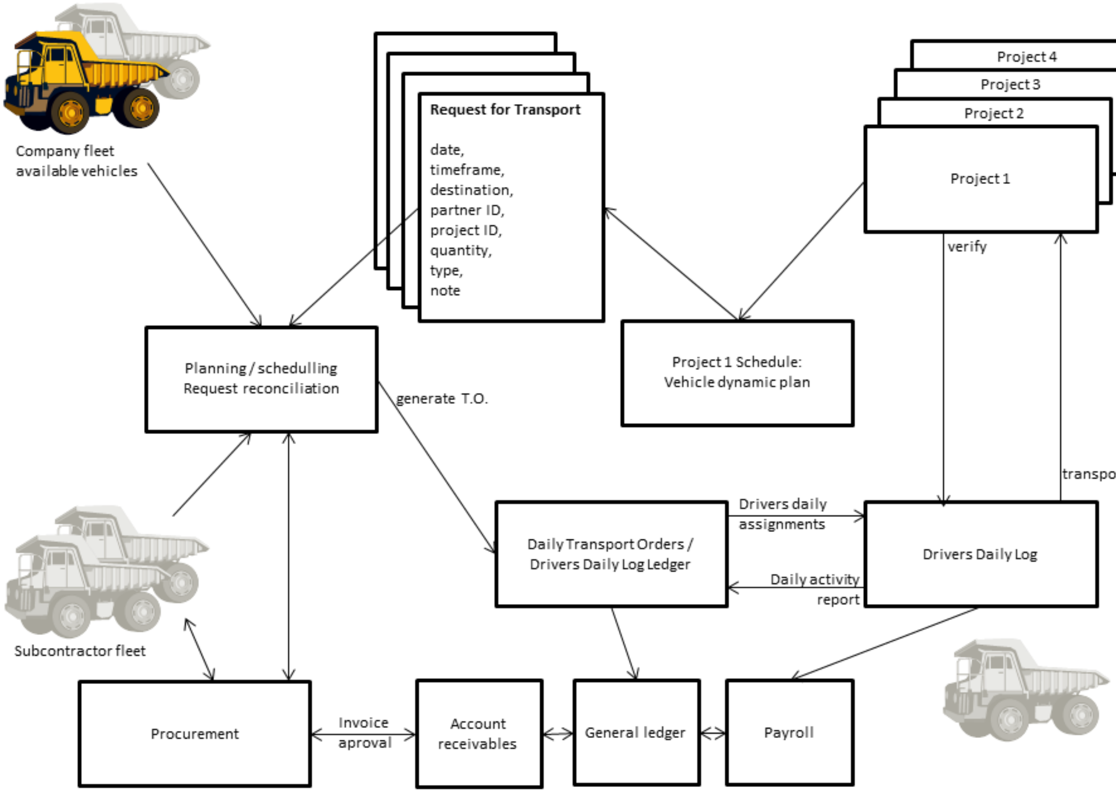

Figure 2 Vehicle reservation system

Drivers are assigned to each vehicle in case that the vehicle doesn't have standard driver. With a click, Transport Vehicle Orders are generated. If the vehicle has to visit multiple construction sites, multiple items, load and unload time items are generated, as well as Bill of Landing ID that will be validated by site supervisor or other authorized personnel.

The link between the Vehicle Reservation Subsystem and the Project schedule data is important because it a lever of control. The vehicle dates scheduled give verification to the project schedule.

2.2. Transport Orders and Daily Drivers Log (DDLO)

The core of the Transport Management System is built around the standard everyday transport documentation that is maintained even without computer infrastructure, namely Drivers Daily Log/Order (DDLO) and Bill of Landing (BOL). That data is used for vehicle utilization reporting and driver's salary calculation. The Vehicle Transport Order (VTO) is either generated by the Vehicle Reservation Subsystem or entered manually. Depending on the company's IT infrastructure, the VTO is printed and handed to the driver or accessed online. It also contains data the driver logs into the Drivers Daily Log. At the end of the day, the driver enters the data if working online, or gives the filled VTO to the transport administrator staff. The completed VTO data is used to print the DDL when needed.

The Vehicle Transport Order contains a Unique Identifier, a sequence number for the current year, date, the vehicle ID, driver ID, destination, starting and ending mileage and a various number of line items, each line item representing a detail of Drivers Daily Log data. The driver logs there effective hours and wait or load and unload time, section mileage and Bill of Landing ID of materials delivered.

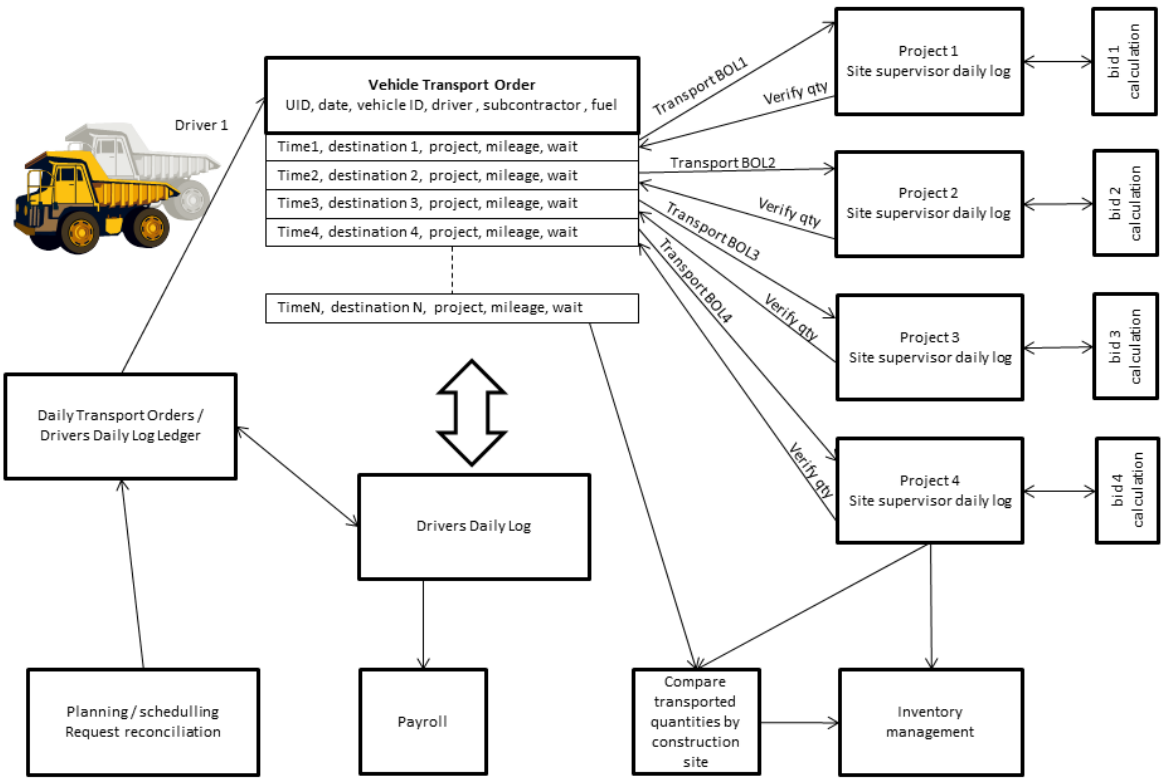

Figure 3 Driver Daily Log

The DDL data is verified by the site manager or administrator. The Bill of Landing is used to generate Received Materials Note and installed materials in Site Daily Log entry on site. The Vehicle Transport order detail item ID will be recorded in the Site Daily Log and site manager or operator ID will be recorded in the VTO, verifying the delivery as well as load and unload times. The received materials logged in the Site Daily Log are reconciled with the materials installed, which is compared to the tender resource calculation for each tender item.

2.3. Bill of Landing Ledger (BOL)

The Bill of Landing is also generated in the Vehicle Reservation Subsystem or entered manually. It identifies the quantities to deliver or remove from the construction site. It is identified by a unique ID and a yearly sequence number. It contains data similar to the VTO, like date, destination, vehicle ID, project ID. It contains a number of line items defining the material code id, quantity and other data.

BOL data is used to verify the concrete or gravel production, as well as scraping asphalt quantities if it is returned to the depot. On the other hand, the quantities delivered to a particular construction site have to reconcile with the quantities installed which are verified against bid resource calculation. This enables a closed loop of control across different subsystems, ensuring a verifiable audit trail of business processes.

2.4. Internal Repair Workshop Order Ledger

Tracking cost of vehicle repairs is of utmost importance for a construction company. It is one of the critical factors that will determine the moment a truck should be replaced for a new one. The cost of repairs is often so high, that companies organize their internal Repair Workshops. The Internal Repair Workshop

Management (IRW) subsystem handles tracking of such costs. There still are repairs that are outsourced to external specialised subcontractors, but those costs are handled through standard Account Payables module, where an invoice, or part of it can be assigned to a particular machine or vehicle, and as such appear in standard cost account structure in General Ledger. Together with cost of depreciation, leasing etc., those costs will appear in the Equipment Ledger and Equipment Balance Sheet.
The IRWM module lets you track hours and spare parts spent to repair each machine, vehicle or other equipment, by Internal Work Order, by each mechanic, by type of repair and, if applicable, by project.
Summary workforce data gives insight of effective weekly or monthly hours spent, so that bottlenecks can be analyzed. Summary by repair type will help strategical planning.
The spare parts issued to complete each Internal Work Order are integrated with the standard Inventory Control subsystem which enables to enforce standard spare parts tracking through Accounting

3. Interdisciplinary enterprise coordination

Coordinating multiple participants from different departments is singled as the top focus of interest to Chief Supply Chain Officers (Heaney, 2012). A study of business excellence (Radujković, Vukomanović, 2011) shows that traditional autocratic top down management directive enforcement is still the primary way of business management in Croatian construction companies. This approach is gradually shifting towards social network paradigm, where the workforce is not just executing orders but is participating in goal achievement and improvement (Vrdoljak Raguž, 2013).
As a result, a new approach, Multidimensional Preemptive Coordination (MPC) was introduced (Bacun, 2013). Although not part of the Transport Management System, MPC is an indispensable communication fabric that complements and enforces cohesive integration of different enterprise segments. MPC is a model of interdepartmental communication system, a tool that helps management improve communication across the enterprise, avoiding bottlenecks and alerting of approaching or missed deadlines, problems and new developments.
A group of people, both management and subordinates are gathered around a business problem. They interact on a Topic News Wall to report progress, comment or discuss shared goals in their scope of visibility, while the traditional Request For Action following the Organizational Breakdown Structure is observed. The system automatically maintains an audit trail of work done, establishing accountability across all levels of the enterprise. Alerts of approaching or missed deadlines are pushed vertically or horizontally across organizational structure of the enterprise, facilitating preemptive action and improving managerial control.
The research report on supplier lifecycle management (Limberakis, 2012) identifies “Lack of insight into supplier performance across the enterprise” as the top business pressure related to supplier management. The same report distinguishes the Best-in-Class companies regarding strategic actions based on maturity class as those who “Use predictive supplier risk monitoring via alerts and real-time online dashboards” and “Establish corporate social responsibility programs through formal supplier relationship teams / supplier boards”.

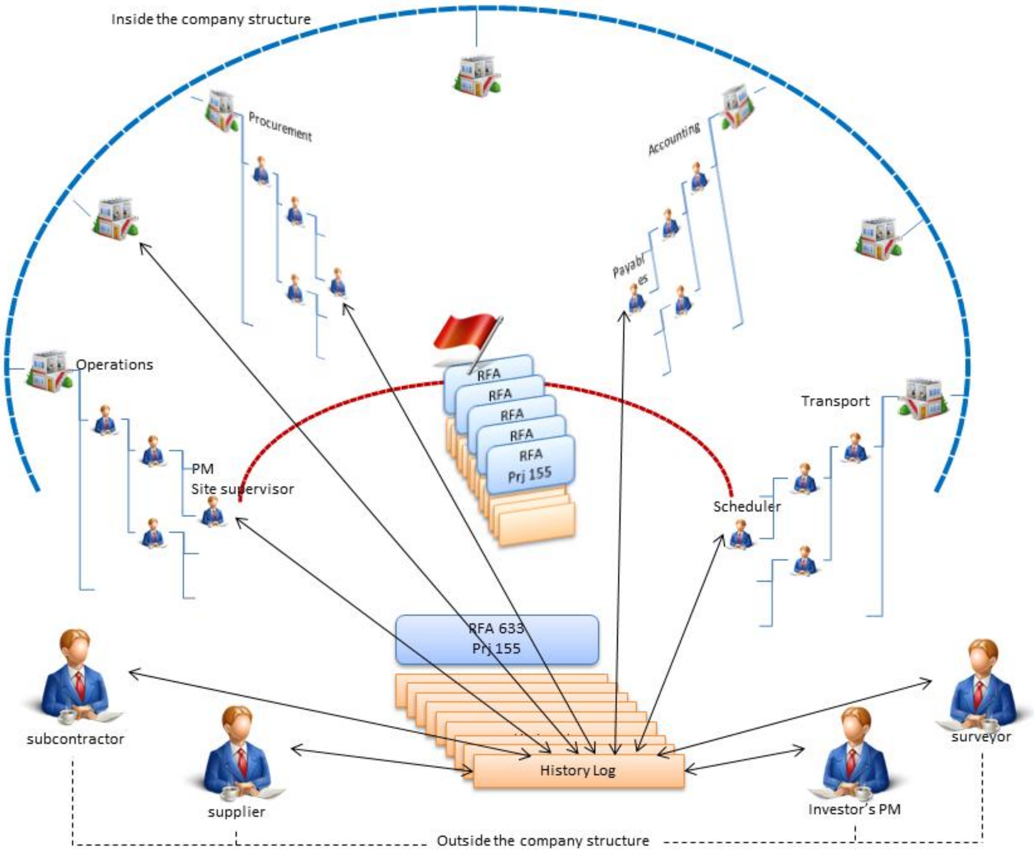

Figure 4 Multidimensional Preemptive Coordination

This indicates that the Multidimensional Preemptive Coordination model should be extended with supplier and subcontractor participation. Their access to the system is mandated with their login. A special Organizational Breakdown Structure parallel to the company's hierarchical structure should be defined, which would limit the external user's scope of visibility to the topics they are invited to by corporate staff. The external users would not be aware of the rest of the system, but would be able to participate in discussion and problem resolution posting comments, information and alerts to the topic wall. Every corporate participant, from different departments, who is part of the topic task force, would be immediately alerted of the new developments a supplier or subcontractor posts. Each external user, supplier or subcontractor, may be part of different topic task forces, and participate in coordination activities in numerous business problems. The system will maintain an audit trail of subcontractor/supplier activities which would enable "monitoring via alerts in real-time" and "insight into supplier performance across the enterprise". Posts to a particular Topic News Wall could be further limited to in-house and external posts, so that the desired level of confidentiality can be reached.

4. Requirement for succesful implementation

If the subsystems are to interact implementing multiple closed loops of control integrating functionality across the enterprise, there are requirements that have to be met.

The most obvious one is also the most difficult to achieve: the unique identifiers have to be consistent across all the subsystems. That means that material code (or unique id) has to be the same in the Inventory management, Internal Workshop Order spare part ID, Bill of Landing material

ID as well as project schedule data, tender resource calculation data, Site Daily Log, Site Survey Log and Request for Purchase in Procurement.
Vehicle ID should span across Asset Management in Accounting, Invoice decomposition in Payables, Vehicle Transport Orders, Vehicle Reservation Subsystem, Site Daily Log, Invoicing of vehicle rent etc.
The above requirements make it practically impossible to integrate software solutions from different software providers, as even if the integration is successful, the different program logic will disable implementing closed loops of system control between different subsystems.

5. Conclusion

The construction project management is changing. Traditional approach of managing a single project without consideration to overall business processes is generating numerous cost and schedule overruns. Monitoring project execution by budgeting gives no insight into problems that might result into delays that will increase the project costs. The fluid flow of information across the enterprise is of paramount importance to improve business management. This generates data overflow, so information infrastructure should provide filtering by each participant's scope of visibility. Different subsystems are interlaced, handling data owned by other subsystems, so they function as control levers in corporate business processes.
Transport is in a unique position to be part of different subsystems simultaneously, the supply chain management, construction site management, project scheduling, asset management and vehicle ROI monitoring. So its importance is far bigger that simple fuel and mileage monitoring per single project.
This paper presents a model of a Transport Management System which enables verifiable audit and accountable control of construction site reporting and project management, mitigating risk of delays and cost overruns.

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CONSTRUCTION CONCESSION PROJECTS AND THEIR STAKEHOLDERS*

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Abstract

Project life cycle phases of traditional projects relationship Investor – Contractor, are different form the concession project phases, known as Public Private Partnership (PPP). Consequently, there is different dynamics between the project and its environment especially its stakeholders.

It is very important that project leader (sponsor, manager) implement, from the early project concept, during the Project Idea design Phase continuous communication with project stakeholders, in order to recognize their particular interests and proposals to use them to increase project opportunities and reduce project risks.

In the paper are analyzed some big motorway projects in Croatia, and strong influences of the, probably not on right time, identified stakeholders to these projects. Authors are giving framework of project processes to be implemented in the todays and future big infrastructure projects to significantly reduce project risks and increase project opportunities.

Keywords: Public Private Partnership, Infrastructure Project, Project Stakeholders, Project phases and processes

* The complete text is available on CD-ROM / Bandić, Orešković, Izetbegović

Introduction

There is intensive interaction between the construction projects and their social and natural environment. Consequently the project organizational structure should be properly designed for timely collection, processing and distribution of all relevant informations to all project participants. That is especially important during the early (project Idea design) phase of the construction project.

Over 50% of project obstacles, especially in the construction phase, have their roots in not enough detailed work during the first, project Idea design phase (Lechner,H 2013).

In this early project phase, Investor/client is responsible for quality of project goals and scope preparation.

This is especially important for analysis of

- Project environment – stakeholders and other environmental conditions
- Project requirements for the project goals definition as the tool for investor/client requirement definition

In order to reduce project risks and project discontinuities, the successful investor/client will engage the experienced experts in the field for the quality processing of the project environment and definition of the project goals based on project requirements.

2. Stakeholders in project environment

A stakeholder is any person, group or organizational unit that will be influenced by, or will influence, the actions during project realization (Applegate 2008).

Project management team as early as possible attempt to

- Recognize and list all potential stakeholders, analyzing project environment and stakeholder's links to the project
- Identify their needs, interests and expectations
- Rate the importance of each stakeholder to the success of the project
- Develop stakeholder's management plan and propose actions which must be taken to meet, clarify or realign stakeholder interests and expectations
- Develop Communication plan to proactively communicate with identified stakeholders.

The possible strategic approaches of the project management team could be defensive, less efficient, or proactive, more effective, collaborative strategies.

During Communications planning, project management team defines

- Stakeholder communication requirements
- Information to be communicated, including format, content and level of detail
- Person responsible for communicating the information
- Person or groups who will receive the information
- Methods or technologies used to convey the information, such as memoranda, e-mail, and/or press releases,

- Frequency of the communication, weekly, monthly…
- Escalation process-identifying time frames and the management chain (names) for escalation issues that cannot be resolved at a lower staff level
- Method for updating and refining the communications management plan as the project progresses and develops
- Glossary of common terminology (IPMA ICB 2006)

Very helpful can be experience collection from the previous projects “Lessons learned“ and analytical checklists for analysis of project environment.

These results are part of the Basic project document – Project book.

3. Project models

There are different dynamics of interaction between projects and its environment when applying traditional and concession project models.

The main difference between traditional and concession project is in the sphere of financing. The financing processes are part of the concession project from the beginning, and especially after establishing The Concession Company (Special purpose vehicle-SPV) which is responsible for the complete process of project financing and for the project revenue and final financial result.

Besides the financing processes and their stakeholders, concession projects have much stronger influence of the politics and their stakeholders.

1.1. Traditional relationship: Investor / client – contractor

Construction projects in traditional relationship investor / client – contractor are realized through sequential phases, which have, depending on project development, and decision of Project management team iterative cycles.

One of the characteristics of traditional project model is that financing process is responsibility of the investor / owner.

Example of traditional project model phases is presented on the next figureFigure 5:

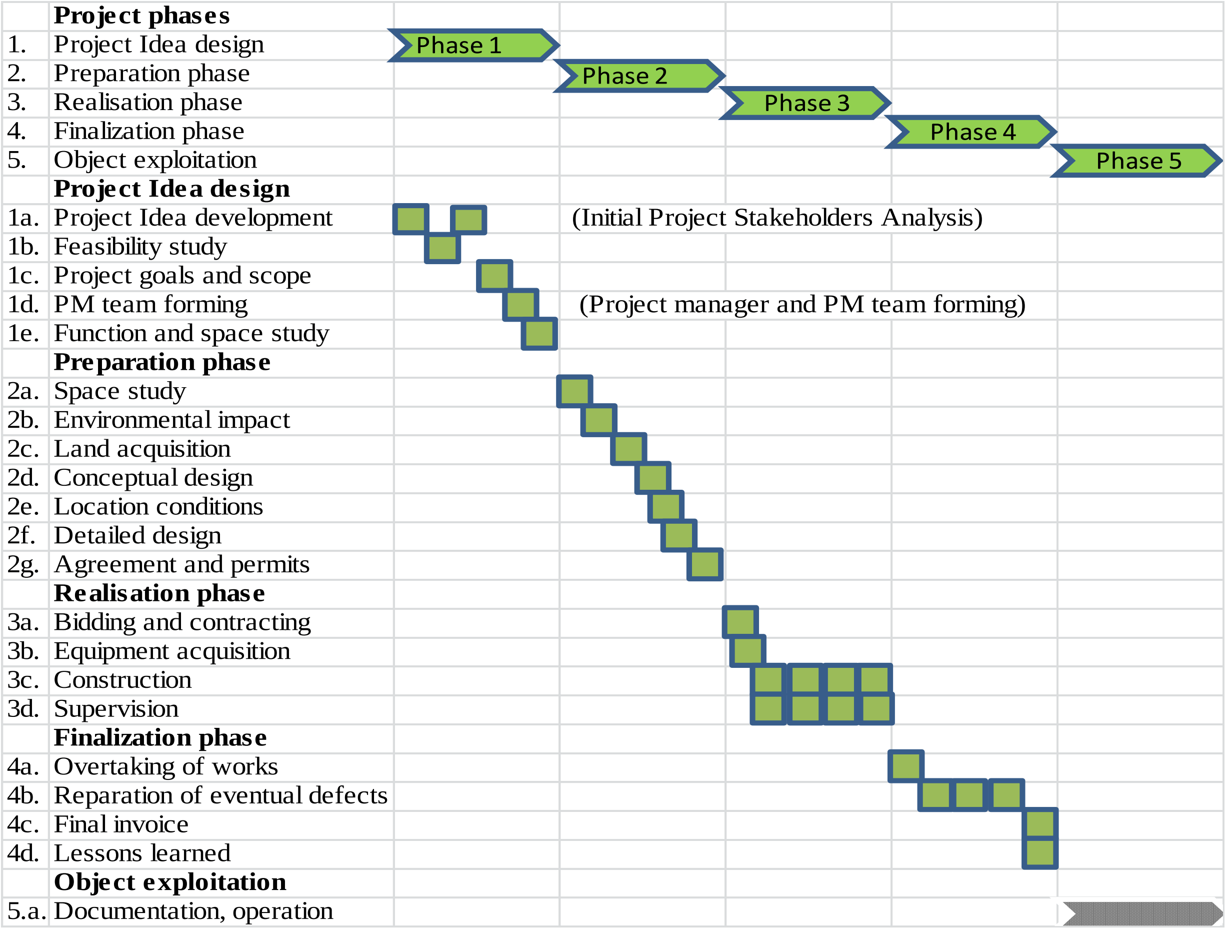

Figure 5: Traditional project model phases framework

3.1. Concession project model

Concession projects have significant differences in phase sequencing, as shown in the next Figure 6.

As early as possible during the Project Idea development phase of concession projects, various risk and opportunities categories and their possible impacts, shall be carefully analyzed.

Among the categories of risks such as Technical, Legal and procedural, Market, Financial, there are Environmental risks that should as early as possible consider requirements of the project environment, prevention policy of stakeholders, public relations etc.

In order to avoid unnecessary project discontinuities, Project management team from the early Project Idea design phase considers all applicable laws and regulations in connection with environment protection and undertakes as early as possible all necessary procedures and activities to resolve stakeholders issues.

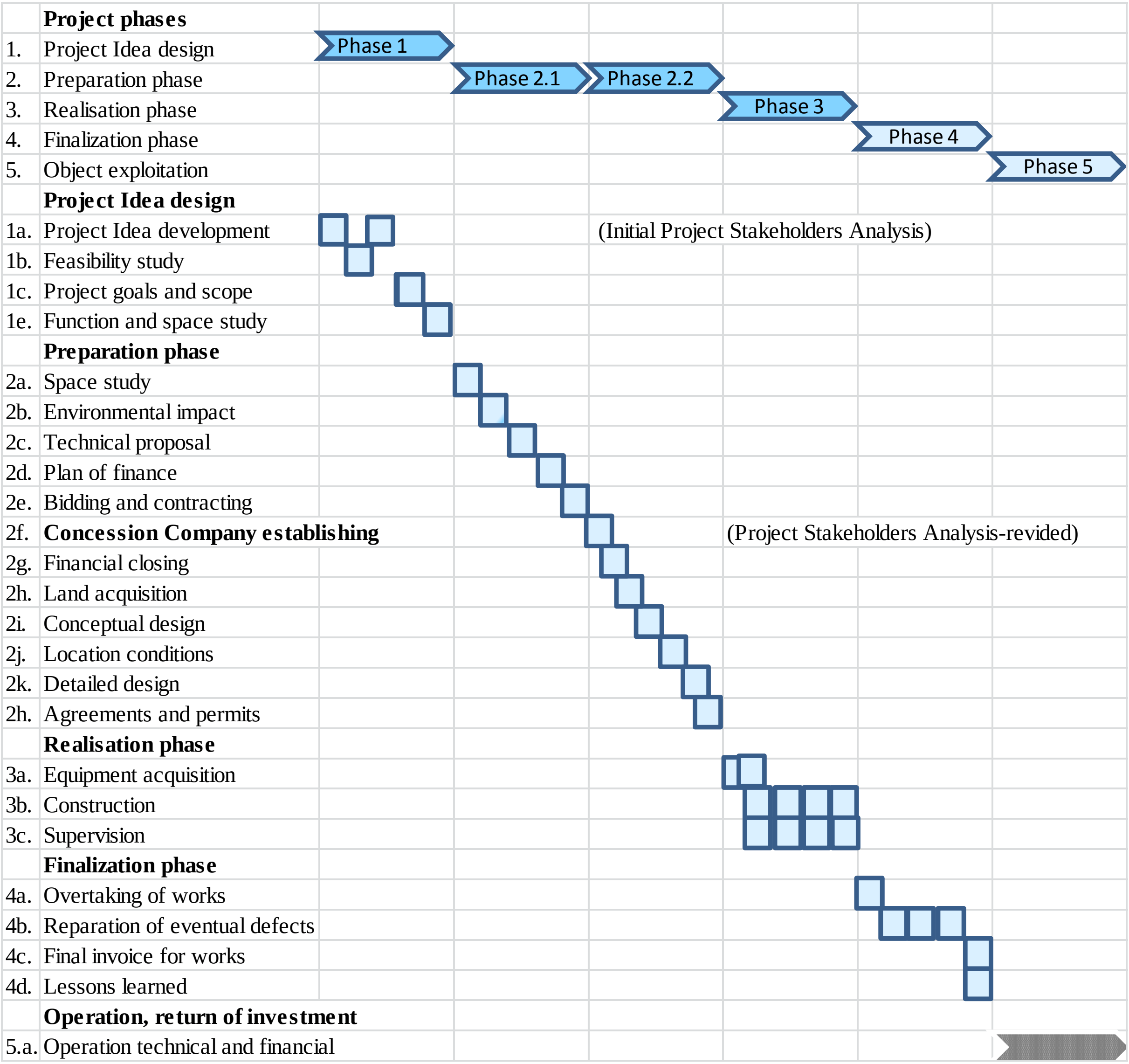

Figure 6 Concession project model

During the project realization, through the active collaborative processes with stakeholders, project management team analyses stakeholder's interests and proposals and their possible impact on the project and apply appropriate project Change management to reduce project risks an increase project opportunities for the final project results.

Project management team, applying tools of problems resolution, identify and asses the detected problems and in collaboration with the stakeholders, analyses and identify roots of problems and, after evaluation, proposes a solution acceptable to all stakeholders (win-win situation).

4. Process of the stakeholder's analysis

The process of the stakeholder analyses is presented on the following Figure 7

The main characteristic of the complete process is transparency and publicity. The project management team, during the process, identifies possible conflicts of interests between stakeholders and project but also risks and chances during the realization of project goals.

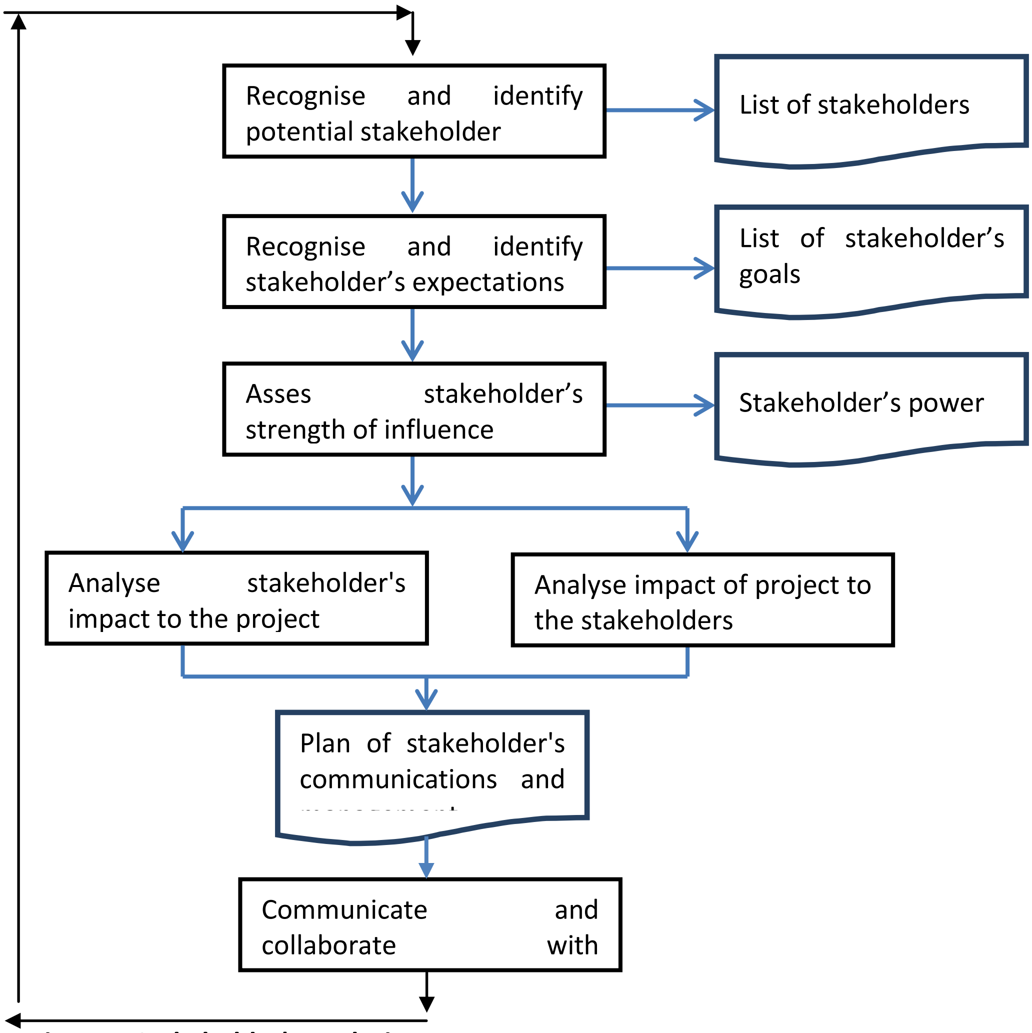

Figure 7 Stakeholder's analysis process

Very useful can be application of the stakeholder's checklists for the project environment analysis. The framework of stakeholder's checklist could be as on the following table:

The project management team should use previous experience of the previous successfully realized projects in the form of checklists for project environment analysis (ProjektManagement aktuell 03/2009).

Table 1: Checklist for project environment analysis (ProjektManagement aktuell 03/2009)

Stakeholder	Description of the influence	Chances			Risks		
		Very good					Very high

5. Some examples of the stakeholders influence on the road concession projects in Croatia

In Croatia road concession projects started in late 90-ies of last millennium. Because of lack of project management experience with concession projects, there were several serious obstacles that caused project's discontinuities. Some illustrative examples are summarized in the next Table 2

Table 2 Examples of the stakeholders influence to the road concession projects in Croatia

Project \ Influence	**Istrian Y**	**Motorway Rijeka - Zagreb**	**Motorway Zagreb - Macelj**	**Motorway Zagreb – Goričan**
Stakeholders influence	Local population stopped pay toll for several years, from	Contractor of two tunnels requested project and price changes. After several months of complaint contractor changed.	Local population several years declined to pay toll on some sections of the motorway.	The pressure of domestic contractors influenced on political will. Concession contract with the foreign concessioner cancelled, started international arbitrage process.
Consequences to project	Reduced operators revenues supported by Government	Several months of the time delay of two tunnel construction, higher costs	Reduced operators revenues supported by Government	Several months time discontinuity. Government's owned company overtook construction and operation of the motorway.

A lot of above recorded stakeholders influence could be better controlled, reduced, or even eliminated by timely analysis of influence better communication and cooperation with the stakeholders.

Example of successful communication and collaboration of the different stakeholders with different interests and their successful collaboration and harmonization of their interests during the construction of the combined tunnel-bridge Oresund transit between Malmö and Copenhagen. Öresund transit has been constructed between the years 1995-2000. Total transit length is 7.845,00 m. (Wiggert 2011)

From the beginning the project has been criticized especially from the ecological organizations. The project development team connected all stakeholders in the decision process. There are included both state governments and parliaments, investors, potential contractors, as well representatives of organizations for shell plantation, fishermen, swan and seals protection.

Complex system of exchange of all actual project informations was accessible to all stakeholders. Intensive open discussion has enabled harmonization of sometimes very opposite interests.

The project finished 6 months before planned end, in the frame of planned costs.

Conclusions

Project environment analysis and active management especially active collaborative stakeholders management is very important from the very early Project Idea development as well as during later project realization phases.

There is different dynamics of the stakeholders influence when applying traditional or concession project models.

At the very beginning of the project development, all possible constrains and project´s conditions coming from project´s environment have to be well known to the project owner and his team.

Transparency of the project goals and scope are prerequisite for the further successful continuous project realization without discontinuities.

Project environment management causes some additional project costs at the beginning, but, if appropriately applied, it brings the new chances and profits.

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BENEFITS OF THE LINE CONSTRUCTION METHOD FOR THE IMPLEMENTATION OF FAMILY HOUSES*

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Abstract

The paper deals with the variant processing of schedule using line construction method for coherence construction projects. Line method is, for the implementation of several buildings advantageous, because it allows a smooth and uniform work of crews, loading resources, supply, but also performance of the tasks. This method makes full use of the time and only with a number of workers than the gradual method of construction, but with a substantial shortening duration of construction. For case study were used building structures in which individual types of critical structures evenly distributed and therefore more evenly distributed their work consuming. The spatial analysis of construction was determined by the size of the normal spatial work zone and the direction of the construction process. In article are gradually considered three variations of schedules to the subject construction of family houses, and these are then compared with actual realized state. Consequently, benefits are analyzed in the context of the line construction method: construction period, the intensity of the deployment, use of resources and necessary costs for construction.

Keywords: line construction method, coherence construction projects, spatial work zone, construction process, family houses, variant processing

* The complete text is available on CD-ROM / Baškova, Krajnak, Slivka

Introduction

The line method of construction in Slovakia has stacked shadow memories of a panel mass construction of housing building agglomerations where found its legitimate use. Associate also now a line method only with the unified structures of the past is short-sighted. Using of benefits of the line organization of construction is also possible in the implementation of architecturally attractive and creative structures (Kozlovská et all., 2010-a). The condition is that the realized building was in its spatial parts of various kinds of structures, and thus their labor intensity (El-Rayes and Jun, 2009), spread evenly and that the scope of work allowed sharing production space for spatial work zones by developing several parallel job queues. Such structures clearly include a row construction of the large amounts of family houses.

2. Conditions for applying the line method of construction

The line method of construction requires careful construction and technological preparation with the solution of a time sequence of specialized work crews in the area of construction. Conditions for the application of the line method of construction can be summarized as follows:

- Must be available batch of products, i.e. approximately the same type and scope.
- Proposal for optimal division of labor between specialized teams in the flow and design of technologically appropriate sequence of processes (Christodoulou et al., 2010).
- Each team (platoon, team) makes by their job a free working front for following platoon, while labour collectives do not interfere with each other, i.e. must not meet in one section of building (spatial work zone). Substitution of crews (processes) on spatial work zone is subject to some coordinated rhythm.
- At a time when ongoing a sub-process in the building object, it must be located in the area of a certain number of objects with different degree of elaboration, when undergoing other processes. Processes that follow each other change the processes that take place in the space next to each other. It is necessary that at the time of completing one product flow smoothly incorporated into another product (Son and Mattila, 2004).

Conditions ensuring for the line organization of construction is subject of solution within the building and construction technology preparation (Kozlovská et all., 2010-b; Kozlovská, 2007). Planning of the line construction method can be divided into the following operations:

- Structurally and technologically appropriate objects are divided into approximately equal parts - spatial work zone (created the series).
- Total (complex) work process is divided into partial, staged and object processes according to technological nature.
- To the whole production will be introduced mandatory rhythm with time-modulated activities of crews on individual spatial work zone.

For the application of the line construction method in practice is important to understanding and willingness on the part of managers, i.e. from construction managers, site managers and their assistants, subject deployment of generating capacity in the construction to the planned work in rhythmic time (Fathi and Afshar, 2008; Kozlovská and Struková, 2011-a). The organization works subject to a predetermined procedure for platoons of partial streams in the area and it is important to also smooth and steady supply of construction by construction materials (Hiyassat, 2001; Kozlovská and Struková, 2011-b).

3. Case study – the line method of construction of row family homes

The case study brings to light a issue of line method of construction of row family homes 2A and 2B phase construction: Panorama - residential complex, Košice. The row construction is execution of usefully-spatial arrangement of functional consecutive family homes mostly the same features, not excluding their architectural diversity. Its building construction minimizes demands on land and maximizes the standard of living striking a balance between privacy and neighborliness in the locality. Extensive row construction of the family houses its structural-technological solution usually creates favorable conditions for the application of line construction method.

3.1. Description of construction Panorama - residential complex, Košice - phase 2A and 2B

Construction phase 2A and 2B includes 56 row family homes, where from structural point of view represented by three types of houses (A 121, B 131 and C 141).

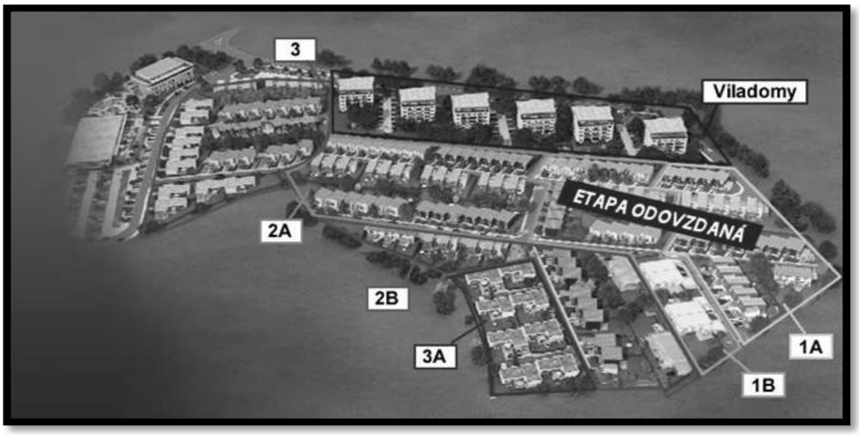


Figure 1: Construction phases: Panorama - residential complex (Source: http://www.domy-kosice.sk)

Family homes all three types are mostly the same structural character with the exception of some construction details. Objects of the family houses based on the foundation strips and footings from unreinforced concrete in combination with formwork blocks. Concrete ground layer of floors on terrain is reinforced with mesh. External bearing masonry include translations of holes is made from ceramic blocks. Masonry, attics and partitions are finished by reinforced concrete wreaths. Pillars under shelter to the family house are from the wood. The horizontal support structure and internal staircase is made from monolithic reinforced concrete. Structure of the roof structure of object above second floor is a wooden shed with a small inclination with PVC covering.

Figure 2: Three types of row family houses - A 121, B 131 and C 141 (Source: http://www.domy-kosice.sk)

3.2 Input data for solution of case study

Solving of case study based on the following documents and information obtained from the real construction:

- the situation of construction;
- drawing documentation of typical houses A 121, B 131 and C 141;
- report and assessment of processes for type houses;
- milestones (beginning and finish) of construction determined by developer (fig. 3), for stage 2A from 11/2011 to 5/2013, and for stage 2B from 8/2012 to 11/2013;
- timetable for the actual implementation of the works, where the realization of the family houses of construction stage 2A and 2B was conducted between November 2011 and the expected end of construction was planned for August 2013 (fig. 3);
- number of workers on site (information from construction), "in the top" working on construction about 130 employees (as indicated max. fig 5, 6 and 7).

3.3 Variant solution of the line organization of construction: Panorama - residential complex

The line organization of construction: row family houses are in the case study prepared for several variants of inputs to scheduling. Variants are compared with one another on the overall construction time (work schedule for the real construction and 3 variants, see fig. 3 , D, and E) and the need for labor resources (histogram, see Fig. 5, 6 and 7).

When designing a variant solution is essentially a search for appropriate answers to three basic questions (Hegazy, 1999) about the spatial, technological and timing allocation of construction:

1. What will the division of more row family houses at about the same (normal) spatial work zones?

Normal spatial work zone could be the spatial part of the house, a house or a spatial work zone composed of the multiple family houses.

In the particular case of the construction was divided into 15 spatial work zones where one spatial work zone consists of 4 buildings A 121, B 131, or 3 houses of type C 141. In determining the size of the spatial work zones was taken into account the scope of work, as well as the recommendation that one should have shot about from 200 m^2 to 600 m^2 ground area of objects. The spatial work zone was adjusted to 5-working days cycle, wherein said spatial division on spatial work zone satisfying the 2-week cycle.

2. What will tact and step of partial streams, i.e. what is the time of duration of the work of crews on spatial work zones and at what time intervals will follow crews assigned to the stream?

Tact (duration of work crews in each of the spatial work zones) is mostly multiple of across all turn, and can take values from one turn already, but the practical experience of the past is an appropriate tact at least 2 or 3 days, practice prefers one week (5 or 6 days when the weekend can be used for smaller delays in production), or longer, for example, two weeks (10 or 12 days). Some crews can work with so-called "double rhythm" (partial stream consists of *n* crews, taking in every spatial work zone refrain from *n*-fold cycle). Work can be designed "speed-line in a way that is crews embarking on spatial work zone immediately after leaving of the spatial work zone by the previous crew (step of flow is equal the tact), or spatial work zone to be taken up after a delay (step of stream is greater than the tact, which is usually chosen as integer multiples of the tact).

In this particular case, the proposed two variants for the duration of the work crews in one spatial work zone: tact = 1 week (5 turns) and tact = 2-weeks (10 turns).

Both variants tact were used for stream-speed method of construction, which is step equal to the tact. The third variant counts with tact one week following the onset of crews with a weekly interval, i.e. step of partial streams is equal to twice the tact (step of = 2 weeks).

3. What will division of the complex work process according to technological nature to split, multistage and object processes?

Proposal of the technological structure for normal spatial work zone, i.e. number and source evaluation partial streams, based on analysis of construction processes: from report and assessment and specification measurement and their technological nature and mutual conditionality so that previous partial stream created workspace for crew of the following partial stream.

Sequence, number and composition of specialized crews of the partial processes/flows have been adjusted to scope of the works in the normal spatial work unit and to selected tact 5 and 10 turns.

When we design a hierarchy of processes/streams was object process divided into 5 construction stages, which in turn were divided into sub-streams corresponding to the one specialized work crews and fictitious streams at the time of ongoing technological break.

Construction stage	Number of the partial streams for tact: 5 turns	Number of the partial streams for tact: 10 turns
HSS – row lower structure	2 partial streams 1 fictitious stream	2 partial streams
HVS – row upper structure	5 partial streams 2 fictitious streams	4 partial streams 1 fictitious stream
ZS – roofing	1 partial stream	1 partial stream
F – facade	4 crews working with double rhythm with the tact of 20 days	2 crews working with double rhythm with the tact of 20 days
D – finishing works	9 partial streams	6 partial streams

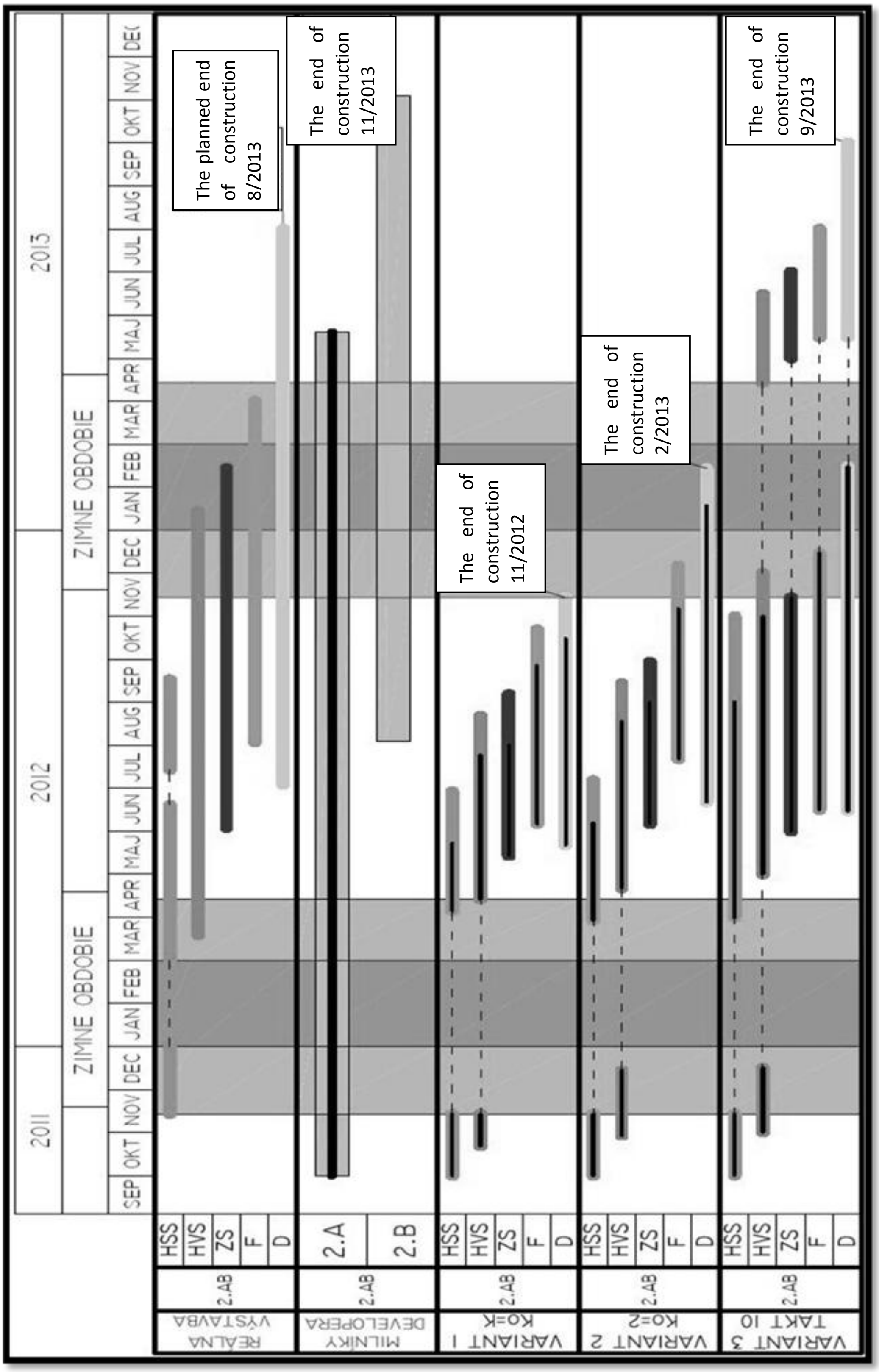
Table 1: Number of the partial streams in the normal spatial work zone (Source: authors)

At Figure 3 is a time-spatial graph course of construction of 56 residential houses of the complex Panorama, processed in the relative calendar for tact: 5 turns, which served as the primary basis for the processing of three variants of construction schedule.

In the schedules (fig. 3 - real construction and proposed options 1, 2 and 3) are taken into account specified milestones (start of construction consistent with the schedule) and the winter season, at which time it was interrupted several partial streams with "wet process" (row lower structure, row upper structure and facade modifications).

Real construction:

- beginning of the construction phase 2A: November 2011 and phase 2B: August 2012;
- expected end of construction phase 2A: May 2013 Stage and phase 2B: August 2013;
- the total construction period is 1 year and 9 months;
- the number of workers site "in the top": 130 workers.



LEGEND

poor winter season

winter season

HSS – row lower structure

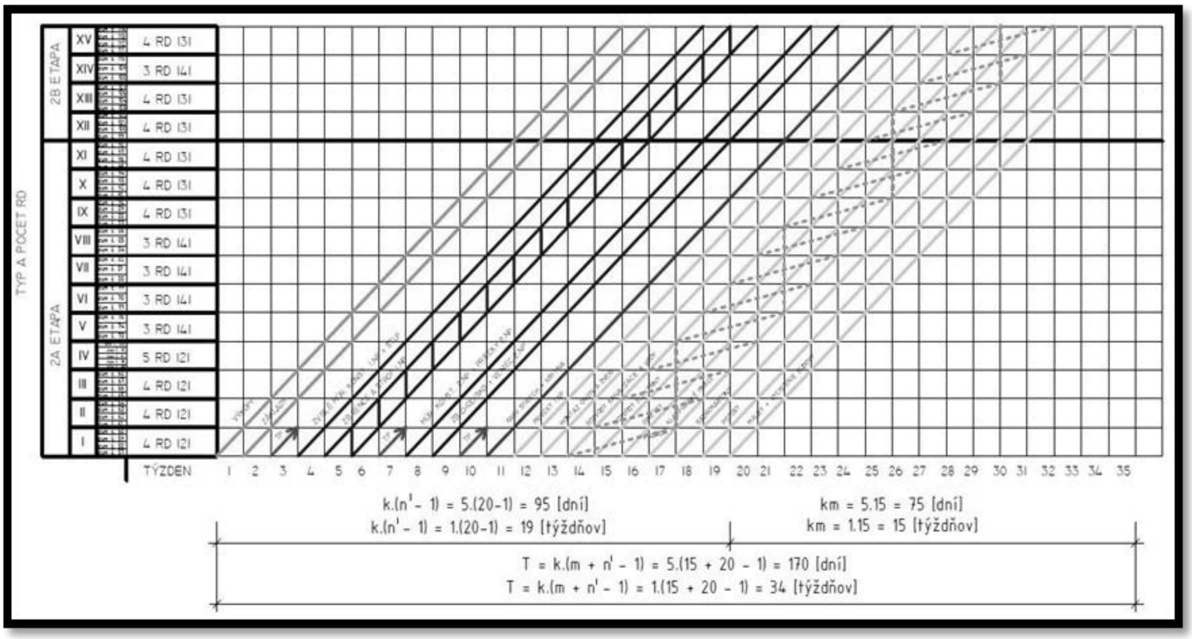
HVS – row upper structure

D – finishing works

ZS – roofing

F – facade

Figure 3: Schedule: phase and stage processes of the real construction and variants 1, 2 and 3 (Source: authors)



Legend: On the x-axis is the time of construction in weeks, and on the y-axis is 15 spatial work zones of 2A and 2B phases divided into specific family houses of this type.

Figure 4: Cyklogram processed in relative calendar (tact = 5 turns) (Source: authors)

Variant 1: stream-speed method of construction for tact - 5 days:

- start construction in October 2011 (planned start of construction);
- expected end of construction in November 2012;
- the total construction period is 1 year and 2 months;
- the number of workers on site "in the top": 116 workers (fig. 5).

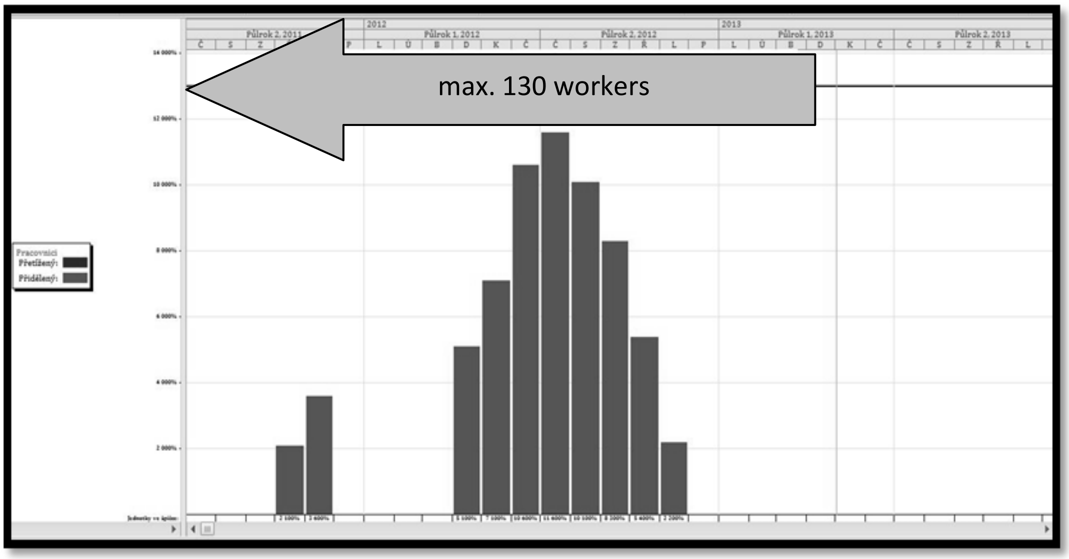


Figure 5: Histogram of workers for variant 1 (Source: authors)

Variant 2: stream-speed method of construction for the tact - 5 days and step of partial streams 10 days:

- start construction in October 2011;
- expected end of construction in February 2013;
- the total construction period is 1 year and 5 months;
- the number of workers site "in the top": 75 workers (fig. 6).

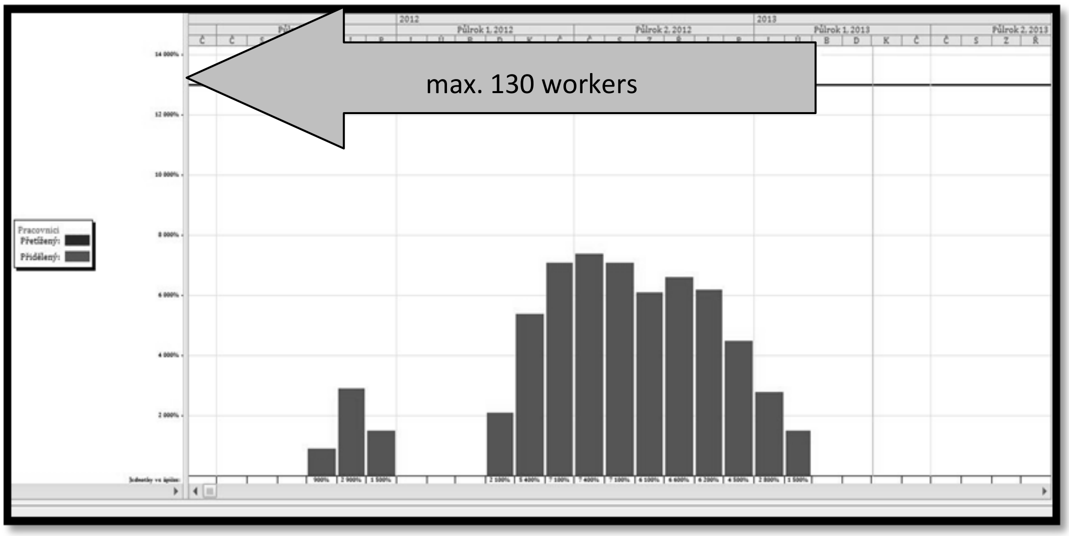


Figure 6: Histogram of workers for variant 2 (Source: authors)

Variant 3: stream-speed method of construction for the cycle: 10 days.

- start construction in October 2011;
- expected end of construction in September 2013;
- the total construction period is 2 years;
- the number of workers site "in the top": 118 workers (fig. 7).

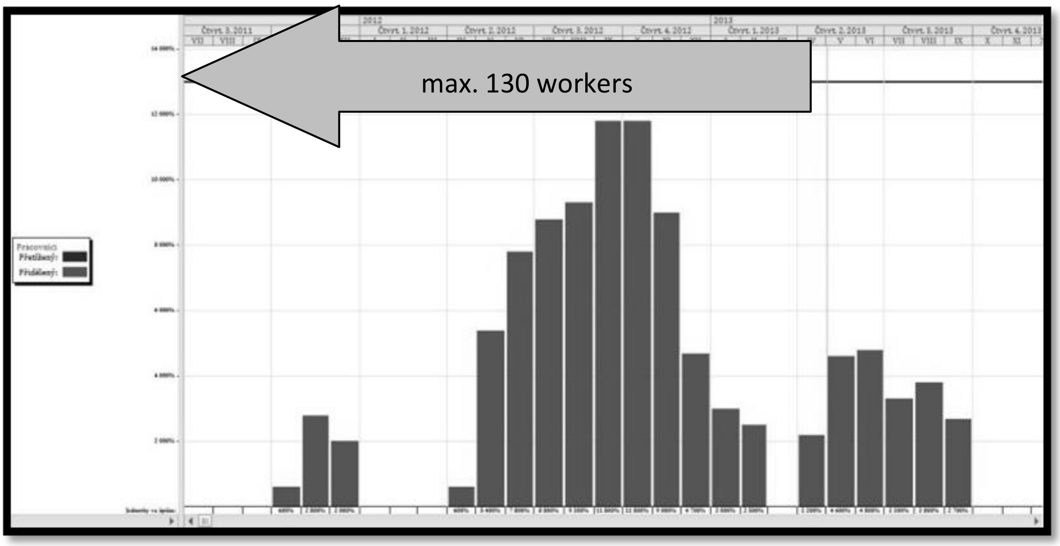


Figure 7: Histogram of workers for variant 3 (Source: authors)

Conclusion

Line method itself does not guarantee a smooth running of construction. Even the design of the time course of the work by a line method may be useful to examine several variants where the variables deal with the solution the division of construction to spatial work zone (number, size of spatial work zone and placement procedure of the construction), number, rank and resource assessment of partial streams and the time interval between the onset of successive partial processes into spatial work zones. Variants may reflect the availability of labor and material resources, different working fund (work over the weekend or more updates) and so on.

Mathematical foundations of line method allow for a relatively short period of time to evaluate selected characteristics of construction (construction period, the intensity of the deployment and use of resources, etc.) For several variants with different input conditions, either by calculation or by graphical display during the construction of space-time graphs or histograms selected sources. Line method of construction is a means of bringing in the organization of construction "order" which can ultimately result in lower construction costs.

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CONSTRUCTION OF THE NATIONAL FORENSIC LABORATORY IN LJUBLJANA*

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Abstract

This paper presents the construction of National Forensic Laboratory in Ljubljana, Slovenia. The construction project is divided in two parts. The first part shows the current construction of a new laboratory built as an annex to the already existing building. The second part represents a future reconstruction of the old section for which the works will begin in the first half of January 2014. The Ministry of the Interior, which published a public tender to complete both parts of the project, finances the project. The building itself is defined by its special architecture and functionality, since all important criminal investigations are to be carried out in the National Forensic Laboratory. This article presents the construction of the first part of the project, which is almost finished, and organization of the construction site of the second part of the project. Construction works started in the beginning of February 2012, while the building will be finished in the first half of June 2014.

Keywords: construction project, reconstruction works, construction-site organization, National Forensic Laboratory in Ljubljana

* The complete text is available on CD-ROM / Cajzek, Klanšek

INTRODUCTION

The National Forensic Laboratory (NFL) was established during 1950's in the former Republic of Yugoslavia and it was named Criminalist-Technical Laboratory (Čebokli, 2012). The laboratory was used for dactyloscopic, chemistry and graphoscope research and was renamed several times until 2010, when it became The National Forensic Laboratory, which has been used as its official name until today. Over the years the number of researchers and technicians has increased to 65 employees. Due to lack of space the Ministry of the Interior has decided to build the new laboratory and to reconstruct the old part of the building.
Location of the building is in the centre of Ljubljana, in the northern part inside the Ljubljana highway circle in the industrial zone Brinje. The parcel is surrounded with Public Company Energetic Ljubljana d.o.o. on the west side and with Public Company Water Supply and Sewage d.o.o. in the northern part, see Figure 1. In the southern and eastern part of the Laboratory there are residential buildings. The existing building was built in 1980's and it replaced previous location of NFL at Ministry of the Interior in Štefanova Street (Golja, 2006).

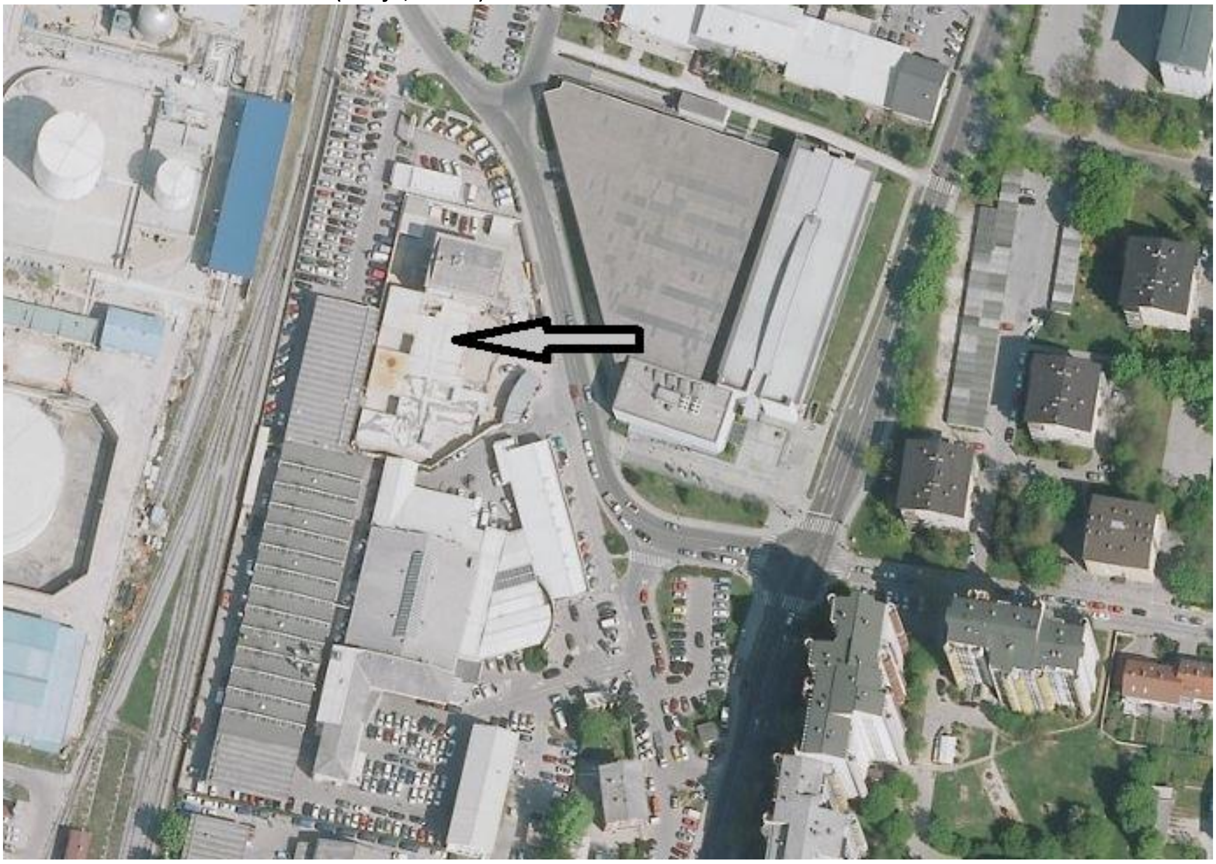

Figure 1. Aerial view of the construction location (Geopedia, 2010)

Particular attention has been paid to the operational regime of the construction site due to operations in laboratories, the conduct of which has been managed to operate smoothly and without any major interruptions during the whole construction process.

2. BRIEF HISTORICAL OVERVIEW

Before the establishment of Criminalist-Technical Laboratory in 1950's, technical departments in Ljubljana and Maribor have been used for the purpose of criminal investigating. Over the years, the laboratory has grown up and in 1970 it employed 13 workers. The equipment in those days was

modest and simple. A major step forward was taken between 1976 and 1982, when the laboratory got a lot of new equipment.
Soon after 1990 the laboratory was renamed into Centre for Forensic Research (CKTP). In 1998 the CKTP was one of the first European forensic laboratories to establish the records of DNA samples, which have been legalized in the same year by the Criminal Procedure Act (ZKP, 1994), and the Police Act (ZPol, 1998). Later, in 2001 the system for electronic fingerprint identification was implemented. In 2010 the laboratory was renamed to its final name, National Forensic Laboratory (Golja, 2006).

3. START OF THE PROJECT

The project works started in the year 2010 with the first building constructor. Figure 2 shows the appearance of the building at the beginning of the project. Due to insolvency and bankruptcy of the first construction company the project was taken over by the second civil contractor. The story repeated itself and the Ministry of the Interior has chosen a third business partner for completion of the project with a Public Tender (2011). All of these actions reflect the global and local financial crisis which has especially affected the construction sector in Slovenia.
The third contract for completion of the National Forensic Laboratory in Ljubljana was signed with the company GIC gradnje d.o.o. in the beginning of February 2012. The deadline for completion has been properly moved according to the above mentioned factors. The main contract includes the following works (Urh et al., 2009a):

- demolition works in the interior of the existing building,
- replacement of joinery with a new one,
- construction of an extension,
- building a water supply and sewage system,
- installation of a heating system and ventilation,
- arrangement of the environment.

Figure 2. Appearance of the building at the beginning of the project in 2010 (NFL, 2010)

At the beginning, when the third contractor started working, the building was built to a certain stage. All the preliminary works, demolition works, earthworks and partial construction works were finished. The construction site has been taken over with a finished basement, ground and first floor without walls.

4. WORK PROGRESS ON THE EXTENSION

4.1 Demolition works

The first activities of the project with previous contractors included demolition works of two existing buildings, see Figure 3. Both buildings were built with modular bricks and reinforced concrete, with the total size of 1544 m^2 net floor area. Before the works started, contractors provided a professional disconnection of all installations and disassembly of technological equipment, sanitary items, ventilation system and other mounted equipment. During demolition all necessary measures to prevent dust emissions were taken.

Figure 3. Demolition works of the existing building (NFL, 2010)

During demolition works water was used to prevent dusting in the case of dry weather. In case of windy weather, it was necessary to postpone all works in accordance with the demolition plan (Urh et al., 2009b). Construction waste produced during demolition has been properly separated by type and has been handed over to the authorized dealer for further processing and deposit. All works have been carried out in accordance with valid regulations on waste management (Urh et al., 2009c).

4.2 Excavation of the construction pit, foundation and construction of an extension

With the completion of demolition works, the excavation of the construction pit started, see Figure 4. Under a thin layer of humus there was sandy clay with gravel-stone to a depth of approximately 0.6 m. Under this layer was gravelly-sandy soil, which is the alluvium of the Sava River. The lowest

point of the excavation was at minus 3.7 m for the basement of the new extension, see Figure 4. During excavation works protection was carried out in accordance with the plan of the construction pit excavation (Šterk, 2010).
The geotechnical report (Volf, 2009) showed, that the foundation ground was stable and adequate for building. The report proposed strip foundations made of reinforced concrete in depth of minus 0.8 m below the floor of the basement or 4.5 m below zero point of the building. Excavations were also carried out in the area of the existing building in order to determine the initial state of the foundations and their reconstruction, drainage and waterproof construction. Before casting reinforced concrete foundations, the consolidation of the foundation ground was performed to the appropriate strength and stability.

Figure 4. Aerial view of the excavation (NFL, 2010)

The new extension was built in the southern part of the existing building and due to unavoidable movements of the old and the new part properly made with dilatation. The heights of both buildings were not aligned and they have separate roofs. Construction of extensions to some part of the building was carried out as a reinforced concrete shell.
As mentioned before, the third contractor started working on the construction site with implementation of walls on the first floor. In the central part of the new building vertical connection floors via elevator and staircase were built. Due to a high level of fire safety, the building has been designed in accordance with the requirements of the client (Urh et al., 2009d). Therefore a fire staircase for emergency evacuation was made. Floor plates of the new extension were also built with reinforced concrete.
Thermal insulation of the building has been carried out by a “sandwich” prefabricated facade panels with a thickness of 15 cm, made of steel sheet, insulating filler and non-combustible mineral wool. In order to implement thermal insulation of the basement, the extruded polystyrene was used. Strip foundations were made in accordance with the Project Execution Plan (Urh et al., 2009a). After finished excavation the workers have prepared a formwork for the concrete casting and

reinforcement. Below, in Figure 5, there is an example of preparation for the concrete foundation casting and on the right side preparation frameworks for walls.

Figure 5. Implementation of foundations (NFL, 2010)

After implementation of the foundations the placement of wall frameworks for the execution of basement and ground floor began. The walls have been made of reinforced concrete and casted into the frameworks to the approximate height of 5 meters. On finished walls, the framework with supports for the slab has been set up. Figure 6 shows completed ground floor slab and it also represents the last object status before the arrival of third contractor to the project. In a state which is shown below the project was put on hold from middle of August 2010 to February 2012.

Figure 6. Panoramic view of the completed ground floor slab (NFL, 2010)

After February 2012, the works on project has continued with execution of walls and slabs in both floors under the third chosen constructional company. Works which have followed were the implementation of the roofing, installation of joinery and facade implementation.

4.3 Roofing

The roofing of the extension has been made of spruce wood, including props and rafters, see Figure 5. The whole timber framework has been adequately protected and coated with fire-resistant and fungicidal coating. Instead of a conventional roof, prefabricated roofing panels of 20 cm thickness were fixed on the rafters.

Figure 5. Roof works

The roof has a slope of 6 degrees and a shed shape. Due to the requirement of fire-proofing (Urh et al., 2009), the panels were filled with mineral wool instead of polyurethane filler.

4.4 Access for persons with disabilities in motion

The entire facility is designed for the needs of persons with disabilities in motion. The main access to the building is provided on the zero level at the east side by passing two transition ramps. Access for persons with disabilities inside the building is enabled with central elevator in all floors of the facility. Alternative access to the floors of the building is also possible via central staircase made of natural stone, so that the design is consistent with the interior floor design.

4.5 Particularities of the construction site organization

Due to the specific requirements of the client, Ministry of the Interior, the project has been made in accordance with specific regulations. The opening of the construction site was possible upon the arrival of the concierge; however, work shifts of the required surveillance were suitably adapted to the needs of the scheduled construction plan. All participants in the project have been reviewed by the client for any past offenses. Based on past actions the attendees have been authorized to enter to the construction site for specific works. There was also controlled and secure access to the construction site for all other site visitors. Particular attention was also paid to the inspection of vehicles and cargo entering the construction site. All special works needed to be announced in advance so that processes in laboratories were not disturbed. Particular attention was paid to the implementation of rough works for example concrete drilling or cutting due to the sensitivity of investigative equipment.

4.6 Specific technical approach in design

Special attention was paid to the construction of certain facilities that were designed for investigations. These facilities include various laboratories, a shooting range and different storages. Most laboratories have been built in accordance with the required air pressure control. At the entrance to the laboratory, the intermediate air chambers were built with air compressors for pressure control. Thus, with the help of overpressure which prevents ingress of dust particles in the space where the research will be carried out. The integrated intelligent system that controls opening and closing doors additionally helps preventing incorrect entrances. Shooting range has been designed in accordance with the special requirements of the project execution plan (Urh et al., 2009a). Due to the specific rules, walls, ceiling and floor coverings were made of special material which can absorb large amounts of energy from the projectiles and has abrasion resistance. Furthermore, special acoustic plates have been mounted on the ceiling and walls for noise reduction and fire-resistance panels for preventing fires. The third set of special designed facilities represents different storages, where fire safety is important. To provide the necessary fire-resistance, special non-combustible panels were mounted including flame-retardant doors and a fire alarm system (Urh et al., 2009d).

4.7 Future reconstruction of the old section

With the completion of the extension, the works will begin in December 2013 after a short delay. The second part of the contract includes a complete reconstruction of the existing building. The existing building comprises a basement, ground floor and two additional storeys and was built with a traditional brick construction. The windows are made of wood and the roof is covered with asbestos panels. The facade is made of silicate bricks and is already worn out in some parts. Vertical communication throughout the facility is provided with stairs.

First activities of reconstruction will include preparations of the construction site and emptying the building, (Urleb et al., 2012). After that, minor demolition works will follow, including the floor, aluminium joinery and roof replacement. The roof will be unified with the new roof on the finished object and will be made of prefabricated roofing panels with a slope of 6 degrees and a shed shape. The facade will be replaced with the new one made of “sandwich” prefabricated facade panels with non-combustible mineral wool. Installation of the facade will be made to the existing, in some places it will be necessary to remove previous silicate brick facade. In the existing building a complete replacement of all installations will be done, including electrical and plumbing installation. Craft works inside the building will include all strands of finishing works. The completion of the reconstruction is expected in the first half of June 2014.

5. FUNCTIONAL DECOMPOSITION OF FACILITY AFTER EXTENSION

The building of the National Forensic Laboratory is together with the extension divided into the following sections (Urh et al., 2009c):

- garage,
- automobile repair shop,
- shooting range,
- storage,
- lobby,
- offices,
- laboratories,
- photo-video studio and
- auxiliary spaces.

Figures 6, 7 and 8 show the typical layout, transverse and longitudinal cross-section of the object after the completion of the extension.

Figure 6. Characteristic building plan after the extension (Urh et al., 2009a)

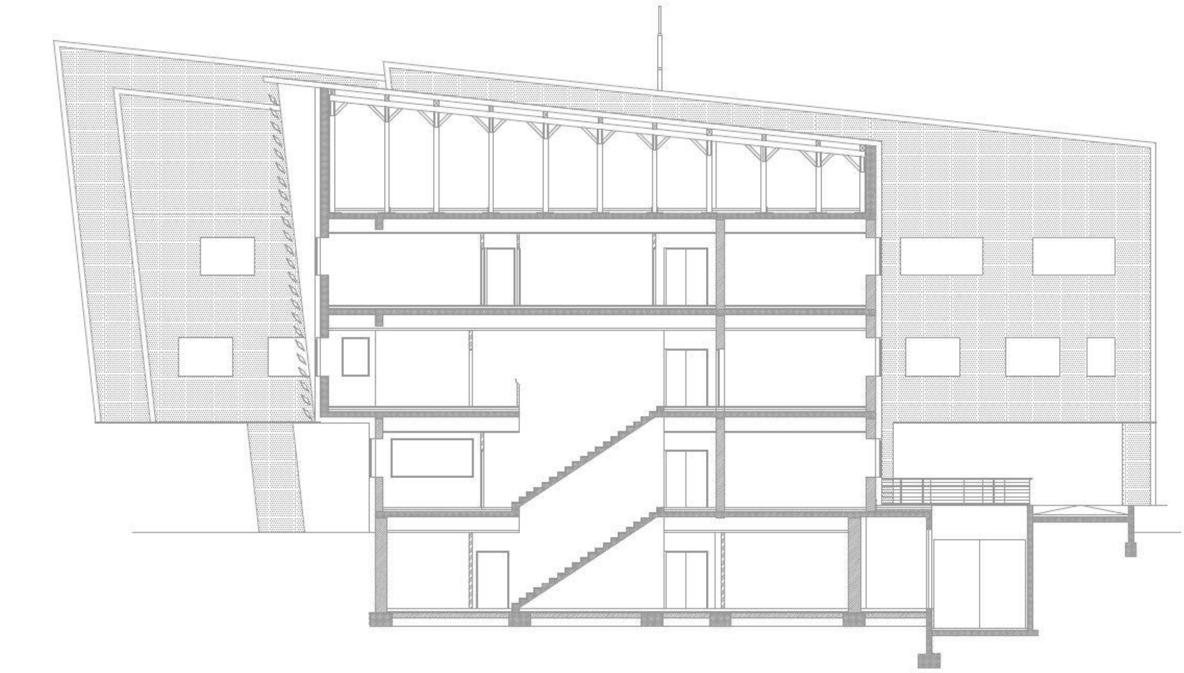

Figure 7. Characteristic transverse section of the building after extension (Urh et al., 2009a)

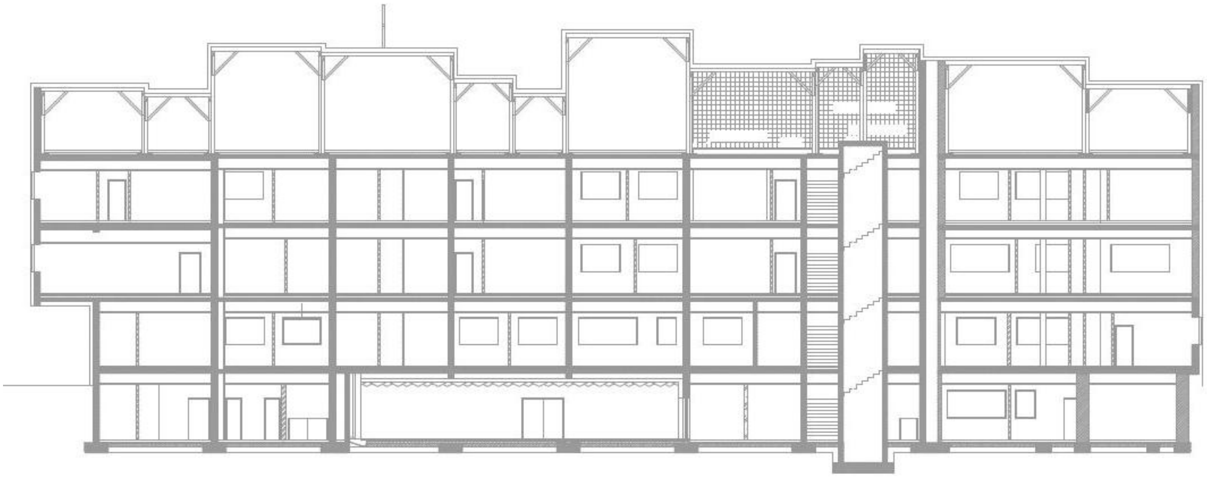

Figure 8. Characteristic longitudinal section of the building after extension (Urh et al., 2009a)

The basement floor is designed for automobile repair shop, garage, laboratory for fire testing and storage. There is also a shooting range with the collection of ammunition and weapons for the purposes of ballistics research. On the ground floor there is a lobby, for the reception of visitors, various offices and a photo studio. In this part of the building there are also different laboratories for examination of explosions and fire.

On the first floor there are laboratories for substance research, laboratories for comparative investigation of bio-fibres and premises for review of objects for colour analysis. In this part of the building there are also offices, storage spaces and research units for ballistics. The second floor is designed for production of samples, laboratory for DNA analysis and offices for technicians. The final appearance of the building is interesting because of the facade and undulating floor plan, see Figure 9.

Figure 9. The final appearance of the building

The shape of the object is rectangular with many consoles, which gives a different, modern look. Particularly interesting is the facade due to the implementation with fixed blinds and attractive design. Finished project represents an interesting and appealing facility because of the above mentioned characteristics and because of usefully distributed spaces for employees at the same time.

6. CONCLUSION

This paper presents an overview of the extension and reconstruction of National Forensic Laboratory in Ljubljana. The investor, Ministry of the Interior, has provided necessary financial resources for the completion of the project. Project documentation for construction works was created by Urh arhitekti d.o.o. and the main contractor was constructional company GIC gradnje d.o.o. from Rogaška Slatina. Works started with first contractor in May 2010 with the demolition and excavation of the construction pit. The second contractor started in August 2010 by making foundations, basement and ground floor.

After a delay, the third contractor has been assigned and construction works began in the beginning of February 2012. The finished building, including the reconstruction of the existing part, was put into use to the Ministry of the Interior in the second half of August 2014. With the reconstruction, extension and conversion of the National Forensic Laboratory an important building for the collection and examination of evidence from different crime scenes will be gained. Over the years, the experts' opinion and interpretations of their findings have become very useful for the police and important for judicial authorities in the trial processes. The new building also provides better working conditions and the possibility for further development.

7. ACKNOWLEDGMENT

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COMPARISION OF ORGANIZATIONAL CULTURE AND DESIGN OF CIVIL EGINEERING FACULTIES IN ZAGREB, OSIJEK AND BRNO*

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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. Organization, as a connected and structured set of individuals, is very vividly described by its organizational culture and structure. Analyzed organizations in this paper - through theirs organizational culture and structures - are Faculty of Civil Engineering Zagreb, Faculty of Civil Engineering Osijek and Faculty of Civil Engineering Brno. Organizational cultures were analyzed through surveys of the faculty members on the faculty level, on the department level and then among the subcultures in the organization. Surveys were conducted according to the earlier investigation of organizational culture and structure of the Civil Engineering Faculty in Zagreb, so that surveys presented in this paper could be comparable. Results of the surveys comparison were in most aspects very similar but significant difference were noted at general work satisfaction, interpersonal and students-personnel relationships, and implementation of new rules such as dress code both for students and faculty members.

Keywords: organizational culture, structure, University, Faculty, survey

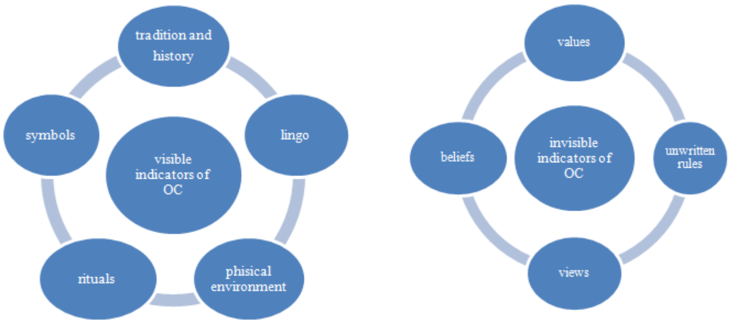
* The complete text is available on CD-ROM / Galić, Antić, Hanak

Introduction

Recent research of the organizational culture on Civil Engineering Faculty in Zagreb (Antić et al., 2010) has shown how organizational structure and culture are manifested on the entire organization through its employees and students, by their general satisfaction, communication, written and unwritten rules, current and desired system of values. This research was starting point of the organizational structure and culture researches on the Civil Engineering Faculty in Osijek and Civil Engineering Faculty in Brno, which are presented and compared in this paper. This paper's research methodology was similar to the mentioned earlier research so that these three researches can be compared and united to one research. Authors conducted a survey on their faculties with the questionnaire structured of the questions which were part of earlier survey on Civil Engineering Faculty in Zagreb. Although questions do not address organizational culture directly, they address the most important elements of organizational culture, especially satisfaction of lecturers with organizational climate. Survey consists of fourteen questions about organizational culture. In literature review authors also consider why organizational culture is important, is it a significant and comparable characteristic among similar organizations. Organization, as a connected and structured set of individuals, is very vividly described by its organizational culture. Dependent on the organization individuals, their principles and personality, size and structure of the organization, culture as a side effect of the organization existence can offer an explanation how well this organization operates.

1. Organizational culture – literature review

Most authors, ever since Peters and Waterman introduced modern organizational science with the concept of organizational culture in their book (Peters and Waterman, 1982), agree with following facts: (a) it is not easy to uniquely define organizational culture (OC) and (b) it is certainly a characteristic of all organizations, even those which ignore its existence. According to (Jones, 2004; Sikavica, 2011.; Schein, 2004) OC can be defined as a system of values and beliefs common to members of some organization which enhances fellowship and membership to the organization, but also a system to control the interaction inside the organization and organization with the environment. Even further, it could be described as *glue* which keeps together all the organizational segments and members (Sikavica, 2011.). Interesting definition of OC was stated by (Hofstede, 2012) saying that OC is "*The collective programming of the mind that distinguishes the members of one organisation from others*", even though collective programming of different people and their personal cultures in long terms is highly questionable. Possibly the most accurate definition of OC is a combination of two definitions given by (Pfister, 2009) saying that OC is the way that organization members cope with processes of external adaption and internal integration, and the way that processes are reflected on organization shared values, assumptions and social norms, and in addition to this definition (Schabracq, 2007, pp. 8) gives the dimension of time saying *"...culture produces the everyday reality of an organization"*.

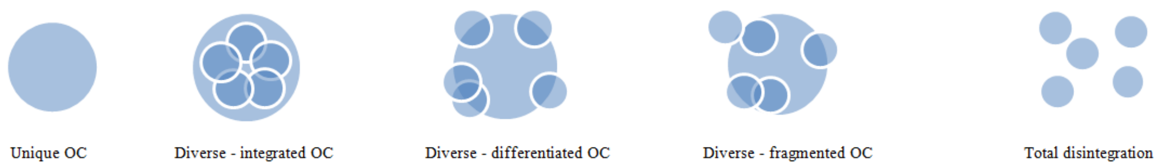


(fig. 1.) Visible and invisible indicators of OC

Organization culture is definitely set of measurable and immeasurable, or we could even say visible and invisible indicators (figure 1), values, beliefs, assumptions and connections between individuals and subcultures in the organization by which organization is recognizable. The reason why organizational culture became so interesting, to point in which is impossible to analyze an organization without analyzing its organizational culture, lies in fact that it affects organizational effectiveness. Earlier researches (Cameron and Quinn, 2006) have shown that neglecting the OC was the most frequently cited reason of failure of other organizational changes such as TQM, reengineering or strategic planning and downsizing efforts. According to (Jones, 2004) OC affects organization's effectiveness because it can:

- Provide an organization with a competitive advantage
- Improve the way an organizational structure works
- Increase the motivation of employees to pursue organizational interests

There are quantifiable indicators of OC, such as number of days to sick leave, replacement of ill personnel and staff turnover, data from audits of work satisfaction, work-related stress and motivation, which tell us about the climate within the organization which influences its profitability and financial health. But there are more indicators that significantly affect the profitability and financial health of the organization, which are very difficult to quantify such as: poor motivation of employees, low trust on the part of employees, internal and external disturbances in communication with all stakeholders and internal conflicts, external conflicts, missed opportunities, low or decreasing product quality, diminished attractiveness to potential new employees and undesirable publicity (Schabracq, 2007). In his paper (Carmeli, 2005) noticed a relationship between organization culture, withdrawal intentions and behaviour. In other words, when an employee shows or has intentions of such behaviour it will affect the functioning or productivity of the entire organization. However, it is very risky to exclusively consider OC as a tool to improve organization's effectiveness and financial health or tool of *managerialization* (Alvesson, 2002, pp. 46). An effective performance culture is hard to emulate, because it is embedded in a complex set of links that operate all the way from the level of organizational culture through to eventual organizational performance (Cooper et al., 2001), but it is certain that positive organizational cultures are those that enable the organization to improve (Cheung et al., 2012).



(fig. 2) Integration of organizational culture in organization

Each organization has its characteristic signs of organizational culture (figure 2) and therefore any organization, when considering culture, should first be considered separately. Analyzing the OC alone can't provide a clear answer about the organizations effectiveness or general efficacy. It has to be compared to cultures of similar organizations (benchmarking) or related to some other organization's characteristics or information. Organizations similarity, when analyzing OC, has to be noticed by any of the following parameters:

- organizational structure (design)
- organization's main activity
- number of employees
- number of organization locations
- subcultures

2. OC and design on Faculties of Civil Engineering in Zagreb, Osijek and Brno

OC and design – Faculty of Civil Engineering Zagreb (FoCEZ)

Like many others organization, FoCEZ 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. 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. 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' defences 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. FoCEZ 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.

Altogether 47 out of 69 senior lecturers filled the questionnaire (68,12%).

OC and design – Faculty of Civil Engineering Osijek (FoCEO)

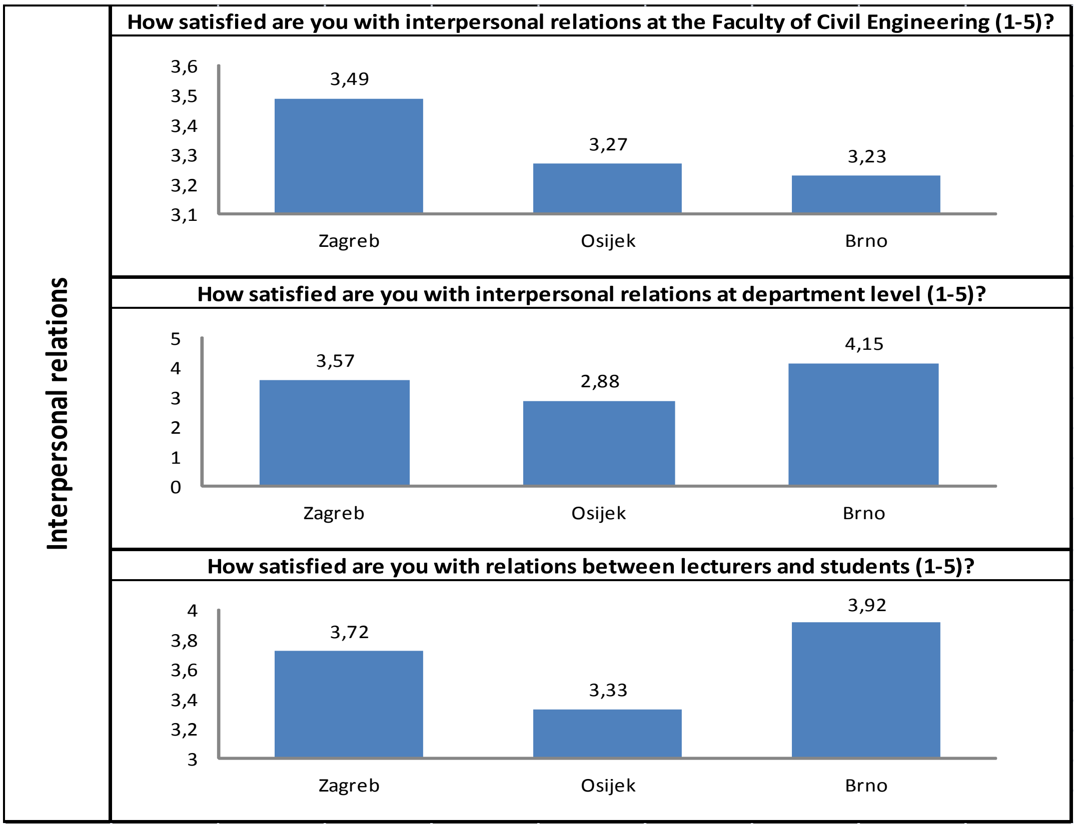
Similar to FoCEZ's organizational design, FoCEO is structured of 6 teaching and research departments, administration staff and other non-teaching staff. This similarity of the faculties provides a firm base for OC comparisons. At the time of writing this article FoCEO employs 88 people, of which 59 employees teaching / research staff, located at two faculty locations. At both locations is approximately equal number of cabinets and employees generally. Thus divided organization logically creates two subcultures within the organization: (a) employees who are most of the time on first location and (b) employees who are most of the time on second location. This fact makes harder to describe FoCEO's organizational culture as a single-strong culture. Unlike FoCEZ, where is noticed the principle of closed-door what is characteristic of authoritarian organizational culture (Sikavica and Novak, 1999), at the FoCEO is an interesting situation: on first location teachers generally have their office door opened, while on the second location they all have closed office doors. This can be explained by the fact that first location is autonomous in terms of space, while the second location is a leased building and shares some facilities with High School. The first important survey's indicator of organizational culture is the response to questionnaire which totals 75.3% (64 employees out of 85 employees filled out the questionnaire). The highest percentage of survey response in respect to the position is from the assistants and senior assistants (100%), and for non-teaching employees (96%). The lowest responses have lecturers and assistant professors (28%), while the response of senior professors is satisfactory with 68% completed questionnaires. Organizational culture in FoCEO is clearly present. Not dominant, it is clear, flexible and participatory. It is comprised of subcultures (the two locations, and divisions "younger-older, teaching and non-teaching staff, departments). OC on

FoCEO is diverse-differentiated in the organization (figure 2). Symbols, rituals and ceremonies are present and employees are aware of them, and by most are respected and supported.

OC and design – Faculty of Civil Engineering Brno (FoCEB)

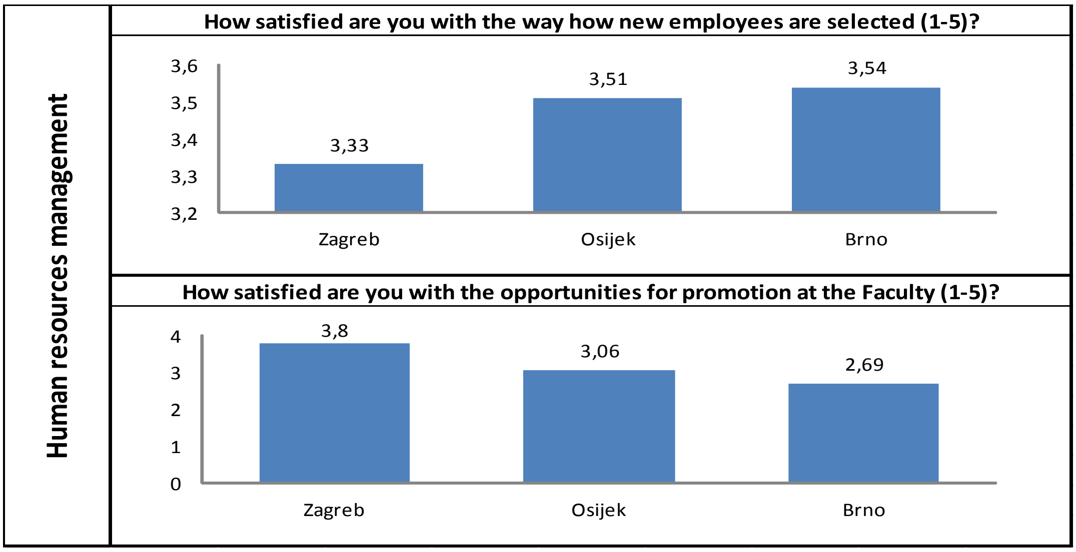
FoCEB consists of 23 teaching and research institutes, 6 administrative units and faculty library. In 2011, a total number of 384 teaching and research personnel were employed at the faculty, of which 25 professors, 75 associate professors and 284 assistant professors and assistants. Nowadays, the whole faculty is located in Veveří faculty campus which comprises of 9 buildings. However, in the past two decades, few institutes were temporarily dislocated in other university buildings due to extensive reconstruction of the campus and therefore dislocated institutes comprised their own subcultures. FoCEB is the oldest and the largest (with almost 7,000 students) faculty of the Brno University of Technology, founded in 1899. Probably due to long tradition, the rites of passage for students and rites of enhancement have the best score of all three evaluated faculties. These rites keep historical tradition and are carried out in historical premises of faculty or university assembly hall. Faculty itself is located in a historic complex whose facade is protected as a cultural monument of the Czech Republic.

Comparison results of OC surveys on three faculties



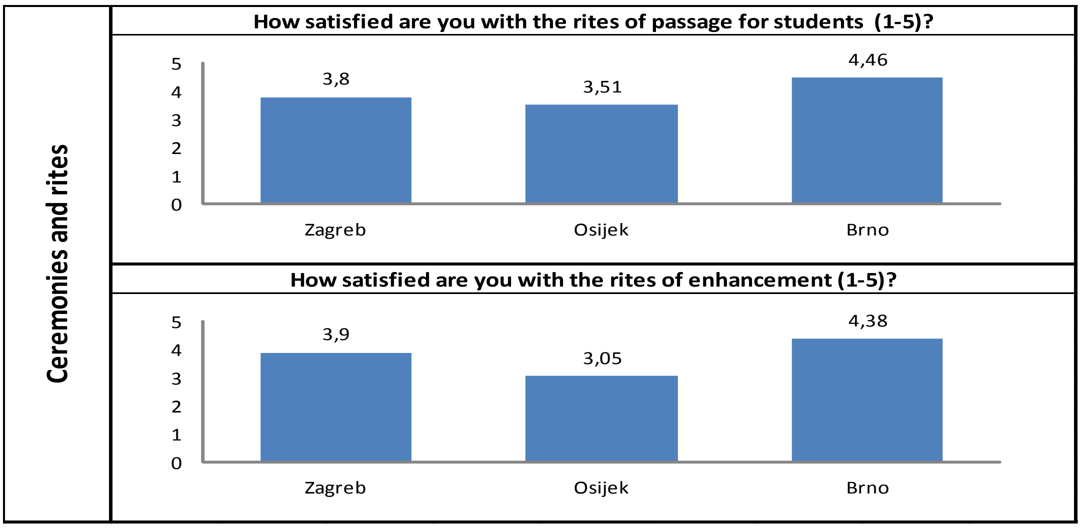
(fig. 3) Comparison of satisfaction with interpersonal relationships

As it can be seen on (figure 3) general satisfaction with interpersonal relations is lowest on FoCEO. Results to Q1 are similar and expected, but results on Q2 and Q3 indicate that employees of FoCEZ and FoCEO are significantly less satisfied with their relationships on the department level and with students. Interpersonal contacts among departments on FoCEB are not very often, so the result is 3.23 and it can be considered as neutral. This is also due to the fact that FoCEB has much more departments in contrary to FoCEZ and FoCEO, furthermore departments are quite large (e.g. Institute of Building Structures has more than 50 employees). Relations of teachers with students from 1st and 2nd year of study are formal, but from 3rd year of study students have to choose their specialization and thus students know teachers well and vice-versa (since they study more subjects with just 1 teacher). That is probably why relations students-teachers are evaluated top at FoCEB (3.92). On FoCEZ and FoCEO students choose their specializations on 4th year of study, and number of students on 4th and 5th year is significantly smaller than it is on first three years of study where relations are formal.

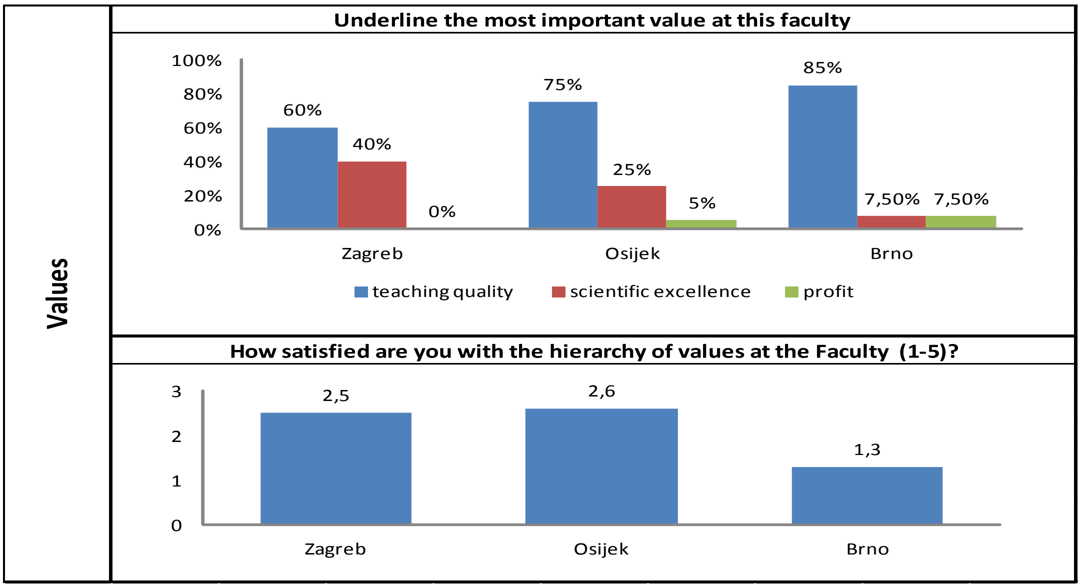


(fig. 4) Comparison of satisfaction with faculty's human resource management

Human resource management of analyzed OC on faculties is doesn't vary significantly (figure 4). On all three faculties selection of new employees is made in standard way so there are no negative opinions. Teaching staff has the only option of promotion by finishing PhD or appointment of Assoc. Prof. and Prof. by faculty/university. The conditions for Assoc. Prof. and Prof. are generally quite demanding, furthermore faculty must have approval from "accreditation committee" and university to be allowed to appoint Assoc. Prof. and Prof. The second option is to get managerial positions like dean, vice-dean, head of institute etc.

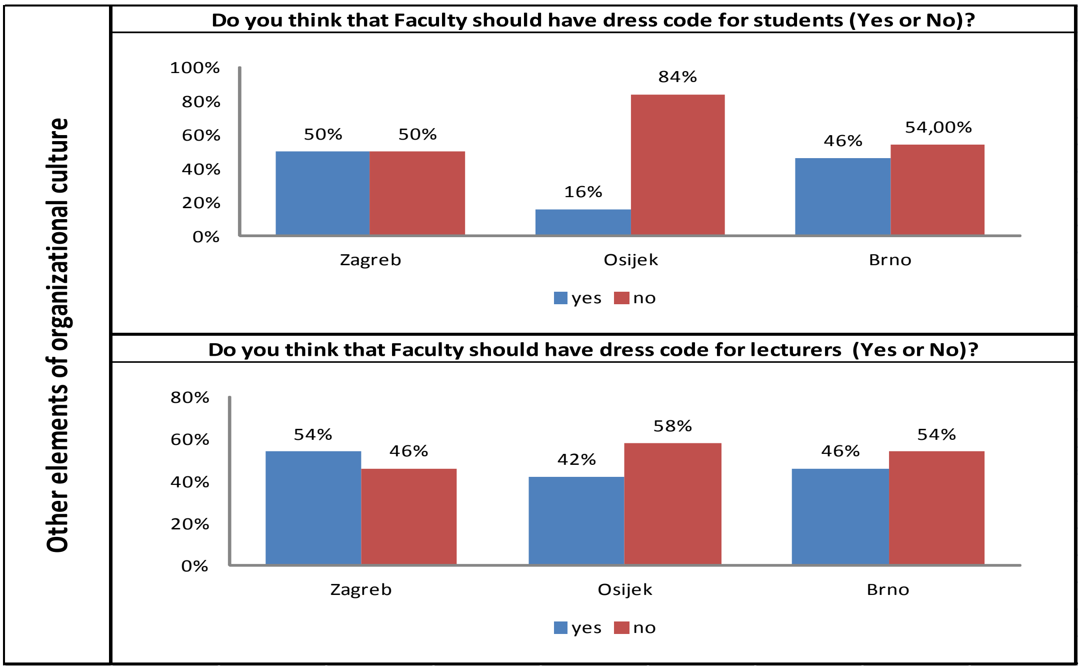


(fig. 5) Ccomparison of satisfaction with faculty's rites and ceremonies



(fig. 6) Comparison of values

Figure 6 shows that most of teaching staff on all three faculties traditionally considers that teaching activity is the most important mission of university. Management of the faculty stress the scientific work. Amount of allocated finances from the side of Ministries is considerably dependent on the results of scientific work. That is in contrast to the Q.8. where is considered that the most important value for the faculty is the profit (closely related with scientific outputs).



(fig. 7) Comparison of other OC indicators

3. Discussion and conclusions

Organizational design (structure) has a big impact on the organizational culture, but OC rarely has such a big impact on the design. Organization in its natural state tends to fragmentation into smaller parts - subcultures. On the faculties logical subcultures are based on the department levels, teaching and non-teaching staff, "young-older" employees, locations, etc. Comparing OC of these three faculties we can see this fact. Organizational culture is significant, in order of understanding organizational life in all its richness and variations in the organization (Alvesson, 2002). However, results of comparison do not offer much surprise. Lecturers (at the faculty level on all three faculties) are moderately satisfied with interpersonal relationship, with selection of new employees, with the opportunity for professional promotion and with the ceremonies at the faculty. Unexpected result, at the beginning of research, was a relatively low level of satisfaction with the value system on all three faculties. Similar results of OC on different faculties provide a firm base for further comparisons and OC research. Further research should include results of OC on other faculties of civil engineering in Croatia and abroad, and comparison of OC on faculties and OC in organizations in civil engineering practice.

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REENGINEERING THE CONSTRUCTION COMPANIES IN TIME OF THE RECESSION*

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Abstract

Traditionalism, difficult transformation and hard adaptability to demanding and changing market, are characteristics of construction industry. Compared to the other industries those characteristics can be called disadvantages. The effort of construction companies to maintain pace through its business and competitiveness with the current market is perhaps the main reason for problems they are dealing with today. Foresight and clear business strategy are obvious solutions to be one step ahead on the current market and to be a respected competitor. In time of the economic crisis this might be difficult to achieve. Other industries found the solution in reengineering which has been showed in long terms successful. In this paper authors have analyzed reengineering and its aspects as a possible response to construction company's poor performance. In the first part of the paper authors analyzed experiences with reengineering in companies which are not in construction sector, abroad and in Croatia, then they discuss the conditions and possibilities for implementation of reengineering in construction companies based on the case study construction company. This paper aim is to determine the methods, the most appropriate way and time to carry out the reengineering in construction companies. It has been pointed that reengineering as a Business Process Reengineering (BPR), which has been helpful for companies in non-construction sectors, isn't fully applicable for companies in construction sector.

Keywords: reengineering, process, lean, agile construction, optimization

* The complete text is available on CD-ROM / Galić, Završki, Dolaček-Alduk

Introduction

In the past 20 years, how long it is present, reengineering was equally number of times disputed and confirmed as a solution for troubled company's business. However, since the 1990s its presence and implementation, along with the IT development, is undeniable. Authors (Hammer and Champy, 2004) say in their book that reengineering is back in the limelight. Interestingly, reengineering returns to the focus of public attention with a return of the economic crisis and then usually considered as a devise or an injection that will as soon as possible repair and refresh poor results of unfortunate and usually excellent management. In this case, positive long term impact of reengineering will be absent, and apparent argument to challenge the reengineering will be obtained. Reengineering is a process and as a process it requires a strategic and precise plan for an appropriate implementation.
In the first part of this paper authors made a review of the literature to determine the current state of reengineering across industries, and to show the definition change in time and usage. In the second part authors have analyzed a performing construction company in Croatia named Company X. Analyzed business parameters were: organizational structure, number of employees, main activities, number and locations of realized projects, annual income, processes and sub-processes in the company's business, and ways of using the existing information technology. In the third part of the paper analyzed company was compared with companies that are similar by analyzed parameters, and which are competing with Company X at regional and national level.

2. Literature review

2.1. Business Process Reengineering – BPR

The most frequently cited and used definition of BPR was given by (Hammer and Champy, 2004) saying that BPR is a fundamental rethinking an radical redesign of business processes in order to achieve dramatic improvement rated by modern criteria such as costs, quality, services and speed.
The main characteristic of this definition is focus on company's necessary orientation change from task to process by holistic approach with fundamental changes of company's way of business.
According to this definition reengineering is exclusive: either it is carried out or not! There is no partial reengineering that will bring positive long term progress of the company. Partial reengineering brings confirmation of bad strategy and management's myopia, and it guarantees the continuity of poor business results.
However, there are different opinions of BPR researchers like (Davenport, 1992) saying that *classical* reengineering practically means downsizing and that it has to be carried out cautiously and successively using company's experience. Even though, authors (Hammer and Champy, 2004) and (Betts and Wood-Harper, 1994) say that when reengineering is planned and carried out correctly it doesn't necessary has to result with employee downsizing, rather it means that with the same number of employees to produce more, to be more productive. It is the easiest way to reduce company's expenses by cutting salaries or even layoffs. If the first step of reengineering is downsizing it is highly questionable: who and how is caring out reengineering? Is it that same management with same ideas which has brought that company in the poor position in which reengineering is needed as a *fast solving life-saving injection*?
In table 1 we can see in supplemented chronological order (Nelson et al., 1999): how, when and in which context authors have defined reengineering, its principles and expected outcomes:

Authors	What	How	Expected outcomes
(Davenport and Short, 1990)	Business process IT Strategy Organizational structure	Analysis and design	Business improvement
(Manganelli and Klein, 1994)	Strategic evaluated business process System, policy and organizational structure	Quick and radical redesign	Optimization of production workflows
(Ryan, 1994)	Market, clients, products, services, suppliers and benchmarking	Fundamental changes	Business improvement
(Teng et al., 1994)	Ongoing workflow	Critical analysis and radical redesign	Significant improvement of efficacy
(Elzinga et al., 1995)	Systematic analysis of improvement, control and management	Processes analysis	Quality improvement of products and services
(DeToro and McCabe, 1997)	Functionally related work teams	Testing and modification methods	Business improvement
(Zairi, 1997)	Production Marketing Communication	Analysis and design	Continuous improvement of the main activities
(Hayes et al., 1998)	Experience and data bases Processes Techniques Equipment Technical infrastructure	Change of business approach, IT problem modelling	Fundamental changes in the way of business
(Sobotka, 2000)	System research models Bottle necks research Optimizing in respect to company's objectives	Simulation modelling and multi variant solutions	Logistics improvement in the project planning stage
(Cheng and Tsai, 2003)	Processes defining Selection Operations analysis	Representation, transformation, evaluation and process redesign	Business improvement
(Đukan et al., 2004)	Client satisfaction Risk management Quality insurance Flexibility	IT implementation and radical organizational redesign	Significant business improvement
(Suman et al., 2009)	Organizational structure Connected project team	Implementation of IT and mobile communication	Business improvement
(Kararić and Završki, 2012)	Organizational culture and design Company's competitiveness	Outsourcing, TQM, benchmarking, virtual communication, learning organizations	Business improvement with constant monitoring

(tab. 1) BPR literature overview

As we can see in table 1, authors suggested that reengineering is a process of business improvement in which IT implementation is inevitable as way of modern business. Improvement is expected by the change of organizational structure, communication, company orientation, product quality insurance. Concluding the definition of BPR it is necessary to add that reengineering is a *modern* set of approaches to management which provide company's business performance improvement by improving its business and work processes. Will it be a radical and dramatic improvement depends on the state of the company and management characteristics which implements reengineering.

2.2. Construction Process Reengineering - CPR

Application of reengineering in construction industry is possible in two ways: (1) classical BPR of the construction company; and (2) reengineering of the company's production processes CPR. Those two reengineering processes are different and directly related because the impact of the company's operation productivity on the company's business productivity is evident. However, earlier researchers (Mohamed, 1997; Chan et al., 1999) have pointed that BPR is not fully adoptable in construction industry due to its uniqueness: clients and other project participants have a significant impact on how organizations conducts their business, changing boundaries and limitations (*ad hoc* processes), difficult to model, dominantly project based, etc. Concept of construction process reengineering CPR was recognized in the USA in late 1990s as a result of the massive BPR theoretical and practical applications in all economic sectors. CPR philosophy is based on the assumption that construction productivity can be improved by reducing the overall construction time and costs while increasing the value and quality of construction products (Ćirović, 1999), or by integrating lean principles and computer simulation techniques (Mao and Zhang, 2008). CPR has been defined by (Love et al., 1997) as an "*innovative, integrated and holistic approach to the project delivery process focusing on setting and high standards in key performance measures whilst fulfilling the ultimate customer requirements and satisfying individual business needs of each participant*''. While (Mohamed, 1997; Chan et al., 1999) directly suggest that CPR is an approach *"customer focused, project based, process oriented, performance improved and value generated."*

Main goals of CPR, given by author (Ćirović, 1999), are: empirical data base in order of understanding the construction processes and learning organization, determination of responsibility for the process of design making, implementation of principles and methods of construction process improvement, researches and monitoring methods.

Practical examples of implemented BPR (Hammer and Champy, 2004) in companies like IBM Credit, Ford or Kodak are true indicators of the transition from task to process in their business, with the inevitable help of IT. Highly specialized jobs were replaced with the related multi-disciplinary processes. Modern managements committed to the customers, such as: global quality management (TQM), a competitive engineering, just-in-time management and benchmarking, are consolidated into a coherent term Lean Production, as a natural response to the end of the previous mass production (Betts and Wood-Harper, 1994). It can be concluded that lean production is an unavoidable by-product of the reengineering. Recently, the concept of lean production slipped in the construction industry through its propositions: reduction of waste, reduction of production costs, reduction of production time, optimizing production (Mao and Zhang, 2008). Authors (Betts and Wood-Harper, 1994) very well predicted and concluded that the process maps must replace the management flow charts, then it can be worked out to details in order of reengineering easier implementation, and IT implementation is a key factor in this.

In his report "*Rethinking Construction*" in 1998 Sir John Egan stated that if the construction companies want to improve their business they firstly have to change their traditional way of business, their top and lower management has to be highly committed to work, their company policies have to be customer focused, and their business has to be structured of the integrated processes and teams, while maintaining quality insurance through TQM; and IT is the *enabler (Kagioglou et al., 1999).*

In 2001 International Council For Research And Innovation In Building And Construction (CIB) conducted a survey among worldwide construction companies to point the main industry problems (Courtney and Winch, 2002) and stated problems are: fragmentation of responsibilities in construction projects, concentration on the initial costs, conflicts, inadequate or lack of information, poor quality. These problems are universal in construction industry and a quest to science and practice to reduce or even solve them.

3. Conditions and possibilities of implementing reengineering in case study - Croatian construction Company X

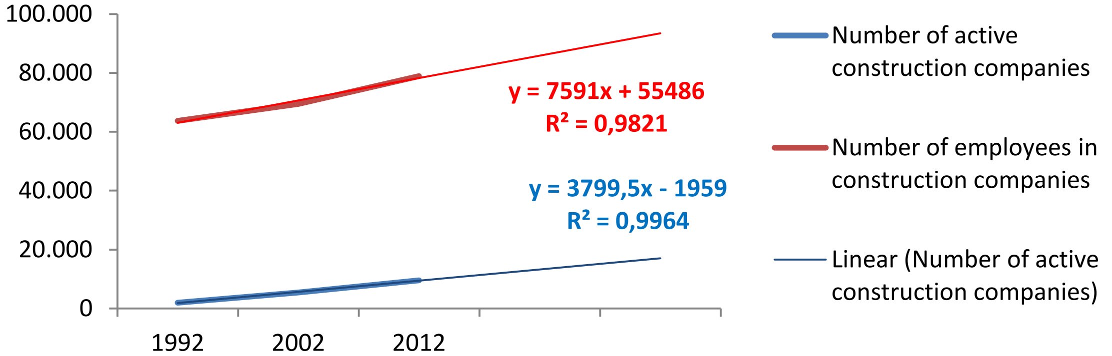
3.1. Description and analysis of construction industry in Croatia

Harsh and colloquially called "unfair" competition caused by the current market's lack of interest for certain buildings constructions (such as residential and non-residential buildings), and at the same time market's emphasizing the criteria of quality assurance while reducing costs, becomes an argument for need of reengineering in Croatian construction companies. The current way of business of the major construction companies is almost fully described by the CIB's problems in construction which have been mentioned earlier. IT implementation for improving business in the construction companies is still considered unsafe and unnecessary. A study published in paper (Izetbegović et al., 2004) shows that the majority (67%) of managers in Croatian construction companies are only partially satisfied with the existing use of IT in companies and that they are aware of the need for additional education. The classic approach to business confirms data from the same survey, saying that 66% of respondents believe that IT is a key factor for the company's competitiveness on the market.
The number of active construction companies and the number of employees in construction companies since 1992 until 2012th, adapted from research published in paper (Đukan et al., 2004) and from the Croatian Chamber of Economy, in the period of over 20 years is increasing (table 2):

	year	1992	2002	2012
total number of active construction companies		1972	5377	9571
number of employees	0-50 employees	1784	5091	9319
	51-250 employees	122	226	213
	more than 250 employees	66	60	39

(tab. 2) Number of construction companies with main activities: construction of residential and non-residential buildings in Croatia

By the trend of increasing number of small businesses it can be concluded that competition among them the will strengthen, but also increase possibility of mergers of small businesses in order to become competition to medium and large companies. To increasing number of construction companies authors added a trend of number of employees in the construction industry in the same time intervals (figure 1), to get a clearer view of the industry trends:



(fig. 1) Trend of the number of companies and employees in the construction industry in Croatia

3.2. Description and analysis of Company X

Company X is a Ltd private construction company founded in 1946. in eastern part of Croatia. The main company's activity is building constructions, and it is classified by the Croatian Chamber of Economy as a large company due to number of employees and company's revenue. By the Croatian Chamber of Economy, Company X in 2012 had a 642 employees and earlier research (Šandrk Nukić, 2012) shows that in the last four years number of employees is almost the same (table 3):

year	2008.	2010.	2012.
number of employees	650	640	642
annual income [mill. €]	42,5	58,9	60

(tab. 3) Company's X number of employees and annual income in past 4 years

Company has a license to build the most demanding technically and technologically buildings (Group A) issued by the Croatian Ministry of Environmental Protection, Physical Planning and Construction from April 2008th, and also ISO certification ISO9001: 2008 and ISO14001. With a long tradition company has also a long list of national and international awards.

year of the project completion	number of projects
before 2000.	23
2000.	4
2001.	5
2002.	4
2003.	4
2004.	5
2005.	16
2006.	9
2007.	30
2008.	25
2009.	21
2010.	4
2011.	1
still active	17
total completed projects	**168**

(tab. 4) Company's X number of projects

From 2000 till 2012 Company X has 128 completed projects (table 4) and it can be seen that company's high point is in 2007 and from that year number of projects is significantly decreasing. Total number of completed and active construction projects (168) is more defined by the distribution by category of the buildings shown in table 5:

building	number of projects
dwelling houses	18
gas stations	13
religous buildings	18
industrial buildings	19
cultural inharitage buldings	20
commercial buildings	20
schools	20
sport and recreational buildings	20
reinforced concrete halls	20

(tab. 5) Company's X scope of construction buildings

Uniformity of projects due to the category of buildings shows continuity of operations, a clear management strategy and a clear vision of the market. To gain clearer impression of the company business authors analyzed locations of completed projects in relation to distance from the company's headquarters and production facilities (table 6):

total number of projects:	168
number of projets which are in the company's metropolitan area:	90
number of projets which are outside of the company's metropolitan area:	78
Avarage distance between company's headquarters and facities [km]:	40,97
number of projects in range of 0 -20km:	5
number of projects in range of 20-30km:	14
number of projects in range of 30-40km:	14
number of projects in range of 40-50km:	9
number of projects in range of 50-100km:	24
number of projects in range of 100 -200km:	1
number of projects in range of 200 -500km:	10
number of projects in range of preko 500km:	1

(tab. 6) Distances of company's project in relation to its headquarters and facilities

Table 6 shows that more than half of company's projects are in metropolitan area of the company, and the other half is located in distance of 100km. It can be concluded that the company does business at the local level because of its production capacity and availability of machines that allow competition in that market, and the functional organization structure of the company. Individual projects beyond the reach of local businesses are possible the result of the current market saturation of the types of buildings for which Company X has the knowledge and references. The organizational structure of the company is typical functional structure, characterized by decentralized decision making function and narrowly specialized managers with the latent risk of sub-optimal decisions (Sikavica and Bahtijarević-Šiber, 2004).

3.3.Comparison of Company X with the competitive companies in Croatia

In table 7 authors compared Company X with the similar large construction companies with same main activity as Company X, and by parameters such as the number of employees, total annual income, the share of annual expenses for salaries and total annual revenue for year 2012 (table 7):

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Construction company	**number of employees**	**total annual income [€]**	**(3)/(2)**	**license**	**share of annual expenses for salaries**	**(6)/(3) %**	**year of company's foundation**
Company X	**642**	**60.000.000,00**	**93.457,94**	**A**	**7.190.374,32**	**11,98%**	**1946.**
Company 1	606	39.333.333,33	64.906,49	A	6.787.175,76	17,26%	1984.
Company 2	846	119.333.333,33	141.055,95	A	9.475.166,16	7,94%	1992.
Company 3	1131	107.333.333,33	94.901,27	A	12.667.154,76	11,80%	1947.
Company 4	381	56.666.666,67	148.731,41	A	4.267.184,76	7,53%	1989.
Company 5	362	54.000.000,00	149.171,27	A	4.054.385,52	7,51%	1993.
Company 6	321	23.333.333,33	72.689,51	A	3.595.187,16	15,41%	1948.
Company 7	225	67.333.333,33	299.259,26	C	2.519.991,00	3,74%	2000.
Company 8	252	59.333.333,33	235.449,74	A	2.822.389,92	4,76%	1994.
Company 9	156	40.666.666,67	260.683,76	A	1.747.193,76	4,30%	2002.
Company 10	81	34.000.000,00	419.753,09	C	907.196,76	2,67%	1991.
Company 11	285	20.666.666,67	72.514,62	A	3.191.988,60	15,45%	1991.

(tab. 7) Comparison of large construction companies in Croatia

This comparison is descriptive and doesn't show current or future performance of the business, it serves only to determine the intervals of some parameters for description of Company X. Companies which are used for comparison are not direct competitors to Companies X, they are similar by their main activity and by their category. It can be seen that companies with smaller number of employees (250-400) have significantly higher income by one employee than Company X and that share of annual salary expenses in relation to total annual income is relatively high (11,98%). The explanation of this can be found in the fact that the Company's X ratio of operating and non-operating staff (in terms of construction site operators and administration) is 1:1,15.

3.4.BPR or CPR of the Company X

Company X has a long tradition and a long list of references in its core of business. Logistics and technological equipment of the company is at a high level, which has allowed businesses to grow but locally. By business analysis it is evident that the company is not expanding the market, but for now does business with the increase of total annual revenues while maintaining a constant number of employees. Competitiveness of the company is provided with its references, as well as manufacturing facilities and technology, which also prevents company to expand its market in the wider area. Certain saturation among local market is one of the potential problems of the company, as well as growing competition by opening markets. Another potential problem is the current way of business through direct agreement without public tenders, only 20% of the company's projects were gained through public tendering (Šandrk Nukić, 2012). Fragmentation of the functional units, which is caused by failure of management, and fragmentation of responsibilities as a result of strict functional structure of the company, are characteristics that hinder company's business. Operating segment of the company is rather unrelated to the rest of the company's structural segments. Operating site engineers are most likely, and find easier, to agree among themselves for various combinations of resource allocation (working groups, machinery or materials) than by management. Communication between logistics, management and construction site operational units is still traditional: direct meetings or via mobile phone. Implemented control system (System Application Products-SAS) project is still more concerned with business process management and logistics, rather than production. So, reengineering in this company makes sense in terms of redesigning business processes, while in the production processes there is no need for radical changes while keeping the current practice of investing in additional trainings for their employees and in new technologies, as well as the investment in IT and IT knowledge, and through this prospective Company X is already in constant cycle of reengineering. Therefore, the most likely improvement of the company's business is through a redesign of the organizational structure. Matrix structure or heterarchy is more appropriate structure for modern large companies, but it is also clear that private companies in general this type of company structuring still hasn't fully accepted. Despite the positive financial performance of the Company's X reengineering should not stop and should serve only as small steps in improving certain processes. The market situation for the large companies can change significantly in a very short time and therefore they need to be one step ahead. Strategic expansion of the Company's X business is possible through two aspects: the expansion of the scope of activities which should be accompanied by expanding the technology, expertise and manufacturing plants, or expanding operations to other markets with the initial determination of the potential market and competition, and the establishment or moving production facilities. Reengineering which is in progress in Company X should be slightly more radical but not as much authors (Hammer and Champy, 2004) suggest. Davenport's reengineering of the *broken* process is more adequate for this case study construction company.

4. Discussion and conclusion

While planning about the implementation of classical BPR or applied BPR in the construction processes CPR, it is necessary to keep in mind the questions that must be asked and answered:

Who is caring out reengineering and who is responsible for its outcomes?
The authors who are cited in the literature review reluctantly wrote about who has carried out reengineering in their case studies, or who should be necessarily implemented in reengineering and who is responsible for reengineering outcomes. Reengineering is certainly not carried out alone or it can be done by an individual. It can be lead by teams inside which are already part of the organization or teams outside of the organization in which is reengineering caring out. Clearly, if the company's management strategy and policy brought the company to the point of poor business results it is logically to question the credibility and ability of the same management to implement reengineering. Responsibility for reengineering in both cases is entirely on the current management.
What should be reengineered or redesigned?
There is no and there will never be some general recipe for reengineering. Every company and in certain situation has to be considered and analyzed separately. But the case studies of implemented reengineering suggest the systematic process of reengineering divided into four interrelated and dependent steps with feedback:

Step 1: recognized deformed processes or segments should to be reformed
Step 2: already reformed processes or segments should be harmonized
Step 3: already harmonized processes or segments should be confirmed
Step 4: already confirmed processes or segments should be executed

Business process is the object of the reengineering, if the object becomes management or employees reengineering is no longer effective. Changes in management, employees and business should only be the result of reengineering.
How to carry out reengineering?
Will there be a radical reengineering, with the fundamental shift in business or determination and redesign of individual processes depends on the state of the company, its objectives and capabilities of employees, but also of the reengineering team. In the construction industry the recent significant development of information technology enables solving the fundamental problems such as the integration of project units, strengthening earlier phases of projects, modeling and planning processes, but still not fully recognized by the practice. So, like most authors suggest reengineering has stronghold in high IT implementation in business.
When to start with reengineering?
Reengineering in modern construction companies should be constant; they should always be in the process of reengineering. If reengineering starts at the stage when the company already operates with poor results for a long time then reengineering becomes ineffective. Surely as a process it takes time and precise plan.

Reengineering team with clear answers to the questions above has the fulfilled conditions for reengineering implementation which could offer improvements in the operations of the company. It should be pointed that naturally reengineering is in progress on the performing business. Construction industries in Croatia and abroad are facing nearly the same fundamental problems. Potentials of present achievements of IT are used insufficiently in construction industry compared with other industries. Awareness and a tendency to expand the use of privileges and opportunities offered by IT are small, but still visible. Downsizing of employees in relation to the growth of construction companies is a clear indication of the reengineering caused by the economy crisis. For the Croatian construction companies reengineering proposed by the authors (Hammer and Champy, 2004) as a radical and fundamental shift in the business whish need to make drastic improvements in operations are not applicable, and it will be very difficult for the construction companies to give up the company processes which they have done well for a long time. More applicable reengineering is that one proposed by the author (Davenport, 1992) where the reengineering is carried out on the processes or segments which are not functioning properly. In the case study Company X this is clearly visible because the company is doing well, but some processes should and could be much better. Modern aspects of management such as Total Quality Mengement, the Lean and Agile Production, Value Management, etc. are operational reengineering CPR, and as such are already in use in the construction practice in Croatia and abroad.

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EFQM-EFFECTIVE TOOL FOR CONTINUING IMPROVEMENT OF QUALITY MANAGEMENT IN A CONSTRUCTION COMPANY*

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Abstract

The purpose of this contribution is to increase quality level of construction organization applying the EFQM (European Foundation for Quality Management) excellence model. It provides analysis of current quality management trends, defines EFQM model structure and criteria and possibilities of its introduction in construction companies. In our contribution is also proposal of electronic manual and automated system of evaluation the criteria and sub-criteria of EFQM model by company management and also by external auditors. Empirical methods are applied to an electronic survey that aimed to determine knowledge of the EFQM model and its use in practice among organizations operating in Slovakia. Methods of scientific analysis was used during the evaluation of current issue of Quality Management level and EFQM criteria implementation in construction sector. Scientific synthesis method was used during the process of EFQM model development and in a process of electronic manual creation. The main results of our research work was to propose the methodology concerning the EFQM model development and implementation in a construction company and application of electronic manual and software for automated evaluation of construction company quality management level. This results allows in a relatively short time to identify the opportunities continually improve quality management level in construction company.

Keywords: quality management, model, construction, effectiveness

* The complete text is available on CD-ROM / Gašparik, Gašparikova, Elingerova

Introduction

The EFQM excellence model is an European model based on Total Quality Management – TQM (Oakland, J.S.,2003). It is designed for all organizations that are interested in continuous improvement and progress towards excellence. The main purpose of the EFQM model is self-assessment of the organization in order to achieve continuous improvement of quality. It helps identify strengths and opportunities for improvement and encourages solutions. It allows for an independent view on the organization and its functioning (Hakes, C., 2007).
The EFQM model is a basis for assessment and evaluation of a business aspiring to receive the European Quality Award (EQA), but also the National Quality Award of the Slovak Republic. In order to win the EQA, the model must be applied for at least three years and the first is auditing by itself organization and then by professional auditors.
Similar model for public organization is model CAF (the Common Assessment Framework), but our contribution is focused into model EFQM.

2. Structure of EFQM model

The EFQM model was created by the European Foundation for Quality Management (EFQM), which was founded in 1988. Its establishment involved fourteen large European corporations. The aim of the foundation was to create a model based on Total Quality Management (TQM) in order to achieve excellence in European companies and make them competitive in comparison with the U.S. and Japanese companies in the global market Porter, L. J. - Tanner, S. J., 2004). Society-wide recognition of quality in the USA (Malcolm Baldridge National Quality Award) and Japan (Deming Application Prize) proved that the application of TQM models delivers measurable business results to organizations. The EFQM model first appeared in 1991 and it was called The European Model for Business Excellence (EFQM, 2003). It was innovated in 1999 and in 2010 and became more universal and applicable in a larger number of organizations. For public administration, the CAF (Common Assessment Framework) model was developed. It was launched in 2000 and revised in 2002.
The EFQM model is based on 9 criteria : leadership, policy and strategy, people, partnerships and resources, processes, customer results, people results and key performance results. The first 5 criteria are enablers (what the organization has got) and the remaining 4 criteria are results (what the organization achieves). All criteria are divided into sub-criteria; the total is 32 sub-criteria. The diagram of the model, together with score for each criterion is shown in figure 1. The direction of arrows shows the dynamic nature of the model. Innovation and learning help improve enablers, which leads to improved results. This process is continuous. Criteria and sub-criteria of the model are very sophisticated and deal with all areas of the organization, even with the environment surrounding it. The model emphasizes the ethical principle crucial for those who are exceptional. Quality Management System according to ISO 9001 and TQM philosophy are bases for application of EFQM model.

3. Survey concerning the EFQM model implementation

The survey concerning the EFQM model implementation has been carried out during three months in year 2011 by the form of electronic and anonymous questionnaire. There were surveyed 160 construction companies in Slovakia of all sizes. The questionnaire completed 36 of them.
The issues were identified about whether the model has been applied for excellence in the organization, the purpose of its application (or the reasons not to apply it), as well as interest of the construction company to introduce the EFQM model in the future.
Graphical interpretation of some of the responses is shown in tables 1 and 2 and figures 2 and 3.

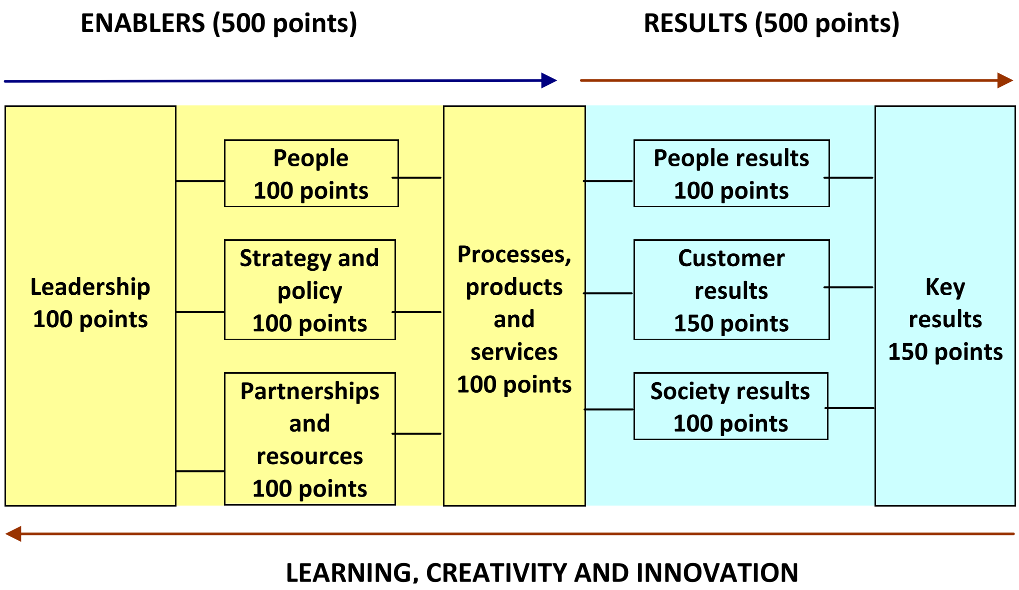

Figure 1 EFQM Model Structure (last revision in year 2010)

Table 1 Application of the EFQM model at present or in the past in surveyed companies (Gašparík, J., Gašparík, M.,2012)

EFQM application at present or in past	Number of answers	%
YES	4	11
NO	32	89
Total	36	100

The results obtained by survey (Gašparík, J., Gašparík, M.,2012) shows that the EFQM excellence model and its application in practice in Slovakia are still relatively new, unexplored issues. Most companies do not exclude its application in the future, but they need much more necessary information about this model and effective training process. The solutions contained at this contribution can be helpful for the performance of the EFQM model to organizations, which have aims to continually improve their quality management level and implement maximum positive effects in future activities.

3.1 Problems and areas for improvement regarding the EFQM model application in construction organizations

The results obtained by survey shows that the EFQM excellence model and its application in practice in Slovakia are still relatively new, unexplored issues. Most companies do not exclude its application in the future, but they need much more necessary information about this model and effective training process. The solutions contained at this contribution can be helpful for the performance of the EFQM model to organizations, which have aims to continually improve their quality management level and implement maximum positive effects in future activities.

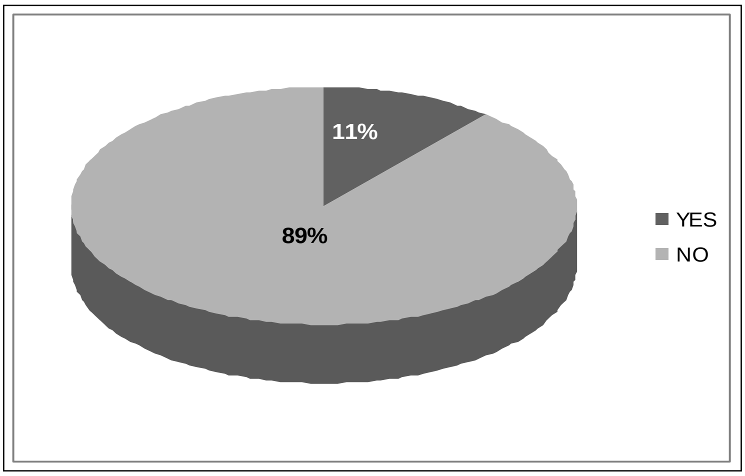

Figure 2 Application of the EFQM model at present or in the past in surveyed companies (Gašparík, J., Gašparík, M.,2012)

Table 2 Interest of surveyed companies to implement EFQM model in future (Gašparík, J., Gašparík, M.,2012)

Interest to implement EFQM model in future	Number of answers	%
Definitely YES	13	36
Probably YES	14	39
Rather NOT	9	25
Certainly NOT	0	0
Total	36	100

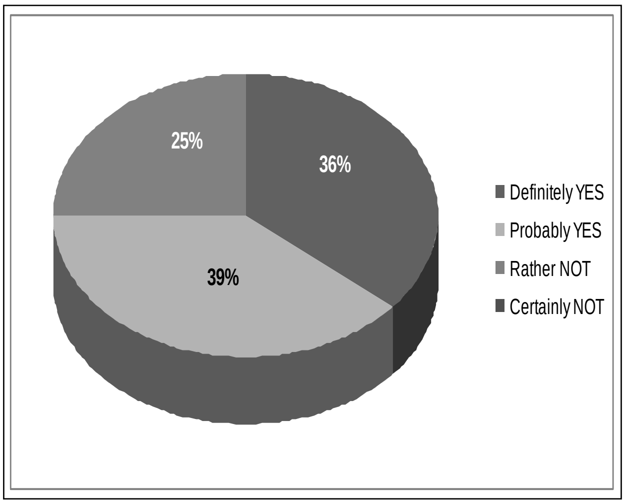

Figure 3 Interest of surveyed companies to implement EFQM model in future
(Gašparík, J., Gašparík, M.,2012)

The path towards excellence according to the EFQM model is a long-term process that must be upheld by the whole business from the top management to the last employee. If only the top management desires the introduction of the EFQM model and then delegates the application duties to employees – failing to properly explain its effects – it encounters resistance and the process is doomed.
The current competitive environment in the global marketplace requires organizations to continuously improve quality. This applies not only to products, but also to processes and management. Today, it is often not enough to satisfy customer needs, but it is necessary to exceed them. This requires excellence in organizations. One of the tools that can help organizations on their path of improving and achieving a lasting success is the EFQM excellence model understanding and effective implementation.

4. Methodology for the EFQM model application in construction organization

During the research work at this area, we propose a methodology for application of the EFQM model, which is proposed especially to manufacturing organizations, which have developed and implemented Quality Management System (QMS) according to standards ISO 9001 and plan further development and improvement of the existing management system
using the model EFQM. Steps of the methodology are illustrated in figure 4.

4.1 Manual for the EFQM model implementation

Electronic manual is designed on the basis of the EFQM model criteria and sub criteria requirements and helps to organization in a shorter time to understand and apply the EFQM model and evaluate their own performance and effectiveness. The structure of the proposed manual consists of three main parts:
• analysis of EFQM model requirements defined by criteria and sub criteria and determine the existing quality level of the organization and opportunities for improvement,
• self-assessment system of organization quality management level using the criteria and sub criteria of the EFQM model by electronic automated system.

4.2 The evaluation system of the EFQM model criteria

EFQM model consists of prediction and result parts. For each of them is in the manual suggested a specific method of evaluation. In this paper we provide an example evaluation of prediction part of the EFQM model.
In the process of self-assessment of the organization is for each of the manual requirements of prediction part of the EFQM model selected phase of applications based on the Deming cycle (tab 3) and the performance level (tab 4).
The selected phase applications and performance levels are the basis for calculating the assessment for the achievement of the criterion and sub-criterion requirement. Position in the current phase of the application assumes management of the previous phases. If the company in meeting this requirement found for example in phase "act" with the degree to 0.5, the overall percentage achieved in meeting this requirement are:

$$\underset{\text{PLAN}}{1x10} + \underset{\text{DO}}{1x15} + \underset{\text{CHECK}}{1x20} + \underset{\text{ACT}}{0{,}5x25} = 57.5 \quad (\%)$$

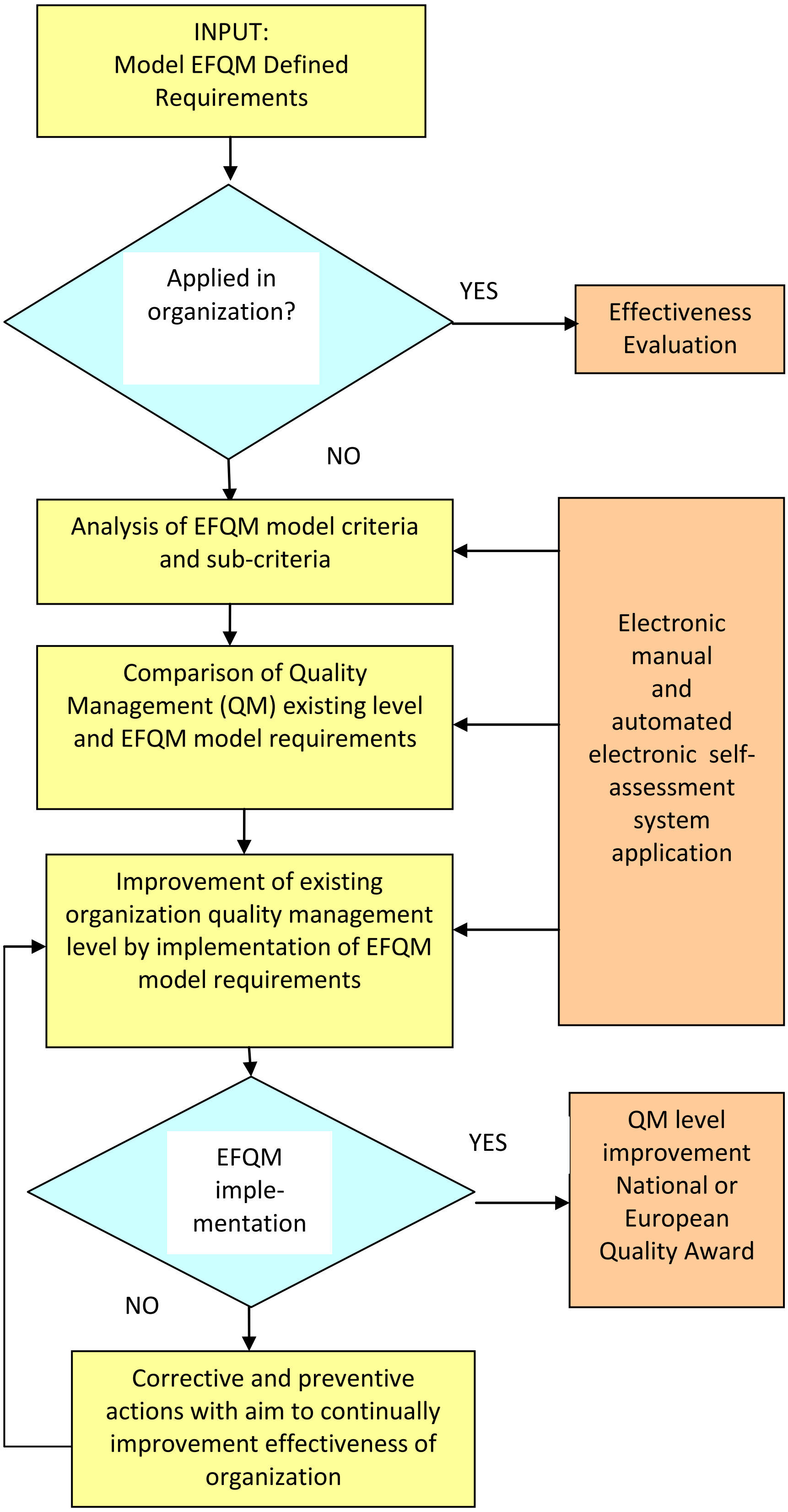

Figure 4 Steps to apply EFQM model in organization

Table 3. Evaluation of activity level application according to requirements of EFQM model sub-criterion in organization

Activity is:	Description	Evaluation %
P (planned)	Organization plans the activity to apply	10
D (done)	Activity is implemented	15
C (checked)	Organization checks the effects	20
A (acted)	In a case of positive effects activity is used in practice	25
B(benchmarked)	Organization com-pares the activity with best organization in market	30

Table 4 Level of EFQM model sub-criterion fulfilling in a given phase of application

Level of fulfilling	Description
0	There is no evidence to fulfill the requirements
0,25	There exist indicators of compliance requirements
0,5	Partial evidence of requirement fulfilling
0,75	Significant evidence of require-ment fulfilling
1	Clear evidence of requirement fulfilling

By this way is calculated the percentages evaluations for all requirements. The percentage evaluation of each sub-criterion is the weighted average of achieved percentage values for each of its requirements, and a set of weights represents the coefficients of importance.

$$P_{K_iS_j} = \frac{\sum_{r=1}^{n} P_{K_iS_jR_r}.d_{K_iS_jR_r}}{\sum_{r=1}^{n} d_{K_iS_jR_r}} \qquad (1)$$

where: P_{KiSj} is achieved percentage evaluation of "j" sub-criterion in "i" criterion
r = 1,2...n – number of requirements in criterion K_i and subcriterion S_j,
d_{KiSjRr} is coefficient of importance for "r" requirements of "j" sub-criterion in "I" criterion

Each of the criterions of the EFQM model has a defined maximum point value which can be achieved. It is evenly distributed among the individual sub-criteria. The resulting number of points for the sub-criterion we obtain by multiplying of the achieved percentage value by maximum number of points. Generally we can for any criterion express:

$$B_S = B_{max} \cdot \frac{P_s}{100} \qquad (2)$$

where: B_S is achieved score in evaluated sub-criterion
B_{max} is maximum score which can be in a given sub-criterion obtained
P_S is achieved percentage evaluation for given sub-criterion

The resulting score for each criterion is the sum of achieved point value of its individual sub-criteria. The total achieved point value concerning the enablers is the sum of achieved points for criterion 1 to 5. The maximum possible score can be 500 points (see enablers – fig. 1).

4.3 Electronic evaluation of the proposed solution

Electronic solution of proposed evaluation system is realized by using Microsoft Excel Program. The aim was to design and develop an automated system using computer technology, which would on the basis of defined requirements in electronic manual and in evaluation system allow easy, fast and comfortably realize evaluation of business performance and effectiveness, as well as clear and understandable display output of the evaluation process. Entering of inputs is handled through a questionnaire form, by selection of predefined options from "drop down menu" (dropdown list). The user does not perform any calculations, nor inscribe the input values. The results are updated immediately after any change in input data. The selected values the user can change at all time during the evaluation process (fig. 5). Sheets “enablers” (fig. 6) and “results” (fig. 7) clearly show achieved percentage scores for each sub-criteria and requirements, and from these values is automatically calculated score for sub-criteria, and all criteria of “enablers” and “results” sections. Changes of point values are automatically transferred to the sheet EFQM - assessment, in which is a graphical view of the structure of the EFQM model with the nine criteria and the corresponding percentage and scoring for each of them for the “enable” and “result” part and also total assessment of all criteria.

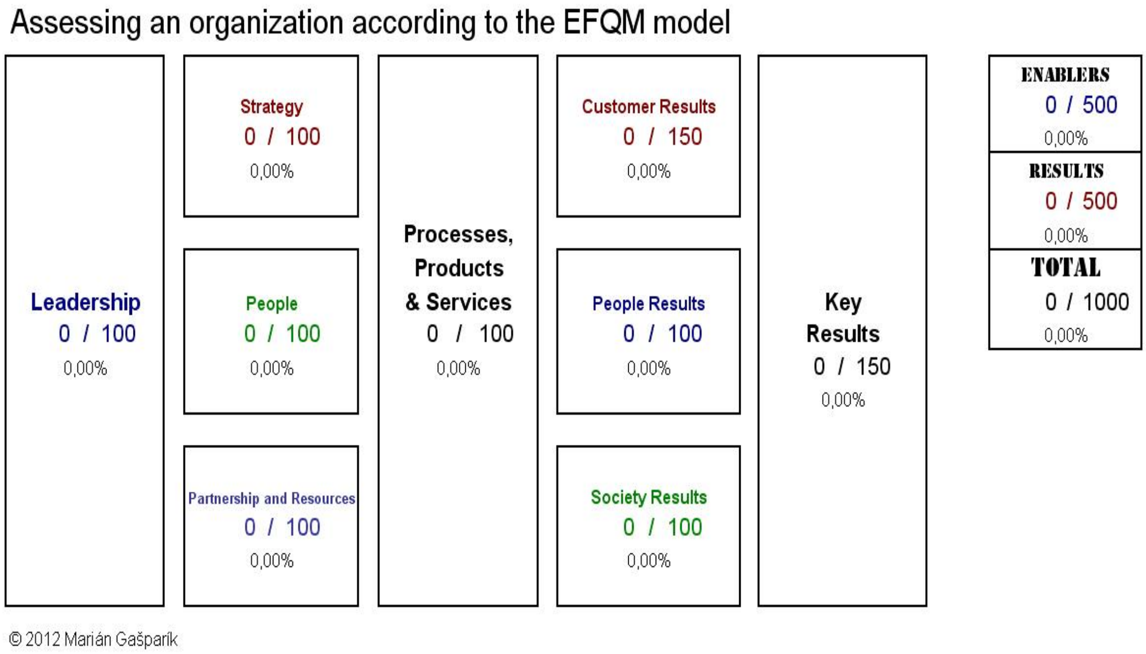

Figure 5 Software illustration of EFQM model basic structure (starting level of criteria evaluation)

1 LEADERSHIP

Start over

1a Leaders develop the mission, vision, values and ethics and act as role models.

	Activity is					
REQUIREMENT	P - planned	D - applied	C - verified	A - put into practice	B - compared with the best on market	% for requirement
1a - 01	0	0	0	0	0	0
1a - 02	0	0	0	0	0	0
1a - 03	0	0	0	0	0	0
					OVERALL % for subcriterium 1a	0
					POINTS for subcriterium 1a	0
					MAXIMUM number of points	**20**

1b Leaders define, monitor, review and drive the improvement of the organisation's management system and performance.

	Activity is					
REQUIREMENT	P - planned	D - applied	C - verified	A - put into practice	B - compared with the best on market	% for requirement
1b - 01	0	0	0	0	0	0
1b - 02	0	0	0	0	0	0
1b - 03	0	0	0	0	0	0
					OVERALL % for subcriterium 1a	0
					POINTS for subcriterium 1a	0
					MAXIMUM number of points	**20**

1c Leaders engage with external stakeholders.

	Activity is					
REQUIREMENT	P - planned	D - applied	C - verified	A - put into practice	B - compared with the best on market	% for requirement
1c - 01	0	0	0	0	0	0
1c - 02	0	0	0	0	0	0
1c - 03	0	0	0	0	0	0
					OVERALL % for subcriterium 1a	0
					POINTS for subcriterium 1a	0
					MAXIMUM number of points	**20**

1d Leaders reinforce a culture of excellence with the organisation's people.

	Activity is					
REQUIREMENT	P - planned	D - applied	C - verified	A - put into practice	B - compared with the best on market	% for requirement
1d - 01	0	0	0	0	0	0
1d - 02	0	0	0	0	0	0
1d - 03	0	0	0	0	0	0
					OVERALL % for subcriterium 1a	0
					POINTS for subcriterium 1a	0
					MAXIMUM number of points	**20**

Figure 6 Software illustration of EFQM model part „enablers“

6 CUSTOMER RESULTS

Start over

6a Perceptions

	Requirement	Aim	Positive Trend	Contribution	Comparison With Competitors	% for requirement
1	6a - 01	met/slightly exceeded	3 periods	significant	above average	77,5
1	6a - 02					0
1	6a - 03	not set				0
1	6a - 04	not met				0
1	6a - 05	met/slightly exceeded				0
1	6a - 06	significantly exceeded				0
0	6a - 07					0
0	6a - 08					0
0	6a - 09					0
					OVERALL % for subcriterium 6a	12,92
					POINTS for subcriterium 6a	9,69
					MAXIMUM number of points	**75**

6b Performance Indicators

	Requirement	Aim	Positive Trend	Contribution	Comparison With Competitors	% for requirement
1	6b - 01					0
1	6b - 02					0
1	6b - 03					0
1	6b - 04					0
1	6b - 05					0
1	6b - 06					0
0	6b - 07					0
0	6b - 08					0
0	6b - 09					0
					OVERALL % for subcriterium 6b	0
					POINTS for subcriterium 6b	0
					MAXIMUM number of points	**75**
				Number of points for criterium 6	9,69	
				MAXIMUM number of points	150	

7 PEOPLE RESULTS

7a Perceptions

	Requirement	Aim	Positive Trend	Contribution	Comparison With Competitors	% for requirement
1	7a - 01	significantly exceeded				25
1	7a - 02					0
1	7a - 03					0
1	7a - 04					0

EFQM-SCORE / ENABLERS / RESULTS / vysledky-numeric / Koeficienty významnosti / pdca-score

Figure 7 Software illustration of EFQM model part „results“

5. Application of the proposed methodology and manual into construction company

Application of the proposed methodology and the electronic manual was made for a construction company in Slovakia by personal communication with director and heads of key departments. During our cooperation we offered to the company basic training process concerning the EFQM model development and application and electronic manual for self-evaluation according to EFQM model criteria. Process of self-evaluation was realized using our software for automated evaluation quality management level in company according to EFQM model criteria. By application of the higher described methodology and electronic manual and the company during 1 year showed improvement in all criteria of the EFQM model (fig. 8). Our cooperation will continue and we assume more dramatic improvement next 1-2 years after implementation next actions especially in production process.

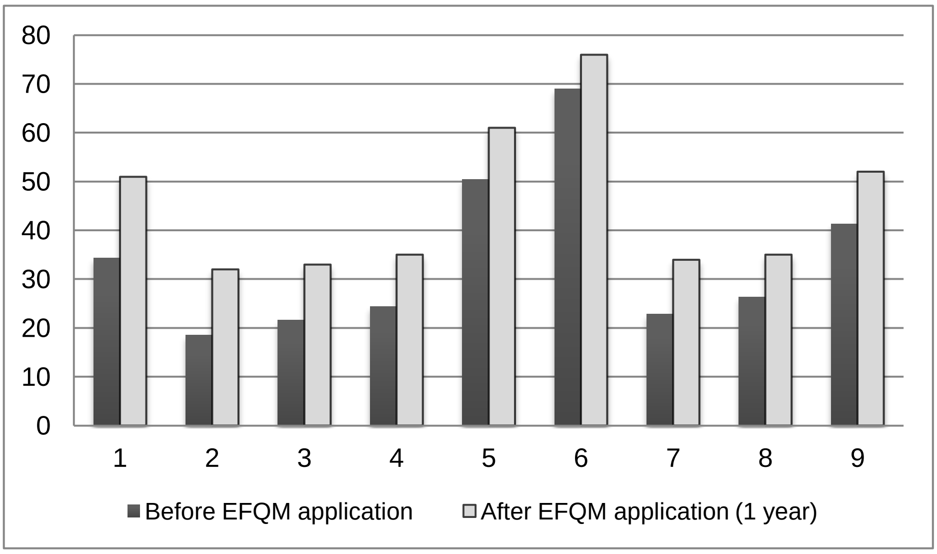

Figure 8 Evaluation of EFQM model in construction company before model application and after 1 year (Gašparík, J. ,Gašparík, M., 2012)

Legend to Figure 7:
1 - Leadership 2 - Policy and strategy 3 - People (employees) 4 - Partnership and resources
5 - Processes, products and services 6 - Customer results 7 - People results 8 – Society results
9 – Key results

Conclusions

Model EFQM is useful to implement after development and implementation of Quality Management System (QMS) according to ISO 9001. QMS represents very good basis for application of higher quality management philosophy, like TQM, KAIZEN (Paulová, I. et al., 2008), reengineering (Hammer, M., Champy, J.,1993), or model EFQM. Research work described at this contribution results in the form of its own methodology and electronic manual allows to construction organizations effectively introduce and implement EFQM model requirements to practice in a relatively short period of time with aim to constantly improvement its performance towards excellence.

Defined methodology suggests and explains the sequence of steps towards EFQM model applying the electronic manual describes all of EFQM model sub-criteria and provides concrete suggestions and solutions to meet them. The part of manual there is also automated electronic assessment

system for construction organizations which was verified in real company. Application of the methodology and manual enables in a short time to evaluate company quality management level and to identify opportunities for continually quality improvement.
The main results of our research activity are:

- creation of a new electronic manual for implementation and evaluation of EFQM model criteria and sub-criteria in construction company,
- the definition of mathematical models for automated evaluation of EFQM model criteria,
- the proposal of own software for automated evaluation of quality management level for company using EFQM model,
- continual improvement of construction company quality management level in all areas of its activities.

Model EFQM is an effective tool for continual improvement of organization quality, which leads not only to higher level of quality, but also to customer satisfaction, success at national and world market and to increasing the culture of whole organization.

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FEASIBILITY STUDY FOR THE PRODUCTION DEPARTMENT IN THE COMPANY XY*

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Abstract

This feasibility study is based on techno-economic parameters retrieved from different data bases or collected through business and marketing research. Specific index values used in price calculation modelling and financial statement composition were observed. Other data sources relate to company's trial-balance, surveys, and interviews with the management. In order to establish numerical relations between the market, the production capacity and management's expectations, the authors used different marketing and financial methods and models. This paper was written in accordance with the rules of scientific methodology, while in its essence, it is an expert paper composed as a feasibility study for an investor. The numerical estimates are minimalized, while the calculations are based on market statistics and company's financial information. Finally, a conclusion, and two recommendations are presented. All information presented in this paper was carefully used considering the principles of ethics, while it is publically available and does not pertain to corporate secrecy issues.

Keywords: feasibility study, market trends, construction, profit potential

* The complete text is available on CD-ROM / Grebenar, Banović, Bošnjak

Introduction

This feasibility study deals with the production department consisting of three existing and two new production lines in the company XY from Vinkovci, Croatia.
The existing production lines include:

1. Block making machine for production of paving stones, road/park curbs, trench drains, etc.
2. Concrete production plant for production of concrete
3. Tilery for production of roof tiles (hereafter: tiles) with concrete production

The new production lines include:

1. PVC and aluminium production line for production of PVC and aluminium joinery
2. Glass production line

The company XY has already invested significant amounts of money into new equipment/production lines. Currently, the invested sum exceeds the amount of 200.000 HRK. The company XY plans to use this feasibility study to gain better insights into a possibility of commencing a new production cycle based on both the existing and the new production lines. Considering their previous (relevant) experience, the authors of this study estimate that another 200.000 HRK will have to be invested into new machinery and quality control equipment in order to commence the full production cycle.
On the macro-level, the economic activity in the construction sector has been struggling since 2008. In January 2012, it stood at its 2002 levels, which makes it lower by more than 30% compared to the successful 2008.[*] Such a fragile economic situation led to bankruptcy of many construction companies. On the other side, a large number of construction businesses with strong financial positions not only survived the shrinking economic activity, but improved their top-line figures, particularly from 2010 onwards, which was the weakest business year for the construction sector in general. Sales improvement recorded by a portion of construction firms originated largely from increased market share due to bankruptcies, liquidations, and subdued business activity of many other companies in the sector, which were unable to cope with challenges on the declining market. This is highly important for the company XY since it is a company with a strong financial position, which survived the toughest years of crisis and managed to increase its market share in the respective period (source: www. poslovna.hr).
As a result, the company XY entered a growth phase, after having declined by some 32% in sales. In 2011, the company XY recorded sales growth of more than 38%. 2012 was somewhat weaker and resulted in declining revenues compared to 2011, driven largely by weaker public investment, which was subdued due changes on the domestic political scene. Nevertheless, the increased market share on the national market indicates that the company XY is still expanding, even though the total value of construction works in the domestic economy is far below the pre-crisis levels. In other words, the competition lost a portion of its market share, part of which was taken over by the company XY. Accordingly, the company XY is exiting the period of crisis with a much stronger market position.
Currently, the management of the company XY is focusing on defining a new strategy for the future years and opt to choose between the two alternatives:

- The strategy of stabilizing the business
- The strategy of business growth

The purpose of this paper is not to focus on any kind of a business strategy and its implications, but to approve or reject the idea of capital investments into the company's production department, with the aim of creating potential for future sales and profit growth.

[*] http://www.dzs.hr/Hrv_Eng/publication/2012/03-01-01_01_2012.htm

2. Methodology

This study was written considering the rules of the IMRAD concept, and can be divided into four sections: Introduction, Methodology, Research, and Discussion. The IMRAD concept was chosen in order to minimalize the influence of subjective estimates and decision-making based on different criteria with no academic or expert background. The opening discussion aims to summarize and critically evaluate the information gathered during the process of working on this study. In the opening discussion, the authors analyse the current situation and the market position of the company XY. The conclusions are logically established based on the total review of information presented in this paper.
The methodological approach can be described as follows:

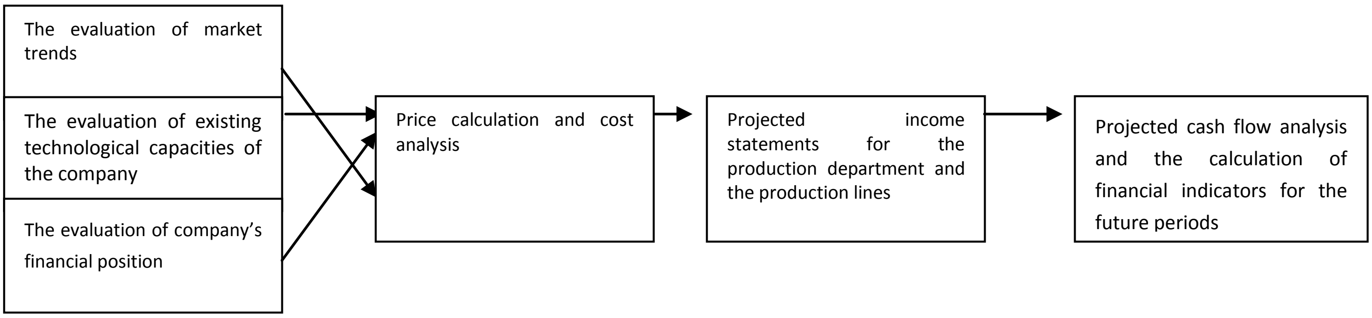

Diagram 1: Methodological approach

The methods used in this study were the following: secondary data collection (statistical offices, public data bases, other data bases), primary data collection (surveys, interviews), business intelligence (collecting information about norms, technology, cost structure, margins etc.), SWOT and PEST analysis, allocation of general costs based on SOFIT model, price calculation based on IAS 2, internal income and cash flow projections, and the calculation of NPV and IRR.

3. Research

3.1. Market research on sales trends of PVC joinery, concrete garment, and tiles, and selected financial indicators

22.23 The production of plastic products for the construction industry (NKD 2007)

Sales trends – PVC joinery 2008-11	SALES and SALES/EMPLOYEE							
	2008		2009		2010		2011	
	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee
20 company average	9.443.684	430.429	7.823.363	429.991	6.321.167	359.854	6.742.757	435.903
Trends (2008 – basis year)	100%	100%	-17%	0%	-33%	-16%	-29%	1%

23.61 The production of concrete products for the construction industry (NKD 2007)

Sales trends – concrete garment 2008-11	SALES and SALES/EMPLOYEE							
	2008		2009		2010		2011	
	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee
10 company average	28.510.450	489.891	29.711.756	578.124	17.012.345	393.893	19.998.757	412.677
Trends (2008 – basis year)	100%	100%	4%	18%	-40%	-20%	-30%	-16%

23.32 Production of bricks, roof tiles and other similar products for the construction industry (NKD 2007)

Sales trends – roof tiles 2008-11	SALES and SALES/EMPLOYEE							
	2008		2009		2010		2011	
	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee	Sales	Sales/ employee
3 company average	117.634.100	563.855	86.865.588	468.878	84.788.457	431.046	85.813.219	467.157
Trends (2008 – basis year)	100%	100%	-26%	-17%	-28%	-24%	-27%	-17%

Table 1: Sales trends for the period of 2008-11 - PVC joinery, concrete garment, and roof tiles

Table 2: Financial indicators - producers of PVC joinery and concrete garment in 2011

22.23 The production of plastic products for the construction industry (NKD 2007)

Financial indicators - producers of PVC joinery	DAYS SALES OUSTANDING	DAYS PAYABLES OUSTANDING	NET PROFIT MARGIN	ALTMAN Z SCORE
20 companies average	155	136	-3,90%	1,86

23.61 The production of concrete products for the construction industry (NKD 2007)

Financial indicators - producers of concrete garment	DAYS SALES OUSTANDING	DAYS PAYABLES OUSTANDING	NET PROFIT MARGIN	ALTMAN Z SCORE
10 companies average	161	98	-1,40%	1,88

3.2. Business intelligence research on prices of selected groups of products - PVC windows 100x120 cm, paving stones 10x20x6 cm, and roof tiles

Table 3: Prices of PVC windows (100x120 cm), paving stones (10x20x6 cm grey), and roof tiles (classic grey)

THE PRODUCERS OF PAVING STONES - 10x20x6 cm	PRICE	+VAT
AVERAGE PRICES	65,12	81,41
AVERAGE WHOLE SALE PRICES (DISCOUNTS INCLUDED)	60,00	75,00
THE PRODUCERS OF PVC WINDOWS - 100x120 cm	PRICE	+VAT
AVERAGE PRICES WITHOUT INSTALLATION	1.371,77	1.714,71
AVERAGE WHOLE SALE PRICES (DISCOUNTS INCLUDED)	1.097,42	1.371,77
THE PRODUCERS OF ROOF TILES (CLASSIC)	PRICE	+VAT
AVERAGE PRICES	5,29	6,61
AVERAGE WHOLE SALE PRICES (DISCOUNTS INCLUDED)	4,23	5,29

3.3. The allocation of costs and the keys to cost allocation in the company XY (Source: company's trail balance as of Dec 31, 2011)

Table 4: The allocation of general costs per profit center and keys to allocation

COSTS	OPERATIONS	PRODUCTION	MECHANICS	TRANSPORT	ADMINISTRATION	TOTAL
Basic materials	2.112.225	755.174				2.867.399
Secondary materials	15.771	5.639				21.410
Maintenance - materials	83.524	29.862				113.386
Other materials	13.498	4.826				18.324
Office materials					17.487	17.487
Energy		2.634	2.634	2.634	2.634	10.535
Heating fuel			6.885	6.885	6.885	20.655
Fuel - trucks		69.099		449.146		518.245
Fuel - cars				62.142	6.794	68.936
Small inventory	53.625	2.822				56.448
Postal services					53.082	53.082
Other services	2.444.745					2.444.745
Maintenance costs	50.651	9.330	102	5.585	932	66.600
Promotion					2.393	2.393
Accounting					84.998	84.998
Certification	25.723	9.196				34.919
Vehicle registration		9.836		63.933		73.769
Car registration				7.439	1.500	8.939
Other costs					20.621	20.621
Gross wages	1.444.298	100.221	109.611	74.926	187.220	1.916.277
Daily allowances	1.346.522	14.026	14.026	14.026	14.026	1.402.627
Deprecation	33.458	33.458			66.916	133.832
Insurance					56.901	56.901
Bank services					62.623	62.623
Taxes, fees					15.957	15.957
Seminars, education, other					27.643	27.643
	7.624.041	1.046.124	133.258	686.716	628.612	10.118.751
% direct costs in total	87,93%	12,07%				
Mechanics	117.179	16.079				
Transport	686.716					
Total conversion costs	8.427.936	1.062.203				
% allocation of period costs	*88,81%*	*11,19%*				
Costs in the period 2011	558.253 kn	70.359 kn				
% of period costs in total profit center costs	6,21%	6,21%				

3.4. Price calculation of selected products and half-products in the company XY

Table 5: Price calculation - concrete MB 40

CALCULATION: Concrete for gallantry MB 40 efficiency factor 4, grade 25 %						
DESCRIPTION	UNIT	QUANTITY	PRICE	Efficiency factor	Cost of inventory	TOTAL
Fraction 0 - 4	m³	0,48	122,43		59,01	59,01
Fraction 4 - 8	m³	0,27	101,90		27,82	27,82
Fraction	m³	0,47	97,98		46,35	46,35
Cement	m³	0,35	640,000		220,80	220,80
Water	l	200,00	0,020		4,00	4,00
Additives	kg	1,50	10,000		15,00	15,00
Labor work	h	0,07	29,75	4,00	7,93	7,93
Depreciation	kn		0,77	4,00	3,10	3,10
Spare parts and maintenance	kn		1,28	4,00	5,10	5,10
Oil and fuel	kn		6,05	4,00	24,20	24,20
Certification and laboratory	kn		0,21	4,00	0,85	0,85
General production costs	kn	6,49		4	25,96	25,96
General costs of the period	kn	2,31		8	0,00	18,52
TOTAL (kn/pcs)					418,34	458,64

Table 6: Price calculation – concrete for paving stones and curbs

CALCULATION: Concrete for gallantry MB 40 efficiency factor 4, grade 25 %						
DESCRIPTION	UNIT	QUANTITY	PRICE	Efficiency factor	Cost of inventory	TOTAL
Fraction 0 - 4	m³	1,17	122,43		143,25	143,25
Cement	m³	0,44	640,000		281,60	281,60
Water	l	200,00	0,020		4,00	4,00
Additives	kg	1,50	10,000		15,00	15,00
Labor work	h	0,07	29,75	4,00	7,93	7,93
Depreciation	kn		0,77	4,00	3,10	3,10
Spare parts and maintenance	kn		1,28	4,00	5,10	5,10
Oil and fuel	kn		6,05	4,00	24,20	24,20
Certification and laboratory	kn		0,21	4,00	0,85	0,85
General production costs	kn	6,49		4	25,96	25,96
General costs of the period	kn	2,31		8	0,00	18,52
TOTAL (kn/pcs)					489,21	529,51

Table 7: Price calculation – paving stones 10x20x6 cm

CALCULATION: paving stones h=6 cm, MB 40 efficiency factor 2, grade 50 %								
DESCRIPTION	UNIT	QUANTITY	PRICE	Monthly production	Increase	Efficiency factor	Cost of inventory	TOTAL
Concrete	m³	0,06	418,34	2.200	5%		57.981,97	57.981,97
Gray quartz film	m³	0,01	489,21		5%		5.650,36	5.650,36
Palette	pcs	220,00	30,00		5%		6.930,00	6.930,00
Other materials	kn	1.272,67				2	2.545,34	2.545,34
Maintenance	kn	194,38				2	388,75	388,75
Deprecation	kn	1.394,08				2	2.788,17	2.788,17
Certification	kn	1.149,56				2	2.299,12	2.299,12
Labor work 4 R / 8h	h	704,00	29,75			1,43	29.920,00	29.920,00
General production costs	kn	5.840,00				2	11.680,00	11.680,00
General costs of the period	kn	2.083,33				2	0,00	4.166,67
TOTAL (kn/pcs)							54,63	56,52

Table 8: Price calculation – road curbs 15x25x100 cm

CALCULATION: curbs 15x25x100 MB 40 efficiency factor 2, grade 50 %								
DESCRIPTION	UNIT	QUANTITY	PRICE	Monthly production	Increase	Efficiency factor	Cost of inventory	TOTAL
Concrete	m³	0,0338	418,34	6.600	5%		97.989,54	97.989,54
Gray quartz film	m³	0,0002	489,21		5%		678,04	678,04
Palette	pcs	330,00	30,00		5%		10.395,00	10.395,00
Other materials	kn	1.272,67				2	2.545,34	2.545,34
Maintenance	kn	194,38				2	388,75	388,75
Deprecation	kn	1.394,08				2	2.788,17	2.788,17
Certification	kn	1.149,56				2	2.299,12	2.299,12
Labor work 4 R / 8h	h	704,00	29,75			1,43	29.920,00	29.920,00
General production costs	kn	4.166,67				2	8.333,33	8.333,33
General costs of the period	kn	2.083,33				2	0,00	4.166,67
TOTAL (kn/pcs)							23,54	24,17

Table 9: Price calculation – roof tiles

CALCULATION: roof tiles MB 40 efficiency factor 5, grade 20 %								
DESCRIPTION	UNIT	QUANTITY	PRICE	Monthly production	Increase	Efficiency factor	Cost of inventory	TOTAL
Concrete	m³	0,0019	418,34	86.900	5%		72.421,76	72.421,76
Gray quartz film	m³	0,0001	489,21		5%		2.678,27	2.678,27
Palette	pcs	341	30,00		5%		10.734,71	10.734,71
Other materials	kn	1.272,67				5	6.363,34	6.363,34
Maintenance	kn	194,38				5	971,88	971,88
Deprecation	kn	1.394,08				5	6.970,42	6.970,42
Certification	kn	1.149,56				5	5.747,79	5.747,79
Labor work 10 R / 8h	h	1.760,00	29,75			1,43	74.800,00	74.800,00
General production costs	kn	4.166,67				5	20.833,33	20.833,33
General costs of the period	kn	2.083,33				5	0,00	10.416,67
TOTAL (kn/pcs)							2,32	2,44

Table 10: Price calculation - PVC window 100x120 cm

CALCULATION: PVC window 100x120 KBE efficiency factor 1.25, grade 80 %, 12 pcs/day								
DESCRIPTION	UNIT	QUANTITY	PRICE	pcs/month	Increases	Efficiency factor	Cost of inventory	TOTAL
Framework 69mm SELECT	m¹	5,20	24,75	264	5%		35.675,64	35.675,64
Wing 80 mm SELECT	m¹	5,60	27,00		5%		41.912,64	41.912,64
64 mm SELECT	m¹	1,20	35,55		5%		11.825,35	11.825,35
Reinforcement	m¹	12,00	6,38		5%		21.205,80	21.205,80
Lath 24mm	m¹	6,72	5,25		5%		9.779,62	9.779,62
Other	kn	150,00			5%		41.580,00	41.580,00
Glass Ug= 1,1	m²	0,85	179,81		5%		42.376,80	42.376,80
Other materials	kn	1.000,00					1.000,00	1.000,00
Deprecation	kn	2.500,00				1,25	3.125,00	3.125,00
Certification	kn	1.149,56				1,25	1.436,95	1.436,95
Labor work 4 R / 8h	h	704,00	29,75			1,25	26.180,00	26.180,00
General production costs	kn	5.840,00				1,25	7.300,00	7.300,00
General costs of the period	kn	2.083,33				1,25	0,00	2.604,17
TOTAL (kn/pcs)							921,96	931,83

3.5. Cost and Revenue analytics for the production department for the year 2014

COSTS AND REVENUES	GENERAL COSTS	ADMINISTRATION	Production unit PVC&ALU	Production unit GALLANTERY	Production unit GLASS	Production unit ROOF TILES	Production unit CONCRETE	TOTAL PRODUCTION
Raw material	80.000	4.000	1.273.747	60.317	161.057	221.275	811.567	2.607.963
- basic raw materials			1.265.932	0	161.057	180.240	771.072	2.378.301
- other materials	5.000	2.000	7.815	60.317	0	41.035	0	114.168
- energy	75.000	2.000					40.495	115.495
Cost of services	13.000	50.000	0	2.333	2.000	2.333	8.539	28.204
- maintenance	10.000		0	2.333	2.000	2.333	8.539	25.204
- other	3.000	50.000	0	0	0	0	0	3.000
Costs of internal realization	*0*	*0*	*331.192*	*418.340*	*0*	*0*	*0*	0
- concrete			*0*	*418.340*	*0*	*0*	*0*	0
- glass			*331.192*	*0*	*0*	*0*	*0*	0
Fines	2.000	1.000	0	0	0	0	0	2.000
Depreciation and maintenance	86.500	7.000	30.000	16.729	20.000	16.729	10.365	180.323
- depreciation	84.500	7.000	30.000	16.729	16.000	16.729	8.365	172.323
- small inventory, maintenance	2.000	0	0	0	4.000	0	2.000	8.000
Certification			13.795	13.795	13.795	13.795	13.795	68.973
Wages and salaries	168.900	38.000	251.328	29.920	64.260	179.520	20.944	714.872
- wages	168.900	38.000	251.328	29.920	64.260	179.520	20.944	714.872
- over-hours								0
General costs	0	0	95.080	95.080	70.080	95.080	95.080	100.000
- general production costs			70.080	70.080	70.080	70.080	70.080	0
- general administration costs			25.000	25.000	0	25.000	25.000	100.000
TOTAL	350.400	100.000	1.995.142	636.514	331.192	528.732	960.289	3.702.335
Internal realization			1.300.000	0	331.192	0	418.340	1.300.000
External realization			700.000	792.000	0	656.964	500.000	2.648.964
Total realization			2.000.000	792.000	331.192	656.964	918.340	3.948.964
EBIT=EBT			4.858	155.486	0	128.232	-41.949	246.629
EBITDA			51.758	189.115	32.900	161.861	-16.684	418.951
NET PROFIT MARGIN			0,19%	15,71%	0,00%	15,62%	-4,57%	7,45%
BREAK-EVEN POINT			1.973.470	355.648	331.191	448.728	1.489.567	3.108.519

Table 15: Projected income statement for the production department and per individual profit center for the period of 2014-17

3.6. Net cash flow for the investor (NPV and IRR)

BASE CASE SCENARIO	Discount rate	Initial investment	2013	2014	2015	2016	2017	2018	NPV	IRR
	11,95%	-403.290	-141.182	163.544	163.544	163.544	163.544	315.917	75.266	16%

The discount rate is 11,95%. It includes the average interest rate for Croatian government bonds (6,95%) as a basis and the risk premium of 5%.
The initial investment amounts approximately 400.000 HRK. It includes the acquiring costs of machinery for the production of PVC and aluminum joinery and glass, as well as estimated costs needed for the acquisition of additional equipment for the block making machine, tilery, and quality control.
In the first projected year, we expect negative cash flow of some 140.000 HRK. During the following four years, the expected annual cash flow is positive and is around 165.000 HRK. In the final year's projection, there is no additional investment into the production department, but solely the collection of receivables from the previous year. The projected period is limited to four years due to the fact that this period corresponds with the usage-period (lifetime) of equipment. Additionally, a portion of receivables from the fourth year will be collected in the fifth year of the projected period.
Around 87% of annual receivables will be collected in the same year, while 13% are due in the following year. In a base case scenario, we estimate that around 5% of the receivables will be written off.
The calculated Net Present Value (NPV) is positive. It amounts approximately 75.000 HRK.
The calculated Internal Rate of Return (IRR) is 16%, and is higher that the discount rate.

4. Discussion

20 producers of PVC joinery, 10 producers of concrete, and 3 producers of roof tiles were randomly selected, and the basic sales indicators were calculated (source: www.poslovna.hr). Following indicators were analyzed:

- Sales trends for the period of 2008-2011 (Basis year - 2008)
  - 2010 was the weakest business year for all segments (PVC, concrete, and tiles)
  - 2011 reflects a recovery in sales for the companies, which survived the economic downturn from the previous two years
- Sales/employee indicator for the period of 2008-2011 (Basis year – 2008)
  - Trends are very similar to those of sales movements
  - The productivity recovered in 2011, after a catastrophic 2010
- Days sales outstanding
  - PVC joinery producers: days sales outstanding amount 155 days and are 19 higher compared to day payables outstanding
  - Concrete garment producers: days sales outstanding amount 161 days and are 63 higher compared to day payables outstanding
- Days payables outstanding
  - PVC joinery producers: 136 days
  - Concrete garment producers: 98 days
- Average net profit margin
  - PVC joinery producers: the average net profit margin is negative. It stood at -3,9% in 2011, which indicates that the analyzed companies recorded losses in that period.
  - Concrete garment producers: the average net profit margin is negative. It stood at –1,4% in 2011. However, the net profit margin ranged from -1,4% and +2,2%, which indicates that some companies recorded profits in the respective period.
- Altman Z Score
  - Companies, which have the Altman Z Score higher than 3 are stable. Companies, which range from 1,8 and 3, are facing financial problems, while the companies, which are below 1, are seriously threatened by bankruptcy issues.
  - PVC joinery producers: The Altman Z Score is 1,86 on average
  - Concrete garment producers: The Altman Z Score is 1,88 on average

With the help of various business intelligence methods, detailed information on competition’s whole sale prices for selected products in the Vukovar-Syrmia County and the Republic of Croatia were collected. Considering their market position and innovativeness, the four categories of companies were taken into consideration: market leaders, market challengers, market followers, and market nichers. The aim of this research was to calculate the average whole sale price of selected products relevant for this study: PVC windows 100x120 cm, paving stones 10x20x6 cm grey, and roof tiles (grey and classic). By contacting the sales personnel of randomly selected companies, the information on whole sales prices was gathered, and an average value was calculated. The average price for a PVC window is approximately 1.090 HRK. The average price for a paving stone is approximately 60 HRK. The average price for a roof tile is approximately 4,20 HRK. The price of 4,20 HRK for a roof tile is associated with market leaders and market challengers on the clay roof tiles market. The price of concrete roof tiles is somewhat lower and is around 3,15 HRK. Our assumption is that optimum prices for the producers should be in these zones.

Considering technical (and technological) characteristics of company’s production department, the cost of basic raw materials, and the allocation of direct and general expenses, the cost price for (selected) basic final products and half-products was calculated. Based on the calculation, specific ratios and a contribution of expenses to the average whole sales price were computed. The relation between whole sale prices and costs was used as the key factor for the calculation of future income statement projections. Considering demand trends, such projections assume that the efficiency of production lines in 2014 (in a base case scenario) would be as follows:

1. Block making machine; 50% efficiency, realization approximately 790.000 HRK
    a. Break-even point: 355.000 HRK
    b. Net profit margin: 15 % (for 5 months of paving stones production, and 1 month of road curbs production); EBITDA: 190.000 HRK
    c. Employees: 4 employees for 8,5 months
2. PVC & aluminum production line; 80% efficiency, realization approximately 1.300.000 HRK for construction sites, and 700.000 HRK for sale
    a. Break-even point: 1.975.000 HRK
    b. Net profit margin: 0,2 % (for 9,7 months of production); EBITDA: 50.000 HRK
    c. Employees: 4 employees for 12 months
3. Tilery; 20 % efficiency, realization approximately 655.000 HRK
    a. Break-even point: 450.000 HRK
    b. Net profit margin: 15% (for 2,3 months of production); EBITDA: 160.000 HRK
    c. Employees = 10 employees for 3,3 months
4. Concrete production; 25 % efficiency, realization approximately 420.000 HRK for the block making machine, and 500.000 HRK for sale
    a. Break-even point: 1.490.000 HRK
    b. Net profit margin: -4,5% (for 3 months of production); EBITDA: -15.000 HRK
    c. Employees: 1 employee for 4 months
5. Glass, ???% efficiency, realization approximately 340.000 HRK for the PVC production line
    a. Employees: 1 employee for 12 months
6. *PRODUCTION DEPARTMANT (total) – average efficiency approximately 60%, realization approximately 3.950.000 HRK in 2014 (and in each following year)
    a. Break-even point: 3.110.000 HRK
    b. Net profit margin: 7,45%; EBITDA: 420.000 HRK
    c. Employees = 1 manager, 1 production manager, 6 production workers, + others (temporarily)
    d. *Production in 2013: 25 % efficiency, realization approximately 1.975.000 HRK

According to the calculated NPV and IRR values, and considering the risk premium rate of 5%, we can conclude that the observed capital investment is more profitable than an investment into Croatian government bonds. The discounted cash flows associated with the respective capital investment indicate that this investment produces a return, which exceeds the one associated with Croatian government bonds by approximately 75.000 HRK. The IRR, which is higher than the discount rate, leads us to a similar conclusion.

5. Conclusion

Even though the struggling construction sector in the Republic of Croatia has caused a lot of bankruptcies of construction firms since the start of the global crisis in 2008, this paper shows that many new business opportunities on the construction market, which can be seized immediately or in the near future, have been created as well. A detailed market, price, and competition analysis in a form of a feasibility study based on various methods of managerial accounting, business intelligence, and survey research has been conducted for an existing construction firm facing a declining, but dynamic market. Results strongly suggest that despite struggling economic activity, new business opportunities on the Croatian construction market can successfully be recognized, analyzed, and seized by using simple methodology. Furthermore, the feasibility analysis, which represents the essence of this paper, indicates that business expansion, and exploitation of new opportunities, if it is conducted by financially healthy company does not require large additional investments, but is likely to generate new profit streams, and remarkably strengthen company's market position in the future.

The data gathered from both internal and external environment suggest that the analyzed company XY has entered a recovery phase, driven by positive sales trends, and a rise in the number of employees, both of which tend to increase company's capital. Furthermore, the company XY is investing into its production department, particularly into its existing and new production lines. Around 200.000 HRK have already been invested, while it is estimated that additional 200.000 HRK will have to follow.

On the macro-level, the activity in construction sector in the Republic of Croatia has been struggling since 2008. In January 2012, it stood at its 2002 levels, which makes it lower by more than 30% compared to the successful 2008. In a base case scenario, the new public investment cycle should be expected in the next 2 to 3 years, which ought to give a more significant boost to the construction business in general. Unlike a large portion of its competitors, the company XY has improved its (domestic) market position during the toughest (crisis) period of 2008-2012, particularly by increasing its market share as some of its competitors faced bankruptcy or declining business activity. Additionally, company's healthy financial indicators make it highly robust and well prepared for future periods, which should bear the majority of the recovery in the construction sector.

Considering the (expected) economic recovery in the near future, capital investments into the production department of the company XY have a potential to provide it with additional growth possibilities in highly profitable business segments. According to calculations, the average net profit margin for the modernized and extended production department is approximately 7,45%. Furthermore, the discounted cash flows associated with the observed capital investment (and the extended production department) indicate a return, which exceeds the one associated with Croatian government bonds, thus making the investment into the production department a highly profitable one.

For future, the authors summarize two basic recommendations:

1. A study on the evaluation of growth potential must be conducted in order to analyse the barriers to growth
2. A general business strategy, based on which the company should define its vision and long-term goals, must to be developed

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RISK ANALYSIS IN RELATION TO CONSTRUCTION COMPANY ECONOMY*

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Abstract

The paper deals with particular approaches to evaluation of risks in the construction company related with its economic activity. Analysis of the present state in the area of identification and evaluation of risks is carried out in the first part of the paper together with the assessment of the possibility of utilization of particular methods for evaluation of risk in examined area. A particular attention is given to methods of sensitivity analysis, scenario analysis and simulation based on Monte Carlo method. Suitability of utilization of above-mentioned methods is assessed on the case study regarding information capability and difficulty of processing of particular methods. The most important risks are projected to construction company economy using the financial plan.

Keywords: Risk Analysis, Construction Company, Economy, Financial Plan

* The complete text is available on CD-ROM / Hanak, Hromadka, Vitkova

Introduction

The risk is the challenge for each economic subject. Each company must solve this challenge in some way. There exist many approaches to the risk management from very simple methods to very sophisticated and from mathematical point of view difficult approaches. In the paper there is solved the problem of the evaluation of the economic risk of the construction company and its impact on the company economic result (Damodaran, 2002). The paper deals with the various approaches to the risk management, mainly with the sensitivity analysis, the scenario analysis and the simulation and their usability for the company management.

2. Present state references

2.1. Risk determination

The risk is in some form connected with any human activity. It is an element of uncertainty, which more or less influences expected result of the human work. In the literature there exist a lot of ways of explanation of this term; however the basic sense is still the same. It is possible to characterize the risk e. g. like:

- probability, with which some event arises with the result different from the result expected, when at least one of possible results is unwanted, or
- probability of the result or the event different from the asked result, when at least one of the results is unwanted, or
- possibility of the rise of the unwanted result of the event different from the result expected.

The risk is on the one side connected with expectation to achieve extra good economic results, on the other side it could be threatened by the danger of the entrepreneur failure leading to losses, which can significantly affect the financial stability of the company and can lead to its downfall (Smejkal, 2005).

The risk can exist in a lot of different forms and it can have very different impacts even if the attention is paid just on construction sector and construction company. Furthermore, many researchers analyse risks from different perspectives. E.g. Shen et al (Shen, 2007) suggest safety risks, health risks and ecological risks as an integral part of construction project sustainability performance checklist. Other authors focus on natural risks, e.g. in order to enhance risk-based decision making in the case of floods (Hall, 2008). This paper is focused mainly on the risk of construction company activity; from this aspect it is possible to define e. g. the technical and technological risk, the production risk, the economic risk, the market risk or the financial risk (Hromádka, 2010).

Regarding the high amount of possible risks, which can be met during the planning and the realization of investment projects, it is necessary to manage particular risks (Sanderson, 2012). The main objective of the project's risk management is to increase the probability of the success of the project and to minimize the danger of its failure.

The steps of the project risk management are following:

- determination of risk factors of the project,
- assessment of the importance of risk factors,
- the project risk assessment,
- valuation of the risk of the project and the suggestion and the acceptance of operations for its decreasing,
- preparation of the plan of correction operations (Fotr, 2006).

Generally, risk management has to be carried out efficiently. It must permeate all areas, functions and processes of the project (Schieg, 2010).

2.2. Determination of risk factors

The determination of risk factors and the evaluation of their importance are basic steps for the company risk management (Edwards, 1999). The company risk factor can be characterized as a variable, which possible future development can in positive or negative way to influence its economic situation. The identification of risk factors is not in principle difficult issue, but it poses heavy requirements on experiences and professional knowledge of the evaluator. The next way to make easy the risk factor determination it is also suitable to question those important risk factors influencing the results of the company, which have been taken into account as sure. There exists only small amount of inputs, which development can be considered as sure. It is necessary to dispute values of factors, which have not been considered as dangerous variables for the company yet (Minasowicz, 2009).

In the frame of the risk management system it is possible to create and to use other tools, which make easy the risk factors identification. There can be help-list including the set or questions coming from experiences connected with the current activity of the company or check-lists involving the summary of potential risk factors, which could hypothetically the company´s economy to threaten. Very good can be in this area also interviews with experts on the examined issue or group discussions. The result of the factors identification is written summary of all relevant risk factors.

2.3. Assessment of the importance of risk factors

The importance of risk factors assessment is next very important step of the risk analysis. The importance of the specific risk factor provides information, if it is necessary to carry out next detailed analysis, which assesses the total amount of risk, or it is only the residual risk, which the subject is willing to accept and which will not be then analyzed. For the risk factor importance assessment there are distinguished mainly expert evaluation and the sensitivity analysis. (Hromádka, 2010)

The essence of the expert evaluation consists in the determination of the probability of the occurrence of the risk factor and the intensity of the negative impact. The probabilities of the occurrence of risk factors and their intensities can reach five degrees from very low to extra high. As important there are considered these factors, which probabilities of occurrence together with intensity of the negative influence are reaching at least the middle degree and these factors, which probability of occurrence is low, but the intensity of negative impacts is extra high. The sensitivity analysis consists in the assessment of the sensitivity of certain economic criterion (Net Present Value, profit, costs) on factors, which influence this criterion (demand for production and the production capacity utilization, sale prices, prices of raw materials, investment costs, bank rates, tax rates and the others).

2.4. Project risk assessment

It is necessary to quantify important risks in suitable way. The risk can be assessed in numeral form or indirectly using specific managerial characteristics. This paper is focused mainly on risk assessment in the numeric form. The risk assessment in numeral form consists in the calculation of statistical characteristics (mean, variance, standard deviation and coefficient of variability), which in the financial management express the rate of the risk. The starting point is the determination of the probability distribution of the evaluation criterion (NPV, IRR, profit, etc.). For the determination of the risk in the numeral form it is possible to use more simple approach in the form of probability trees, in the frame that there are defined particular scenarios of the development of risk factors. The analysis of defined scenarios consequently brings the general information about the statistical characteristics of selected valuation criterion. More difficult approach consists in the definition of the

simulation model, which describes the probability distribution of the selected valuation criteria characterizing the risk of the company. The simulation can be carried out with the Monte – Carlo Method. Monte – Carlo method enables effective assessment of the mean of the random variable and its next probability characteristics. The basic input necessary for the Monte – Carlo method utilization is the probability distribution of the random variable. The probability distribution of the random variable defines all possible values of the random variable and for each value determines the probability of its occurrence. In the case of continuous random variables it is possible to describe the variable with the distribution function or the probability density (Korytárová, 2011).
The next very important tool, which is for the Monte – Carlo method necessary, is quality random number generator. The basic principle of the Monte – Carlo method consists in the consequent generation of the random numbers from the range (0; 1), which are then transformed respecting the probability distribution into values of the appropriate random variable. From achieved values there are then, using calculations carried out in the frame of particular steps of the simulation, assessed the probability distribution, the mean, the variance or next probability characteristics of the monitored random variable (in this case selected valuation criterion). The number of generated numbers in the frame of particular input variables equals to the number of random trials. The higher number of random trials, the higher accuracy it is possible to achieve (Korytárová, 2011).

3. Case study

The case study is oriented on the projection of the risk consideration into particular items of the financial plan of the construction company creation. In the frame of the case study there are considered some simplified assumptions. The most important one is that all relevant revenues and costs are expressed as the linear function of the amount of the production. All used probability distribution and predicted values are assessed with the expert estimate.

3.1. Input data

Basic input information for the analysis comes out from the financial plan, which has been conducted in the form of the profit/loss account, see table 1.

Tab. 1 Financial plan – profit/loss account

Profit / loss account item	**31.12.2012 (th. of CZK)**
Revenues from sold goods	0
Expenses on sold goods	0
Sale margin	0
Production	160,500
Production consumption	87,000
- Consumption of material and energy	38,500
- Services	48,500
Added value	73,500
Personnel expenses	74,300
Taxes and fees	400
Depreciations of intangible and tangible assets	1,350
Revenues from disposals of fixed assets and materials	500
Net book value of disposed fixed assets and materials	0

Profit / loss account item	31.12.2012 (th. of CZK)
Other operating revenues	0
Other operating expenses	1,250
Operating profit / loss	-3,300
Financial revenues	50
Financial expenses	700
Profit / loss from financial operations	-650
Income tax on ordinary income	0
Profit / loss of current accounting period	-2,650

According to the financial plan there were identified critical variables – risk factors:

- Production
- Sale price
- Unit costs for material
- Unit personal costs
- Unit costs for services

Those risk factors serve as basic input variables for all next methods of the risk analysis.

3.2. Sensitivity analysis

The sensitivity analysis was carried out with utilization of the software Crystal Ball by Oracle. The results of the sensitivity analysis are presented in the tornado graph in the fig. 1.

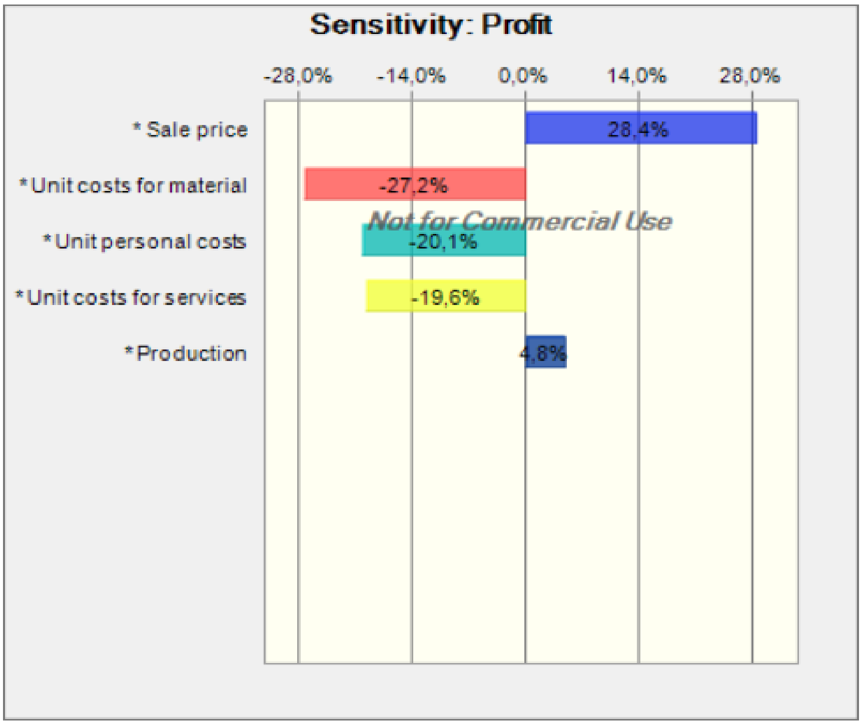


Fig. 1 Sensitivity analysis – tornado graph

From the tornado graph is evident that the most important risk factors influencing the economic result of the company in this case study are following:

- Sale price
- Unit costs for material

Those critical variables – risk factors will be processed within scenario analysis conducted in the next chapter.

3.3. Scenario analysis

Scenario analysis is based on determination on particular developments of the company depending on changing critical variables – scenarios. For each scenario it is defined the probability of occurrence and the value of evaluation criterion – profit. The values and probabilities depend on probability distributions of particular critical variables described in the tab. 2.

Tab. 2 Probability distributions of critical variables

Risk factor - random variable	**Pessimistic**	**Neutral**	**Optimistic**
Sale price (th. of CZK)	157.5	160.5	165.5
Unit costs for material (th. of CZK)	40.5	38.5	35.5
Probability (%)	**20**	**50**	**30**

Results of particular scenarios including probability of their occurrence are calculated in the tab. 3.

Tab. 3 Scenarios analysis

Scenario	**Profit (th. of CZK)**	**Probability (%)**
S1	2,750	6
S2	5,750	15
S3	10,750	9
S4	-250	10
S5	2,750	25
S6	7,750	15
S7	-2,250	4
S8	750	10
S9	5,750	6

The final outputs of the scenario analysis in the form basic statistical variable are displayed in the tab. 4.

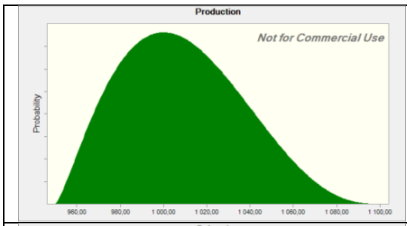
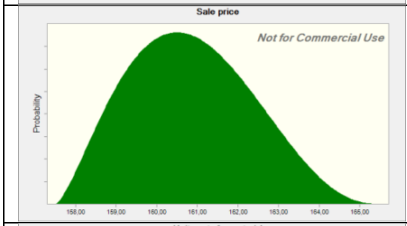
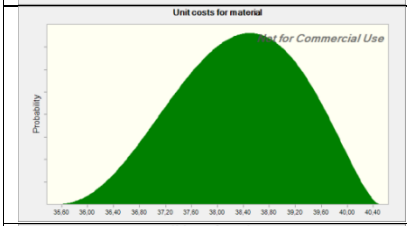
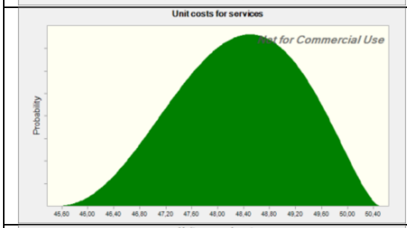
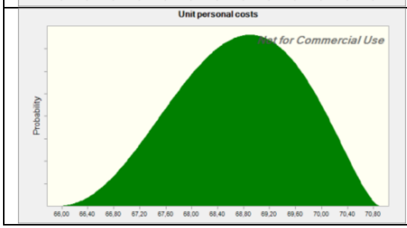
Tab. 4 Results of scenario analysis

Criterion	
Mean (th. of CZK)	4,150
Variance	11,740,000
Standard deviation (th. of CZK)	3,426
Coefficient of Variability	0.8

3.4. Monte-Carlo analysis

In the risk management the Monte – Carlo analysis is applicable, in contrast to the scenario analysis it takes into account all risk factors, which can influence the company economy and which have been identified during the risk management process. Identified risk factors and their continuous probability distributions are displayed in the tab. 5.

Tab. 5 Risk factors and their probability distributions

	Assumption: Production BetaPERT distribution with parameters: Minimum 950.00 Likeliest 1 000.00 Maximum 1 100.00
	Assumption: Sale price BetaPERT distribution with parameters: Minimum 157.50 Likeliest 160.50 Maximum 165.50
	Assumption: Unit costs for material BetaPERT distribution with parameters: Minimum 35.50 Likeliest 38.50 Maximum 40.50
	Assumption: Unit costs for services BetaPERT distribution with parameters: Minimum 45.50 Likeliest 48.50 Maximum 50.50
	Assumption: Unit personal costs BetaPERT distribution with parameters: Minimum 65.90 Likeliest 68.90 Maximum 70.90

The probability distributions were assessed by expert estimate using minimal, likeliest and maximal value of the factor as BetaPERT distribution.

For the risk assessment there was used the Monte – Carlo method and the software Crystal Ball. Basic output of the simulation in the form the probability distribution of the evaluation criteria (profit) is presented in the fig. 2.

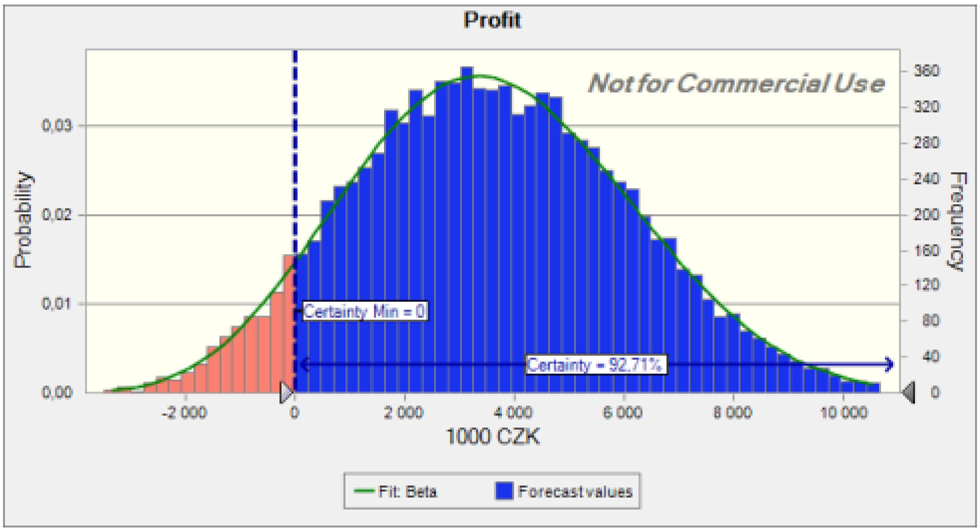


Fig. 2 Probability distribution of the evaluation criteria

From the picture no. 2 is evident that the probability of the positive value of the profit is nearly 93 %. Detailed information about statistic characteristic of the profit expressing the rate of the risk of the company is presented in the tab. 6.

Tab. 6 Statistic characteristics of the evaluation criteria – profit

	Forecast values
Trials	10,000
Base Case	2,750
Mean	3,597
Median	3,510
Standard Deviation	2,518
Variance	6,338,551
Coeff. of Variability	0.700
Minimum	-4,346
Maximum	12,561
Range Width	16,907

Based on output of statistic characteristics of the evaluation criteria it is evident that mean value (which is positive) signifies good result of the company. But other statistics (variance, standard deviation, coefficient of variability) reveal about quite big rate of the risk (volatility) of the presumption.

4. Conclusions

In the first part of the paper there were presented basic approaches to the risk management, main attention was posed on the sensitivity analysis, the scenario analysis and the simulation analysis by Monte – Carlo method. In the second part there is carried out the case study oriented on the analysis of the impact of the risk factors on the company economic result. The sensitivity analysis shows the importance of particular risk factors that are used for the subsequent scenario analysis and simulation. Results of used approaches are similar and show expected good results of the company on the one side, but quite big

rate of the risk on the second side.
All solved methods are suitable for the risk analysis and provide similar results, but both methods intended for the risk analysis (scenario, simulation) need for correct results quality inputs. More difficult (and key) can be the assessment of the probability distributions, discreet for scenarios, continuous for simulation. The scenario analysis is limited in number of analysed risk factors, while the simulation requires the utilization of the suitable software support.

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COMPETENCE BASED TEACHING IN CIVIL ENGINEERING – EXPERIENCES IN INNOVATIVE TEACHING*

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Abstract

The so called "Shift from Teaching to Learning" (Wildt, J. 2003) provides a strengthened focus on education of competences such as method-, social- and self-competences. Students should learn – beside the technical knowledge – important competences and skills for their work life. Integration of these opportunities into education of construction engineers is discussed in this paper.
A process for optimization of teaching and its organization within the faculty is shown, especially regarding the development of the curriculum.
Different types of courses and lectures have been analyzed regarding competence-oriented teaching. It can be seen that courses with focus on self-dependent learning like project work are appropriate for competence based teaching.
A project work supported by tutors is shown as an example for competence based teaching. Focus was set on the competence based teaching and on interdisciplinary work of students. The evaluation results show good impact on the development of the students' skills.

Keywords: civil engineering; soft skills; method-, social- and self-competences; flexibility; education; teaching

* The complete text is available on CD-ROM / Heinendirk, Čadež

Introduction

Developments in information technologies and networks result in new approaches for studying. Supported by the internet, students nowadays can reach innumerable resources within seconds. This development is affecting the students' possibilities for learning and getting information.
Furthermore the technical requirements and regulations of civil engineering are subject to a continuous change. The demands on civil engineers during work life have changed as well: more interfaces between different participants in the process of planning and building, more cost pressure and higher demands on the results (Bauer, H., 2007).
Students of civil engineering should learn how to deal with these various demands during their work life. Besides the obligatory transfer of technical knowledge in the different subjects, a more competence-oriented way of education could be an answer to this challenge. Students should learn more method-, social- and self-competences. Furthermore, they should learn how to collect, analyze and question information and data; a demand, which is a key factor in their following work life. One way to fulfill those demands is a self-dependent way of learning, for example project work or other innovative courses. This so called *"Shift from Teaching to Learning"* (Wildt, J., 2003) focuses on the education of these competences. Students should learn more independent and be self-organized.
To realize innovative teaching within a faculty, an organizational framework is needed to ensure that the different types of courses focus on various competences and multidisciplinary skills. In this paper, an idea for an implementation of this framework for optimization of teaching is presented.
Different types of courses will be analyzed in terms of their potential to support this shift from teaching to learning and to integrate competence oriented learning in education of civil engineering. As an example, the findings of an innovative teaching project in the Master Program "Real Estate and Construction Management" at TU Dortmund will be provided.

1. Competence-oriented teaching and learning in Civil Engineering

A survey among the bachelor students, who graduated in civil engineering at universities in 2009, was conducted one year after their graduation regarding the content of their studies. The findings show the students' opinion, that competences like method competence (96 %), social competence (86 %) and competence for self-organization (90 %) are more important in their work life than a broad technical knowledge (76 %) (VDI, 2009).

This proves the necessity of defining competence oriented teaching and learning. Competence is understood as communicative and personal abilities, which show up in various activities. The term competence has to be separated from the term qualification which means the ability to transfer objective and describable knowledge into specific tasks (Fuchs, S., 2011).

In university didactic discourse, the competences and qualifications are often separated into three groups: method-, social and self-competences. **Method-competences** cover contents such as learning and organizing, project management and competences in consulting and research. **Social competences** are qualifications such as the ability to work in a team, conflict management, mediation ability or social and entrepreneurial responsibility. **Self-competences** are abilities such as motivation, creativity or consciousness (Redlich, A., Rogmann, J., 2007).
Looking at further survey results, it becomes clear that the implementation of competence-based teaching and learning is not yet completed. The students have been asked about their experiences in teaching and learning. Only 44 % of the students said, that there was a variety in methods of teaching; 42 % confirmed, that they have been encouraged to actively participate in courses and a minority of 29 % pointed out that discussions and debates in courses have been promoted in lectures and seminars (VDI, 2009).

To implement competence-orientation in teaching and learning at universities, the first step should be a faculty-wide process for the coordination and design of the curriculum.

2. Design of curricula in civil engineering

Teaching and research at German universities are tasks, which are approached together by professors and research assistants. A separation of these tasks, which can be found in other countries, is not designated in Germany. Due to this combination of teaching and research, actual teaching on the basis of latest research findings should be provided. In Germany, the so called "freedom in research and teaching" is based in the legal framework of constitutional law (Grundgesetz, Art. 5 Abs. 3, 1).
Nevertheless, a comprehensive and faculty-wide setting of the curriculum seems to be useful to ensure an all-embracing education. Besides the technical knowledge, the framework of competence-based education should be defined, especially the types of courses. With these definitions, an education which equips all the necessary competencies can be assured. With regard to the bachelor- and master-systems, which have been rolled out in Germany within the last years, a connection of contents in different degree programs is essential. To meet these requirements, a process of developing this setting of the curriculum within the faculty should be designed as shown in the following figure.

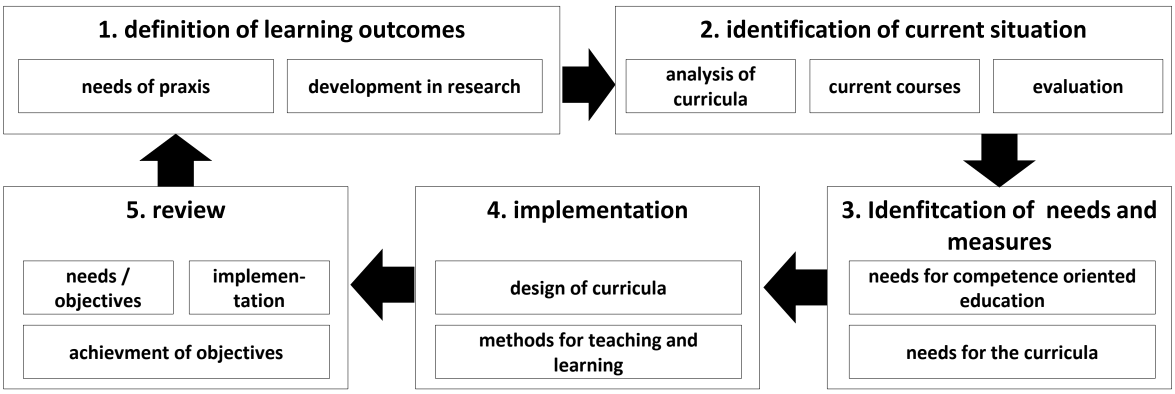

Fig. 1 Process of developing the setting of the curriculum

As a first step, learning outcomes should be defined. Therefore, at least two sources of input should be used: the needs of praxis regarding the students' knowledge and the current development in research such as new systems or regulations. Simultaneously or in a second step, the current situation should be identified. This can be achieved by analyzing the curricula, giving an overview over current courses and conducting surveys.
As a third step, needs and measures can be deduced. The focus should be on the needs for technical knowledge as well as on the needs for a competence orientated education. These results have to be implemented in the fourth step. A new curriculum can be designed and professors and research assistants can be taught in innovative methods for teaching and learning. This process should be frequently reviewed to verify the achievements and to check the needs and objectives on actuality. In Germany, the concept and implementation of the curricula is controlled and watched by accreditation committees. These committees consist of professors and experts from different universities and act as an independent review committee.
Accomplishment of this process should be supported by the dean, who should have enough personnel resources and a course coordinator with deep knowledge of contents in the bachelor and master programs and work-life requirements.

3. Competence oriented education in Civil Engineering

To achieve objectives in the curriculum – especially regarding competence orientation – different types of courses and ways of teaching can be used.

Looking at the current status at universities, classical lectures with little interaction between lecturer and students can be often found. Innovative forms of teaching, e. g. in project work or internet-based learning are not yet state of the art. It is difficult to substantiate and quantify the effect of different types of courses on the development of students' interdisciplinary competencies, nevertheless some types of courses support this development better than others. In the master program "Real Estate and Construction Management" at Technical University of Dortmund, Faculty Architecture and Civil Engineering good experiences with some types of courses regarding the students' development could be made. In the following figure 2, different types of courses and competencies are matched to show, which way of teaching can support which development of competence. Different course formats are sorted in ascending order from little to much student activity.

Course format / **Competence / Knowledge**	Lecture	Internet based learning*	Case studies	Seminars and tutorials	Project work	Theses
TECHNICAL KNOWLEDGE						
Knowledge based on latest research	XX	XX	X	XX	X	XX
Knowledge to solve practical questions	XX	X	XX	XX	XX	XX
Ability to reflect knowledge and problems in a multidisciplinary context	X	X	XX	XX	XX	XX
METHOD COMPETENCE						
Learning competence	O	XX	X	X	XX	XX
Competence in information retrieval	O	X	X	X	XX	XX
Competence in organization and project management	O	X	X	X	XX	XX
Competence in consulting and research	X	O	X	XX	X	XX
SOCIAL COMPETENCE						
Ability to transfer knowledge	X	X	XX	XX	XX	XX
Competence to work in a team	O	O	X	X	XX	O
Conflict management	O	O	X	O	XX	X
Mediation ability	O	X	X	O	XX	X
Social responsibility	X	X	XX	X	XX	X
SELF COMPETENCE						
Motivation	X	XX	X	X	XX	XX
Creativity	O	X	XX	X	XX	XX
Conscientiousness	X	X	X	XX	XX	XX
XX: high suitability X: suitability O: little impact						
* Internet-based learning is basically the organization of courses, the distribution of working material, information and tasks. Furthermore with internet-based learning tools the communication between students and lecturers regarding organizational and other content can be structured.						

Fig. 2 Possibilities of competence-oriented learning in civil engineering (Čadež, I. et al. 2013)

Competence-oriented types of courses can be distinguished by an active role of the students. This means, that students have a big part in designing the course and its contents. Actively participating students usually learn better than passively listening students.
Due to this, project work, seminars with close interaction and Bachelor- or Master Theses are highly appropriate for competence based learning.
In work life of civil engineers, interdisciplinary projects are part of the daily work. There are many interfaces, e.g. with other engineers, architects or clients. To prepare students properly for this challenge, especially interdisciplinary projects are useful.
In project work, especially social competences such as teamwork, conflict management or mediation abilities and self-competences such as conscientiousness and motivation can be trained. Less useful for the development of multidisciplinary competences are courses, in which the focus is set on knowledge transfer without interaction with the students, such as lectures. Lectures can be useful for developing complex technical knowledge. It becomes clear that a well deliberated mix of courses seems to be useful in students' education.
For the transfer of technical knowledge internet-based learning can be a good solution as well, however it should be mixed with physical attendance at university. In online-tutorials, students can acquire knowledge independently without time or space limitations. In meetings at university, questions can be answered and discussions can be made.
Here the role of the lecturer, professor or research assistant is changing from a broadcaster of knowledge to a coach, who is supporting the students' process of learning.
It is important to be sensitive while changing the way of teaching and learning. Students and also lecturers may need some time to get used to new lesson formats, roles and responsibilities in their teaching and learning. Lecturers may need more time to prepare lessons, students may get used to higher demands on their work in courses.
Besides the competence-orientation, a second component is rather important in education of civil engineers: the practical requirements of civil engineers daily work life (Wildt, J., 2007).
External lecturers and close collaborations with enterprises can fulfill these demands. Actual requirements can be transferred from offices and construction sides to lecture halls and the academic view can be transferred the other way around. In the Master Program at TU Dortmund, a mixture of lectures held by professors and academic staff and external lecturers turned out to be a good basis, either to focus on theoretical or practical needs. Besides the technical knowledge, external lecturers can also point out needs of competence oriented skills. These are particularly personnel management and social and entrepreneurial responsibility. Furthermore, experts from enterprises can act as role models to the students. They can explain the development of their own career and how they deal with problems and requirements in their work life.
At TU Dortmund, relationship of external lecturers and students developed rather well, several students successfully applied for a job at these enterprises.

4. Multidisciplinary project work for Architects and Civil Engineers

In the Faculty of Architecture and Civil Engineering at TU Dortmund, Architects and Civil Engineers are educated within one faculty. There are two Bachelor programs and three master programs: "Civil Engineering", "Real Estate and Construction Management" and "Architecture and Urban Development" (fig. 3).

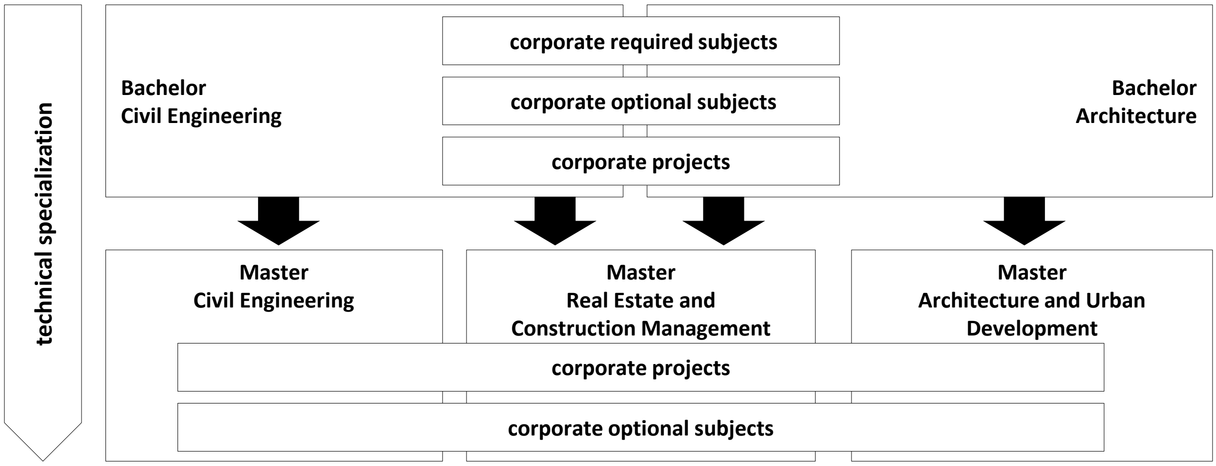

Fig. 3 Interdisciplinary education in Civil Engineering and Architecture at TU Dortmund

Within these Bachelor and Master programs, students of all disciplines are educated in shared projects and basic subjects together. They are also educated in separate subjects to gain specific knowledge in their actual topic. Thus, students are able to work in a team with different disciplines early in their studies, which is very useful regarding their future work.
A focal point is the so called "Project 3" in the master programs. Here, students of the three master studies work together on one project. Within the Master "Real Estate and Construction Management" they are additionally supported by specially trained tutors.
Training of tutors and complex support of students has been analyzed in a research project regarding innovative teaching, which was supported by the Center of University Didactic at TU Dortmund.

4.1. Project work at TU Dortmund – experiences of Project 3 in the Master program "Real Estate and Construction Management"

Improvement and learning of competences like method-, social- and self-competences can be achieved especially with active and responsible work of students. Therefore, the Project 3 is an outstanding opportunity.
Within this project, students of the master program "Architecture and Urban Development" are designing a building on a certain space with a defined conceptual formulation. These students are supported by students of the master program "Civil Engineering", who are planning the bearing structure of this building in close cooperation with the Architectural students.
The students of the master program "Real Estate and Construction Management" are developing an economic feasibility study of the project. This feasibility study is focusing on the whole lifecycle of the building. The students are calculating financing, planning and construction costs, operation costs and operation returns in a dynamic feasibility model.
They are closely working together with students from the other disciplines. For a high learning outcome project work is structured as shown in the figure below (fig. 4).

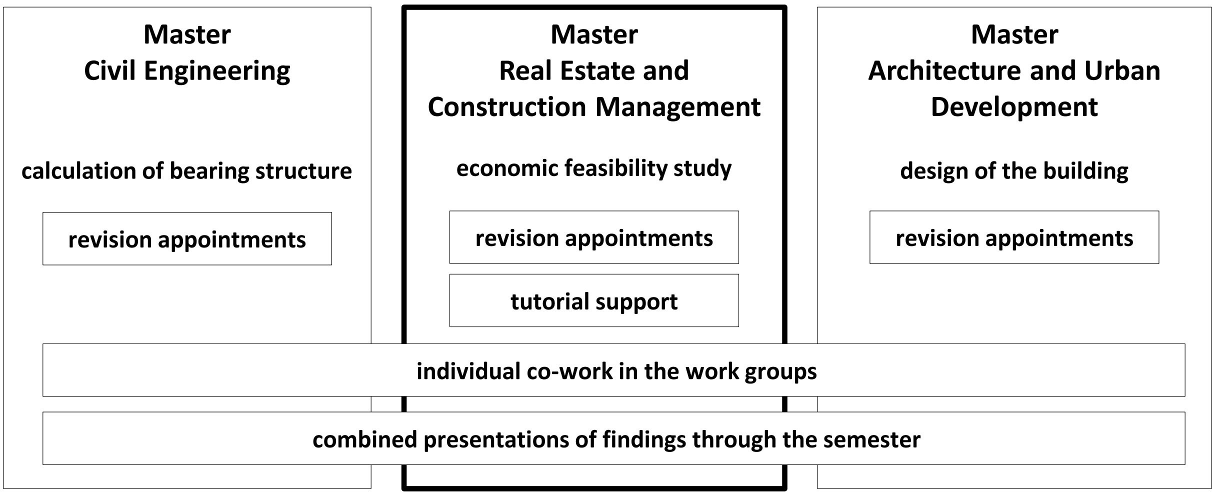

Fig. 4 Structure and process of Project 3

A huge part of co-work between the different disciplines is the individual work of the different groups and combined presentations from students to students of all subjects. Students of "Civil Engineering" as well as "Real Estate and Construction Management" attend revision of architects; students of "Civil Engineering" are explaining their calculations and students of "Real Estate and Construction Management" present their results and the point of view as an investor to the other student Groups.
The focus of the presented research project is the economic feasibility study in the master program "Real Estate and Construction Management".

4.2. Innovative teaching supported by tutors

In summer semester 2013, an innovative teaching project "Tutor coaching in project 3" was developed for education of tutors. The tutor's task is the support of students in their project 3 work. Aims of this project were, on the one hand, optimization of students' support in their project 3 and, on the other hand, to educate students of higher semesters regarding their development of competences as a team leader and to prepare them for these requirements on their later job.
Tutorial work at universities has to be distinguished from **students' advisory work**. Students' advisory work is an important task of universities regarding support and help of students. Tutorial Work is a part of students' advisory (Krause, C. / Müller-Benedict, V., 2007). In Project 3 at TU Dortmund, tutorial work can be defined as a continuous support of students through their project and their semester regarding questions to project work and structuring of the work process in group work.
Here, qualification of the tutors bases on two effects. On the one hand, these students have already passed the project work themselves one year ago with above-average results. On the other hand, they have been trained in a structured process regarding their technical and multidisciplinary skills.

4.3. Training concept "Tutor coaching in project 3"

The training concept had a major focus on developing multidisciplinary competences of tutors in order to qualify them to work as a tutor and for their later demands on the job. The concept can be divided into three parts. The first part focuses on technical knowledge of the tutors. They should be able to answer questions of students and to support the students' work process.
The second part focuses on multidisciplinary competences. Here, the focus is set on method competences in a teaching and supporting process. Basic input was given on topics of communication and moderation, learning psychology and team work.

Timetable workshop "Multidisciplinary Input"	
1	Welcoming the participants
2	Education at universities – appreciation and relevance
3	Communication and moderation
4	Moderation – role play
5	Motivation of students
6	Learning psychology, coaching in group work
7	Implementation of learning psychology in the tutorial support
8	Feedback

Fig. 5 Example: Time-table workshop multidisciplinary input

The structure of the training was separated into parts with input-presentations and a big part of discussion and case studies. The tutors should experience situations with students in role plays to clarify their own role and to be prepared for conflicts or discussions with students.
Most important was to gain a deep understanding of the tutors' own competences and requirements of their tutorial employment. Also important was to get a certain basis and understanding of tasks and aims for tutors in general, especially because they worked in different student groups. Due to this, a basic standard support could be ensured.
Besides these workshops – as third part – two reflection meetings with the tutors and a research assistant were conducted during the semester. The current statuses of the coaching process, questions and further steps have been discussed.
Within the tutorial coaching, three tutors had been coached. These tutors evaluated the workshops. It could be noticed, that the content of the workshop has a very positive impact on necessary competences and knowledge for the tutorials. The tutors were content with the workshop and agreed that it fits to the needs of the tutorials. They felt enabled to work with the students, especially considering technical knowledge and multidisciplinary skills.
The workshops also had a positive influence on the motivation and the tutors' approaches to teaching. A big aim of the project was to enable students to work independently with necessary support of the tutors.
It could be proved, that the coaching had a good influence on abilities and motivation of the tutors in their project. These findings correspond with experiences of project work. The tutors had a strong identification with their project work and with the student groups they worked with. The tutors were motivated to deepen their knowledge, in order to be able to support the students properly.

4.4. Concept Project 3

The concept of the project 3 structure was separated into frame meetings and three different modules, which rotated weekly (see fig. 6). Module A was the tutorial coaching, in which the tutors worked with little groups of students. They gave students a structure to work with and answered their questions.

Module	Name	Participants
Frame	Introductory Course	professor, research assistant, tutors
Module A	Tutorial Coaching 1	tutors
Module B	Concept Colloquium	professor, research assistant, tutors, lecturers and students of Architecture and Civil Engineering
Module C	Workshop 1	professor, research assistant, tutors
Module A	Tutorial Coaching 2	tutors
Module C	Workshop 2	professor, research assistant, tutors
Module A	Tutorial Coaching 3	tutors
Module B	Design Colloquium	professor, research assistant, tutors, lecturers and students of Architecture and Civil Engineering
Module A	Tutorial Coaching 4	tutors
Module A	Tutorial Coaching 5	tutors
Module C	Workshop 3	professor, research assistant, tutors
Module A	Tutorial Coaching 6	tutors
Frame	Final Presentation	professor, research assistant, tutors, lecturers and students of Architecture and Civil Engineering

Fig.6 Weekly structure of project 3

Module B consisted of different meetings together with the students and lecturers of the master programs “Architecture and Urban Planning” and “Civil Engineering”. The students of all master programs presented their work results. Aim of these meetings was the discussion of the project between the different participants regarding different approaches to the project work. Architects gained knowledge about economic issues, students of “Real Estate and Construction Management” learned about the design of buildings. Due to this, students of the different master programs trained the multidisciplinary approach to complex building projects.
Module C included teaching of professor and research assistants. In this module, the focus lay on discussing the results of tutorial coaching and working results and presentation of the next steps in the project.
Due to this structure, research assistants and the professor could focus on strategic points of the projects and provide advice in complex questions, whereas the tutors were the direct contact persons to the students for operational problems.

4.5. Evaluation of the Project 3 in “Real Estate and Construction Management”

Both, tutors and students, had a significant learning outcome on multidisciplinary competences. For example, tutors gained knowledge in leadership and students worked strongly on their multidisciplinary skills. Team work and interaction combined with professional presentations for other disciplines led to outstanding results.
The tutorial support has been evaluated by the students. Aim was, to measure the success of the tutors and the project concept. As shown in figure 7, the average answer was agreement (2.05-2.38) on learning success within the project. The students could work autonomously and got knowledge about the practical application of the content.

Self-evaluation of students' qualifications during Project 3 with tutorial support [arithmetic mean]	I agree 1 2 3 4 5 I disagree
I am content about my qualifications and learning success in the project. (n=21)	2.38
I got knowledge about the practical application of the content. (n=20)	2.05
I could discuss about the topics with students and tutors. (n=21)	2.33
I could autonomously work on certain questions and topics. (n=21)	2.10
I could frame important terms and issues in the therorectial context. (n=19)	2.05

Fig.7 Self-evaluation of students' qualifications during Project 3 with tutorial support

Tutors received very good results in the evaluation (see fig. 8). They explained the structure and objectives of the project clearly (1.7), answered questions and gave support (1.52) and created opportunities for the students' participation (1.43).

Students' evaluation of the tutors [arithmetic mean]	I agree 1 2 3 4 5 I disagree
The tutor explained the objectives and structure of the Project 3 clearly. (n=23)	1.7
The tutor answered the demands for further enquiry and help. (n=23)	1.52
The tutor put certain aspects in an overall frame of the topic. (n=21)	2.14
The tutor gave possibilities for student's participation. (n=23)	1.43
The tutor expresses critic fairly and positively. (n=23)	1.75

Fig.8 Student's evaluation of the tutors

The didactic and methodic design of the tutorial and the project work was evaluated well. The sequence of the topic and workshops was good (2.05) and learning outcomes and tasks were clear (2.09).

5. Conclusion and Outlook

It can be derived, that neither interdisciplinary and specialized education, nor development of technical knowledge and multidisciplinary competences are excluding each other.
Future challenge is the development of a mixture of different types of courses and the focus on different aims in the study programs, while the number of students is increasing and the budgets of universities are decreasing. The optimized "shift from teaching to learning" has to be found individually for each study program.
Implementation of competence based education and interdisciplinary work needs to be pushed on different organizational levels. On the one hand, the dean and the faculty have to sensitize professors and lecturers for the need of competence based teaching. A faculty-wide process should

be enabled to ensure an all-embracing knowledge in Architecture and Civil Engineering as well as a focus on competence-based education in step with actual practice.

The professors and lecturers themselves should get knowledge about different possibilities of education. A possibility to strengthen didactical skills is attending in workshops. These can often be found at universities' didactical centers.

The political visibility of education should be improved to ensure enough academic staff for high quality education. Courses and lectures with a strong interaction need more time in preparation to ensure an optimized support of students. The organizational work increases in interdisciplinary projects as well. Nevertheless, the good evaluation results of Project 3 show the value of this effort. Both, tutors and students, had a big learning outcome regarding their technical knowledge and their development of competences for their later work life.

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BIM APPLIED IN EDUCATION

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Abstract

Large civil engineering projects increasingly apply Building Information Modelling (BIM) concepts in order to integrate Systems Engineering, 3D modelling, planning, cost calculation, document management and other project related information. This paper provides a brief overview of the state-of-the-art BIM technology in Europe. As to study how a large group of novice users would respond to these techniques, we applied a selection of BIM tools in a number of our university courses. Here, we present how approximately 290 second year civil engineering students, divided into 24 groups and without any prior BIM knowledge, succeeded in collaborating as a whole within 8 weeks. Their assignment was given in a deliberately ambiguous form. We therefore feared for 24 more or less incoherent designs. However, the group rapidly organised itself with the help of social media, produced detailed individual designs as well as a reasonable coherent whole (i.e. including infrastructure and shared concepts).

Keywords: Building Information Modelling, Systems Engineering, Education, BIMLab

Introduction

The Architectural, Engineering and Construction (AEC) industry in Europe faces major challenges. The economical crisis forces the industry to cut failure cost while simultaneously the type of projects change from large-scale new buildings and infrastructure to smaller scale maintenance and upgrade projects with a strong focus on sustainability. It is required to collaborate more efficiently and transparently, and to apply advanced techniques.
In this regard, many companies believe that Building Information Modelling (BIM) is a helpful concept. They attempt to stimulate BIM developments by forming sector-wide organisations. Universities stimulate this innovation by implementing them in their educational programs.
We start with a brief overview of BIM in the Netherlands (similar developments can be found in European context) and explain the importance of Systems Engineering. We then demonstrate how we applied BIM in the 2nd year project, during which students normally solve a practical Civil Engineering problem - but this time with more focus on BIM. Finally it introduces our BIMLab at the Delft University of Technology.

2. BIM in the Netherlands

During the past 5 years, BIM has been adopted and implemented in Dutch infrastructural and building companies at a rapid pace. The maturity of these companies was recently investigated by Berlo et al (2012). Based on approx. 700 BIM Quickscans in the Netherlands (questionnaires, conducted either by companies themselves or by a certified consultant), they conclude that these companies sport a fairly high maturity rate of around 50% on aspects such as *Organisation and Management*, *Mentality and Culture* and *Information structure and Information flow*; however the aspect *Tools and Applications* clearly “falls behind in comparison to the maximum potential” (~20%). In other words, the mindset is right, computers and the Internet are of high quality and therefore the time to create and implement innovative BIM tools at a large scale is ripe.
Two major Dutch agencies (Rijkswaterstaat, with focus on infrastructure and water works, and Rijksgebouwendienst, with focus on buildings) recognise this new era and elaborated on exchanging essential BIM information semantically with contractors during the entire project life-cycle - independent of BIM software (an example is given in RGD (2013)). The main thought is to use Systems Engineering to uniquely code all important information in a project (such as functions, objects, risks etc). These codes can then be used in all other software applications to exchange information (refer to chapter 2).
In order to stimulate an ecosystem of BIM environments, The Netherlands Organisation for Applied Scientific Research (TNO) introduced the BIM server and works on EU research projects such as Manubuild, SWOP and InPro.

3. The importance of Systems Engineering (SE) in BIM

3.1. *Why applying standards is difficult*

One of the key BIM concepts is to integrate and visualise data from various sources rather than being locked in by a single all encompassing model and a single software vendor.
This flexibility comes with a drawback: one needs to semantically exchange object information between the various software tools. In the past, researchers attempted to address the problem by introducing object libraries. If all stakeholders in the AEC industry would comply to the object libraries’ coding system and also comply to standards such as IFC, then there would be no obstacles in using BIM efficiently and flawlessly (Big BIM).

Unfortunately, this approach failed in practice. Stakeholders are unwilling or unable to comply to standards, standards develop sluggishly and stakeholders develop their own fit-for-purpose standards (Little BIM) (refer to figure 1).
The resistance to industry-wide standards in the AEC industry is comparable to other industries such as the smartphone or automobile industry; even though the competitors' products share many properties, each company tends to define its own standard. One may view this as a problem, however it has the advantage that companies start competing, which is positive for the sake of variety and quality.

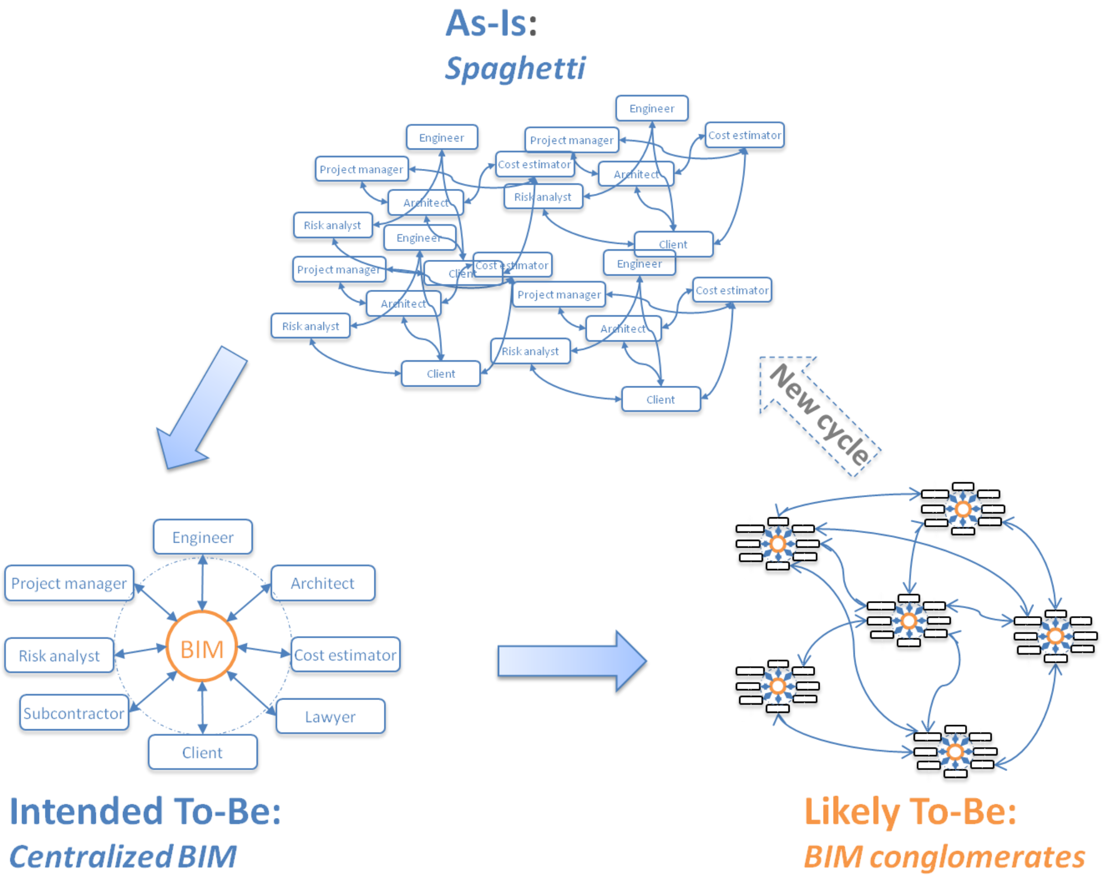

Figure 1 Spaghetti to spaghetti model [source: Ruitenbeek (2012)].

The AEC industry attempts to arrive at a uniform BIM model (Big BIM), however due to complexity and competition, many variations of the BIM model were introduced (Little BIM). Therefore a new problem is introduced: how to manage the variety of small BIMs, for example within a consortium [Hertogh, 2010]? This new situation (spaghetti) is comparable to the old situation (spaghetti), except for that the interactions are both more advanced and more complex.

3.2. An alternative to using standards

A straightforward solution for achieving the same goal is to apply a simple project-specific coding system. Each meaningful object within the project receives a unique code by which it can be identified. The corresponding objects in the various software tools (e.g. a beam in a CAD tool and the same beam in a planning tool) can be decorated with a metadata field that holds this unique code. Hence, the objects in the various software tools are loosely coupled. From that point, it takes little effort to establish meaningful integrations, such as creating an animation over time of the beam by coupling the same beam in both the CAD and the planning tools (refer to figure 2).

The object codes can be organised hierarchically in a so-called Product Breakdown Structure (PBS) and be stored in a project database that is accessible over the Internet (such as Relatics and other web services). Besides a PBS, System Engineering (SE) features other breakdown structures, such as a Work Breakdown Structure (WBS). Each item in a WBS is merely a combination of an object, a responsible person, an activity and start and end date (hence WBS entries can always be related to PBS entries). Therefore the WBS codes are often being applied to identify the planned items in planning software.
The PBS and WBS are project specific, but they may obviously inherit from high-level (industry standard) libraries if needed (for example, one may use a standard bridge decomposition). In practice, they are created on the fly in order to account for project-specific needs, except for when a substantial amount of repetition is involved within a project; in such cases, a project-specific library is created. These project-specific libraries are potential candidates for company-specific libraries, however the lack of time and the complexity of implementing and maintaining such higher level libraries discourages initiators.

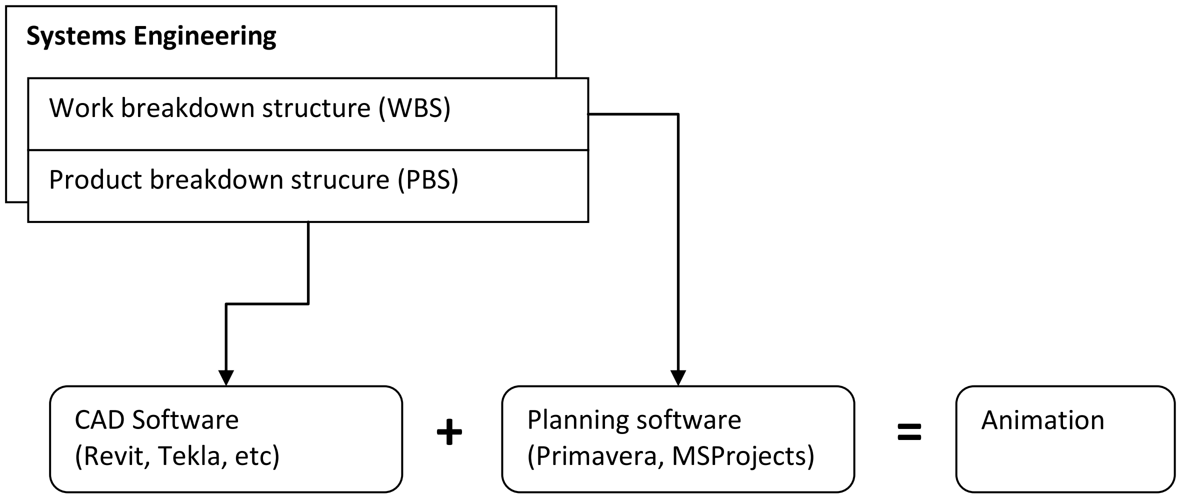

Figure 2 Using Systems Engineering as a vehicle to uniquely define objects.

If each meaningful object in a project is identified with an unique PBS code in a hierarchical structure, then these codes can be used to tag objects in the various software tools and to create meaningful integrations. In the case of CAD tools and planning software, one may create a simple tool that automatically shows and hides CAD objects over time (building animation) based on the PBS codes in both the CAD software and planning software. In this way, both CAD modellers and planners remain focused on their core tasks, while the tool provides the animation automatically.

Since an increasing amount of large-scale projects apply Systems Engineering, and since the loose coupling mechanism explained above provides room for meaningful BIM couplings with or without standardisation, one may hypothesize that SE is the heart of BIM. The authors created various tools as an experiment and tested whether students without any prior knowledge of BIM or SE are able to apply these concepts. Simultaneously, the tools are successfully being applied in actual large-scale Dutch infrastructural projects.

4. BIM project with 290 Civil Engineering students

It is important for civil engineering and architectural students at universities to be familiar with BIM and SE concepts, since the AEC industry is rapidly adopting and implementing it. Therefore, during the past years, we offered a number of BIM courses at our faculty, during which approx. 8 groups of

4 students were asked to work on BIM projects, such as collaboratively designing a stadium.
The results are positive. Students quickly grasped the concept of BIM and immediately started dividing the work in SE structures and agreed upon exchange formats as soon as the assignment was given. For example they distributed a basic template with zero coordinates, created parametric sub-models, linked the planning to the model to produce a 4D animation, performed light studies and simulated mass evacuations. Most importantly, they enjoyed working together and produced more output than required. After the course, 80% or more were aware that the success of BIM largely depends on proper human communication. These initial results convinced us to upscale the experiment to a group of 290 (2nd year) students.

4.1. Preparations

At the start of the project, the students were given a 2 hour introduction during which the assignment was given (refer to paragraph 2.2) and the basic concepts of BIM and SE were explained. The assignment was to create an entire masterplan for a region. Half the group (145 students) was asked to solve the parking problems for the region, the other half was asked to create floating homes (figure 3). The required final result was a logic concept that included all necessary infrastructure, offer sufficient capacity, be free of clashes, include multi-functional, sustainable buildings and attractive architecture.
There was one main client (the municipality) and each sub-group of 12 students had a sub-client. The sub-clients only had a vague idea of the organisation, and the sub-groups were required to break down the assignment themselves. It was completely up to them to divide the assignment into distinct areas or into functions (parking problem, infrastructural problem, etc).

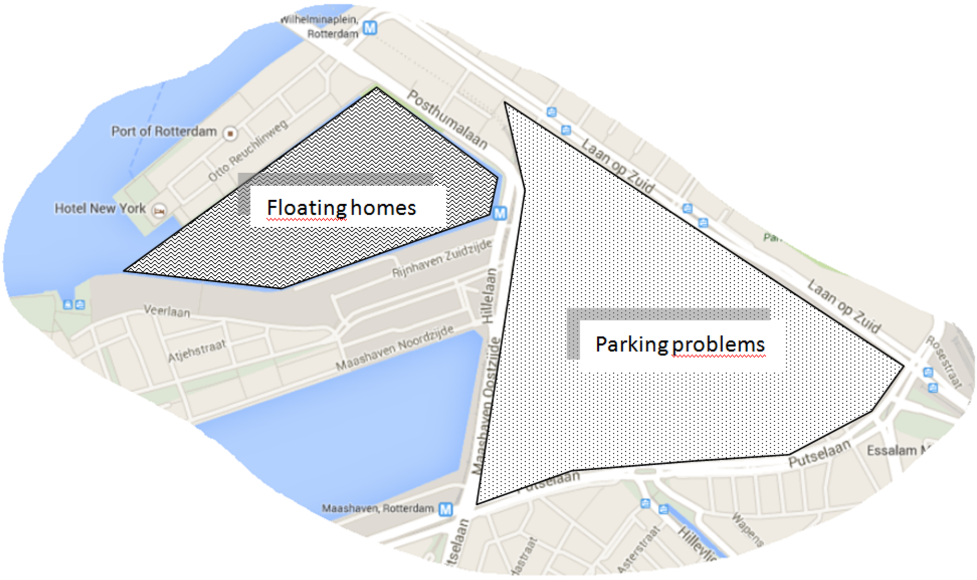

Figure 3 The 290 students' assignment was to build floating homes and to solve a parking problem.

It was explicitly stated that BIM were required. The required level of complexity was reduced to only 3D modelling and attaching the planning to it using SE codes to form an automatic animation (=4D modelling). Moreover, the students were required to merge all groups' models into a single large working animation of the entire region every week. They were advised to assign a project leader and a BIM manager for each sub-group. Finally, they were wished the best of all luck and were sent to the 4 hours crashcourse BIM. The course included basic 3D modelling skills (Revit Structure), merging models from various sources (Navisworks), creating a planning (MSProject / Excel) and linking 3D models with planning using SE PBS codes to form an animation (=4D modelling).

4.2. The assignment

A translated, slightly shortened version of the students' assignment is given below (introduction text is omitted here, a similar text was given to the floating homes group).

> *"The municipality of Rotterdam intends to change the streetscape of the Afrikaanderwijk in Rotterdam. The requirement is that all parked cars disappear from the streets.*
> *The final product must be delivered with BIM. The BIM model (Navisworks) will be used during the weekly group meetings and during contact with the main client. As a minimum, the BIM model must contain 3D geometrical information and it must be linked to the planning (this will be explained during the BIM crash course).*
> *Every Monday morning we will start college with a discussion of the overall BIM model, that will be led by a delegation of students. Each group must choose a distinct area to solve. The aggregated solutions must form a coherent whole such that the entire Afrikaanderwijk is provided with sufficient but invisible parking area and that the road network forms a logic concept. Therefore you need to cooperate with other groups.*
> *During the construction of the garages there is a unique opportunity to implement multi functionality, eg heat / cold storage in the soil. The parking solutions must combine several functions and be sustainable. Underground parking is expensive. There must therefore be a trade-off between small garages (eg immersion garages in the canals or in the streets) and large garages (Disadvantage that residents have to walk far)."*

4.3. The process

The first week of the experiment was more or less a drama in the eyes of the students and sub-clients. The lecturers intentionally sabotaged the process, there were conflicting messages on Blackboard, the main client was unreachable and students lacked contact information of the other groups. In response to all these complaints, the lecturers simply responded that "this is reality in real-life projects, so get used to it".
Near to the end of the first week, a number of students stood up and started organising the entire group simply by finding other groups' contact information, sending clear emails and arranging meetings with the other sub-groups' managers.
As a result, they reached an agreement on how to divide the work over the sub-groups as to avoid clashes and to arrive at logic overall concept (figure 4). The floating homes group divided the area into floating hexagons that could be coupled as needed and on top of which they could build houses. The parking group divided the area into subareas based on the number of anticipated amount of parking places and suitable areas for underground garages. The result of the first week was a concept master plan.

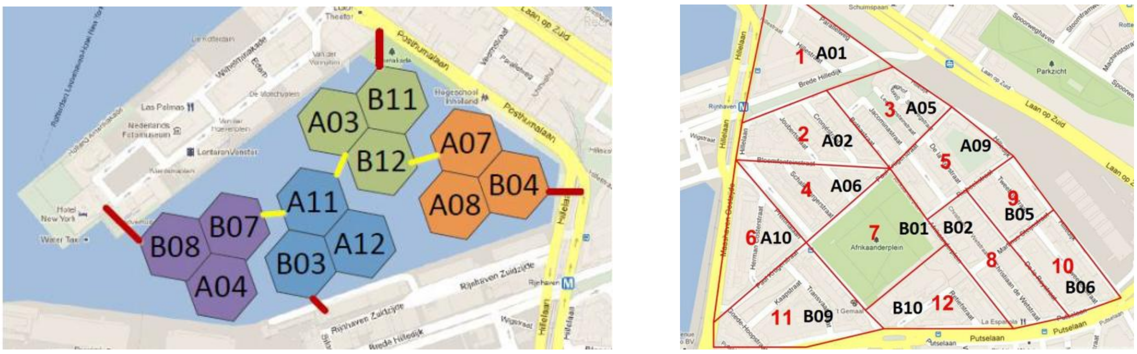

Figure 4 The students agreed upon dividing the work after one week
[source: final reports of two of our BIM student groups]

From the second week and onwards on each Friday, the students produced a merged 4D model of the entire area (floating homes and underground parking). The following Monday, a delegation of 8 students presented this model to the entire group, discussed a number of uncertainties and voted for the best solution.
After the third week, most complaints about the project (bad organisation, lack of communication, time pressure etc) suddenly vanished. The sub-groups as well as the managers of all groups had regular meetings (2-3 times a week). The end client received professional emails about important decisions and was occasionally invited to join a meeting. Slowly but surely the merged 4D model reached more and more detail (figure 5). The area was divided, the sub models included a level of detail that matched the design phase (although some groups put in far more detail than appropriate for an early design phase), and there was a rudimentary animation of the building process over time.

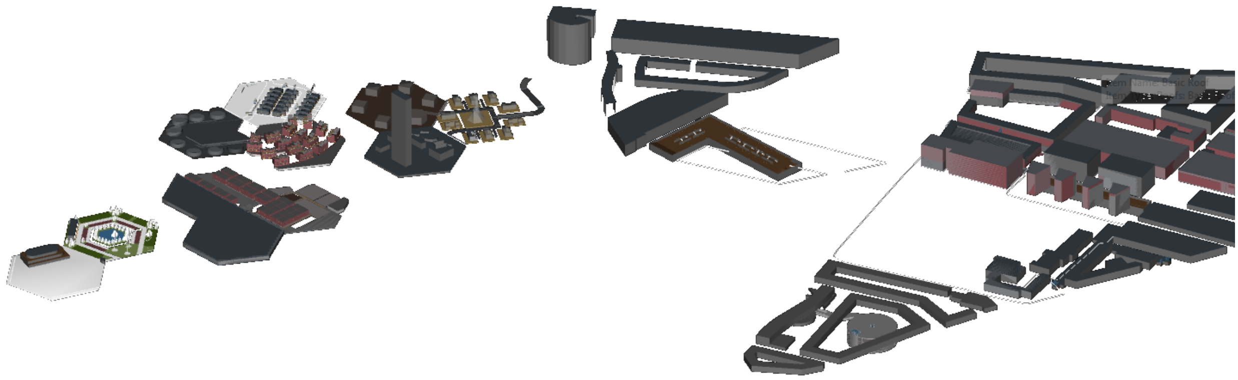

Figure 5 The 4D BIM model after four weeks of work
[source: final report of one of our BIM student groups]

A week after this remarkable turnaround (i.e. at the end of week 4), the end client posted a message on blackboard, saying that the current solution concept was not innovative, that there was little or no multi-functional buildings and that most buildings were far from sustainable. The students were unpleasantly surprised. Nevertheless, the end client received only one complaint, and the students worked around the clock to think holistically and to include the requested features. For instance they proposed how use freed space economically and socially if all cars are parked underground (figure 6). The parking and floating homes groups even attempted to cooperate (e.g. to park cars under water).

Figure 6 The students started to think holistically and in multiple functions
[source: final report of one of our BIM student groups]

For example, they did not only solve the parking problem, but they also proposed how the freed space above ground could be reused efficiently (right picture) After the 7 weeks project, the students were given a matrix with all groups in it. They were asked to rate how well other groups cooperated

with them. The outcome of this survey was that groups rated the groups with which they collaborated with, with an 8 (on a scale of 10) on average. A number of students wrote an article about the project on own volition in a university magazine and the end client received a number of suggestions for future projects.
The main points of this feedback was:

1. the start of the project was extremely difficult. The students expect more momentum if the lecturers provide slightly more structure during the first week (e.g. distributing lists with phone numbers and other basal information)
2. the students said to have learnt a great deal about project management due to the high degree of self-reliance that the lecturers expected
3. rather than mastering BIM tools, the students discovered that cooperation and communication are the key success factors for a BIM project (for example Dossick et al (2008) concluded that "Organizational forces and structures must be accounted for in order for BIM to be implemented successfully"

4.4. Reflection on the BIM project

Giving the lectures with focus on BIM in this challenging form seems to be successful. We offered such lectures four times in the past three years; three times with approximately 35 students and once with 290 students. The results are comparable.
The fact that students are expected to produce output of high quality given a vague assignment pushes them to their limits and prepares them for real life projects. The concept of BIM (rather than the actual BIM tools) provides them with a straightforward concept that stimulates them to cooperate. A simple crash course BIM and Systems Engineering suffices for that purpose, although they might benefit from a more gradual BIM introduction during the first years of their studies (e.g. drawing by hand, then drawing with CAD, then object oriented thinking / parametric design, then BIM concepts and finally applying BIM software).
There is a number of risks involved in the aforementioned form of education:

- Students may or may not spontaneously organise themselves, so lectures must have a plan B. Fortunately, our students always organised themselves.
- Students may lose momentum under to too much pressure. Pushing students a little too far may discourage them altogether and may even cause a meltdown in the entire group and distract attention from the primary goal: to teach students to collaborate in real-life conditions (chaos, uncertainty, a lack of clarity, conflicting interests etc) by using BIM as a thinking model.

We identify many opportunities for future lectures:

- Implementing BIM at an earlier stage in education. We first lectured BIM in the master program, but it might be more efficient to introduce the concept gradually from the first year.
- Giving students a large amount of responsibility seems to encourages them to perform far beyond the expected average. We may therefore conduct an experiment during which students will form their own company/consortium and participate in an actual Dutch (PPP) project.
- Students indicated that they would like to continue with BIM during the course of their studies. Therefore we introduced a BIMLab (refer to the next chapter).

An interesting fact is that students introduced weekly cycles in their own groups as well as in the global group in order to merge models (fig 7). In actual Dutch infrastructural projects, we observe a similar pattern. A selection of all stakeholders meet each week to discuss clashes, risks, interfaces, planning and other aspects. One of these people (a BIM modeller) usually displays the BIM modal (e.g. the Navisworks model) on a large smartboard as to help clarify any uncertainties during the meeting and to digitally document comments (using redlining).
The findings in our research may prove helpful in research how new technologies are adopted in the

industry. The students exhibited similar behaviour as professionals and created similar solutions. One may therefore use education to test new technologies on a fairly large scale. There are several benefits in such an approach: The students become familiar with the new technology, they are better prepared for their future jobs and they may come up with even more innovative technology. Simultaneously, companies may reduce their failure cost by preventing mistakes and they are upplied with more knowledgeable new employees.

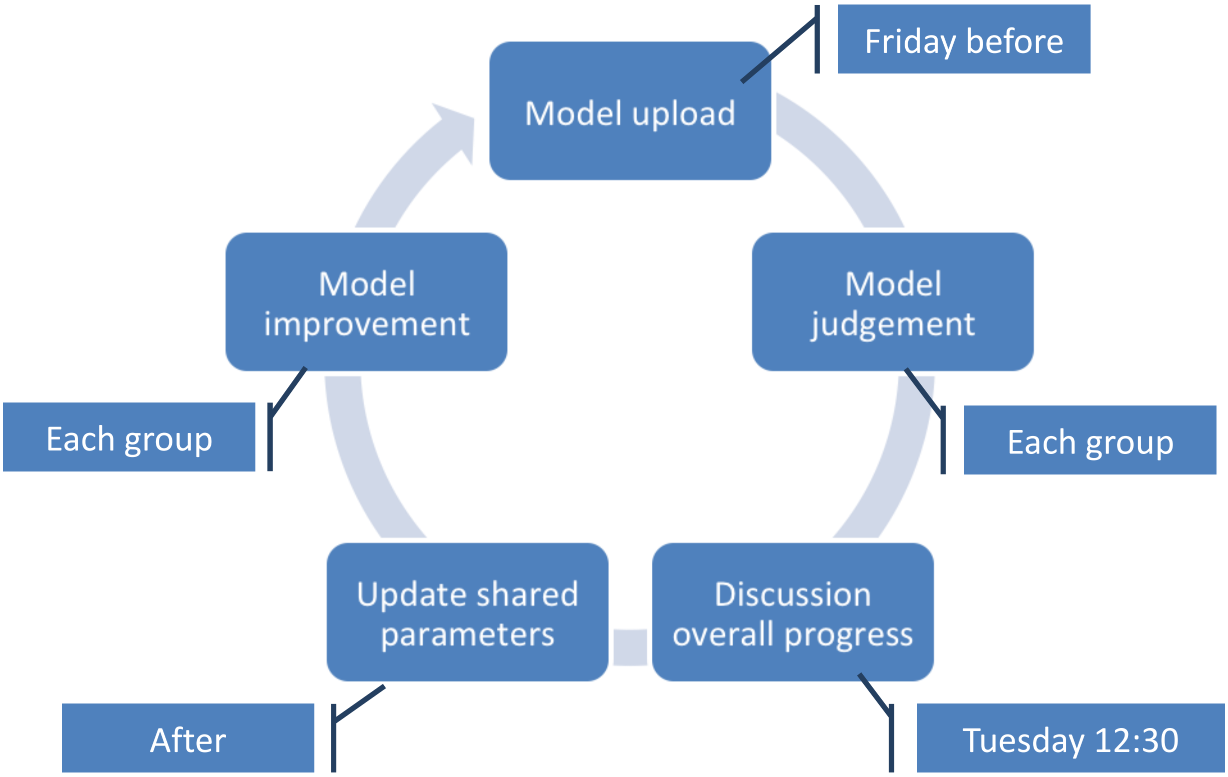

Figure 7 Students introduced a weekly cycle to manage the BIM process
[source: final report of one of our BIM student groups, translated from Dutch]

Students introduced a weekly cycle to manage the BIM process – both in sub-groups and for the group as a whole. This cycle is very similar to that of professionals in Dutch infra projects [source: final report of one of our BIM student groups, translated from Dutch].

5. BIMLab

In order to stimulate BIM in education, reseach and in Dutch practice, the authors decided to create a BIM laboratory (BIMLab) at our section. This BIMLab is a place where students, clients and governments come together to discuss relevant BIM technology, to experiment with it and to exchange knowledge.
As of today, we assigned 3 of our best BIM students from the previous courses to lead the BIMLab. Their duty is to manage te BIMLab, to attract new opportunities, to organise workshops, to create research proposals etc etc. A preliminary investigation amongst about 10 large Dutch companies (contractors, engineering firms and software vendors) yielded positive reactions for such a collaboration.
The BIMLab primarily focuses on recognisable, state-of-the-art BIM technology as to connect with interesting parties more efficiently and to implement the concepts in our bachelor programs. Obviously, the BIMLab also provides near future (5 years, MSc students) and far future research (10

years PhD candidates). All research proposals that fit our lines of research will be positioned within this simple model (fig 8) as well as in a hierarchy (top level research lines and derived research).
The concept of a BIMLab is not new; graduate schools already started with it. However, their focus is on a more practical level, and governments and large companies generally prefer cooperation with well established universities. For this reason, our BIMLab will target a different audience while searching for cooperation and knowledge exchange with existing BIMLabs.

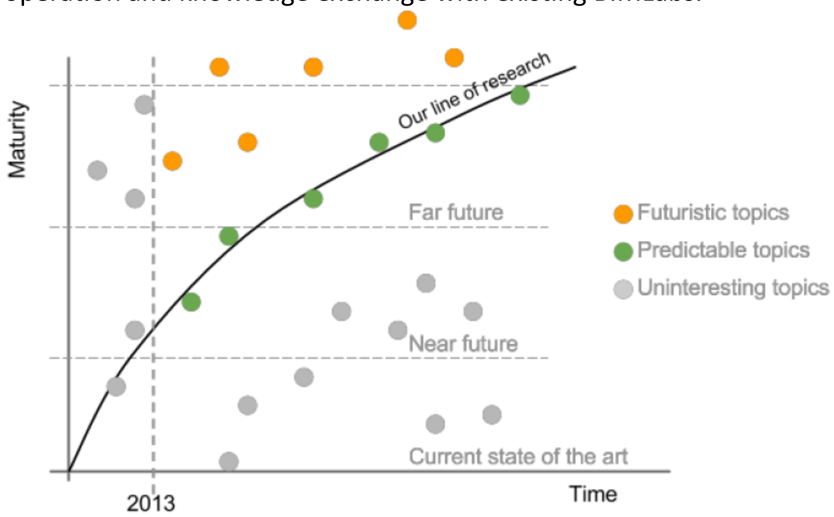

Figure 8 BIMLab research for State-of-the-art, near future and far future technology

The BIMLab facilitates research on

1) the current state-of-the-art BIM technology (for promotion, education and collaboration purposes),
2) Near future technology (MSc projects) and
3) Far future technology. The dots on the line of research are interesting topics. Dots below the line indicate potentially outdated technology, dots above the line are too futuristic.

Conclusion

The Dutch AEC industry is transitioning to BIM. In order to prepare the students at our university for this future situation, we implemented BIM in our education program and applied BIM concepts to large groups of novice students (~290). We observed that these students are able to rapidly adopt BIM, to organise themselves and to solve a challenging design problem collaboratively.
Inspired on these results, we introduced a BIMLab that features state-of-the-art technology as well as near future and far future research. The BIMLab is being led by a number of our previous students. We expect that the BIMLab will join universities, governments and corporations and positively influence the further acceptance of BIM in the AEC industry.

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SUSTAINABILITY ASSESSMENT METHODS FOR INFRASTRUCTURE PROJECTS*

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Abstract

In accordance with a sustainable development across the construction industry, sustainability rating systems for infrastructure projects are gaining more and more importance for public authorities, contractors and clients. Established sustainability approaches, as ENVISION, CEEQUAL or the IS-Rating System, are offering numerous different criteria in order to evaluate environmental, economic and social performance of a project. However, the majority of these rating systems focus either on general criteria or consider only selected environmental and social aspects without paying attention to economic aspects. In addition existing rating methods neglect the projects´ specific technical and process-related issues of sustainability. Hence, existing rating systems have to be improved in order to ensure a holistic sustainability assessment of specific infrastructure types. As result an innovative multidimensional assessment approach for highway projects is presented which is derived from the German DGNB system for vertical projects. As a main difference to existing rating systems this new approach is covering not only environmental, economic and social aspects but also technical and process-related issues and includes specific evaluation criteria for highway projects for the first time.

Keywords: sustainability, infrastructure projects, assessment methods, rating system, triple bottom line

* The complete text is available on CD-ROM / Hoffman, Čadež

Introduction

Infrastructure projects are strategic resources and present significant possible savings. The transportation sector in particular represents an important factor for global economy. It is responsible for 22 % of global energy consumption, 25 % of fossil use and 30 % of global air pollution along with greenhouse gas emissions. It also accounts for approximately 10 % of the world´s gross domestic product (GDP) (Eisenman, 2012). Hence, a sustainable development is becoming more and more important for the construction industry, design teams, institutions and its clients. In order to determine a projects´ sustainability performance and to reduce its environmental, social and economic impacts it is necessary to identify and measure appropriate criteria. To meet this demand, sustainability rating systems are widely-used tools for clients during planning and design phase of projects (Clevenger et al., 2013).

Existing sustainability rating systems are based on consideration of environmental, social and economic aspects - the three dimensions of sustainability. This approach is called the Triple Bottom Line (fig. 1). The concepts main aim is protection of natural resources. In recent years the Triple Bottom Line has served as a common ground for numerous sustainability standards and rating systems in general as well as for the construction industry in particular. In accordance with the demand of a holistic sustainability determination, the majority of existing rating systems provide a wide range of specific evaluation criteria for all three sustainability dimensions (Ebert et al., 2010; Lee et al., 2010).

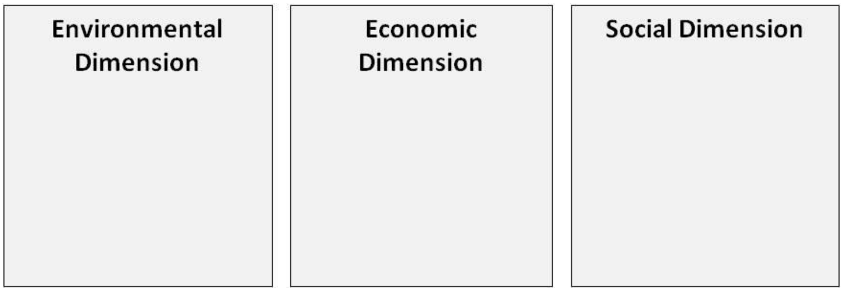

Fig. 1: Triple Bottom Line

Sustainability rating systems have been developed and implemented in the construction industry over the last 20 years. *Building Research Establishment´s Environmental Assessment Method* (BREEAM, GB, 1990), *Leadership in Energy and Environmental Design* (LEED, USA, 1998) and *Green Star* (Australia, 2003) are international established assessment methods for various types of vertical projects. Recently, these systems have been complemented by newly-arranged assessment methodologies as *Deutsche Gesellschaft für Nachhaltiges Bauen* (DGNB, Germany, 2009) in Germany (Ebert et al., 2010). Use of sustainability assessment methods, however, has occurred primarily in vertical construction (buildings). Since 2005 several assessment methods for horizontal and public infrastructure projects have been developed or are currently under development (Clevenger et al., 2013; Lee et al., 2010; Venables et al., 2005). Though, development of rating systems for horizontal and vertical projects is proceeding almost independently from each other.

The purpose of this paper is to reveal a new sustainability assessment approach for transport infrastructure projects. In the first instance three existing rating systems for infrastructure projects, ENVISION (USA), CEEQUAL (GB) and the IS-Rating Scheme (Australia), will be analyzed and compared. Advantages and disadvantages as well as evaluation limits will be identified. Subsequently a new assessment approach for horizontal projects which is for the first time derived from established rating systems for vertical projects will be presented and explained.

2. Sustainability rating systems for infrastructure projects

2.1. ENVISION

ENVISION is a web-based sustainability project assessment and guidance tool. It was launched in February 2012 and is operated by the Institute for Sustainable Infrastructure (ISI) in joint collaboration with the Harvard Graduate School of Design (Cambridge, Massachusetts, USA). The ENVISION assessment tool rates the following infrastructure construction types: energy generation, water storage and treatment, waste management, transport, landscape and information systems. It serves criteria for a projects life cycle covering planning, design, construction and operation phase. Projects are rated in a two-stage assessment. In a first step the applicant carries out a self-assessment with a provided checklist. The second stage entails an external verification combined with a public recognition process. Depending on the achieved score the assessed project will finally be rewarded. ENVISION includes four award levels (ISI, 2013; Bertera, 2012; Clevenger et al., 2013):

- Bronze (minimum of 20 % of total applicable points)
- Silver (minimum of 30 % of total applicable points)
- Gold (minimum of 40 % of total applicable points)
- Platinum (minimum of 50 % of total applicable points)

ENVISION is a framework of general indicators and performance achievements including 60 rating criteria distributed into five categories:

- *Quality of Life (13 criteria)*
- *Leadership (10 criteria)*
- *Resource Allocation (14 criteria)*
- *Natural World (15 criteria)*
- *Climate and Risk (8 criteria)*

A projects **social** impact on local community and its local environment is evaluated in the category *Quality of Life*. Main aim is to ensure public health and safety and to improve quality of life as well as to preserve historic and cultural resources. The category *Leadership* measures the involvement of stakeholders, planning and management issues of a project. The categories *Resource Allocation, Natural World and Climate and Risk* include mainly **environmental** rating criteria. Consumption and recycling of materials and use of non-renewable resources, energy and water are important aspects of evaluation. Reduction of greenhouse gas emissions and further negative impacts can help to avoid short- and long-term hazards for natural systems (Bertera, 2012; ISI, 2013). As a disadvantage ENVISION neither serves **economic** rating criteria nor includes specific criteria related to different types of infrastructure projects.

2.2. CEEQUAL

The Civil Engineering Environmental Quality and Assessment Scheme (CEEQUAL) is a UK-based sustainability rating system for civil engineering, infrastructure, landscaping and public realm projects. It was developed by the Institution of Civil Engineers (ICE) with financial support from UK Government in 2004 (Venables et al., 2005; CEEQUAL Ltd., 2013). The assessment scheme was initiated for horizontal projects as an equivalent to the BREEAM rating method for vertical projects and is applicable to all kind of civil engineering projects. It contains a framework of approximately 180 questions relating to aspects of environmental and social concern. As a key difference to other rating systems CEEQUAL is matched to each project being assessed by scoping out non-relevant questions which leads to varying evaluation criteria frameworks (Cartwright 2008; Venables et al., 2005). The self-assessment process is carried out by CEEQUAL trained assessors who are part of the staff of the applicant. Afterwards results and award recommendation are checked and ratified by a licensed external Verifier from CEEQUAL Ltd. As result of evaluation there is a percentage score related to the maximum possible score. Finally the applicant is awarded with one of the following awards (Venables et al., 2005):

- Pass (> 25 % of possible score)
- Good (> 40 % of possible score)
- Very Good (> 60 % of possible score)
- Excellent (> 75 % of possible score)

The general criteria framework of CEEQUAL covers following 180 evaluation criteria which are assigned to twelve categories:

- Project Environmental Management (23 criteria)
- Ecology and Biodiversity (14 criteria)
- Use of Materials (21 criteria)
- Water (14 criteria)
- Energy (13 criteria)
- Waste (16 criteria)
- Land use (15 criteria)
- Landscape (13 criteria)
- Archaeology and Cultural Heritage (10 criteria)
- Transport (13 criteria)
- Nuisance to Neighbours (17 criteria)
- Community Relations (11 criteria)

The categories *Project Environmental Management, Ecology and Biodiversity and Use of Materials* measure **environmental** risks and processes of active environmental management. Main aim is to minimize emissions by considering different approaches of construction methods or used materials. *Water, Energy* and *Waste* apply to a sustainable use of resources in the project. The categories *Land use* and *Landscape* primarily embody aspects of minimum land-take and landscape design. In addition the categories focus on minimisation of flood risks, possible contamination of landscape and a projects implementation in existing environment (**social** and **environmental** criteria). Negative impacts to neighbours (e.g. noise, vibrations, air pollution) or a participation of local community are important **social** aspects. Therefore, the categories *Archaeology and Cultural Heritage, Transport, Nuisance to Neighbours* and *Community Relations* serve several **social** evaluation criteria (Cartwright, 2008; CEEQUAL Ltd., 2013).

2.3. IS-Rating Scheme

Developed and launched by the *Infrastructure Sustainability Council of Australia* (ISCA) in 2012 the IS-Rating Scheme is a voluntary sustainability assessment method for the Australian infrastructure market. The rating scheme is comprised of a technical manual, a rating tool scorecard and a material calculator. Applicants have to follow a four-step assessment process: project registration, assessment, verification and certification (ISCA, 2013). The IS-Rating system supports different rating phases (design, construction and operation phase) and is applicable only to selected infrastructure types. The scheme is classified into groups of *Transport, Water, Energy* and *Communication* and focuses mainly on transport infrastructure projects as airports, railways, roads, ports and cycleways (ISCA, 2013).

The IS-Rating Scheme covers 15 criteria within six categories:

- Management & Governance (3 criteria)
- Using Resources (3 criteria)
- Emission, Pollution & Waste (3 criteria)
- Ecology (1 criteria)
- People & Places (4 criteria)
- Innovation (1 criteria)

The category *Management & Governance* contains three evaluation criteria related to **environmental and social** aspects of a project: Management Systems, Procurement & Purchasing and Climate Change Adaption. Main aim is to ensure an implementation of a holistic sustainability consideration from policy level down to detailed processes (e.g. purchasing of goods and services, effectiveness of management systems). *Using resources* applies to sustainable use of materials, water and energy. In combination with *Emissions, Pollution & Waste* and *Ecology* the three categories allow to measure a projects´ total use of resources and possible options of reducing emissions as well as opportunities of monitoring and controlling its **environmental** impacts. In addition **social** effects (e.g. community health, wellbeing and safety) and specific innovative sustainability strategies are evaluated by the categories *People & Places* and *Innovation.* The current criteria framework of the IS-Rating Scheme does not cover **economic** aspects of sustainability. Though, ISCA intends to add two categories called *Economic Performance* and *Workforce* soon. These categories are currently under development and will include additional criteria of economic and social relevance (ISCA, 2013).

3. Analysis of existing rating systems for infrastructure projects

3.1. Comparison of main structure, applicability and criteria framework

Obviously, the three introduced rating systems have structural similarities though they present approaches from three different countries. An overview of the systems applicability and their total number of categories and evaluation criteria are presented in table 1.

Rating System	Groups of infrastructure types	Total number of construction types	Total number of categories	Total number of rating criteria
ENVISION	6	37	5	60
CEEQUAL	∞	∞	12	Approx. 180
IS – Rating Scheme	4	10	6	15

Tab. 1: Applicability and criteria framework of infrastructure rating systems

The reviewed systems are applicable to various types of infrastructure projects where ENVISION covers 37 types of projects for six defined groups. CEEQUAL Ltd. does not limit applicability of its rating scheme. The Australian IS-Rating Scheme can be used for ten different construction types distributed into four groups. All analyzed rating methodologies are applicable for planning, design, construction and operation phase. The ENVISION rating system is a single rating approach which includes design, planning, construction and operation elements for evaluation (Clevenger et al., 2013). Within the CEEQUAL assessment the applicant can choose between five different approaches depending on the stage of the project (Cartwright, 2008; Venables et al., 2005). The IS-Rating Scheme can be used for three different rating types: Design, Construction (As built) and Operation (ISCA, 2013).

In addition the three assessment methods cover varying numbers of rating criteria and categories. The range of evaluation criteria varies from 15 criteria for the IS-Rating Scheme to approximately 180 criteria for the CEEQUAL assessment method. ENVISION covers a total number of 60 rating criteria.

Though, all approaches cover almost the same criteria framework (fig. 2). ENVISION differs from CEEQUAL only by neglecting issues of transportation. The IS-Rating Scheme and CEEQUAL are almost equal while their rating criteria are only distributed into varying numbers of categories. Consideration of innovative aspects by the IS-Rating Scheme is the only difference between these two approaches. Criteria frameworks of all three rating systems are related to mainly **environmental** and **social** aspects of a project. Currently none of the analyzed approaches provides **economic** rating criteria in order to evaluate economic sustainability performance of a project.

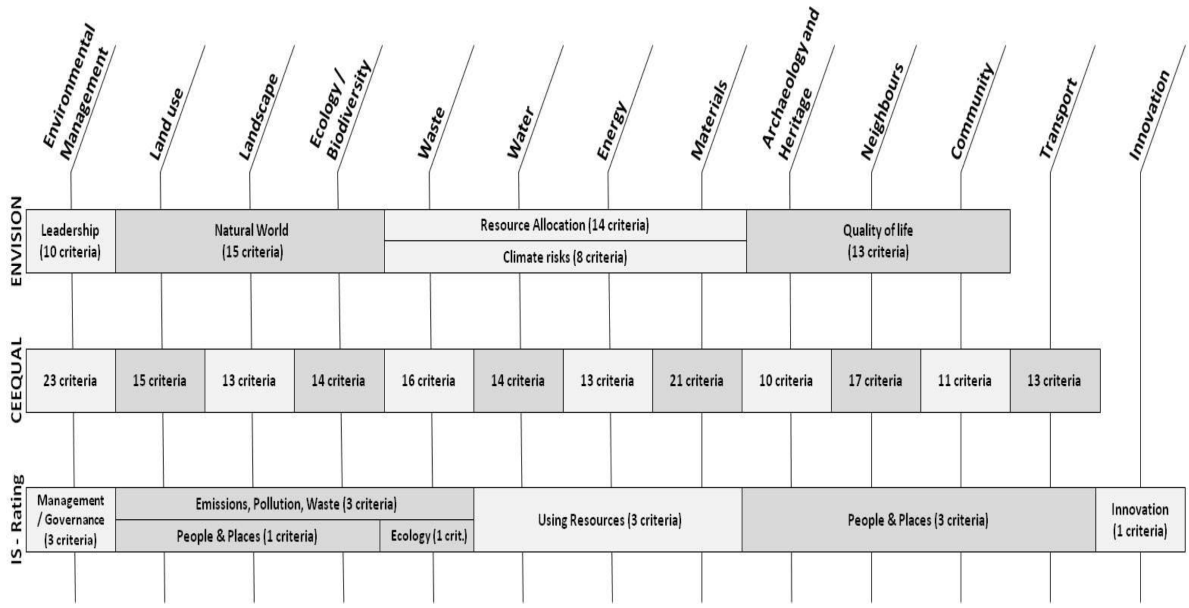

Fig. 2: Distribution of rating criteria

3.2. Evaluation limits of existing rating systems

Existing rating systems for infrastructure projects display three major weaknesses. Assessing various types of infrastructure projects requires a general criteria framework. However, general criteria prevent a detailed evaluation of specific requirements and functions for different construction types. A projects´ main function (e.g. transportation, water storage) is the most important indicator for its sustainability requirements. Depending of a projects´ function environmental, economic and social aspects vary in importance and weight. For example, an airport causes higher environmental and social impacts in terms of land use or emissions compared to a wind power plant. This entails varying sustainability standards for assessing infrastructure projects. In addition it is necessary to consider the relevance of a project for its user and community. Compared to private operated projects publicly available infrastructure constructions differ in their sustainability requirements related to e.g. safety and health issues. Hence, it becomes apparent that a general criteria framework is not sufficient for specific sustainability ratings and is not able to rate specific technical characteristics of a project (Cadez et al., 2013).

Compliance with the Triple Bottom Line is basic prerequisite of sustainability assessments. Current European engineering standards as ISO / TS 21929-1:2006, ISO 15392:2008 and EN 15643-1:2010 provide general information and core indicators for sustainability rating systems and are applicable to buildings and other construction works. Existing standards are completed by the ISO / TS 21929-2 for infrastructure constructions which are currently under development. A homogeneous international standardization for sustainability ratings has not been finalized yet (Häkkinen, 2009; Lützkendorf, 2011; Zinke, 2012). Existing rating systems do not meet the needs of a holistic environmental, economic and social evaluation as they focus only on selected dimensions of sustainability. Criteria frameworks of CEEQUAL, ENVISION and the IS-Rating Scheme focus mainly on environmental and social aspects. Particularly with regard to economic criteria (e.g. life cycle costs, economic value and stability) these approaches neglect important aspects of sustainability. Thus, established rating schemes have to be improved for sustainability evaluations of transport infrastructure projects since they do not offer a completed framework.

Review of the three major sustainability rating systems also reveals that a general sustainability approach is not appropriate to evaluate specific sustainability performance of a project as technical, functional, process-related and user- / operator-specific aspects remain disregarded. Though, it is obvious that environmental, social and economic impacts of a project are influenced by the technical standard of facilities as well as by their processes in design, construction and operation phase (Cadez et al., 2013). To what extent sustainability is achieved remains uncertain since there is no consensus regarding system applicability, base design, assessment process, validation, criteria framework or weighting of criteria. This fact is owed by a missing international standardization for sustainability assessment and detracts the comparability of established systems (Clevenger et al., 2013; Lee et al., 2010; Zinke, 2012). Hence, existing rating systems have to be extended in terms of structural standardization as well as in terms of implementation of processes and technical facilities.

4. Multidimensional sustainability approach for highway projects

4.1. Multidimensional system structure

Transport infrastructure projects in particular present significant possible savings in sustainability since they are large in scope and typically long in duration. Hence, there are contributing factors for its sustainability performance as internal and external costs or increasing energy consumption. Uses of resources and materials as well as quality and safety issues are specific evaluation criteria for highway projects (Clevenger et al., 2013; Cadez et al., 2013). But especially construction processes and technical facilities of a project affect economic, environmental and social aspects and therefore also its sustainability. Project preparation, construction methods, technical standard of pavements or design of subgrade bearing structure have to be evaluated. Also capacity reserves for future lane enlargements or cleaning, recycling and maintenance concepts are important criteria which cannot be allocated to one of the three existing sustainability dimensions. Hence, for assessment of highways the Triple Bottom Line is insufficient and has to be extended (Zinke, 2012).

Recent sustainability rating approaches as DGNB (Germany) base upon the new European engineering standard EN 15643-1:2010. It contains additional technical and process-related criteria for sustainability assessments. The assessment process refers to a multidimensional approach (Lützkendorf, 2011). Thereby the Triple Bottom Line can be extended by two additional dimensions in order to rate a projects technical and process-related performance. Since technical and process-related criteria affect all existing dimensions of sustainability they are illustrated as all-over dimensions in figure 3.

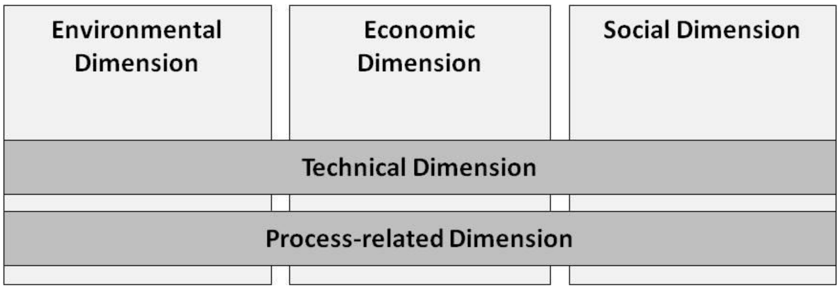

Fig. 3: Multidimensional sustainability approach

In addition to environmental, economic and social aspects a multidimensional approach allows to rate a projects´ specific technical and process-related indicators and their effects on sustainability. Of course general rating criteria of established systems as ENVISION or CEEQUAL can help evaluating sustainability for infrastructure projects to a certain degree. Appropriate criteria can be adopted but have to be extended by specific indicators for each construction type in order to meet the requirements of a holistic sustainability approach (Cadez et al., 2013).

Recent studies have identified general and specific criteria for highway projects. First specific rating systems for transport infrastructure projects came up in the United States of America as the GREENROADS rating scheme (University of Washington) or the BE2ST-In-Highways system (University of Wisconsin). These approaches present general as well as first specific criteria for transport infrastructure and for highways in particular. However, these approaches focus only on limited aspects. BE2ST-In-Highways measures only impacts of using recycled materials in pavements while GREENROADS covers a general criteria framework for all kind of transport infrastructure projects (Clevenger et al., 2013; Lee et al., 2010). None of the new approaches assigns a holistic criteria framework for highways. In addition these approaches neither solve the problem of evaluating specific technical and process-related aspects for highways. These approaches can be used for identification of a multidimensional criteria framework of highways. In the following chapter an overview of the results of realized studies are presented. In addition selected new rating criteria for highway projects are introduced.

4.2. Multidimensional criteria framework

Highways are classified as field-assembled line structures. Construction phase is affected by reiterating processes and a high output of emissions. Subgrade, pavement and bearing structure have to carry heavy loads. Main function of the bearing structure is to transfer accelerating, breaking and centrifugal forces into ground. Furthermore the covering has to absorb atmospheric influences as frost, rain or incident solar radiation. Planning, design, construction and operation processes have to be adapted to these specific requirements. This affects the choice of construction materials as well as its assembling methods. During operation phase maintenance of road safety, traffic flow and quality of traffic are of prime importance (Zinke, 2012).

Hence, rating criteria for line structures especially have to cover technical and process-related indicators. Preliminary planning and definition of project aims are integral parts of planning and design phase since sustainability aspects have to be implemented in tender and assignment processes. In addition an initial start-up, pre-service testing of technical facilities or an accompanying documentation and quality control can help to minimize problems during operation phase. In addition specific technical issues as technical standard of pavements or noise abatement measures can be evaluated (Cadez et al., 2013). As pointed out, several aspects of sustainability from existing rating systems can be transferred. This mainly affects environmental criteria as land use, water or energy consumption. Researches by Beuving in 2004 and Graubner in 2010 highlighted the huge importance of environmental life cycle assessment for highways which can also be implemented into the criteria framework (Graubner et al., 2010; Beuving et al., 2004).

As a result of a done multi-stage research a criteria framework for highways including 24 criteria distributed to five dimensions can be presented in table 2. The research process was carried out in three phases. In a first step existing sustainability rating systems for vertical and horizontal constructions were analyzed. Identified applicable or transferable rating criteria were adapted to the specific requirements of highway constructions in a second step. Finally new specific evaluation criteria for highway constructions were added.

Dimension	Criteria
Environmental Dimension	Environmental life cycle assessment of assembled materials
	Emission of dangerous substances of pavements and technical facilities and its materials
	Environmental design and landscaping
	Use of renewable and non-renewable energy
	Water use and utilization of rain water
	Land use
Economic Dimension	Life cycle costs
	Economic efficiency during operation and maintenance phase
Social Dimension	Noise abatement measures for concerned community
	Visibility, avoidance of dazzle effects, artificial lighting
	Road safety and risks of accidents
	Travelling comfort and quality of traffic
Technical Dimension	Technical standard of noise abatement measures
	Ease of cleaning and ease of maintenance of pavement and technical facilities
	Ease of reconstruction, ease of recycling of new assembled materials, recycling rate of re-used materials
	Technical standard of pavement and coverings
Process-related Dimension	Preliminary planning and project aims
	Integral planning and design
	Documentation and quality control
	Implementation of sustainability aspects in tender and assignment processes
	Construction site management
	Pre-qualification of construction corporate
	Choice of construction method
	Initial start-up and pre-service testing

Tab. 2: Multidimensional criteria framework for highway projects

The criteria framework embodies modified criteria from existing sustainability approaches as DGNB, ENVISION or CEEQUAL as well as new developed rating criteria covering specific requirements of infrastructure projects (Cadez et al., 2013). It includes both general and specific evaluation criteria where *Environmental Dimension* consists of six criteria, *Economic Dimension* covers two criteria, *Social Dimension* and *Technical Dimension* counts each with four criteria and *Process-related Dimension* comprises eight criteria. It becomes obvious that half of the criteria are related to technical and process-related themes with effect on the three main pillars of sustainability. This underlines the importance of technical and process-related aspects for both infrastructure projects in general and highway projects in particular.

5. Conclusions

Comparison and analysis of established sustainability rating systems reveal that recent approaches are not appropriate for holistic assessments of infrastructure projects in general as well as transport infrastructure projects in particular. Due to missing international standards sustainability certification processes are varying in their methodologies and their applicability concerning different types of infrastructure constructions. Comparability and significance of achieved results remain uncertain since most rating systems use only general rating criteria. Even if established rating systems seem to be eligible in assessing holistically indicators of all dimensions of sustainability, there are certain improvement opportunities pointed out in this paper. This affects partial neglecting of economic aspects as well as full absence of technical and process-related criteria.

Neglecting important sustainability criteria prevents a holistic sustainability evaluation in order to meet specific evaluation requirements for transport infrastructure projects. This leads to the conclusion that an extended sustainability rating approach is necessary. As a result a new multidimensional criteria framework for highway projects including 24 rating criteria is presented. Due to that fact that this approach does not only cover environmental, economic and social aspects but also serves indicators for technical and process-related issues it can be considered as a holistic sustainability approach. The framework comprehends both general and specific evaluation criteria either extracted from established systems or new defined indicators referring to particular requirements of highway projects.

The presented framework does not provide a ready-made rating system since evaluation standards containing measuring methods and documentation requirements are not provided for each indicator. Also an accurate criteria weighting is missing. Hence, further research regarding additional rating criteria, criteria weighting and development of evaluation standards have to be carried out in future. In addition it has to be mentioned that the presented criteria framework is elaborated for highway projects and is not applicable on other civil engineering structures as bridges or tunnels.

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THE INFLUENCE OF CHEMICAL ADDITIVE "KS-4" ON BRICK BODY*

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Abstract

The goal of this paper was to examine the effectiveness of the waste mixture KS-4 on technical characteristics of the brick body. There have been done many tests and measurements in different weight percentage proportions to brick substance, to determine the impact of this waste material to brick. Based to the results obtained, it was found that the additive KS-4 is suitable for application to brick substance mainly to reduce the thermal conductivity of the brick.

Keywords: chemical additive, secondary raw material, brick body, pore-forming agent, thermal conductivity

* The complete text is available on CD-ROM / Janik, Švenda

1. Introduction

The development of civilization and various technologies is constantly increasing the amount of waste generated in the world. Till lately, when the industry was not yet so extensively developed, most of the waste material was in form of plant or animal litter. It was easy to find secondary application for this waste, or it was not necessary to store it, because of the effect on the environment. Currently, there is such a large amount of waste produced, that the question of how to use the secondary raw material is still more discussed. For example, only Europe produces about 1.3 trillion tons of different kinds of waste coming mainly from industrial production and processing of raw materials each year [1]. For example a olive mill generates more than 1 ton of wastewater per ton of transformed olives [2]. The brewing industry in Europe produces about half a million tons of waste every year [3]. Each ton of paper produced in paper mill comes with about 30kg of waste water, in the form of paper sludge. Only in Italy was created in 2004 around 6x 10^5 of this sludge [4]. Not to mention the countless kinds of sludge, sediments, gypsum and other waste generated in industrial production or mining and quarrying.

One possibility is to use these secondary products in the manufacture of building materials, where it is possible to integrate large amounts of waste into final products [5]. Several studies have confirmed that the ceramic industry can "neutralize" various types of waste [6], [7], [8], [9].
Due to environmental protection, constant increase in energy prices and increasing competition, pressure on the brick products with better insulation capacity increases. One of the ways to achieve an increase in thermal resistance of the structure is to increase the porosity of the material, i.e. change the pore structure of the brick body [10].
The aim of this study was to assess the impact of the waste mixture KS-4 on the properties of brick body. The main attention was devoted to the improvement in thermal insulation properties.

2. Experimental part

2.1. Characteristics of raw material and additive

Basic brick raw material was used from the locality Hevlín in Czech Republic, consisting mainly of neogene calcareous fine sandy clays from the Vienna basin. In the raw material is present montmorillonite and also soluble salts. Raw material from this site is primarily used to produce high-quality thin brick products. The chemical composition is given in Tab. 1.

Tab. 1 Chemical composition of brick raw material from the site Hevlín in Czech Republic

Measurand	%
SiO_2	50,10
Al_2O_3	14,50
Fe_2O_3	6,18
CaO	8,40
MgO	3,60

K_2O	2,79
Na_2O	0,99
$(SO_4)^{2-}$	0,24
$(CO_3)^{2-}$	10,70
Ignition loss	12,10

The raw material has been collected from the brickyard Hevlín (HELUZ), which already contained the admixtures in the form of sawdust and cellulose sludge.

Chemical additive KS-4 is a catalytic mixture of dense consistency, dark brown to black colour. It is formed in synthesis of cyclic compounds. Density of the additive is 1054 kg/m^3, and its dry matter is 31%. Before application the additive had to be warmed up to a minimum temperature of 50° C to reduce its viscosity. Additional details are given in Tab. 2.

Tab. 2 Additive KS-4 - additional information

Measurand	%
KOH	5,3
Paraffins 50/60	34
Triethylenglycol	25,2
Hydrazones	30

2.2. Production of samples

From the homogenized raw material were made test portions of a weight 850 grams with 30% humidity. The additive KS-4 was added to a raw material already with a small amount of water used for better homogenization in percentage by weight to the dried weight of the brick material.

Subsequently, from the ingredients were prepared testing batter at doses of 0, 0.25, 0.5, 0.75 and 1% of additive dry weight (expressed in measurement units shown in Tab. 3) to the weight of dried raw material, with constant plasticity tested by STN 72 1074 (Pfefferkorn = 33 ± 0.5 mm).

Tab. 3 Doses of additive KS-4 in measurement units

0,25 %	4,55ml
0,5 %	9,11ml
0,75 %	13,66ml
1 %	18,2ml

Prepared batter ripened for 24 hours in a humid environment. After the ripening, test samples were made. For this purpose was used special form, which had internal dimensions of 100x50x20mm (Fig. 1). Thin PE foil was placed on the bottom of the form. The batter was imprinted and evenly compacted to the form by rubber hammer. Exceeding batter was scraped away. From each test portion were made three test samples. Marks were made for tracking of length changes during drying and after firing on each sample using etalon (slide ruler).

Fig. 1 Form for brick making (dimension 100x50x20mm), filled with brick batter

Test samples were placed on perforated grill, spaced from each other around 20 mm, thereafter for 48 hours monitored values in weight loss and length changes for determining Bigot curve, see Fig. 2

Fig. 2 Test samples stored on perforated grill

Subsequently, the samples were placed in laboratory drying oven, where they were dried to constant weight at temperature of 110 ± 2 ° C. The dried samples were stored in a desiccator and allowed to cool down. The samples were then fired in an electric furnace Bukotherm with controlled firing mode. In the furnace was stable oxidation environment. A burning curve used for firing of test samples was identical with the curve realizable in the brick plant Hevlín in Czech Republic. Maximum firing temperature was set at 915 ° C for isothermal holding time of 30 minutes (Fig. 3). After firing, following properties were determined on the brick body (linear firing shrinkage, weight loss by firing, water absorption by boiling, apparent porosity, bulk density, coefficient of thermal conductivity and compressive strength).

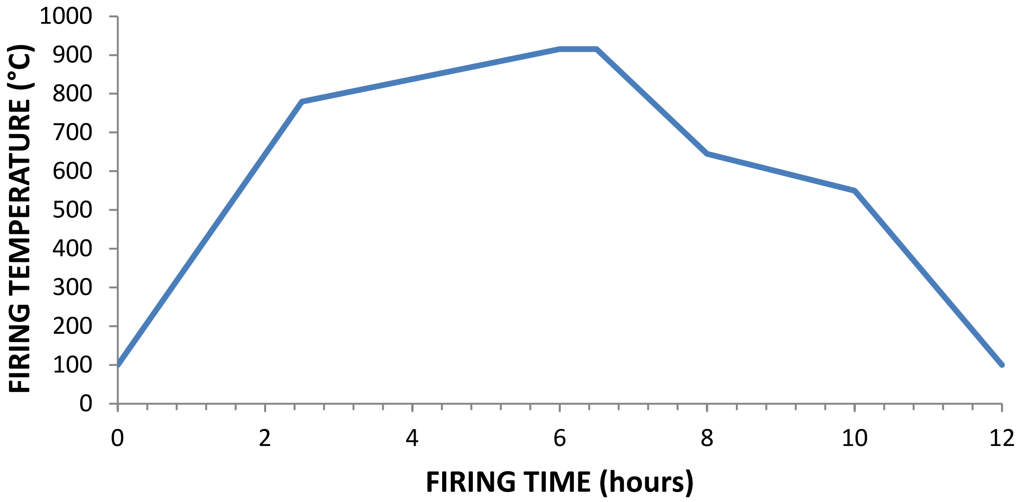

Fig. 3 Firing mode

3. Methodology of testing

Determination of selected properties of brick batter and brick body, were performed according to the relevant standards and test procedures listed in Tab. 4.

Tab. 4 List of standards, test procedures and equipment for determining characteristics of the brick batter and brick body

Characteristics	Standard – test procedure - equipment
Working moisture content, %	STN 72 1074
Linear drying shrinkage, %	STN 72 1565, section 5
Drying sensitivity by Bigot, %	STN 72 1073
Linear firing shrinkage, %	STN 72 1565, section 5
Linear change total, %	STN 72 1565, section 5
Weight loss by firing, %	STN 72 1565, section 6
Water absorption by boiling, %	STN 72 1565, section 6, art. 8
Apparent porosity, %	STN 72 1565, section 6
Bulk density, kg/m^3	STN 72 1565, section 6
Capillarity, mm/60 min	Not standardized test
Coefficient of thermal conductivity, W/m.K	IZOMET instrument (fig. 4)
Compressive strength, MPa	Determined by whole surface load on test sample to fracture limit (measurements of samples: 20x20x20mm)

Fig. 4 Measuring device ISOMET Model 104

4. Achieved results and discussion

The results obtained with additive KS-4 before and after firing, are listed in table 5 and shown in fig. 5 and 6. At a dose of 1% additive the brick batter has started slightly crumbling. For this reason, the higher doses haven't been made.

Table 5 Properties of brick material before and after firing process affected by additive KS-4

Dose	**W_{pr}**	**SD**	**CF**	**CT**	**LF**	**AB**	**PA**	**P_v**	**λ**	**R_{pd}**
%	*%*	*-*	*%*	*%*	*%*	*%*	*%*	*kg/m^3*	*W/m.K*	*MPa*
0,00	**28,63**	**1,152**	**0,10**	**-6,60**	**13,46**	**24,18**	**38,85**	**1607**	**0,428**	**43,6**
0,25	30,63	0,976	0,15	-6,47	13,65	26,17	41,20	1574	0,394	37,1
0,50	31,87	0,874	0,27	-6,28	13,80	27,75	42,82	1543	0,366	32,3
0,75	33,07	0,830	0,42	-6,05	14,00	29,07	44,19	1520	0,344	28,1
1,00	**34,12**	**0,815**	**0,63**	**-5,76**	**14,18**	**30,38**	**45,52**	**1498**	**0,321**	**24,6**

Legend:

W_{pr} - working moisture content
SD - drying sensitivity by Bigot
CF - linear firing shrinkage
CT - linear change (total)
LF - weight loss by firing

PA - apparent porosity
ρ_v - bulk density determined by the hydrostatic method
λ - coefficient of thermal conductivity
R_{pd} - compressive strength

AB - water absorption by boiling

4.1. Coefficient of thermal conductivity

As the porosity increases, which is influenced by increasing dose of additive, also affected by the decrease in density, we follow similar results in the determination of thermal conductivity, fig. 5. At a dose of 1% additive decreased coefficient of thermal conductivity compared to the comparative sample without additive from value of 0.428 W/m.K to 0.321 W/m.K (Table 5) representing a decrease of 33.33%.

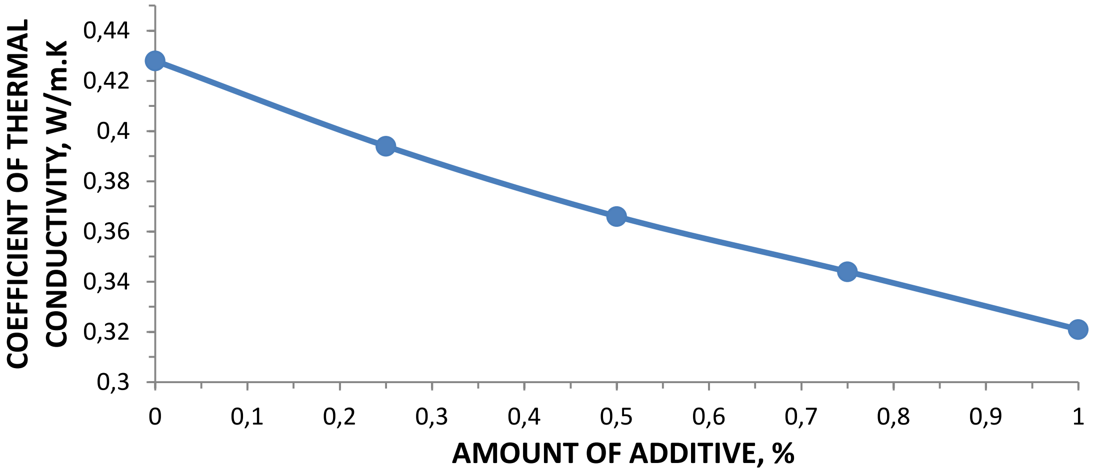

Fig. 5 Effect of additive on the coefficient of thermal conductivity

An interesting relationship is between the coefficient of thermal conductivity of brick body and working humidity (Fig.6). This relation is linear, which proves undeniable impact of studied additive on this property, which was mainly influenced by the increasing water content in the moulding.

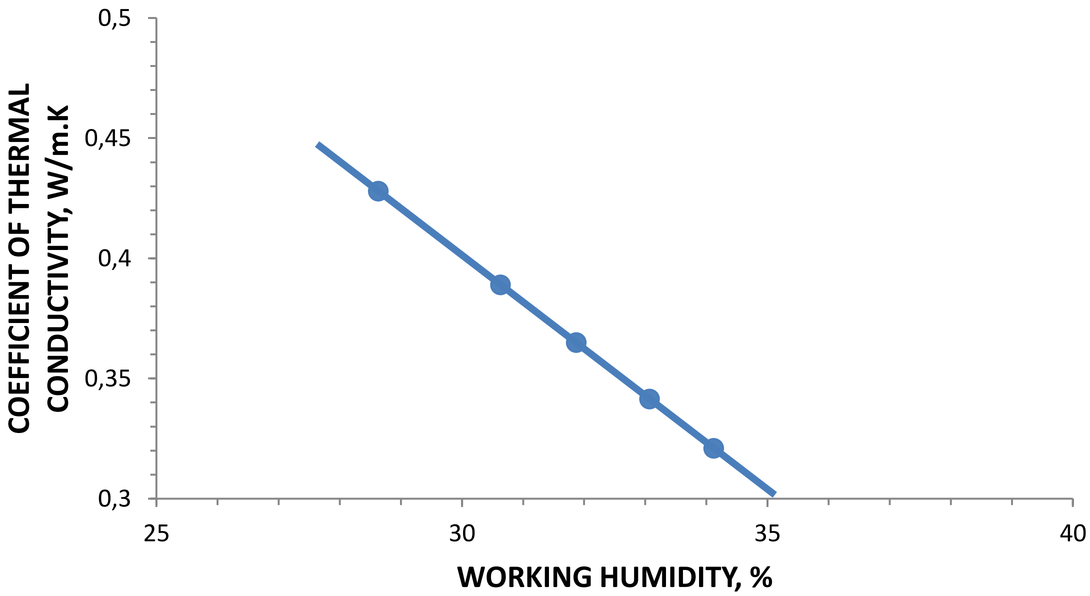

Fig. 6 Influence of working humidity on the coefficient of thermal conductivity

5. Conclusion

Based on the results obtained, we can conclude that the additive KS-4 is suitable for application to brick material mainly to reduce the thermal conductivity of brick body. In the process of drying and burning, there were no unwanted effects of additive, such as unpleasant odour or release of hazardous substances. Its positive effect was also that it will reduce sensitivity during drying process. There was also a decrease in density, which could for example reduce transport costs. The only disadvantage of this additive is its low viscosity at normal ambient temperature. To be able to use this additive in brick industry, it is necessary to warm it up to at least 50° C. Additive KS-4 is recommended to apply at 0.5% solids by weight of the dry brick clay material.

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ADVANCES IN PLANNING AND SCHEDULING METHODOLOGY FOR ROAD CONSTRUCTION PROJECTS*

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Abstract

Planning and scheduling of construction projects has one of the most important influence on their successful realization, therefore, the selection and implementation of appropriate methodology and planning and scheduling approach is extremely important initial step which must be addressed.
Object of this study are construction projects which have one dimension prominent in relation to the other two dimensions, called linear projects, such as roads, highways, pipelines, canals, railways, tunnels, but specifically the whole study is based on road and highway construction projects. The purpose of this study is to develop an methodology for planning and scheduling road construction projects which is supported by empirical equations obtained through the analysis and processing of data from eleven plans and schedules of past road construction projects.
This study aims to identify variables, within the project, with the most significant impact on the duration of road construction projects. Also its final goal is to develop methodology for planning road construction projects, which aims to minimize iteration steps to develop optimized schedule and provide directions for future researchers.

Keywords: road construction project, simultaneity factor, levelled project length, levelled project duration, number of construction directions, planning, scheduling, methodology

* The complete text is available on CD-ROM / Juric, Burcar Dunovic, Levak, Radujkovic

Introduction

Every construction project, including the construction of roads, is characterized by certain characteristics, which have great influence on project duration. Compared to other construction projects, specificity of road construction projects is reflected in characteristics like locality of the road, total length, quantity of cut and fill, number and complexity of facilities (tunnels, bridges, ….), productivity of selected working groups, number of accession points and construction directions.
On the other hand, each design phase of road construction project is correlated with project planning phase or its deliverable. Figure 1 is presenting based on which design document, during which project phase, how detailed plan is done and by whom.

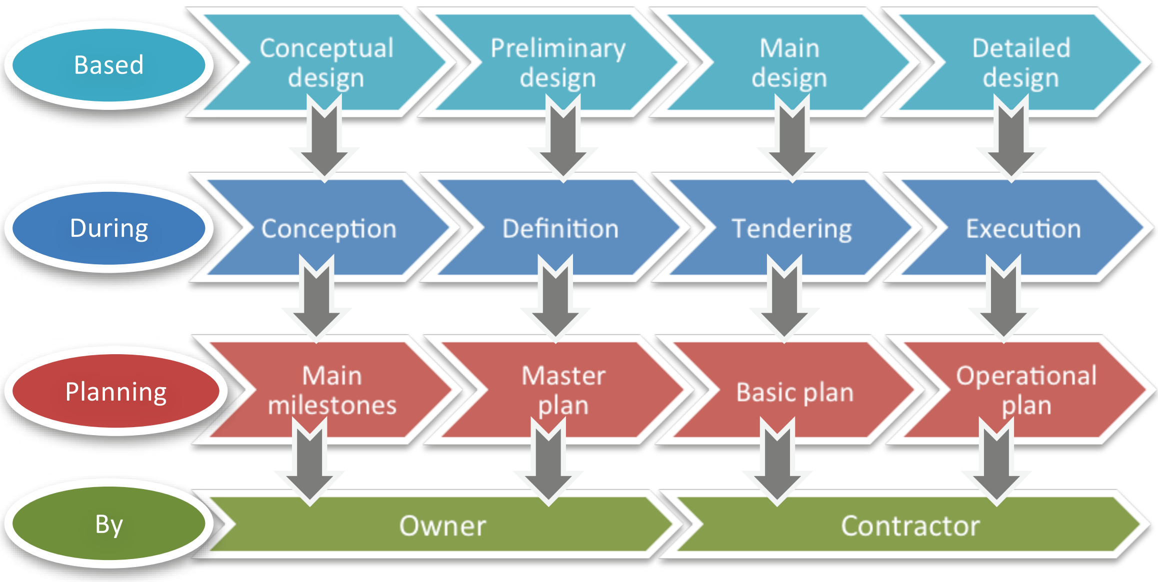

Figure 1 *Correlation between design level, project phase and planning phase*

The main problem in initial planning processes is the level of project design detail. In front phases the problem is lack of data and in later phase large number of data. In both cases, it is necessary to have methodology, which will enable to develop plan based on key characteristics. It will help to develop more accurate plan in front phases and in later phases minimise number of iterations and the final accuracy and quality of schedule.

From the literature review we found models developed to optimize the scheduling of road construction projects. A lot of them are focused only on one specific aspect of planning and scheduling. E.g. Shah and Dawood (2011) developed a model for earthwork activities, which generates a time location plan automatically with the aim to provide location-based scheduling information of earthwork activities by incorporating road design data, sectional quantities, variable productivity data, unit cost, site access points, and haulage distance. Liu and Wang (2007) developed an optimization model for resurce assignment problem of linear construction projects which adopts constraint programming.

Intent of this study is to develop basis for methodology for planning road construction projects, which would simplify, speed up planning process and raise the level of quality of planning in all phases. Development of the methodology is based on recognition of main characteristics (variables) of road construction projects with the largest impact on total duration of the project.

2. Research methodology

This research is aimed to identify characteristics based on which a project plan could be developed without going into detail specifications. The specific objectives of the research study are:

1. to determine the variables with the greatest influence on project duration.
2. to develop the empirical equations on the basis of which will be able to facilitate and accelerate the planning and scheduling of road construction projects.
3. to provide guidelines for further research and further development of Planning and Scheduling Methodology for Road Construction Projects.

After the research direction was chosen, a thorough literature review was necessary to learn from previous research and narrow the research focus. Following the literature review, it was necessary to perform two tasks: collect road construction data and develop a model for using that data to develop Planning and Scheduling Methodology for Road Construction Projects.

The study analyses the eleven schedules for construction of road projects, which were made for seven different projects, highways and motorways in the Republic of Croatian, Bosnia and Herzegovina and Montenegro, which were developed in the Department of Construction Management, Faculty of Civil Engineering in Zagreb. Some projects were performed at once, while others performed at certain parts for which are made separate schedules for their construction.
For the analysis of these schedules is important to note that all the schedules were made with similar principles. Each project is analysed in detail, and based on the length of the road, possible approaches to the field, number and complexity of facilities and a defined project deadline, was determined initial site and construction directions from which the construction of each project have to start. In every project were used groups of machinery with equal production rate for certain types of works. Such data about groups of machinery with equal production rate represents a limitation for this model, which is specifically mentioned in the chapter of the research results.

Two statistical procedures were used for data analysis. Spearman's linear correlation is used to reduce number of independent variables and multiple regression analysis to determine how the variables are correlated.

As opposed to the Pearson correlation, which implies a linear relationship between variables, for the Spearman's correlation that is not a requirement, and can be used on a model with smaller samples ($N < 35$) [1]. Variables were selected based on data from the correlation of the independent variables against *Aligned project duration* D_{apd} (the duration of the project that would be achieved if there was not overlapping in activities).
However, based on these data it was not possible to conclude in what way dependent variable depends on the independent variables. Therefore, in the second step of the data processing, using multiple linear regressions was analysed simultaneous impact of values for which there was a significant level of correlation in the first step to describe how a dependent variable depends on the independent variables. Multiple regression model was used because we needed a model with one dependent and two or more independent variables:

$$Y = f(x_1, x_2, x_3, \ldots x_j, \ldots x_k) + e \qquad (1)$$

Linear relationship or a linear dependence between independent variables (x_1, x_2, x_3, ... x_j, ... x_k) to them dependent variable (Y) is described by the coefficient of multiple determination R^2. This indicator takes the value in segment [0,1], and the model is representative as the coefficient of determination is closer to the 1. But the great value of the coefficient of determination (e.g. $R^2 = 1$) does not necessarily mean that it is a good linear regression model (Hines and Montgomery, 1990). Variable ***e*** is stochastic variable that represents non-systemic effects of the dependent variable (Hines and Montgomery, 1990).

Finding the parameters for determining aligned project duration D_{apr} is not the end of the research because this value is dependent on technical aspects. It is necessary to include organisational aspects to be able to control or fulfil demands on project duration D_{pr}. The first the variable is *Concurrency factor,* which determinates the level of concurrency of activities and its value is rate of aligned project duration (D_{apr}) and project duration (D_{pr}):

$$CF = \frac{D_{apd}}{D_{pd}} \Rightarrow 1 \leq CF \leq \infty \quad (2)$$

From the above it can be concluded that if the project is executed from one building site in one direction of construction, where every succeeding activity can begin after the completion of the previous one, concurrency factor would be equal to 1. It is the smallest value that the concurrency can have. Concurrency factor can be defined as the value that reflects how much is the execution (performance) of a construction project time-loaded with activities.

The goal of planning and scheduling is to develop a project plan to finish the project within desired time span with optimal use of the resources. Therefore, it is necessary to determine how many accession points and construction directions do we need to finish construction within certain time. The same methodology was applied to determine *number of construction directions* (N_{cd}).

3. Research results

The preliminary result of the analysis was a list of variables, which are assumed to affect the project duration. After the Spearman's analysis of each variable two sets of independent variables were generated; the first set affects the dependent variable, **project duration (D_{pd})**, and another set that also affects the dependent variable, the **number of construction directions (N_{cd})**. Variables correlated to D_{pd} are named Technical parameters, and those correlated to N_{cd} Organisational parameters.

Table 3 Independent variables

TECHNICAL VARIABLES
Total amount of cut and fill
Length of the route
Number of bridges, viaducts and overpasses
Total length of bridges, viaducts and overpasses
Number of underpasses
Total length of tunnels
Total length of retaining walls
Number of crossing
Number of ancillary facilities
Total length of secondary roads along the main road
ORGANIZATIONAL VARIABLES
Concurrency factor (FI)
ratio of Aligned project length and Project length (L_{uk}/L_{pr})

In the process of forming a selection of variables the bridges, viaducts and overpasses are grouped as one variable because their structures and other important technical features approximately equal. If we look at other variables that describe the facilities on the road, it is evident that as a variable number of objects in the road would take only the number of bridges, viaducts and overpasses, because of the complexity of their construction, which greatly depends on their length and number, while the construction of tunnels and retaining walls is much more affect by their length than their number. For underpasses is taken just a number as a variable because that are typical buildings with equal length, so the length does not have a significant impact on the project duration.

Results of the Spearman's correlation for technical variables against aligned project duration are shown in Table 4. Statistical significance is determined with value $p \leq 0.05$, which satisfies only four of the ten selected variables. Such results can be explained by small sample size, where it is assumed that the increase in the number of samples will improve the results of p values for the selected variables. But since this is just the first step after which the second statistical analysis will be performed, variables with p value greater than 0.5 were selected.

Table 4 Results of the Spearman's correlation for technical variables

TEHNICAL VARIABLES	CORRELATION COEFFICIENT	P
Total length of bridges, viaducts and overpasses	0,809	**0,003**
Total length of tunnels	0,679	**0,022**
Total length of retaining walls	0,642	**0,033**
Number of bridges, viaducts and overpasses	0,633	**0,037**
Total length of secondary roads along the main road	0,478	**0,137**
Total amount of cut and fill	0,445	**0,17**
Length of the main road	0,409	**0,212**
Number of underpasses	0,328	**0,325**
Number of crossing	***0,169***	***0,619***
Number of supporting facilities	***0,073***	***0,83***

In the end, the last two variables are shown in Table 4 were discarded, the number of crossing and the number of ancillary facilities. For other variables that have a value of p greater than 0.05, it was concluded that these variables in practice significantly affect the duration of road construction projects and in order to increase the number of samples their value will be reduced to the required level. In addition, since the number of crossing is disconnected from further analysis, by including the total amount of cut and fill we have taken into account the impact of crossing in which most of the works are works on earthworks.

The second group of variables have to be calculated based on Project length (L_{pr}) and Aligned project length (L_{al}), as well as durations D_{apr} and D_{pr}. Project length (L_{pr}) is the **total** length of the main road (with length of all facilities on the road; like bridges, viaducts, tunnels) and Aligned project length (L_{al}) is the sum of the Project length (L_{pr}) and Length of secondary roads along the main road. Concurrency factor is calculated for each analyzed schedule, as shown in
Table 5.

Table 5 Concurrency factor (CF) of analysed schedules

R.Br.	D_{pr} (days)	D_{apr} (days)	CF
1.	249	776	3,11647
2.	872	5.098	5,84633
3.	546	4.073	7,45971
4.	301	2.026	6,73090
5.	815	14.008	17,18773
6.	377	5.385	14,28382
7.	394	4.414	11,20305
8.	548	4.121	7,52007
9.	270	2.005	7,42593
10.	434	2.846	6,55760
11.	294	2.213	7,52721

Table 4 shows results of the Spearman's correlation of organizational variables with number of construction directions (N_{cd}).

Table 6 Results of the Spearman's correlation for organizational variables

ORGANIZATIONAL VARIABLES	CORRELATION COEFFICIENT	p
Concurrency factor (CF)	0,371	**0,261**
ratio of Aligned project length and Project length (L_{uk}/L_{pr})	-0,577	**0,063**

The results show that the independent variable concurrency factor (CF) and the ratio of Aligned project length and Project length does not satisfies the condition p ≤ 0.05. Such a result, as with the technical variables, can be explained by small sample size, where it is assumed that the increase in the number of samples will improve the results of p values for the selected variables. Both variables are retained in the further data processing.

After the selection of technical and organizational variables, using multiple linear regressions for two regression equations have been developed as a result of this study. Results of the multiple linear regression analysis of technical variables with Aligned project duration are shown in
Table 7.
The resulting model has a coefficient of determination (R^2) equal to 0.429, which means that approximately 43% of the variability in the aligned project duration is explained when using all eight of these technical variables. Such results can be explained by small sample size, which was available for this study, because from the construction practices it is evident that all the variables shown in the model affect the project duration.

Table 7 Results of the multiple linear regression analysis for technical variables

TEHNICAL VARIABLES	REGRESSION COEFFICIENT	STANDARDISED REGRESSION COEFFICIENT	CONSTANT
Total amount of cut and fill **(Q_{IN})**	**- 0,002**	- 0,615	**1104,095**
Length of the main road **(L_{TR})**	**0,378**	0,304	
Number of bridges, viaducts and overpasses **(N_{MVN})**	**562,315**	0,790	
Total length of bridges, viaducts and overpasses **(L_{MVN})**	**0,426**	0,099	
Number of underpasses **(N_P)**	**- 472,420**	- 0,309	
Total length of tunnels **(L_T)**	**1,960**	0,638	
Total length of retaining walls **(L_{PZ})**	**0,626**	0,114	
Total length of secondary roads along the main road **(L_{CT})**	**0,035**	0,020	
R = 0,655 ; R^2 = 0,429			

According to the results of regression analysis the first regression equation is:

$$D_{pr} \times CF = 1104{,}095 + 0{,}378 \times L_{TR} - 0{,}002 \times Q_{IN} + 562{,}315 \times N_{MVN} + 0{,}426 \times L_{MVN} - \\ -472{,}420 \times N_P + 1{,}960 \times L_T + 0{,}626 \times L_{PZ} + 0{,}035 \times L_{CT} \quad (3)$$

- where:

D_{pr} – Project duration (D_{pr}) – according to defined project deadline [days]

CF – Concurrency factor (output data from the equation 3)
D_{pr} × CF = D_{apr} – aligned project duration
L_{TR} – Length of the main road (without length of all facilities on the road;bridges,viaducts,tunnels) [m]
Q_{IN} – Total amount of cut and fill [m]
N_{MVN} – Number of bridges, viaducts and overpasses
L_{MVN} – Total length of bridges, viaducts and overpasses [m]
N_P – Number of underpasses
L_T – Total length of tunnels [m]
L_{PZ} – Total length of retaining walls [m]
L_{CT} – Total length of secondary roads along the main road [m]

Equation (3) indicates that increasing of total amount of cut and fill and number of underpasses reduces Aligned project duration and that also reduces the concurrency factor while increasing of other variables increases Aligned project duration and the concurrency factor. This trend is understandable because in road construction project bigger impact on increasing the project duration have facilities such as bridges, viaducts, overpasses and tunnels than the amount of cut and fill on the road. Larger amount of cut and fill on the road instead of a number of bridges of viaducts resulting with shorter project duration because the construction of bridges or viaducts is much more complex than works on excavation. The same applies to the underpasses whose structure and construction is relatively simple compared to the bridges or tunnels structures and construction. Results of the analysis shows that variables number of bridges, viaducts and overpasses and total length of tunnels have the greatest affect on Aligned project duration, what is in accordance with expectation. Variable with the least affect is total length of secondary roads along the main road, which is also in accordance with expectations.

Table 6 shows results of the multiple linear regression analysis of organizational variables with number of construction directions (N_{cd}). The resulting model has a coefficient of determination (R^2) equal to 0.363, which means that approximately 36% of the variability in the number of construction directions is explained when using those two variables.

Table 8 Results of the multiple linear regression analysis for organizational variables

ORGANIZATIONAL VARIABLES	REGRESSION COEFFICIENT	STANDARDISED REGRESSION COEFFICIENT	CONSTANT
Concurrency factor **(CF)**	**0,186**	0,178	**11,368**
Ratio of Aligned project length and Project length (L_{uk}/L_{pr})	**- 4,523**	2,555	
R = 0,602 ; R^2 = 0,363			

Such a result may also be explained by small sample size used in this study because the concurrency factor is a value that reflect how much is the execution of a construction project time-loaded with activities on this project. Consequently, it is clear that the concurrency factor and number of construction directions are two dependent variables. If there is a situation that for the same road construction project we have two different concurrency factors, it is understandable that for lower concurrency factor we´ll get smaller number of construction directions, while for higher concurrency factor we´ll get greater number of construction directions.

According to the results of regression analysis the first regression equation is:

$$N_{cd} = 11,368 + 0,186 \times CF - 4,523 \times L_{apr} / L_{pr} \quad (4)$$

- where:

N_{cd} – Number of construction directions

CF – Concurrency factor (output data from the equation 3)
$\mathbf{L_{apr}}$ - Aligned project length (sum of the Project length (L_{pr}) and Length of secondary roads along the main road ($\mathbf{L_{PZ}}$**)** **[**m]
$\mathbf{L_{pr}}$ – Project length [m]

Comparing standardized regression coefficients for the concurrency factor and the ratio of Aligned project length (L_{apr}) and Project length (L_{pr}), we can see that second variable have much more affects on the number of construction directions than concurrency factor which may also be explained by small sample size used in this study. Concurrency factor should have a greater impact on the required number of construction directions, which should be achieved by increasing the sample size.

4. Application and limitations of research

Fundamental concept of this methodology consists of two steps, which should be made before beginning the road construction scheduling process.
First step is the analysis of the project on which should be this methodology applied and determining the technical variables needed for the equation (3). With help of technical variables and project duration (D_{pr}), given by the investor, you calculate the Concurrency factor (CF).
The Concurrency factor (CF) describes the necessity for overlapping of activities in order to comply with, by the investor given, deadline. Thereby you get the information of the relative scope of the resources, which is required to comply with the deadline.
After Concurrency factor calculation, the second step is equation (4). As input data for the equation (4) is Concurrency factor and ratio of Aligned project length (L_{apr}) and project length (L_{pr}). The output is the number of construction directions in order to comply with the given deadline.
Based on number of construction directions it is possible to calculate number of accession points from where the construction directions can be accomplished.
Ratio between construction directions and number of accession points is described with:

$$N_{ap} \le N_{cd} \le 2 \times N_{ap} \tag{5}$$

N_{ap} – number of accession points
N_{cd} – number of construction directions

When this methodology is applied it's useful to use Linear scheduling method (LSM) because of the advantages compared to other scheduling methods. The greatest advantage of this technique is a simple design of alternatives and changes on existing plans where is easy to detect time and space limits.

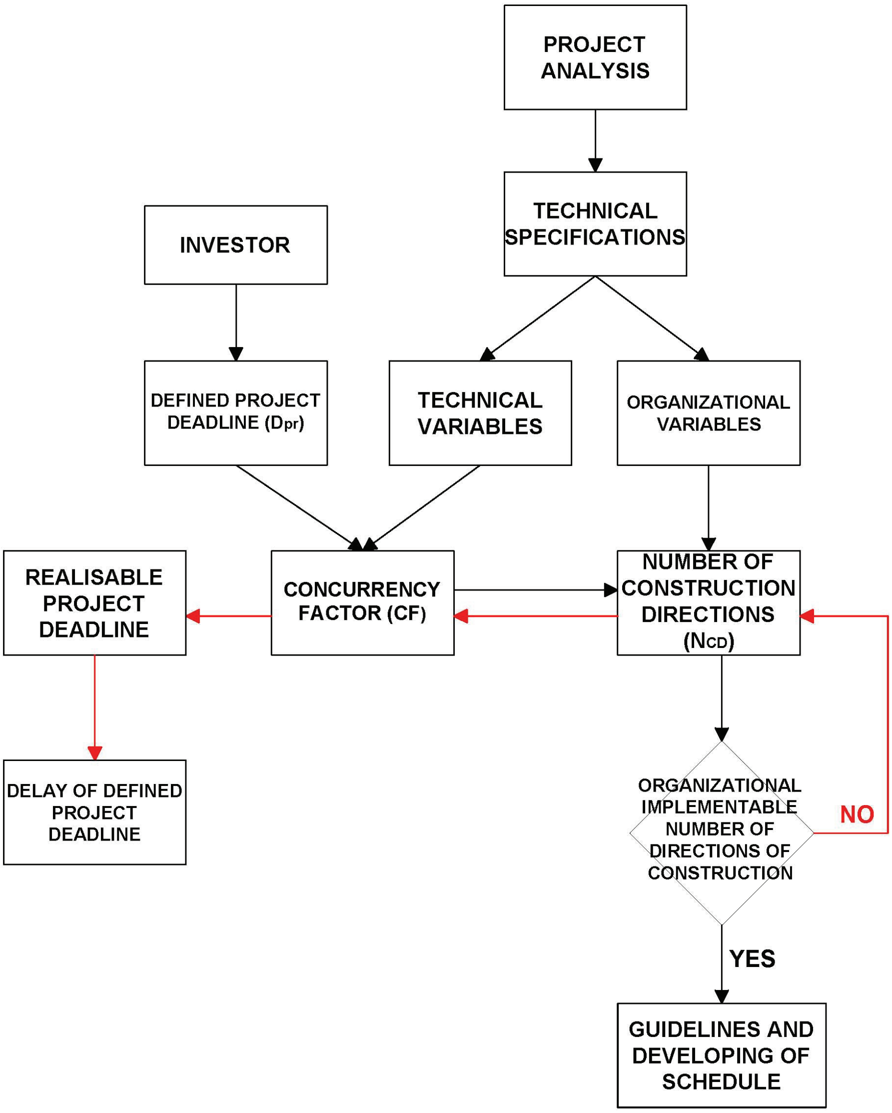

Figure 2– Methodology for planning and scheduling construction road projects

It's important to mention that, if it is impossible to solve equation (4) because the resulting solution is impossible to organize, the Concurrency factor is possible to figure out by putting realizable number of construction directions in the equation (4). Then the Concurrency factor, as result from equation (4), is used as input data for equation (3). In that case equation (3) is used to determine magnitude of time deviation from the, by investor, given project deadline.

For practical usage of this methodology is important to consider certain constraints which refer to the planning phase, group of machines which are required and constraints resulting from the given model. Constraints are:

1. This methodology can be used up to the tendering phase because the Concurrency factors in this study correspond to the factors of that scheduling level. If the Concurrency factors would be calculated for the same project on operative level of scheduling they would be larger.
2. This methodology is applicable for following production rate of machine groups:
    a. Machine group for preparatory road construction works– $U_p \approx 100\ m^3/h$
    b. Machine group for soil removal - $U_p \approx 100\ m^3/h$
    c. Machine group for soil installation - $U_p \approx 120\ m^3/h$
    d. Machine group for road bearing structure - $U_p \approx 120$ m3/h

e. Machine group for asphalt works- $U_p \approx 35\ m^3/h$
f. Machine group for concrete works - $U_p \approx 20\ m^3/h$
g. Machine group for girders assembly $U_p \approx 4$ pcs./day
h. Machine group for pilotage - $U_p \approx 1$ (1,5) pcs./day
i. Machine group for tunnel excavation:
    i. Soil III category - $U_p \approx 7$ m´/ day
    ii. Soil IV category- $U_p \approx 3$ m´/ day
    iii. Soil V category - $U_p \approx 2$ m´/ day

3. Model is not robust enough due to small sample size in this study.
4. Model is useful to calculate data, which can be used as guidelines for more detailed scheduling.
5. The resulting number of accession points does not necessarily mean that it is achievable in some road construction project. It's necessary to analyse the project and identify possible number of accession points and construction directions.

Nevertheless, these results are valuable for foundation for further studies, for which we give the following suggestions and options:

1. Sample size in further studies should be in range of 50 to 100 plans in order to obtain more accurate results of statistical evaluation.
2. Development of greater number of alternatives on a smaller sample and comparison Concurrency factors in dependence to number of building directions. (create more alternative schedules for the same road construction project with regard to change number of construction directions and construction directions and follow changes occurred in the plan).
3. Implementation of a new Concurrency factor (f_c) oriented on group activities which would take in consideration total duration of construction certain facilities and total duration of works on certain part of road.
4. Determination and insertion in the model other variables with significant impacts which would avoid the limitations of the current model, e.g. production rate of machine groups.
5. Development of the model that will consider the effect of other important features of the project, e.g. geomechanical properties of soil or access to the construction site.
6. Development of the model that will include the risks that may affect the performance of construction works, e.g. predicting weather conditions.

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CONCURRENT CONSTRUCTION APPROACH BASED ON BUILDING INFORMATION MODELING*

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Abstract

The article studies a complex of economic and administrative matters devoted to concurrent course of the design and construction processes. The synchronous exchange of model and document-based data becomes the base for overlapping Project Lifecycle Phases. The condition precedent for all these changes is the implementation of the BIM network/software technologies providing sharing of the interdisciplinary model. In the most general sense BIM-based concurrent construction approach will mean joining of multidisciplinary project participants, working under centralized control and solving general tasks. The theoretical basis, implementation and control methods of the concurrent construction, when all design and construction actions are integrated, are concurrently planned and implemented to maximize a common advantage, together with optimization of constructability, serviceability and reliability become the result of the article.

Keywords: integration, design process, construction process, concurrent construction, building information modeling.

* The complete text is available on CD-ROM / Kalinichuk, Tomek

Introduction

In the construction industry there is a necessity for innovative methods to improve the construction efficiency that proves to be true happening now and for soon expected changes. Combination of site positioning, design requirements, materials selection, budget constraints and the availability of specialized skills makes each building project absolutely unique. Also, the construction industry is well-known for its highly fragmented and competitive environment. The need for greater co-ordination and integration within the construction industry has led to the adoption of various concepts from other industries. One of these, which fits to construction industry more efficiently and helps to solve major scope of problem related to effective co-ordination and integration within the industry, is Concurrent Engineering (CE). One of the earliest and most popular definition of CE describes it as a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements (Winner, 1988). In the relation to the construction industry there is another definition of CE as an attempt to optimize the design of the project and its construction process to achieve reduced lead times, and improved quality and cost by the integration of design, fabrication, construction and erection activities and by maximizing concurrency and collaboration in working practices (Anumba, 1997).
The key features of CE can therefore be summarized to include the following:

• Concurrent and parallel scheduling of all activities and tasks as much as possible.
• Integration of product, process and commercial information over the life cycle of a project; and integration of life cycle issues during the design stage.
• Integration of the supply chain involved in delivering the project through effective collaboration, communication and coordination.
• Integration of all technologies and tools utilized in the project development process (Anumba, 2007).

2. Building Information Modeling

Building Information Modeling is a process involving the generation and management of a digital representation of physical and functional characteristics of a facility. This process results in a building information model.
Building Information Model is: well coordinated, agreed upon and interconnected, ready for calculations and analysis, having a geometrical binding, suitable to the computer usage, allowing the necessary update of numerical information concerning a projected or already existing object that can be used for:

• Accepting a concrete design choice;
• Creating of high-quality design documentation;
• Predicting of a functional performance of an object;
• Estimating and making building plans;
• Ordering and manufacturing of materials and equipment;
• Controlling of a building erection;
• Controlling of maintenance of the building and means of technical accessories during all life cycle;
• Controlling of a building as an object of commercial activity;
• Projecting and controlling of reconstruction or repairing of a building;
• Pulling down and utilizing of a building;
• Other purposes connected with a building.

All advantages from BIM usage can be divided into straight and indirect ones. Sure gains are easily seen in practice, but quantitatively indirect advantages are prevailing. The advantages divided on processes are presented in Table 1.

Tab. 1: BIM Benefits

BIM Design Phase Benefits	BIM Construction Phase and Fabrication Benefits
Earlier and More Accurate Visualizations of a Design	Quick Reaction to Design Changes
Easy Verification of Consistency to the Design Intent	Discovery of Design Errors and Omissions before Construction
Automatic Low-Level Corrections when Changes are Made to Design	
Generation of Accurate and Consistent 2D Drawings at Any Stage of the Design	Use of Design Model as Basis for Fabricated Components
Earlier Collaboration of Multiple Design Disciplines	Synchronization of Design and Construction Planning
	Synchronization of Procurement with Design and Construction
Extraction of Cost Estimates during the Design Stage	Better Implementation of Lean Construction Techniques
Improvement of Energy Efficiency and Sustainability	

3. Integration of the Two Concepts

CE and BIM have definitely things in common. It will be logical to use the best practical experience of both concepts not for only to fast-track a project but for profound mapping out and monitoring of the whole process of concurrent construction and each stage of such preconstruction, design, construction, post construction studies. In this case, it is possible to describe BIM as a main link that force CE to work out in construction industry with the full-scale output. The associative communication between CE and BIM is explained by natural life cycle of any building project, main goals, and high technological level. The detailed information necessary for construction studies, as, for example the used building materials, engineering systems, etc., allows minimizing economic and labor expenditures during building, maintenance of an object and after the life cycle termination. Figure 1 presents some general benefits for BIM and CE which design participants can share, using these two approaches. Table 2 presents Concurrent Engineering (or Fast-Tracking) evaluation in relation to construction industry. Table 3 presents Concurrent Construction economic advantages (Integrated approach benefits).

Both CE and BIM's tools and techniques can be grouped into two broad categories which are interrelated: organizational and technological. Organizational enablers provide the framework for people and machines to work 'concurrently'. This includes: facilitating the work of multidisciplinary teams, involving all relevant parties in the product development process, and managerial/technological support for organizational team and individual levels of working. The condition precedent for all these changes is the maturity of network/software technologies providing sharing of BIM interdisciplinary model.

Technological enablers facilitate concurrent working within organizations. They include all the Information and Communications Technologies (ICTs) and software required for integration, concurrent working, communication and collaboration. The synchronous information interchange is produced on the basis of an information model in the documented form. It creates conditions for all-round, unified, capable to sharing information models that also include business analysis, principles of economical building, and a policy of green building and accounting of the whole life cycle of a building object.

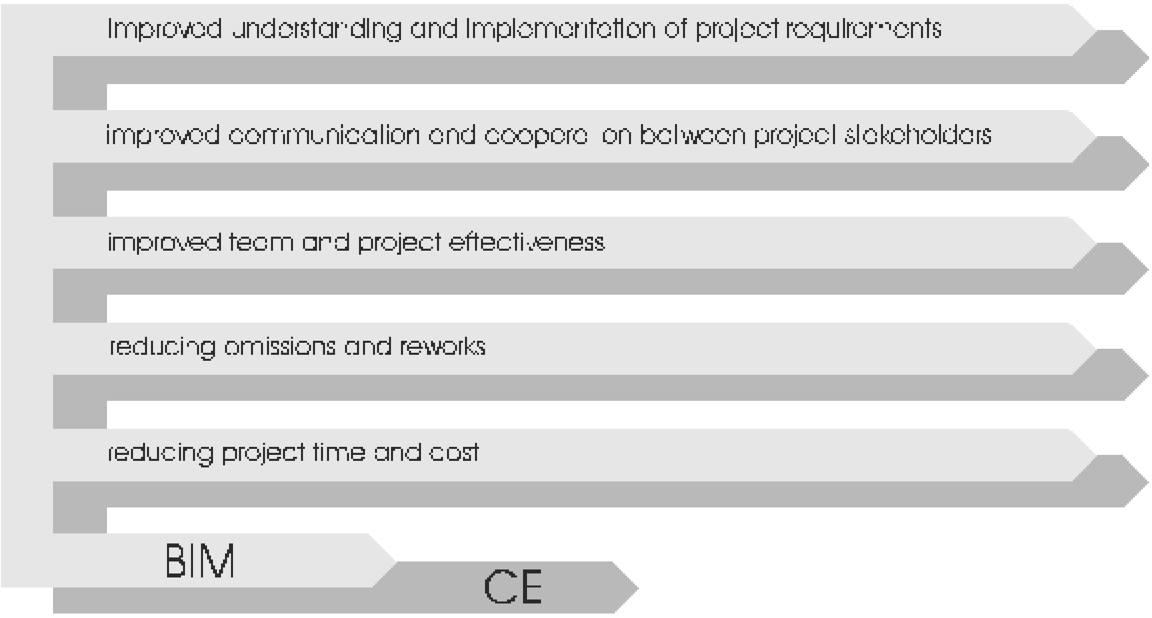

Fig. 1 BIM and CE common benefits
Source: Own elaborations

Technological enablers facilitate concurrent working within organizations. They include all the Information and Communications

Tab. 2: Concurrent Engineering (or Fast-Tracking) evaluation in relation to construction industry

Advantages	Disadvantages
1 Capability of ordering long lead items during the early phases of a project	1 High possibility of misunderstanding between the owner, designer, and the contractor
2 Expedites the construction process	2 Propensity to an increased number of errors from the designer
3 Increasing of productivity by speeding up the construction process	3 Total cost of the project is unknown
4 Cost minimization of overruns	4 Coordination of all trades can be more difficult
5 Positive cash flow would start sooner for an owner	5 Potential for more change orders to correct errors or to change to more advantageous designs
6 Can avoid winter or other adverse weather conditions	6 May have to obtain various municipal approvals and more permits than what would normally be required
7 Can save on inflationary cost of materials, products, and equipment	7 Contract with the owner has to be clearly defined: • Percentage of construction documents completed • Allowances • Contingency amount and who owns it
8 Can obtain critical subcontractors early in the process	8 Incomplete drawings and specifications are incrementally released for bidding, governmental review, and construction

Source: Own elaborations

Tab. 3: Concurrent Construction economic advantages (Integrated approach benefits)

Time Related Advantages	
1	Bonus for prescheduled project completion
2	Faster turnover of capital
3	Reduction of overhead costs
4	Reduction of Loan expenses, Inflation effect, etc.
Integration Related Advantages	
5	Decrease of loss by sharing risks

6	Increase of profit by sharing profits
7	Increase of working efficiency by more rational using of resources
8	Increase of products/works quality by specialization increasing
9	Lower net cost
Sustainability Related Advantages (BIM benefits)	
10	Elimination of unbudgeted change
11	Cost estimation accuracy
12	Considerable reduction in time taken to generate a cost estimate
13	A Savings of the contract value through clash detections
14	An Increase in field productivity
15	Sustainability

Source: Own elaborations

4. Traditional Approach

In the construction industry, based on the paper-based modes of communication, the architect produces an architectural design, which is given to the structural engineer, who on completing the structural design passes the project to the quantity surveyor to produce the costing and bill of quantities. And only then it would passed to the contractor who takes responsibility for the construction of the facility. Errors and omissions in paper documents often cause unanticipated field costs, delays, and eventual lawsuits between the individual parties in a project team. These problems cause friction, financial expense, and delays.

The key disadvantages prevalent with this approach include:
• The fragmentation of different participants in the construction project, leading to mistakes and misunderstandings;
• The fragmentation of design and construction data, leading to design clashes, omissions and errors;
• The occurrence of costly design changes and unnecessary liability claims, occurring as a result of the above;
• The lack of true lifecycle analysis of the project, leading to an inability to maintain a competitive edge in a changing marketplace;
• Lack of communication of design rationale and intent, leading to design confusion and wasted effort (Anumba, 2007).

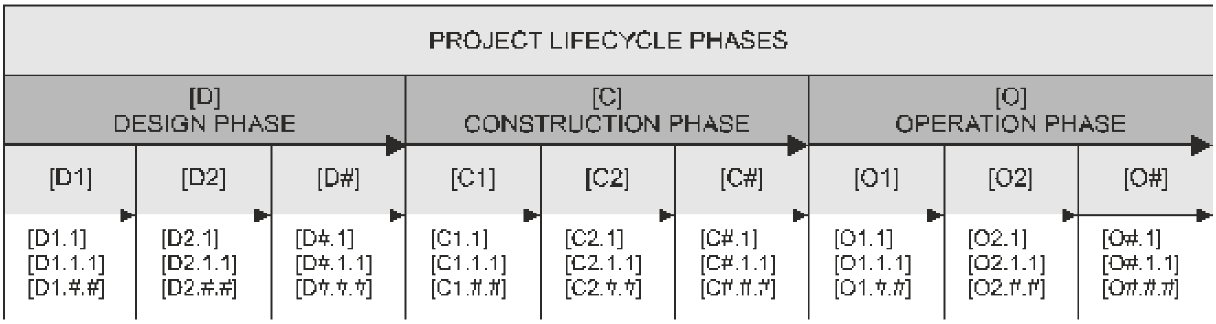

Fig. 2: Traditional construction project lifecycle
Source: Own elaborations

In an addition inconsistency, inaccuracy, and uncertainty in design make it difficult to fabricate materials offsite. As a result, most fabrication and construction must take place onsite and only after exact conditions are established. Onsite construction work is more costly, more time-consuming, and prone to produce errors that would not occur if the work were performed in a factory environment where costs

are lower and quality control is better.
Because of all shortcomings described above, construction industry shows huge interest in accepting of new technologies in the sphere of nD visualization, data analysis, information sharing, communications and collaboration.

5. BIM-based Integrating of Design and Building Processes

In the most general sense BIM-based concurrent construction approach will mean joining of multidisciplinary project participants, working under centralized control and solving general tasks. A condition of such alternative form of the organization of building is encouragement of open dialogue and minimization of parting layers in an information flow. It implies that a person and a group cooperate simultaneously, not consecutively to develop and implement the project and process, and to identify knowledge, materials and the equipment demanded for production. The conceptual circuit of such approach is presented in Figure 3 where Model-based collaboration takes place between two Project Lifecycle Phases. In an integrated project, the project flow from conceptualization through implementation and closeout differs significantly from a non-integrated project. Moving design decisions upstream as far as possible to where they are more effective and less costly suggests a re-thinking of typical project phases as it has been suggested by The American Institute of Architects (2011).

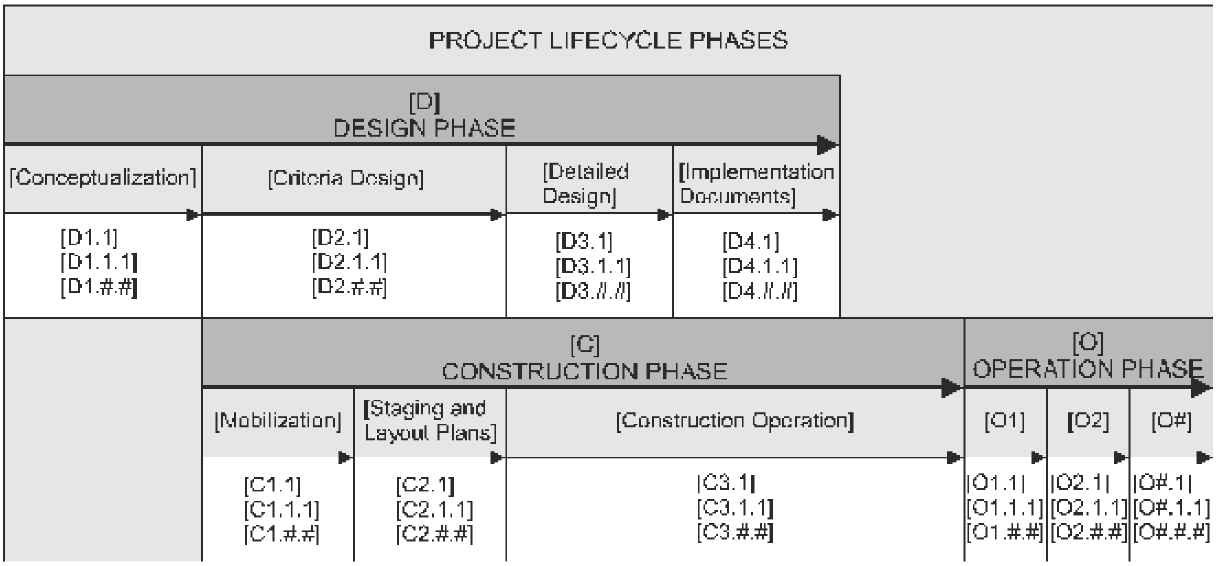

Fig. 3: Concurrent construction project lifecycle
Source: Own elaborations

The synchronous exchange of model and document-based data becomes the base for overlapping Project Lifecycle Phases. Already at this stage 'concurrent construction' completely shows its worth. 'Concurrent construction' is a term used when "all project activities are integrated and all aspects of design, construction, and operation are concurrently planned to maximize the value of objective functions while optimizing constructability, operability and safety" (Succar, 2009).
BIM-based concurrent construction approach does necessary overestimation of the main contractual relationships, risk-allocation models and procedural flows, for the building enterprises involved in implementation of the project process. And in addition it includes the following mandatory elements:
• Building Information Model represents the information nD model of a building object connected to an information database;
• The rules of development of an information model and a rule of depositing changes into it;
• The frame resources which are responsible for creation and development of an information model;

• The software, whose configuration corresponds to information model requirements;
• The modification rules in information models (specific adjustments, databases, etc.), a configuration of the software and composition of its functional connected tools;
• Computer hardware, software, and communications devices, corresponding to specifications for creation and work with information models;
• The project feasibility human resources, including staff on service, adjustment and adaptation of computer hardware, software, and communications devices;
• Rules of usage of the software and the user instructions, the rules of training and certification of users.

Control basic functions are mapping out, co-ordination, supervisory control, analysis and estimation of activity which are carried out in project implementation process. It is rather difficult to control the given circuit effectively, considering a great number of project participants, diversification of used resources and the increased speed of acceptance and implementation of design choices. The management decisions formed during the course of performance of above enumerated functions serve as the starting point for concrete executors. Therefore BIM-based concurrent construction composes means for documentation provision of control, information support of data domains, the communication software, means of the organization of collective operation of employees and other auxiliary (technological) products. It follows from this that the mandatory requirement to BIM-based concurrent construction approach is integration of a great number of the software solutions implementing various management methods of simultaneous flow of a design and construction process.

In integrating the design and building processes BIM becomes the base for creation and usage of interdisciplinary nD models (Lee, 2003). Collaborative work takes place over all-round, unified and capable to an exchange data model. It allows carrying out complex analyses at early stages of virtual design and construction. Further, the model will include business intelligence, lean construction principles, green policies and whole lifecycle costing.

Interaction between project participants can happen by different technological ways depending on the selection of BIM software tools by every project participant. Two various examples of model based collaboration include the interchange (interoperable exchange) of models or part-models through 'proprietary' formats (ex: between Revit® Architecture and Revit® Structure through the RVT file format) and non-proprietary formats (ex: between ArchiCAD® and Tekla® using the IFC file format) (Succar, 2009).

6. A Tentative Estimation of Changes Connected with BIM-based Concurrent Construction Approach

The scale of changes of the building companies connected to application of information technologies and implementation of BIM can begin from insignificant and reach the most cardinal ones. Figure 4 shows four types of structural changes of the building organization, aspiring to pass to BIM-based concurrent construction approach: automation, rationalization, reengineering and paradigm change. Each type of change corresponds to a certain risk level.

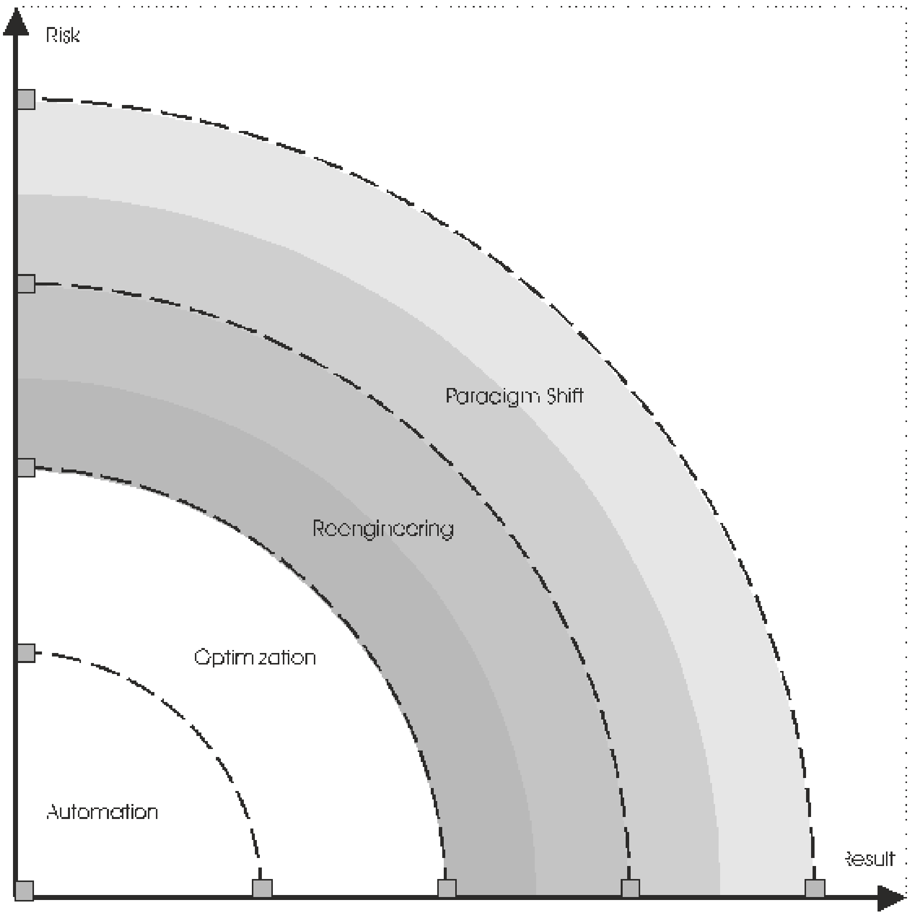

Fig. 4: The scale of structural changes connected to application of concurrent construction
Source: Own elaborations

The new concurrent construction approach presumably will lie between Reengineering and Paradigm shift areas. Reengineering essence consists in analysis, simplification and remodeling of processes. Reengineering implies radical revising of workflow and business of processes of production of building products. Using BIM, organizations can refine the productions for increasing the rate and quality of performance of the operations, represented services and lowering of costs. The primary goal of Reengineering of projecting and building processes is reorganization of labor processes on a building site and behind its limits. The procedure of Reengineering is more difficult than Optimization procedures since it opens a new vision of how implementation processes of the building project should be structured.

New approaches in project delivery can radically change the structure of all organization, changing methods of functioning of the company, or even directions of its activity. Such more radical form of change of activity of the company is called Paradigm shift. Paradigm shift implies revising of character of activity not separate procedures and processes, but the company itself.

World experience shows that passage to BIM demands organizational-structural changes in a design team. BIM-based concurrent construction approach is an even more serious change of the approach of implementation of projects, and it is impossible to get rid of reengineering separate productions (as BIM itself implies implementation of new rules of creation, actualization, back up and information processing), not mentioning decision making processes.

With the help of reengineering processes in construction based on BIM, it is possible to reach sharp increase of efficiency of design operations. It principally creates new business processes sharply raising efficiency of activity of all construction stakeholders. The distinctive feature of reengineering processes is a cardinal change of processes, instead of their step-by-step improving.

Reengineering processes are implemented in three stages:

• Modeling and analysis of existing building processes;

• Reconsideration and development of principally new building processes;
• Implementation of new processes.

For effective reengineering, it is necessary to have an extensive strategic vision of results which are necessary to achieve.

Until now, many building companies have been focused on acceptance of BIM technologies with which they can refine industrial and economic indexes. With creation of BIM-based concurrent construction approach, there is a need of reorganization of key business processes of the organization, both exterior and internal ones. Thus reconsideration of duties, responsibilities, tasks of employees, material, financial and information flows, document circulation, and also corporate culture as a whole are required.

7. Applicability

The new approach must find the area of implementation mostly in large and complicated projects when a project conditions need an earlier involvement of project participants. The general aim of concurrent construction theory is to get over the weaknesses of the classic fast-track projects by high innovative Building Information Modeling. It is intended that the integrated process and interdisciplinary nD models will facilitate improvements in the construction process, particularly with respect to collaboration, project co-ordination, reduction in project duration, reduction in costs, reduction in claims and disputes, meeting of sustainability needs and improvements in product quality. The basic model will be applicable to different European countries, many of which have similarly fragmented construction industries.

Conclusions

BIM-based concurrent construction approach necessary overestimates the main contractual relationships, risk-allocation models and procedural flows. A principal condition for solving the given tasks is the necessity of the analysis of non-traditional pyramid-shaped organization and realization of the alternative form of the organization which encourages an open dialogue and minimizes parting layers in an information flow.

Before realizing the project of integration of processes it will be necessary to formalize as much as possible its purposes, to compare them to appropriate scales for measurement at a level of their achievement. Special attention requires the selection of the software for system of BIM creation concurrent construction. The basis of collaboration is information model of a building.

It is necessary for project participants to overstep the limits of an organization structure which are traditional for the construction industry, and concentrate exceptionally on multidisciplinary design group. In a new organization structure the individual expert and groups of experts cooperate simultaneously, not consecutively in order to identify needs shortly as possible, to develop and implement the building project. The project of integration of processes should have not only the highest priority among other organizational and commercial projects, but also necessary dynamics of development. Similarly, the project head should have high powers, as well as all the design team sometimes should, in order to both motivate positively and organize measures that should raise rate of mastering of new approaches to building.

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LIFELONG LEARNING FOR MANAGERS AND PROJECT MANAGERS IN THE CONSTRUCTION SECTOR*

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Abstract

Specialised education in business management, also known as MBA, is today probably the most highly respected qualification in the business world. It is a form of additional high education in management, because it provides knowledge and skills that enable students to master business processes more easily and to adapt to globalisation processes more quickly and painlessly. Alongside the traditional, full-time studies, the forms of studies that combine classical lectures with distance learning are gaining popularity. In these so called hybrid models, thanks to IT support, there is no loss of education quality and student obligations can be managed in a more flexible manner at a lesser expense for students. In this paper the authors describe the MBA in Construction course at the University of Zagreb, offer information on global trends in this type of education for business leaders and show how this type of studies fit the above trends. Indicated are the main advantages and risks related to distance learning, which is of importance for the decision on joining such a course. Also mentioned are the key criteria for recognising the qualities of such programs, not only from the aspects important to the students but also those important to the employer. In the light of these criteria the authors present the MBACon program.

Keywords: construction sector, lifelong learning, MBA

* The complete text is available on CD-ROM / Katavić, Hunjak, Lovrenčić-Butković

Introduction

The overall purpose of management is to help an organisation achieve its objectives (to achieve profitability and liquidity) under the leadership of its managers. A good manager can save even a bad company, whereas an incompetent manager can ruin even a good company. Our professional practice has numerous such examples.

For many years Croatian civil engineers have been successfully heading building and construction companies as well as work on various large-scale projects such as dams, nuclear power plants, ports, bridges, roads etc. They have proved their technical knowledge, skills and expertise working in a different economic and political environment.

Business conditions on the construction market are very difficult and diverse, because of which it is sensitive to the influence of many technical-technological, economic, sociological and legal-political factors, underlining the need for a serious managerial approach to the running and business operations of construction companies.

In contemporary construction, engineers are more rarely individuals with a precisely defined work task but are as a rule part of a team, either as its members or its head, for which they need to have interdisciplinary knowledge. Very often they intuitively respond to many interdisciplinary demands during the realisation of a project (from simple ones to those that are extremely complex). This ability to make decisions under conditions of uncertainty and very often with a lack of information makes construction managers highly valued. The decision-making problems that they face are becoming increasingly complex, and the price that they must pay for wrong decisions is growing. Quality decisions can no longer be based on intuition grounded in experience, instead, complex knowledge is needed enabling the integration of different kinds of information. This complex knowledge can only be acquired through a carefully designed learning process in which business schools play an unavoidable role. Judging from long-lasting trends, this has been recognised in all business domains.

2. MBA for the Construction Sector

In the last thirty or so years MBA programs have gone through a great expansion and the business-management "knowledge market" is inundated by various forms of educational models, programs and specialisations, necessarily of varying quality. Although the concept of MBA as a program offering very specialised knowledge and skills has been recognised globally, in real life programs of this kind have very different approaches and methods: there are one-year, two-year, full-time and part-time study courses organised in campuses and/or using "distance" learning – "e-learning". There are also forms of MBA consortium schools with specialised programs for particular companies (Nicholls *et al*., 1995).

Birchall and Smith (2000) consider that the MBA programs market still has great potentials. According to Kempner (Kretovics, 1999), the basic tasks of MBA programs are to create executives to manage companies and projects efficiently and profitably in the competitive market environment. In the view of Boyatzis *et al*. (2003), the main task of MBA education is to create excellent managers and leaders. Should MBA offer a kind of specialised education targeting particular market niches (e.g., MBA in the health sector) or should it remain focused on general subjects and methods that can be applied to various fields; this is one of the main dilemmas in the wish to justify the existence of specialised postgraduate studies of business management (MBA) created particularly for the needs of the construction sector, MBACon, like that provided at the University in Zagreb (Katavić, Matić, 2005). One of the fundamental arguments we always use is that the main generic characteristic of construction is the "static nature of the product and the dynamic nature of the forces of production", which makes it necessary adapt, for the construction sector, the approach to system management.

Furthermore, a long time ago Fayol (1949), the founder of modern management, found that the knowledge necessary for management is a correlation of technical knowledge and other kinds of professional knowledge (in economics, sociology, law). In the management hierarchy, the need for the level of general knowledge grows proportionately with the position held on the ladder of management, while the need for professional-technical knowledge falls. Starting from this perception, in 1989 research was carried out by Katavić and Đukan (1989) among engineers who had graduated from the Faculty of Civil Engineering, University of Zagreb, between 1955 and 1985, and was repeated in 2001 (we must not forget, under fundamentally changed socio-economic conditions) by Katavić and Cerić (2002). In 1989 the respondents put technical knowledge and professional skills first, expressing their view that a person "must be a good engineer to be a good manager". The 2001 research showed that "comprehension of managerial knowledge and skills" (planning analysis, organisation, motivation, controlling) came first on the list, while technical knowledge was ranked last on the list of ten necessary competences.

Obviously the perception of managerial functions has changed significantly. Engineers and other technically educated persons are increasingly becoming aware of the need for additional education in the management field, carried out as an intense multidisciplinary and interdisciplinary approach.

The international, university study program Business Management in Construction/MBACon started in February 2003 as a TEMPUS project at the University of Zagreb (Faculty of Civil Engineering and Faculty of Economics) in cooperation with European partner institutions from Great Britain, Germany and Slovenia. Teachers from Dundee University, Reading University, Salford University, Technische Universität München and the University of Ljubljana taught together with colleagues from the University of Zagreb, creating an environment of different business and culturological approaches (Katavić *et al.*, 2005).

In June 2003 the Senate of the University of Zagreb approved the proposed syllabus, which made the course one of two academically verified business management studies in Croatia, and it was also recognised as an international postgraduate specialised study. The program was brought into harmony with the Bologna principles in 2009 and brings 90 ECTS credits. It consists of three semesters of teaching and a fourth reserved for writing a master's thesis. Graduates receive the academic title of university specialist in MBA in Construction.

MBACon is a program conceived as a continuation of the regular undergraduate education of construction experts (and also those of kindred technical professions) and represents a segment of lifelong learning. The Ministry of Environmental Protection, Physical Planning and Construction of the Republic of Croatia recognises the program as a form of professional upgrading and grants participants a total of 90 credits (15 credits for each completed semester, and an additional 45 credits for the acquired academic title). They are also recognised as experts in project management.

The international study of Business Management in Construction (MBACon) of the University of Zagreb is designed as a specialised program providing constructors with the necessary knowledge and skills to independently manage both companies and projects (see in more detail at www.grad.hr/mba). It focuses on providing present and future managers in construction with knowledge in non-engineering fields indispensable for successfully understanding and running complex managerial processes.

As the program for the MBACon course says, its main objective is to train construction engineers, and engineers in other professions kindred to construction, and to provide them with the highest potentials for successfully managing companies and projects. At the same time the long-term aim is to widen the circle of people who use managerial knowledge based on a multidisciplinary and interdisciplinary approach (Katavić, Bošković, 2007).

3. Trends in MBA Education

The Application Trends Survey (2011) gives detailed statistics for the application trends in various MBA studies and specialised study programs of renowned business schools and faculties. It includes data for 649 programs at 331 business schools and faculties from 42 countries. By program type, it covers 467 MBA programs, 158 specialised master's programs and 24 doctoral programs in business. The institution that carried out the research has been doing research of this kind regularly since 2000, which gives its conclusions full validity.

The key findings from this research are the following:

- Two thirds of two-year full-time MBA programs reported a decline in application volume compared with 2010, continuing a trend that began in 2009.
- More than half of one-year MBA programs received fewer applications in 2011 than in 2010.
- Specialised master's programs reported increases in application volumes (most in finance (83%) and management (69%)).
- The academic quality of applicants in 2011 (measured according to results at entrance exams, mostly GMAT[*]) was higher in all programs than in 2010.
- Almost half the programs recorded growth in applications from foreign students.
- Programs that enrolled a smaller number of students (up to 50) had more stable application volumes than programs with more massive enrolment.

Application trends for MBA studies have been followed since 1960. For that year the assessment was 5,000 applicants for these programs. For 2000 the assessment was 100,000, and the present market for MBA education programs of all types is assessed at 500,000 applicants a year (GMAC, 2012), with small variations mostly caused by economic changes. The trend of changes in MBA application volume runs opposite to changes in economic conditions. There is a global trend of increased interest in such programs in bad times and decreased interest in good times, which places business schools in the situation of not being able to count on a market of constant application volume and plan their development on an assumption of stable business conditions. The opposing trends in economic conditions and interest in business schools is not difficult to explain. In difficult times of recession, when people are in search of work, they rely on additional qualifications, and business schools applicants also include people who lost their jobs and want to secure additional advantages on the labour market. Therefore, an MBA degree not only ensures a better paid job, but plays a big role in protecting its holder from unemployment. When times are good there are plenty of jobs and it is not such a great advantage to have an MBA degree, and besides, fewer people have enough free time to be absent from work for as long as MBA studies require (if they are in a full-time form).

[*] GMAT – General Management Admission Test

4. Flexible[*] / Hybrid MBA Programs

Globalisation trends in all forms of MBA education make it more difficult to seek a competitive edge by adapting to local conditions, which makes programs based on satisfying the educational needs of specific environments questionable. Increasingly fewer candidates see an opportunity for career development in acquiring additional qualifications in programs that are recognisable only locally.

Besides the traditional way of responding to these challenges based on verified syllabuses and by taking advantage of the reputation of the institution and of the researches/teachers, more recently it has also become possible to organise teaching in a more flexible manner based in the first place on IT innovations. Almost 40% such programs report increased application volume in 2011 compared with 2010. The relatively greater increase of application volume for flexible programs in comparison with classical programs and those that are completely in the form of distance education indicates that the decision to introduce hybrid teaching at MBACon is completely in accordance with world trends.

Some of the advantages of the hybrid teaching model[†] are the following:

- Online access to teaching materials.
- Online independent research by students and possibility of consulting teachers.
- Possibility of engaging distinguished foreign experts who could not participate if teaching was in the form of full-time studies
- Classically taught modules in the University (faculty) enable students to use the advantages of group work, exchange experiences and have open discussion in cases studied as part of these modules.

There are several reasons for the increased trend of application for on-line and hybrid MBA programs. One is a change in applicant structure. Under conditions of high unemployment, the option of distance learning becomes very attractive because of the considerably smaller expenses. Moreover, applicants may keep their jobs, which also provide them with working experience which is desirable in all programs, and even a condition for some. The traditional full-time MBA study program exposes applicants to high indirect expenses – for accommodation in the study centre, loss of earnings for the duration, expense of living apart from their family, and others. Avoiding part of these expenses is a strong incentive for distance study.

The short-lasting periods during the program when all the students gather to listen to some of the modules taught in the traditional manner in the faculty are of additional value because students can make use of discussion with the other students and the teacher to supplement and enhance the knowledge acquired through self-education. Unlike classical MBA programs in accounting, quantitative analysis, economics, marketing, organisational behaviour and so on, a more modern approach is studies for specialised business fields or industries. One such is the postgraduate specialised MBA program MBACon (Katavić et al., 2012).

5. Which Form of MBA Program is the Most Appropriate for Constructors?

The hybrid study model undoubtedly retains almost all the advantages of classical full-time studies and has some particular advantages which emerge from and rely on IT. Nevertheless, there are

[*] These are programs that combine full-time and part-time teaching options.

[†] By a hybrid study programs we mean combining distance teaching supported by information technologies and classical classroom lectures, carried out in cycles of different length of one or two weeks to several months.

certain negative myths about this kind of program, not all of them unfounded. Negative views are mostly based on proven cases of “selling degrees” and the foreseeable high risk of misuse in environments without a history of honouring the high ethical standards necessary for running such studies.[*] Furthermore, these programs require large initial investment into adapting teaching materials to the specific demands of distance education, additionally training teachers to use specialised program tools, buying these tools and technology. Therefore, the candidate’s confidence in program quality is a key motivating factor in deciding to choose it. The pillars underpinning confidence in the quality of study programs (not only MBA) are the following:

- accreditation procedure,
- the reputation of the institution that organises the program,
- applicant selection based on the GMAT test, the globally dominant entrance exam for studies of this kind.

Employers, too, not only potential applicants, should perceive the program as a good one and during employment consider the weight of the MBA degree. The MBACon program was accredited in the same way as all the study programs of the University of Zagreb. The procedure consists of several iterations with domestic and international reviews, accepting the review report by the Council for the field, and by the Senate.

The institutions whose reputation stands behind this study program are the University of Zagreb and the foreign universities that were partners in the TEMPUS project (Katavić, Matić, 2006) from which the program developed, i.e., the home universities of the permanent teachers at this program. The fact that the Ministry of Environmental Protection, Physical Planning and Construction of the Republic of Croatia recognises the program results as proof of an applicant’s lifelong learning adds special weight to perceptions about its quality.

5.1. Evaluation of the methodological form of the program

The accreditation of online study programs is connected with the problem of the employability of degree recipients. The validity of such degrees is directly linked with quality control, and in online learning quality is expensive. Besides expensive teaching materials, the technology needed to hold exams also has a price and any compromise in this respect directly destroys confidence in the results of the knowledge test. The only defence from doubts concerning quality is accreditation from the appropriate institution and the reputation of the institution that stands behind the program. Consequently, candidates for such studies and employers are recommended to check the accreditation process and take account of the reputation of the institution that stands behind the program.

When assessing program quality, it is also necessary to consider the limited resources at the disposal of both the organisers and the applicants. When examining the limited resources, the following must be taken into account:

- Studies of this kind need a specific teacher profile, one who combines scholarly qualifications with practical knowledge based on working experience.
- If the experts from the field, who teach in the program, lack the necessary teacher training, the process of transmitting their knowledge to students may be ineffective.

[*] There is evidence about the final degree being given on the basis of “life experience“, reports mention a case when a distance learning degree was given to a poodle, see http://www.geteducated.com/diploma-mills-police/life-experience-college-degree/289-dog-gets-life-experience-online-mba-degree

- Applicant quality is a limiting factor in their ability to absorb knowledge, in interactive forms of teaching unprepared individuals threaten the achievement of the other applicants.

One of the key factors contributing to program success is to solve the problems applicants have in time management. The relatively low studying efficiency, measured by the time applicants need to graduate from the course, is greatly the result of it being impossible for them to devote the time necessary to complete fixed study obligations. A more flexible organisation of teaching, made possible by changing to a hybrid study model, will help mitigate this problem.

A SWOT analysis of distance learning, with an accent on aspects relevant for MBACon, was made to assess how to bring study obligations into harmony with applicants' abilities to adjust to them, and the risks to which applicants are exposed because of some of the deficiencies of distance learning (Katavić et al., 2012).

One of the main objections to e-learning is the lack of face-to-face student-teacher contact and the inexistence of face-to-face contacts among the students. In this sense the research performed by Ponzurik *et al*. (2000) shows that various methodological forms can be used to achieve a consistent structure of lectures, but this requires pedagogical innovations.

Technology is nothing without the "brain" – the computer cannot be taught to be a good teacher, only a good teacher can be a good teacher. Lectures given in person and live communication are the essence of studying and its most creative part. They represent the personalisation of knowledge in the creative choice of material, way of presentation, synthesis of experience and stands which can be influenced, and they are therefore motivating and inspiring for followers and students! This effect cannot be achieved in the technical interrelationship of a virtual environment. It is, therefore, certain that the exclusive use of e-learning methods in the study of MBA in Construction would, at this moment, not serve its purpose.

Experience from the earlier organisation of the program showed that intensively spending time with colleagues and teachers is an opportunity for extensive, direct, formal and informal communication, during which work problems and their solutions are presented publicly and without restraint. This further resulted in a synergic group effect, which besides giving rise to a positive feeling of belonging, led to the development of group intelligence and group opinion making, which created a network of people who think about the problems of Croatian construction in a similar way. It is necessary to ensure communication between students and teachers, students among themselves and students as a body with the teachers, and to make it as simple as possible. If this is achieved, communication using information technologies will have the synergic effect of creating group intelligence, not as a substitute for but as a supplement to and catalyst of the live communication that is directly achieved during lectures and formal and informal immediate teacher-student communication (Katavić, Bošković, 2008).

It is completely certain that any program such as MBACon, business management in construction, must definitely find new ways of delivering knowledge, ways that will require less absence from work. This has been done for the new 4th generation of applicants who are now being enrolled. Our target market is young, ambitions managers or candidates for managers, who desire new knowledge and are ready to invest in the realisation of their wishes and needs. Their greatest problem in achieving this objective is lack of time, so the program organisers must find flexible forms of teaching which will not threaten program quality, but will at the same time decrease the need for absence from regular jobs.

Conclusion

There is no doubt that MBA studies have been globally recognised as the most effective form of lifelong learning in the field of business management. Besides traditional teaching forms, it is becoming increasingly popular to combine traditional teaching with forms of distance learning. This so-called hybrid study model retains almost all the advantages of traditional full-time teaching but at the same time leaves all participants the freedom to independently manage the time they will devote to their lifelong learning and career advancement.

Many world universities have introduced hybrid models of studying for certain courses at the postgraduate level (especially in specialised studies), which combine traditional courses based on the simultaneous presence of the teacher and students in the same place, and flexibly organised teaching using various forms of e-learning. This is the case with the new generation of students in the MBACon program, which is moving in the direction of introducing this recognised good practice in the Croatian environment.

And finally, the viability of MBA studies can be ensured through specialisation for the requirements of a particular profession and introduction of a more flexible organisation to ease access to studies for a larger number of candidates. Because of this, the concept of the traditional MBA program has been modified by the gradual introduction of new forms of knowledge transfer based on the application of e-learning.

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IMPACT OF EFFECTIVE MANAGEMENT OF CONSTRUCTION CONTRACTS PROTECTION ON A CONSTRUCTION WORKS QUALITY*

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Abstract

The lifetime of a construction is essential aspect of monitoring its utility and value. We distinguish the technical, economical and moral lifetime of a construction. In construction production, lifetime of the building relates to the lifetime of functional groups. This lifetime can be influenced through consistent control and quality management. The management of construction contracts protection can enforce obeying the rules in building standards and quality management. This means rigorous evaluation of tender documentation and efficient use of protective instruments. The basic management tools of construction contracts protection include the specification of requirements for qualifications of the staff involved, the existence of a quality management, integrity, vocational requirements, economic, and financial and other requirements. Contractual tools include penalty, insurance, definitions to terminate the contract, warranty and liability for defects etc. These tools can assure the delivery of the work in the required quality, in time and with the presumed costs. From the assessment of tender documentation quality and contractual terms and conditions it is possible to conclude the quality of the works, or assume a certain influence on the lifetime and thus economic value of the building. The theme of this article is the tools of construction contract protection management, description of their protected risks and frequency of their use. In addition a possibility of linking monitoring used instruments with a general assessment of the quality of tender documentation and contracts for work is discussed..

Keywords: economic evaluation of building, lifetime, quality, protective instruments

* The complete text is available on CD-ROM / Korytarova, Puchyr, Špiroch, Šimačkova

Introduction

Effective protection of construction contracts serves to ensure the achievement of construction production objectives. Civil engineering handles large financial funds for a long time period, and its outputs are products subsequently used in every kind of human activity. Therefore significant demands are placed on construction production through the costs, time and quality. Many adverse effects can be the cause of non-fulfilment of these requirements. These effects can be called risk factors. There is always a risk in a in construction process. Compared to other economic sectors the risk is escalated by the specific aspects of construction production mentioned. It is necessary to know the risks and to know how to minimize their impact and incidence. Nowadays there is significant pressure on low price of construction production and this is of course transferred to a construction contractor who has to decrease costs in processing. The most significant are the costs of materials, human labour and machinery. It may lead to substitution of high-quality materials by cheaper materials, although not with entirely comparable attributes. The same scheme can be applied to labour because the skilled worker is of course the more expensive one.

Details of required works not adequately specified in tender documentation, or absence of building, architectural and investor supervision, may result in lower quality. Investor can be pleased by handover and acceptance of works on time, especially with low cost. But in long-term monitoring increased lifetime costs for necessary modernization and reconstruction can be detected. Whole situation can result in reducing the length of building's lifetime. Quality and effective protection of construction process can prevent such a case and increase the economic value of a construction project. Monitoring the economic value of a project is considering incomes and costs during the whole lifetime of the project. For building production, construction lifetime is related to the lifetime of its main components, without which construction cannot even partially fulfil its function. Lifetime of the building is therefore linked with the onset of limit states of these main components. The actual length of life is based on testing and real experience, mostly as a range or maximum length deducted by partial aspects. One of these considered aspects could be the quality and effectiveness of the use of protective instruments in the pre-investment and investment phase of the construction. These instruments are especially specified in the tender documents and the contract for the work.

2. State of art

In this article will be described the basic concepts related to the life-cycle of the construction project, lifetime and cycle of repairs of functional parts, risks to the quality and protection instruments used to eliminate them. This basic theoretical knowledge should be used to consider the connection between the use of protective instruments and the quality assessments and the economic evaluation of the project respectively.

2.1. Life cycle of construction project

The life cycle of the construction project is a long period of time beginning with the formulation of the investment plan and ending with liquidation of project. This period is divided into parts by milestones of critical moments of the project. It is an investment decision, handover and acceptance of the work, the end of the construction, the end of the operation of project and disposal. These four basic periods have their own characteristics and the particular challenges and tasks that need to be done and with them related risks and their protection.

Tab. 1 Life cycle of construction project

Life cycle of construction project			
Pre- investment phase	Investment phase	Functional phase	Liquidation phase

Life cycle of construction		
Investment phase	Functional phase	Liquidation phase

Life cycle of project

Source: Korytárová (2011), Management of risks associated with the delivery of the works

The life cycle of the construction project can be divided into pre-investment phase, investment phase, operation phase and liquidation phase. Life cycle of the construction is then directly related to the lifetime of the building.

Pre-investment phase - lasts from the basic formulation of idea of project to the investment decision. There it is necessary to analyse the feasibility and effectiveness of the project from technical or economic aspects. This phase includes working on feasibility study and project documentation.

The investment phase - begins with an investment decision and ends by delivery and acceptance of the building. The contractor is chosen and construction is realized.

Functional phase - lasts from handover and acceptance of the work to end of running of the project. This phase corresponds to the life cycle of the project as a business plan. A successful project should not identify risks at this phase. These should have been already identified in the pre-investment phase and now only defined corrective measures should be applied.

Liquidation phase - the project is no longer in operation, but the building itself as the object exists and generates the final revenue and expenses associated with its disposal.

5.1. 2.2. Lifetime

The life cycle of the construction project is a long-lasting process. Protective instruments and protected risks must be defined during the first two phases, but the whole life cycle of construction which is related to lifetime of construction is essential for the economic evaluation. In the case of building lifetime is related to the lifetime of major construction components.

The EHS direction (2002, 89/106/EEC) declares: *"The lifetime of buildings is the time during which indicators of characteristics of the building will be maintained at a level compatible with the fulfilment of the essential requirements."*

Three kinds of lifetime can be considered: technical, economic and moral.

Technical lifetime of the building is related to the technical lifetime of the main construction components that ensure compliance with the essential requirements of the building. These are primarily vertical and horizontal structures. So it is a time for which is the building capable to perform its function and provide unreduced benefit. It is related to the input materials, the quality of realization of the works, the quality of project documentation, placement of the building with follow-up care and repair.

Economic lifetime of the buildings is the time during which it is estimated that the operation of building (project) will be economically efficient. During this period using and repairing the building would be preferred to terminating the project (building liquidation). This lifetime is related to the technical lifetime, to the overall economic situation of the company and to amortization. All the costs associated with the construction are considered, not just operational ones.

Moral lifetime is the time period during which operation of building meets modern trends and comforts of use. It is related only to the technical lifetime and especially with the progression of requirements for comfort of use and societal trends, for an example, the energy performance of the building.

For the economic evaluation of the project several methods based on examining different types of lifetimes are used.. From the perspective of management of construction contract protection only the technical lifetime can be affected.

Technical construction lifetime

Technical lifetime ends with the emergence of the limit state. There are two kinds of limit states. Limit state of usability and the ultimate limit state. Limit state of usability is related to limit of permanent deformation and ultimate limit state to exceeding the limits of material strength or stability position. These limit states occur in structural elements and functional parts.

The functional part represents the compact part of the building that has one or more of certain specifically defined functions (Markova, 2011). It consists of several construction components and is therefore used three-level classification, which, however, each user can adapt itself to his main claims and to intended use of construction. Classification can be based for example on, in the Czech environment, used construction components grading as a TSKP and SKP, or the CZ-CPA.

Durability of structural parts of buildings can be taken from the Valuation Decree of the Ministry of Finance. Which is issued for the purpose of valuation of buildings? The lifetime is here determined as an interval. And evaluator specifies length of lifetime of the structure on the basis of the material and other characteristics. Refer Tab. 2. From this table it is seen that the size of the interval is high and gives scope for expert treatment.

In order to take into account the using of protective instruments to increase the expected length of lifetime of structures, it is necessary to describe secured risk and protective instruments themselves. This part should explain direct protective effect of instruments used in the tender documents and the contract for work on standards and quality.

Tab. 2: Lifetime of structural elements

Item No.	Title	Presumed lifetime [y]
1	Foundations including ground works	150-200
2	Vertical construction	80-200
3	Roof	80-200
4	Rooftop without roofing	70-150
5	Roofing	40-80
6	Plumbing construction	30-80
7	Interior surfaces	50-80
8	Exterior surfaces	30-60
9	Internal ceramic tiles	30-50
10	Stairs	80-200
11	Doors	50-80
12	Gate doors	30-50
13	Windows	50-80
14	Floor surface	15-80
15	Heating	20-50
16	Wiring	25-50
17	Lightning rod	30-50
18	Internal water systém	20-50
19	Internal sewer systém	30-60
20	Internal pipeline	20-50
21	Hot water systém	20-40
22	Kitchen equipment	15-30
23	Internal sanitary equipment	30-60
24	Elevator	30-50
25	Others	--

Source: Prices journal of the Czech Ministry of Finance, 2013

5.2. 2.3. Risks

Risk is inherently present in all construction projects. Quite often, construction projects fail to achieve their time, quality, and budget goals. The influence diagramming technique and Monte Carlo simulation are used as tools to analyze and evaluate project risks. Alternative risk management strategies are suggested. Such strategies include: risk avoidance, risk transfer, risk retention, loss reduction, and risk prevention and insurance (Al-Bahar and Crandall, 1999).

Significant risks affecting the quality of the delivered construction works include quality of tender documentation, project documentation, construction realization and responsible management of the entire process.

These findings support also another researchers such as Zaghloul (Zaghloul and Hartman, 2003) who addressed the behavior of risk allocating in the North American contracts and identified among their items also uncertainty of work conditions or sufficiency of contract documents.

The **tender documentation** is the first step in creating successful contract documentation. The tender documentation is obligated for the Czech public investors and is highly recommended to elaborate it for private investors. It represents the sum of all the documents, data, requirements and technical conditions for the preparation and submission of tenders (Korytárová, 2011). The minimal accepted content applicable for the public sector is defined by law. But it can also be used by the private sector, as it is compiled on the basis of established practice. The conditions established in tender documentation define the primary protective mechanisms and serve to eliminate contractual risks. It influences the selection of a suitable contractor candidate and so it is a precursor of protective instruments in contract for work. It is defined in the following outline.

- Terms of trade including payment conditions. Or the objective conditions under which it is possible to exceed the offer price.
- Technical conditions.
- Requirements for bids variants, if it is by the contractor admitted.
- Requirements for the method of calculating tender price.
- Conditions and requirements for processing a bid.
- The method of evaluation of tenders under evaluation criteria.
- Other and further requirements.
- Appropriate documentation required by the Building Act in the details necessary for the processing a bid. Can be replaced by the technical specification.
- List of works, supplies and services with statement of quantities

The risk of project documentation consists mainly in the selection of unqualified designer. The quality of project documentation is related to this selection. Another pitfall could be inconsistencies between the investor wishes and projected facts or in missed deadlines related to building permit. Reducing the risk lies in the well-specified selection process for the designer. Especially it is important qualifications and reference projects. Fuse protection risk is then performed in the usual setting of contract for work. Reducing the risk in the investment phase requires good communication between the designer, construction supervision, investor and supplier of construction work.

The risk of insufficient quality is caused mainly by the Contractor and its failure to comply with quality standards and technological processes. To this risk should precede the selection of a contractor of the works according to the requirements described below and selection of responsible quality and technical supervisor. Corrective measures are than specified in the contract for work.

The Risk of responsibility avoidance is based on the possibility of targeted use of imperfections in the legal system, the possibility of different interpretations of the terms and conditions and legislation. The risk is especially in frequent court litigation on quality, price, extra work or damage caused to nature, environment and health.

Construction phase mostly open many other different risks during the preparation and operational phase. The most important risks in that part of the project are insufficient results from geotechnical surveys, bad contractors, claims, increased budget, bad quality of works etc. From the viewpoint of public procurer, the main goal is to ensure that the money has been spent economically, efficiently and effectively, and to find optimal solution to deliver project on time. (Cirovic, 2012).

Therefore it is very important to deal with protective instrument in the pre-investment phase. By them a number of risks can be reduced or eliminated.

5.3. 2.4. Instruments of protective management

Protective functions have three attributes of usage. Preventive function has to ensure for investor the fulfilment of the obligations or to improve position on their enforcement. *Reimburse function is a support tool which provides for the investor financial compensation for all damage that it incurs as a* *result of non-secured rights. Sanction function causes that the contractor is reasonably affected in the case of not-fulfilling obligations.* (Korytárová, 2011)

Qualification requirements are preventive means to influence the choice of the future contractor, designer or construction supervision. They represent a set of requirements, with which compliance authorized to assume the supplier's ability to meet terms of the contract. These requirements can be divided to basic, professional and technical qualifications. *The qualification represents another potential danger for contracting entity since entity is obliged to set out the scope of required information and evidence, indicate the manner of demonstration of the fulfilment of such qualification prerequisites and define the minimum level of such qualifications requirements corresponding to the type, extent and complexity of the subject-matter of the public contract* (Hanák, 2010).

The basic qualification requirement is a clean criminal record in fields related to business activities and other serious criminal offenses of all responsible supplier persons. More precise definitions can be taken from the Act No. 137/2006 Coll., On Public Procurement, as amended.
Candidate has to document affidavit of non-fulfilment of the facts of unfair competition in the last three years. In addition, the candidate has not to be insolvent and could not be subject to insolvency in the previous three years. Also if the decision on bankruptcy or insolvency petition was dismissed due to insufficient amount of assets to cover the costs of insolvency proceedings, or has been placed in receivership pursuant to a special legal regulation. The potential supplier should also not be in liquidation, not have tax arrears and arrears in the health and social security contributions in the Czech Republic and in the country of residence of the company. Supplier must also submit a list of statutory bodies and their members for the past three years. All of these basic assumptions must submit by the prescribed document not older at the time of 90 days.

Requirement on professional qualifications serves to demonstrate professional competence. The applicant may be requested to provide:

- certificate of incorporation, if the contractor is registered in it, or statement from any other similar evidence, if the contractor is registered; this evidence may not be in the last date on which can be shown to meet the qualifications, older than 90 days;
- certificate of authorization to do business under special laws to the extent related to the subject contract, in particular a document proving the business license or other license;
- document issued by a professional chamber or other self-governing professional organization proving his membership in the chamber or other organization;
- document certifying the competence of the supplier or the person through whom the expertise ensures if it is necessary to perform the contract.

Technical requirements demonstrate technical capacity and capability to perform the required work. Requirements as:

- List of works carried out by the contractor for the last five years, and references from clients.
- List of technicians or technical divisions that will be involved in the contract. Especially in the field of quality.
- Certificate of head employees education and practice.
- Overview of the average number of employees and machines.
- Submission of quality management certificates.

The part of tender documentation should also be a work schedule along with defined milestones and methods of **quality controlling** in the control days. Obligations and rights of the interested people are describes in detail in document The Red Book of FIDIC, which contains terms and conditions and general business conditions in the complete range and ensures the legal conditions for the settlement of disputes. Essential assumption to achieve the desired quality is defined continuous control and communication ways during unforeseeable situations.

These measures are intended to prevent the formation of situations that threaten the quality of the final output. However, it is also necessary to define a procedure in situations when an undesirable situation nonetheless occurs. In that case embarking contractual collateral instruments such as:

- Liability for damage.

It arises from delays, defects or damage. Liability for damage is used to protect the subject of the contract and property of the Parties, in particular against material damage. This instrument is arising from law. It cannot be renounced before the damage is occurred. Contractually can be only limited the amount of responsibility. Liability for damage is usually applied in cases where the damage can be quantified and is too big to be paid by contractual penalty. Usually this liability has to be enforced by the court. The existence of responsibility should arrange prevention, direct damage compensation and fines. Liability for damage caused by delay can only be applied if there is proven damage due to this delay. Otherwise is necessary to use contract fines and sanctions. The delay will occur if the obligations under the contract for work are fulfilled late or not at all and contractor will not fulfil its obligation to notify about damage to investor at the time when damage is done. The damage isn't occurred only if investor is not cooperating and damage was caused by his inactivity.

- Contractual fines.

Contractual fines serves to authority to enforce the contractor's obligations under the contractual arrangements or contained in the tender documents. Usually take the form of cash represented by the exact amount of money or by percentage of contractual price. However, it must be explicitly stated in the tender along with the amount and the facts on which it is applicable. Determining the amount is entirely up to the will of investor but in the event of litigation must be in accordance with the good manners and be reasonable. This means that it should cover the damage and be a punishment as well. The fine may enter into force only on the basis of mutual consent. Otherwise, it is proceed by the rules in The Civil Code or through the courts. The court may in contrast to liability for damage reduce the fine with accordance of proportionality. Without the literally specified conditions of simultaneous application of fines and liability for damages in the tender, the fines usage exclude possibility of application liability for damage.

- Liability for defects.

Defects means situation in which the goods does not match the contract conditions. It could be a situation when a quality and workmanship does not match or documents needed for using are not handed over. Another situation with legal liability for defects occurs when the work result is burdened by entitlement of a third party. In the contract for work is liability for defects connected with contractor responsibility to do the work in accordance with specifications stated in contract for work and with duty to alert the investor for situations during the realization which can lead to faulty fulfilment. A mainly wrong instruction or materials gone from investor and the hidden obstacles that prevent completion has to be mentioned by agreed manner. The agreement shall specify the scope of rights application for liability for defects arising during warranty period. The contracting authority has the legal right to demand defects reparation during warranty in case of minor breach of contract, or the reasonable discount or withdrawal in case of significant contract breach. If the contractor fails to comply with time limits, the investor has the right after previous announcement to withdraw from contract.

- Retention fees.

Retention fees are a form of financial insurance used to secure the liability of contractor to client to finishing works. Retention fee lies in not paying all of or whole invoices. Usually the high of retention fees are about 10 % of the works price. Those 10 % are paid only after reparation of any defects and unfinished works found during handover process or possibly after successful release of final building approval. Some part of retention fees can be hold even to the end of warranty. Properties of retention fees are that they become part of investors financial funds where brings profit and investor in case if contractor doesn't do warranty repairs have enough resources to ensure reparations himself.

- Possibility of withdrawal.

In case of failure of preventive functions protective instruments is the last possible step to minimize damage and the possibility of completion of the works withdrawal. Option withdrawal as an extreme solution and must be accurately described in the contract of work together with the manner of mutual settlement of the parties. In contract for work should be written concrete cases of serious breach of contract conditions which entitle for withdrawal.

3. Invention

Innovations of the research should demonstrate the connection between use of collateral instruments and achieving quality of construction output. Statistical methods as monitoring frequency and intensity of used partial collateral instruments in the tender documents and the contract will be used to achieve this objective. To gain opposite information a frequency of reported defects during the warranty period will be monitored as monitoring of the overall lifetime is not possible. Based on the observed data a hypothesis will be defined and using statistical testing with statistical and probabilistic methods confirmed or refused.

4. Results

For described protective instruments can be monitored certain characteristics, and calculate the statistical values. Basic information is simple frequency of uses those instruments expressed as a percentage. In the next step there will be also monitored minimal and maximal setting of used parameters. Then average value and median (if the count of numbers is even, median is average value of numbers at position n/2 and n/2+1) for used parameters will be calculated if it is possible. If will be for some protective instruments used more types of setting parameters (using absolute values or percentage) there will be monitored both ways individually and will be compared ratio in which these methods are used.
From contractual fines will be selected most common and most important representatives. All of monitored parameters will be expressed in four options with regard to relationship between the parties and in two types of contractual subject of performance. It will be variants: aggregated, public authority - contractor, the private client - contractor, contractor - subcontractor and building construction and transport engineering.
On the basis of the information thus obtained will be investigated possible dependence setting of protective instruments to the initial conditions.
Due to the sensitivity of information in contracts for work there were many requirements for anonymity and some information is not available or cannot be declassify. Data to calculate the values in the tables are taken from the currently produced database consisting of works contracts. To achieve statistically significant information are needed many information and big scale of database. Thereafter could be made a statistical test of hypothesis about presumed dependences.

Tab. 3. Frequency of using selected instruments

	Requirement of skilled labour	Liability for damage	Unfulfilled main point	Unfulfilled removal of defects	Liability for defects	Retention fees
Frequency [%]	42,1	52,6	52,6	84,2	42,1	63,2

Source: Created by author

5. Further work

The subject of further research will be more detailed examination of the use of protective instruments. Further works will continue in the expansion of the input database of contracts for work and tender documentations, along with efforts to contact the owner of realized buildings and try to get information about defects arising during the warranty period and possibilities of their prevention from the perspective of protective instruments. The research will further examine the effectiveness of the use of protective instruments in terms of their direct effect on cash flows of the owner and contractor within and after the warranty period of the constructions. It is also important to realize that *Investment process also presents very important element in evaluation of credit rating of company. This process is perceived for evaluation of credit rating from different aspects while are very interesting information about types of investment, the level of investment performance, economic efficiency of investment, markets in which to invest, etc*. (Cetkovič, J, 2012). This means that quality work is important not only for investors and future building users, but are also an important business image for gaining additional contracts.

6. Conclusion

In market-oriented economy based on the lowest costs a voluntary compliance with rigorous quality management and control cannot be widely anticipated. Therefore it is necessary to specify these conditions in the tender documents and the construction contract. Control and monitoring of using these instruments in the economic evaluation of the project can provide information about using and requesting the implementation of quality management during realization. The Interval describing the lifetime of the individual construction components in the Price journal of Czech Ministry of Finance also establishes the possibility to define the assumption of an expert evaluation of the influence of the use of protective instruments on the lifetime of structures, functional components and building. Thus subsequent to checking the technical condition, the repairs and modernization the economic value of the building can be re-estimated.

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LIFE-CYCLE ORIENTED RENOVATION STRATEGIES FOR SOCIAL HOUSING STOCK*

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Abstract

The specific stock of Red Vienna – a protected historic monument, counts 65.000 social housing units, in 382 buildings. These are marked with an insufficient state of repair and a dwelling supply, which does not fit with modern demand considering the size of housing units or the challenges of ageing society. This paper presents life-cycle oriented refurbishment strategies, considering not only structural and thermal refurbishment variants, but also the socio-cultural aspects such as the needs of ageing society and the preservation of culturally important buildings.
In the first step, various façade-systems were evaluated in terms of life-cycle costs, ecologic and socio-cultural impact. The interior insulation based façade-system displayed the best properties in terms of economic, ecologic and socio-cultural properties, fulfilling the monument protection requirements to which the Red Vienna Stock obliges. In further step, building-hull refurbishment variants based on interior insulation, were developed and evaluated in terms economic (production cost) and ecologic (CO_2 emissions) amortization.
The findings imply that the holistic refurbishment (complete building hull) performs the best in terms of heating energy demand reduction (improvement of 37%) and in annual CO_2 emissions (improvement of 60%). Aside from the refurbishment, the greatest ecological impact has the heating system. Only through the change of gas to district heating energy supply the annual CO_2 emissions can be reduced by 70%. Finally, the refurbishment strategy considering the social sustainability was developed, where the financing of refurbishment for assisted living is enabled from the surplus resulting from reduction of the need for institutional care, reinforcing the value of historic building stock as social capital.
This research was carried out within by FFG funded Project ReCoRe

Keywords: Social Housing, Assisted Living, Refurbishment, Life Cycle Costs, Life Cycle Assessment

* The complete text is available on CD-ROM / Kovačić, Summer, Achammer

1. Current issues: housing stock and the new social requirements

This paper presents the evaluation of life cycle oriented, holistic refurbishment strategies of a specific, very large protected historic housing stock of Red Vienna. The stock has been erected in the period of time since 1922 till 1938, fulfilling the urgent needs for proper housing, in front of all for working class, under motto: light, air and sun. The stock is 80 years old and in need of structural, but also thermal refurbishment, considering the Nearly Zero Energy Buildings Initiative by 2020 (EBPD, 2012). The considered refurbishment must comply with economic constraints (limited economic means since manager is non-profit organization, and minimisation of operational costs, such as heating), minimization of emissions and carbon footprint, and protection of cultural heritage as well as of social interests such as up keeping of affordable housing and accessibility, keeping in mind that built heritage is “non-renewable” capital (Hassler, 2009) This is a novel approach, considering social or cultural aspects, which are mostly neglected. The recent literature focuses on energy assessment of stocks (Loga and Diefenbach, 2012) or improvement of energy-efficiency and minimization of CO2 emissions, mostly through application of external insulation, window-improvement or improvement of the heating system (Uhlein and Eder, 2010, Veerbeck and Hens, 2005, Balaras et al, 2007).
The Viennese social housing stock is especially large one, with more than 220.000 housing units (Wiener Wohnen, 2013). The specific stock of Red Vienna – a protected historic monument, counts 65.000 housing units (Lexikon der Wiener Sozialdemokratie, 2013) in 382 buildings (Lexikon der Wiener Sozialdemokratie, 2013 a). These are marked with an insufficient state of repair and a dwelling supply, which does not fit with modern demand considering the size of housing units and facilities. The result is an urgent need of thermal and structural refurbishment. Appropriate renovation strategy, considering the type of building-hull refurbishment with the most sustainable effect over the life-cycle in terms of economy, ecology and socio-cultural sustainability has to be determined. An aging society with the tendency to two person-households (Statistik Austria, 2013) leads to changing of housing requirements. Simultaneously, an aging society causes an increasing demand of care giving institutions. To delay the move into a home for the elderly creates necessity for creation of small affordable and barrier-free housing units, which enable the stay of high-maintenance persons at their beloved home. Therefore, structural renovations in the existing housing stock are necessary. Alternatively the new construction of homes for the elderly can bare the increasing demand of care. Regardless of the individual need affecting the intensity of care the benefits of structural reconstruction in the existing housing stock in combination with institutions for mobile nursing and assisted living should be compared to the new construction of homes for the elderly. Beside the large demand of refurbishment, the Viennese social housing stock has the task to supply inexpensive housing units to create affordable housing for everyone of society. The aspect of affordable living, as well as monument protection of cultural important buildings, such as the building stock of Red Vienna is, together with sustainability aims have to be considered in structural and thermal refurbishment.

2. Towards research model

For the evaluation of refurbishment strategies by the means of sustainability criteria, a case study methodology was chosen, applying life-cycle costing (LCC) for calculation of economic impact (Kohler, 2008); and life cycle assessment method (LCA) represented through assessment of global warming potential (GWP) for calculation of ecologic impact (Garrido- Sorianoa, 2010, Ramesh at al 2010). As specific reference object a housing block “Elderschhof” in the second Viennese district was chosen. The Elderschhof (11 414 m2 gross floor area, six floors) is a housing block owned by the state Vienna and administered by Wiener Wohnen. It was erected in the years 1931 to 1932 and is an example of the building activity during the era of Red Vienna.
This paper is structured as follows: after introduction and problem outline in the first chapter we will continue with development and evaluation of several thermal refurbishment variants of the façade-

systems in chapter three. The façade refurbishment system based on interior insulation complying with the economic, ecologic and socio-cultural sustainability in terms of monument protection, will be chosen for further exploration and evaluation of thermal refurbishment of complete building-hull and improvement of energy system in the chapter four. Chapter five will be dedicated to the comparison of the refurbishment of building-hull with interior insulation versus EPS-based exterior thermal insulation composite system (ETICS). In chapter six we develop a socially sustainable model for assisted living, enabled through structural refurbishment, which proves to be cost-saving in comparison with institutional care, and we finally conclude with the resume of benefits of thermal and structural refurbishment, demonstrating the value of existing stock in chapter seven.

3. Evaluation of façade-systems

In the first step, the life cycle costing (LCC) and life cycle assessment (LCA) methods were used for the assessment of the ecological and economic impact of different facade-system refurbishment variants, using the software Legep (Weka Media, 2012), based on ökobau.dat (Ökobau.dat, 2013) for ecologic data. The software and database was chosen since these are, next to the Baubook (Baubook Eco2Soft, 2013) the only available tools with verified data in the German and Austrian market.

LCA was carried out for the life cycle phases of production and replacement (material-oriented); and production, operation and replacement (energy-oriented).
For the calculation of the life cycle costs (LCC), the “total cost of ownership” approach was used, considering only the emerging costs over the life-cycle of a building, which have to be carried by the owner (König et al., 2009). Outpayments are discounted to the present value of the date of investment (discount rate of 5,5%) and are the base for LCC-evaluation of the investigated buildings, which is calculated over the period of 50 years.

Following refurbishment systems with different thermal characteristics (Table 1) were developed:

1. Refurbishment of the façade without thermal insulation measures (without TIM)
2. Refurbishment using Exterior thermal insulation composite system based on extruded polystyrol core (ETICS EPS)
3. Refurbishment using Exterior thermal insulation system mineral wool (ETICS MW)
4. Refurbishment using Thermal insulation plaster (TIP)
5. Refurbishment using Interior insulation (II)
6. Refurbishment using Vacuum insulation panel (VIP)

Table 9. Thermal characteristics of the façade-systems according to OIB (2012)

	λ [W/m・K]	d [cm]	u-value [W/m2・K]
Existing State	-	-	1.694
ETICS EPS	0.035	20	0.159
ETICS MW	0.040	20	0.179
TIP	0.130	7	0.886
II	0.040	6	0.520
VIP	0.008	5	0.179

The evaluation of the operational phase - savings of heating energy demand (HED) resulting from façade refurbishment compared to the existing state of Elderschhof is determined through calculations of energy certificates along the lines of the OIB (Table 2).

Table 2: Façade-systems HED according to OIB

	Heating Demand (HD) [kWh/m^2·a]	Savings potential to stock (171,69 kWh/m^2·a) [%]
Existing State	123.74	28
ETICS EPS	39.16	77
ETICS MW	40.37	76
TIP	79.18	54
II	59.88	65
VIP	40.36	76

The developed façade-systems were evaluated through triangulation of ecologic, economic and cultural-historical sustainability criteria. The economic aspect is represented through LCC considering the present value, as well as the follow-up costs and capital strain of rental income (Wohnfonds Wien, 2012). The ecologic impact is assessed through CO2 emissions for production (LCA) and operation phase (HED). The cultural-historical aspect is represented through the monument protection criteria defined by the office for federal monument´s guideline "energy efficiency on historic monuments" (National Heritage Agency, 2012). The façade systems ETICS EPS, ETICS MW and VIP are equally weighted (weighs: 1=highest score, 6=lowest score) concerning monument preservation, as exterior applications causing of the same impact on structured facades (Table 3).

Table 3. Façade systems, qualitative evaluation through weighing

Qualitative evaluation	Economic	Ecological	Cultural historical
Without TIM	6	6	1
ETICS EPS	1	2	4
ETICS MW	3	3	4
TIP	5	5	3
II	2	4	2
VIP	4	1	4

The evaluation is carried out with the help of a network diagram (weighs: 1=highest score, 6=lowest score) (Fig. 1). The results concerning sustainability are pictured as areas, where the façade-system with the smallest area has the best performance.

1. ETICS EPS (6.06)
2. II (8.66)
3. VIP (10.39)
4. ETICS MW (14.29)
5. Without TIM (20.78)
6. TIP (23.82)

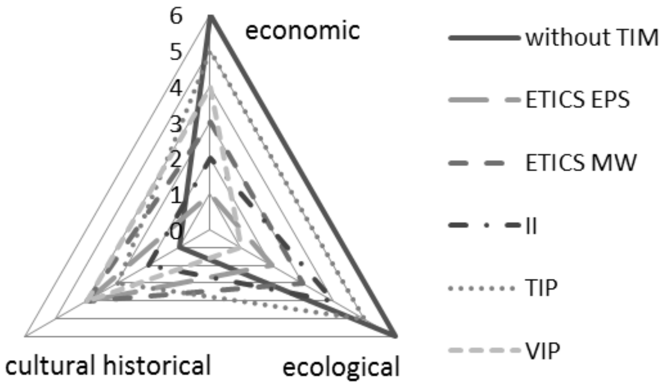


Fig. 1. Qualitative evaluation of façade systems

The evaluation of façade-systems in the context of thermal refurbishment shows, that the best performing variant is the ETICS EPS. Through largest potential for reduction of heating energy demand, both costs and ecologic impact (CO2 emissions) can be significantly reduced, however it must be noted that the data for removal and waste disposal of this material is not reliable. The variants based on exterior insulation of façades are, since 2012 according to the guidelines of the Federal Office for the Protection of Monuments (National Heritage Agency, 2012) not permitted. Only for the not protected parts of the building stock are these variants a feasible option. Already granted subsidies for refurbishments will be accepted by the Viennese Conservatory Department. Due to the requirement of monument protection, the façade system: Interior Insulation, satisfying this requirement and as the second best solution according to the network diagram (Fig. 1) is chosen for the further examination.

4. Evaluation of building-hull refurbishment variants

For the holistic refurbishment of the building-hull, several variants were compiled as abstract and simplified options to enable gaining insights on the potentials of the heating energy demand reduction and its impact on life cycle performance. For this analysis, economic (pay back periods of production costs) and ecologic (CO2 savings through HD-reduction in relation to the CO2 emissions of the refurbishment variant) amortization periods were calculated.
Variant (A) illustrates the existing building und serves as a reference value for the following different refurbishment variants and its savings potential.

Variant (B) represents a thermal refurbishment including the insulation of the topmost and the basement ceiling.

Variant (C) represents the existing building with an insulated façade only.

Variant (D) combines variant (B) (insulated basement and topmost ceiling) and variant (C) (facade insulation)

Variant (E) determines the impact of the windows-replacement only, as single measurement

Variant (F) is a holistic thermal refurbishment of the building-hull (insulated topmost and basement ceiling, façade insulation and windows-replacement)

The thermal refurbishment variants are based on following parameters concerning the insulation quality:

- The basement ceiling insulation is 10 cm, the topmost ceiling insulation is 20 cm exterior thermal insulation composite system XPS.

- The façade insulation is carried out as an interior insulation of the outside walls with 6 cm MW, vapour barrier, gypsum plasterboard and interior plaster only. The renewal of the exterior plaster is considered as well. The facade without interior insulation (ceiling, interior walls) has an approximate share of 20% of the whole façade area. Its heat transfer coefficient equates the existing outside walls without insulation.
- The existing wooden windows are replaced through windows with triple- high-value insulated glass and wooden high-value insulated window frames.

4.1 Potential of heating energy demand reduction: Energy Certificates

For the calculation of reduction potentials of heating energy demand (HED) the energy certificate calculation methodology according to the OIB (2012) was applied based on existing as-built planning documentation. The HED of the developed variants is shown in Table 4.

Table 4. HED (energy certificate) of developed thermal refurbishment variants

Refurbishment variants	HED (kWh/m2.a)
A: Existing building	127,32
B: Existing building – topmost ceiling and basement ceiling insulated	107,17
C: Existing building – facade insulated	107,51
D: Existing building – topmost ceiling, basement ceiling and facade insulated	87,36
E: Existing building – window replacement	119,57
F: Existing building – topmost ceiling, basement ceiling and facade insulated, windows replaced	79,61

The saving-potentials of the refurbishment variants in annual heating energy demand per m2 gross-floor area compared to the existing building are shown in Figure 2.

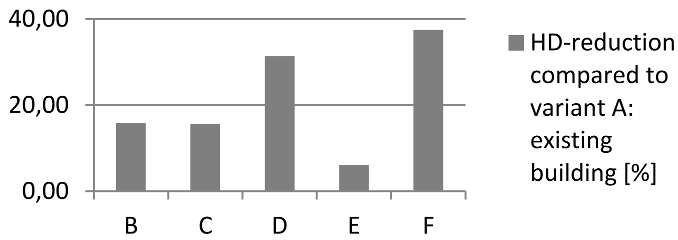


Fig. 2. HED savings potential

The weakest potential for HED reduction as sole measurement shows variant E - replacement of the windows, through improvement of approximately 6%. Variant C - the refurbishment of façade, with the greatest share (~60%) of the building-hull, and the Variant B - insulation of the topmost and basement ceiling show the same potential of HD reduction of 15%. A holistic thermal refurbishment, Variant F, shows the highest HD reduction potential up to 37%. These figures are only guidance values, which have to be seen with a range of fluctuation. The real potentials are depending on the state of repair and refurbishment quality. Therefore a specified database (call for bids) is necessary, but not available.

4.2 Energy supply

The greatest challenge for the ecologic assesment is the lack of data, including the information on number of reference housing units supplied with gas or district heating (DH). A GWP assesment was based on HED calculations (OIB, 2012) for three cases for emissions-assesment related to the energy supply – for only gas supply, only district heating and a proposed mix of 50% gas and DH (Table 5). The three cases represent the theoretical energy supply scenarios in the housing units, since the tenants of the social housing are not obliged to transfer to the new heating system, despite the renewal, so often there are several energy systems in use one single building.

The maximal reduction of 70% of the annual CO2 emissions is achieved with variant A (no measurements) by changing the heating system from gas to district heating (Fig. 3), due the trifold GWP of gas if compared to the DH.

The minimum of CO2 emissions is caused by the Varinat F (holistic refurbishment) supplied by DH.

Table 5. GWP for different energy supply systems and refurbishment variants

Refurbishment variants	A	B	C	D	E	F
Heating system			GWP [CO2 Equ. kg/a]			
Gas	**264 959**	223 026	223 733	181 800	248 831	165 672
DH	81 958	68 987	69 206	56 235	76 969	51 246
Gas/DH (50%)	173 458	146 006	146 470	119 018	162 900	**108 459**

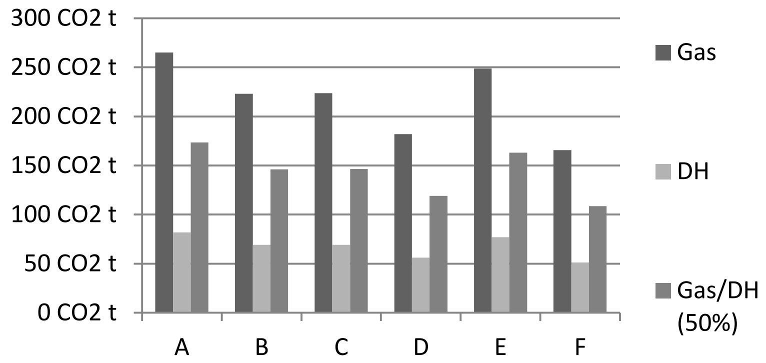


Fig. 3. GWP for different energy supply systems and refurbishment variants

4.3 Ecological pay back period

The GWP of refurbishment variants was assesed for the life-cycle phases: production (cradle to gate), operation (energy demand depending on the energy supply) and demolition (end-of-life). Baubook database (Baubook Eco2Soft, 2013) was used for determining the GWP caused by the production of plasters and windows; and Ökobau.dat database (Ökobau.dat, 2013) for the production of mineral wool, vapour barrier and the gypsum plaster board. The end-of-life of plaster, mineral wool and vapour barrier is determined with the database Ökobau.dat (Ökobau.dat, 2013). The phase service and maintenance during utilization and removal were not considered due to the lack of information. The GWP of heating energy was quantified by the means of conversions factors (OIB, 2012) depending on the used heating system gas, district heating (DH) and a combination of gas and district heating with a share of each 50%.

The employed heating system has the largest impact on the reduction of CO2 emissions for refurbishment variants with equal HED, since gas produces triple GWP than the same amount of energy demand covered by district heating (Fig. 3).

The heating energy system has also the biggest impact on the ecological pay back period - the impact of refurbishment on the GWP-reduction with the variants using energy types with high GWP (such as gas) is much stronger than on DH significantly shortening the ecological pay back period - app. 2 yrs. for gas, whereas 5 yrs. for HD (Fig. 3).

Table 6. Ecological (GWP) pay back period

Refurbishment Variants	II (cradle to gate + removal) [CO2kg/ 100 J.]	Annual reduction GWP HD (Gas) [CO2 kg/a]	Pay back period (Gas) [a]	Annual reduction GWP HD (DH) [CO2 kg/a]	Pay back period (DH) [a]	Annual reduction GWP HD (Gas/DH) [CO2 kg/a]	Pay back period (Gas/DH) [a]
B	65.564	41.933	**1,56**	12.971	5,05	27.452	2,39
C	70.512	41.226	1,71	12.752	5,53	26.989	2,61
D	136.076	83.159	1,64	25.723	5,29	54.441	2,50
E	21.566	16.128	**1,34**	4.989	4,32	10.558	2,04
F	157.642	99.287	1,59	30.712	5,13	64.999	2,43

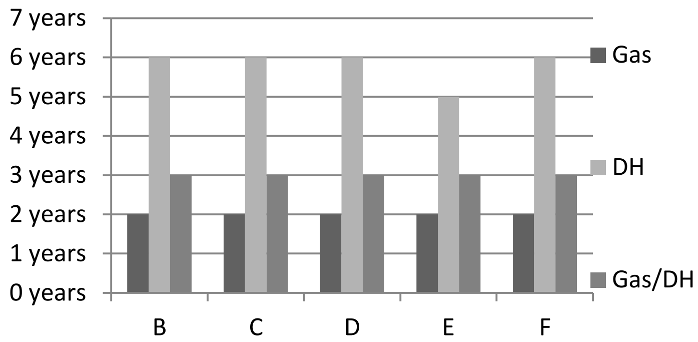


Fig. 4. Ecological pay back period of different energy supply systems (Gas, DH, DH/ Gas)

4.4 Economic pay back period

For calculation of the economic pay back period the production costs of refurbishment variants were compared with the reduction of heating costs caused by the thermal refurbishment. The production costs were determined using the software Legep (Weka Media, 2012), the direct labour costs per unit for gas and district heating were gathered from Wien Energie (Wien Energie, 2013). Nominal cost values were chosen because gas with a higher price per kWh (Wien Energie, 2013) generally has shorter pay back periods than the district heating system.

Compared to the ecological pay back periods, the economic are obviously longer (Fig. 4 and Fig. 5). Not only are the periods longer, but the ecologic and economic evaluation display differing results. In the economic evaluation, the shortest pay back period of 16 years shows the Variant B (insulation of top and bottom cieling) using gas; where as the Variant E (renewal of windows) using DH displays the pay back period of 144 years which is economically not feasible. Not so in the ecologic assesment

– there the Variant E displays the shortest pay back period of only 1,34 yrs.; the second best is the Variant B with 1,56 yrs. pay back.

A window-replacement integrated in a holistic thermal refurbishment (Var. F) which in general displays the lowest annual GWP also creates better economic pay back periods.

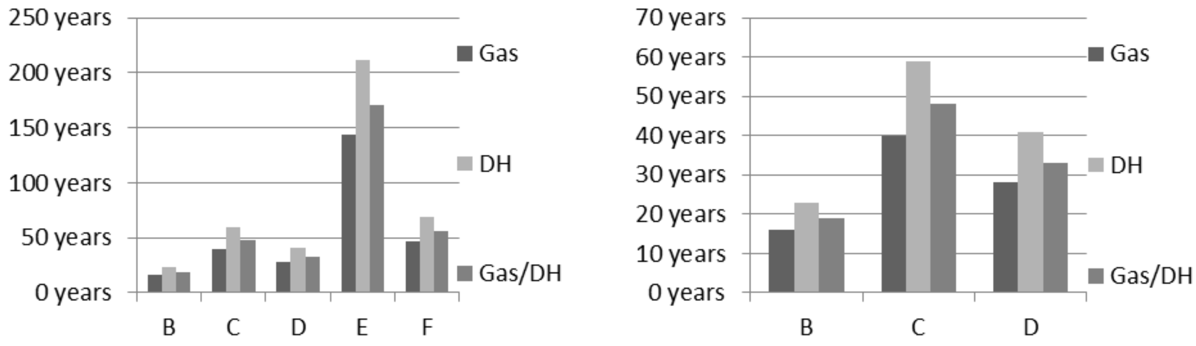


Fig. 5. Economic pay back period of different energy supply systems (production costs/ reduction heating costs)

Table 7. Economic pay back period

Refurbishment Variants	Production costs [€]	Annual reduction heating costs (Gas) [€/a]	Pay back period (Gas) [a]	Annual reduction heating costs (DH) [€/a]	Pay back period (DH) [a]	Annual reduction heating costs (Gas/DH) [€/a]	Pay back period (Gas/DH) [a]
B	170 256	11 016	**16**	7 463	23	9 240	19
C	432 604	10 830	40	7 337	59	9 084	48
D	602 861	21 847	28	14 799	41	18 323	33
E	607 032	4 237	144	2 870	212	3 554	171
F	1 209 893	26 084	47	17 670	69	21 877	56

5. Comparative study of the refurbishment variants using EPS and interior insulation

The current refurbishment practice of existing housing stock, despite the monument protection, is the application of EPS-core based ETIC systems due to the low innitial costs. Since Wiener Wohnen is a non-profit asset manager, the lowest investment costs is the crucial parameter in decision-making process. In order to clearly identfy the differences in the performance of II versus ETICS EPS facade-system, a comparative study of economic and ecological pay back periods of the building-hull refurbishment variants using II and ETICS EPS of was carried out.

5.1 Energy supply

The higher HED related to the façade refurbishment using II results in higher ecological impact compared to the respective version ETIC EPS. The additional GWP caused by the higher HED of façade system II ranges from 53% (Variant C) to 83% (Variant F) using different energy sytems, as presented in Fig. 6.

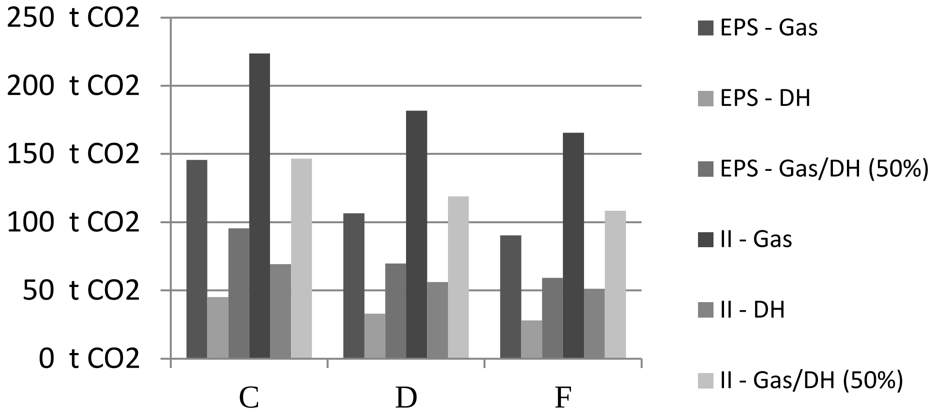


Fig. 6. GWP for different energy supply systems and refurbishment variants for II and ETICS EPS

5.2 Ecologic pay back period

The by 65% higher HED of II facade-systems cannot be neutralised by a better II performance of 40% during the life-cycle phases “cradle to gate and replacement”.

As a result, the pay back periods of II facade-system based variants are prolonged for 1 year (Gas and Gas/DH) and 2 years (DH) as Fig. 7 shows. Only the refurbishment variant D (insulation of topmost and basement and facade) using gas; or the variant F (holistic thermal refurbishment) using gas do not increase the pay back period (Fig. 7).

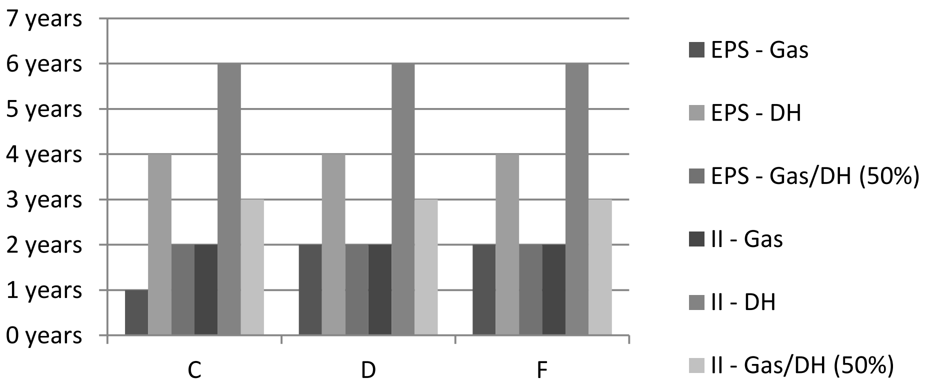
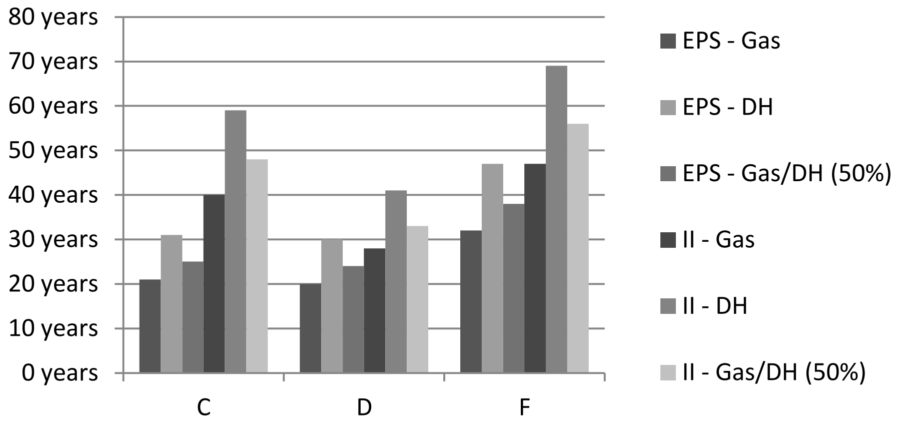


Fig. 7. Comparison of Ecological (GWP) pay back period of different energy supply systems (Gas, DH, DH/Gas) and refurbishment variants for II and ETICS EPS

5.3 Economic pay back period

From the economic point of view, if compared to the ETICS EPS, the II has the higher heating costs (65%) caused through the higher HED. The economic pay back periods are therefore prolonged, depending on the refurbishment variant (Fig. 8). With variant C and the changing of the façade system from ETICS EPS to the II, the economic pay back period increases up to 90% depending on the employed heating system (Fig. 8). Variant D reaches a raise of 37-40% (Fig. 8). In Variant F the holistic thermal refurbishment with II causes an increase of the economic pay back period of 47% compared to the respective version ETICS EPS (Fig. 8).



5.4.

Fig. 8. Economic pay back period of different energy supply systems (production costs/ reduction heating costs), refurbishment variants for II and ETICS EPS

6. Social sustainability – potentials for assisted living through structural refurbishment

In order to determine the potential for assisted living in the existing stock to meet the demands of ageing society, the LCC for the structural refurbishment necessary for enabling of assisted living were compared to the expenses of the public authorities for various nursing services (Federal Ministry of Labour, Social affairs and Consumer protection, 2011). The life-cycle costs caused by a structural refurbishment (floor plan changing measures for accessibility, installation of stair lifts) on the ground floor of the referential object (13 apartments, inhabited gross floor area of 1. 474 m2, initial costs of 350m2/GFA) can be determined with a value of € 650.893, using Legep-Software. The annual gross expenses of the public authorities for various nursing services (Federal Ministry of Labour, Social affairs and Consumer protection, 2011) are shown in the Table 8.

Table 8. Nursing expenses

Nursing services	Gross expenses of public authorities [€]	Looked after persons	Annual costs per person [€]	Accumulated costs over 50 years [€/p]	Costs over 50 years for 13 apartments/ persons [€/p]
Mobile care services	470 133 325	127 891	3 676	183 802	2 389 431
Inpatient care services	2 121 480 105	71 798	29 548	1 477 395	19 206 135
Day care centres	23 091 331	4 564	5 059	252 973	3 288 643

Assisted living	147 485 564	10 806	13 648	682 424	8 871 517

The comparison of the life-cycle costs concerning a structural refurbishment with the gross expenses of the public authorities points out that nursing expenses are a multiple of the life-cycle costs caused by a structural refurbishment for accessibility in an existing building. The nursing costs itself differ widely. Inpatient nursing homes cause minimum the double costs of assisted living. As a result the installation of assisted living in existing building stocks can save nursing costs and creates a high economic and ecological benefit compared to the new building of nursing homes. According to information of Wiener Wohnen the cost-efficient operation of assisted living requires 10-20 connected apartments (Nowak, 2011; Silver Living, 2012). For this aspect assisted living in small buildings is only realisable, if the whole building is barrier-free designed. A requirement is an existing elevator or a subsequent installation. Assisted living only in apartments on the ground floor in small residential buildings without an elevator is realisable if the small residential buildings are located near a nursing institution.

7. Conclusion

In the presented research the life-cycle oriented refurbishment strategies for a specific housing block of Red Vienna have been developed and evaluated, not only according to the criteria of energy-efficiency and CO2 minimization, but more over to comply with cultural heritage and social needs such as aging society.
Thereby LCC and LCA combined with cob-web diagram sustainability criteria (LCC, CO2-emissions, cultural-historic) grading were carried out, in order to determine most sustainable facade-system, which was then used for the evaluation of the building-hull refurbishment variants. The façade-variants with low potential of HED reduction (without TIM, TIP) have, despite the positive sustainable performance in production and maintenance phases, high economic and ecological life-cycle impact (cumulated over 50 years), which cannot be neutralised by the positive evaluation concerning monument conservation. In terms of lifecycle costs and achieved energy- and CO_2 savings the ETICS EPS refurbishment variant shows the best performance over the period of 50 years, however is not compatible in terms of monument protection. As alternative, the interior insulation, causing higher ecological impact (53% more GWP than ETICS EPS as a sole measurement) and higher skills in application, can be taken in account. Finally, the ecologic and economic pay back periods of the thermal building-hull refurbishment based on ETICS EPS was compared to the one based on II.
Since the largest energy consumption occurs during the operation, the most preferred measure is the holistic refurbishment of the complete envelope – Variant F, through the highest heating energy demand reduction of 37% when comparing to the existing state, but also through the lowest annual CO2 emissions. Aside from the thermal building-hull refurbishment, the greatest ecological impact has the change of the heating system from gas to district heating. Only through change of gas to district heating energy supply the annual CO2 emissions can be reduced by 70%.
The results generally comply with the literature, stating that major percentage of energy consumption occurring through operational phase (Cuellar-Franca and Azapagic, 2012, Kesicki 2012) can be cost-effectively reduced through various conservation measurements and increase of district or biomass heating and warm water preparation.
The economic and ecologic amortization show diverging results – ecologic pay back periods are in general much shorter (1,3 – 5,53 yrs.) whereas economic payback periods range from 16 to 212 years. In terms of ecologic pay back the Variant E (window-replacement) using gas displays the best performance of 1,34 years; whereas in the same case, the economic pay back is 144 years due to the very high production costs, and few savings in the operation.
Neglecting the windows, the refurbishment Variant B (insulation of topmost and basement ceiling) using gas displays the best ecologic and economic pay back periods of 1,56 respectively 16 years.

However, Variant B can contribute to the improvement in HED by only 15% when compared to the existing state, and causes 35% more CO2 emissions when compared to the best performing Variant F using gas, or even four times more than the Variant F using district heating.
When comparing the interior insulation with ETICS EPS façade-system in different refurbishment variants, it can be concluded that despite the fact that II has better performance in phases "cradle to gate and replacement" by 40%, due to the higher HED throughout the lifecycle the ETICS EPS reaches better economic and ecologic amortization –in the best performing variant F both economic and ecologic amortization periods are app. 50% shorter.
Finally the study shows, that the economic and ecologic interests diverge, and that incentives are necessary for the implementation of long-term oriented strategies in terms of climate protection or protection of cultural heritage. The study has limitations – instead of the static calculation of economic pay back periods of production costs, a dynamic LCC simulation should be carried out, which is currently difficult due to the lack of reliable data, but is intended in future research.The study implies on large potentials of existing stock for care at home, instead of much more cost intensive institutional care; reinforcing the value of stock as social capital.

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THE INFLUENCE OF COMMUNICATIONS AND OTHER SOFT SKILLS IN THE INVESTMENT PROCESS*

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Abstract

Generally soft skills are called so because they can't be measured. In building industry we can indirectly measure it but only with negative values as defects, backlogs, the number of accidents at work or very obviously - collapsed building. So we can say that relationship between all parties in construction process is not based only on contracts, but on communication level too. Very important is effective communication including feedback. In the article there will be focused list of tools used by good manager, including effective communication, motivation, understanding of the goals and attitudes.

Keywords: Soft skills, communication, management, participant in the construction process

* The complete text is available on CD-ROM / Kovarova

Introduction

Do softskills affect the strength of construction? This question, answered by site managers respondents, has three typical responses:

a) George fell down from scaffolding, concrete hardens in a remote truck mixer and the company *CHEAP DESPERATE MAN* supplied T profile instead of I profile – what was the question?
b) No, I do not know what you're asking.
c) Yes, there where it is missing the building site is flooded with JAM

2. Softskills

Soft skills gained its name because the psychologists cannot measure them. Though in building industry they are measurable, especially in the negative values by the level of defects, backlogs, exceeding the budget, illness of employees, the number of accidents at work and very clearly - collapsed building.

The building is not only built out of concrete and steel, these only put the building together (among other materials). It is created mainly by people and their relationships to the construction site and among themselves. Creating and managing relationships solves softskills.

First of all, effective communication: everybody can speak, occasionally someone listens. But transferring content in its full extent is no longer just an intuitive skill. It requires knowledge and training. In a typical situation from the beginning of the type a) stands a specific person, the manager, who thought well out the logistics of the site and gave specific instructions. He just didn't realize that his workers can absorb only about 10% of what he said due to his tricky expression, and has no idea that he could and should use feedback. Due to this problem another bad building arises and stressed builders who are so typical for this challenging field. Therefore, having the hard skills is not enough - such as knowledge of logistics, properties of building materials, etc. - but we cannot do without basic management instruments:

- Effective communication,
- motivation of himself and others,
- understanding the goals and attitudes of its own - self-reflection,
- understanding the goals and attitudes of their colleagues - empathy,
- the ability to align their surroundings and themselves with the stated goal – teamwork,
- the skill to lead (leadership) and to be led,
- ability to listen and understand,
- take risks and tolerate failure,
- crisis management and conflict,
- negotiation skills,
- diligence,
- ability to make decisions and work under pressure,
- willingness to learn,
- maintaining performance
- directed thinking: structural, business, critical, analytical, synthetic, conceptual, creative, complex,
- openness and truthfulness.

Softskills are facing a problem of being taught and transmitted - it does not make sense to memorize them or require their knowledge by testing managers, because by themselves softskills are empty terms. Content is fulfilled in use. The name reveals it - skills are not identical with knowledge. Nonetheless, we can begin to practice these skills regularly and meaningfully.

To learn softskills experiential learning (experimental education) can be used for its high efficiency. David Kolb's research shows that 80% of our knowledge comes from what we experience ourselves and subsequently revise in our mind to generally applicable knowledge that is stored deeply in our mind. Quantitative data resulted from the research of IBM and UK Post.

	Acquired knowledge		
	Communication	Communication by sample	Communication by sample, by experience
Remembered after 3 weeks	70%	72%	85%
Remembered after 3 months	10%	32%	65%

Tab. 1 – Results from the research of IBM and UK Post

Rehearsed skill anchors to the story which participants play - experience. From this lived experience an applicable experience is anchored in to the memory by hindsight analysis (review), where the instructor transforms into facilitator and helps participants create usable memory structure by using three lines of simple questions:

- **What** we have experienced?
- **Why** do we react in a given situation this way?
- **How** can be this reaction converted into common processes in the company?

Experiential learning also allows without risk and loss test newly implemented management models or change roles in a team in a safe environment allowing looking at your own reactions and decision steps with the passage of bringing rational view (Kolb, Fry, 1975).
To hand softskills over an environment without assessment is suitable - emotionally calm environment. Unlike conventional teaching teacher does not have the formal authority as someone who communicates knowledge and the student passively receives that knowledge. The lecturer is a guide through client's mind in which the client actively transforms experiences into knowledge.
To sensory learning belongs mainly: hard preparation and personally mature trainer whose results will hold up in a business environment where the cost of education is expected to be measurable in business results.
Another effective form of training is coaching, which is now commonly used by middle management level. Works with real storyline in the company, which the coach observes, ranks in the structures and helps to find client´s view of this structure and the tools to deal with it. It searches for client´s strengths and helps him develop his skills.
Third, but not last option of effective development of softskills is an individual work or essay based on personal development and learning about own personality.
On the very top of the list of softskills stands effective communication; because without agreement no work can be done.

3. Effective communication

Prerequisites for effective communication are internal:

- If we want to lie, we do not want to communicate, but to manipulate.
- If we are not sure about ourselves, or our real and declared aims diverge – we do not communicate with partner, because we either talk or we are preparing next speech.
- If we evaluate partner´s communication, we do not communicate, because we do not hear what he tells us.

In the construction industry we often reduce "communication" to mere communication of information.
Even simple communication can be significantly improved through training feedback (Svatoš, Lebeda, 2005).

General definition:

"Feedback = situation or mechanism when the output of the system affects back its entry"
Improves communication process and prevents excessive loss.

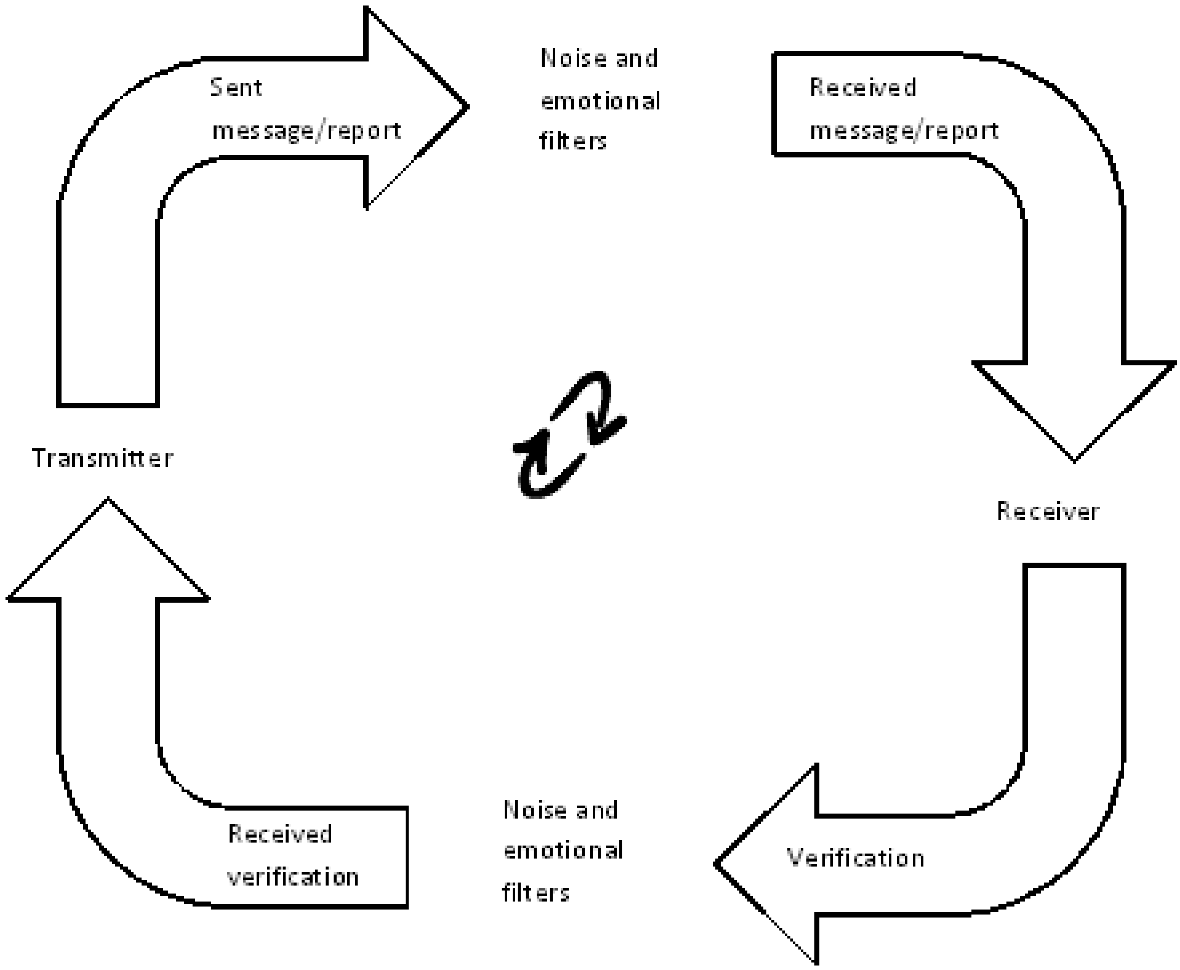

Fig. 1: Transmission of information with the feedback loop

Responsibility for communication is double-sided.
"Transmitter" is responsible for:

- Confirmation of the capacity of recipient before communication,
- accurate "coding",
- focus on news broadcasting,
- to verify that the message was passed on.

"Receiver" is responsible for:

- Signalization of capacity for receiving or being overloaded,
- concentration for decoding,
- active verification of the passed report.

Techniques:

- Questions,
- paraphrasing,
- verbalization of feelings,
- summarization.

4. Verification techniques of understanding

Best practices rules:

- Do not interpret, do not evaluate, and do not judge, do not agree or disagree.
- Just make sure that you understood well.
- Only after that supply your own idea!

Questions for checking understanding:

- "Do you mean ....?"
- "Do I understand you well if you say ....?"
- "Please correct me if I understood you well ... you mentioned that ..?"

Paraphrase (verbal reflection) – means to repeat the same or similar words the essence of what was said. Finally, you can connect the authentication question. This facilitates understanding.

- "So you're saying that ... (is it?)"
- "You just said that ... (Do I understand you correctly?)"
- "So your opinion is ..."

Verbalization of feelings (transfer feelings in words):

- "It sounds like you had fun of it / it bothers you ..."
- "I do not think you were satisfied with ..."

Summarization – summarizing:

- "So the main point that you have in mind ..."
- "So what you said can be summarized as follows ...."
- "So it can be briefly explained in points as follows: ..."
- "So overall ..."
- "I'll take two of the most major points ..."

Conclusion

The construction industry, as we see it today, ignores softskills significantly, we especially see substitution of real communication by directive multistep procedure without feedback to the people on the front line, which leads to the loss of basic experiences and knowledge passed on among people - crafts, relationships, risk management, real time schedule - and replaces them with business conditions, theoretical models and even wishful thinking of management. In this area, often training in softskills is considered as time-wasting. On the other side in daily practice we see unnecessary time and material losses caused by lack of softskills and communication failures. To ensure the implementation of these trainings in company operations makes sense it is needed to pervade the whole company, including its owners. In subsequent work after company training we hear that their communication has improved and accelerated but top management does not want to communicate with us better. During softskills training implementation in companies it makes sense to work with the method of sharing information in the company towards opening their flow.

A pleasant exception are family businesses or new emerging phenomenon free company where information flows freely - they are not owned and used for internal fight for positions, where working position and competencies vary from case to case, and the company is held together by common goals, rather than a solid structure. Their domain is often IT, in construction industry rather smaller specialized suppliers - for example in the field of high-rise works.

Application of softskills training into educational system would be beneficial to the building industry itself but to graduates from building engineering schools as well (Popelka, 2011). Softskills training can be achieved by the help of lecturers with practical experiences in building industry as well as by collaboration among students from different study fields.

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POTENTIAL FOR EXPANSION OF BIM TECHNOLOGY IN SLOVAKIA*

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Abstract

BIM is currently the most common name for a new way of approaching the design, construction and maintenance of buildings. It has been defined as “a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle” (Bryde et al., 2013). The submitted study deals with the level of awareness of BIM technology in Slovakia, which provides construction design solutions in building intelligent 3D-BIM model, based on the information. It analyzes the extent of the use and limitations in advancing the development and application of this technology among architects and designers who are the most important working positions in the process of construction projects. The survey is process through a questionnaire. Its significant is an objectively creating a background of knowledge and the level of use of this progressive technology in Slovakia. The survey has been realized by the researcher of Civil Engineering Faculty, Technical University of Košice in year 2012.

Keywords: construction design, BIM technology, potential

* The complete text is available on CD-ROM / Kozlovska, Spišakova, Petrik

Introduction

Currently, there are increasing demands for more effective planning and design of constructions. We can use a wide variety of design software that simplifies the process of designing, thereby reducing of the project preparation and increasing the quality of construction project. It also allows to quickly and relatively easily implementing the changes in the construction projects. On the other hand, the demands of investors are increasing and the process of design is necessary to improve. There is an increasing emphasis on communication among the construction participants (investor, designer, constructor, suppliers, etc.). After many years of development of various software used in construction was created a new technology - Building Information Modelling (BIM) that is becoming increasingly widespread. BIM leads to more effective work and its simplification, allows the outputs in 2D and 3D, more interactive links between of ground plans, sections, views and tables (Sabol, 2010). Based on this connection, we are able through the BIM to describe the model of building with all needed information in almost fully consistent with the reality. The aim of this paper is to assess the using of this innovative BIM technology of design in Slovakia.

1. Potenctial of BIM technology for preparation and realization of construction

In the present, the term "Building Information Modelling" (BIM) is appearing increasingly, although the concept of computer simulation with the maximum emphasis on information about construction began to create much earlier. The concept of Building Information Modelling was first proposed by Professor Chuck Eastman in 1975 in the Journal of American Institute of Architects (AIA) as "Building Description System" (Dzambazova, Krygiel, 2010). In the mid-eighties, this concept was developed parallel in the USA and Europe. The USA used the term "Building Product Model", Europe used "Product Information Model". We can assume that term "Building Information Model" was created by the linguistic unification of these two names. This term was first appeared in literature in 1992. In 1986, Englishman Robert Aisha, as a creator of program RUCAPS, first used the term "Building Modelling" in the meaning, as we understand the concept of "Building Information Modelling" today. Moreover, he formulated the basic principles of BIM as a tool for three-dimensional modelling, automation of construction drawings design, creating of construction objects databases, construction schedules, etc.. Robert Aisha presented a new approach to comprehensive modelling during the reconstruction of Heathrow Airport in London. This is the first use of BIM for the real realization of construction (Kozlovská, Sabol, 2010).

1.1. Digitizing of construction solution

Nowadays, we understand the BIM as a digital process, which American Institute of Architects defines as a model based on new technology which is connected with the database of project information. Thus, it is a modelling and documenting that are characteristic by creativity and use of coordinated, internally consistent information which describe a construction project from design, realization to final form (Suermann, 2010). BIM offers a unique opportunity to create a model that is used in various fields given the possibility of integrating of various construction components, including the building geometry, special elements, quantity and the characteristics of materials into the complex parts. We can have all information and knowledge connected with one project that is shared from one database and provides the information about various fields.

BIM presents the processes and methods of design and construction during whole construction duration. It is a platform for information sharing and communication among the project participants. The BIM usage allows us to view all phases of construction process: from the design to pre-construction project, the particular construction process, even to post-construction projects. BIM is

based on the sharing of information by the engineers, architects, building managers and subcontractors. The building managers and subcontractors by the BIM model can specify the methods and volume of construction works during the mutual meeting (Pavan et al., 2010). In addition, the project managers can create the construction drawings, coordinating management plans, plan costs or estimate the construction duration by the use of building model.
The model BIM includes the planning, scheduling and coordination of construction in time and space during the phase of virtual model. The schedule is created by the time valuation of individual elements of virtual construction what presents a fourth – time dimension of 4D modelling (Hergunsel, 2011). This 4D-BIM model can be used as a visualization tool for the identification of safety risk which can occur at different time of construction. Based on this knowledge, the safety elements can be post-modelled in the BIM environment and integrated into the projects. The spatial and time modelling 4D-BIM can be used to improve the planning and monitoring of safety on construction site (Collins, 2011).

1.2. Problems connected with the extension of BIM technology

Based on the experiences of other countries (mainly the USA), we can claim that the transition to BIM technology is not matter only an upgrade of software, but requires a certain organizational changes in the project team (Post, 2010). This structure is generally presented by the roles of architects, engineers, modellers and designers (their formal and objectively position is not quite the same as the professional roles in our environment). Firstly, the architects and engineers are the key people who have the most experiences and knowledge in the field of design. Their task is to design the construction, to create a shape and construction details, to comply with the standards, to manage of design and results of project. The second level of employees is "modellers". Their task is to create an information model. Therefore, they should well understand the construction problems and can use software needed for the BIM technologies. They are considered as the main employees of project. The third level of employees represents the designers who have to develop the project documentation. They use the BIM model as a base for the all needed information.
It follows that the extension of this technology is decelerated by all chronic causes that prevent the implementation of most new technologies, such as conservatism, conservation of traditional roles, lack of motivation, narrow mentality of professional communities or competing commercial interest vs. non-commercial system and sharing knowledge.

2. Survey focused on the use BIM technology in Slovakia

The main activities at acceptance of new methods and technologies have to be awareness, knowledge of its effectiveness, good examples and education. The purpose of this submitted survey was to determine the level of awareness about particular technology, especially in the group of people who have to active use these technologies – architects and designers. The questions are directed at those who are users of BIM technology, but also to those who do not know this technology. The survey also creates the assumption for first or second group to expand their knowledge about the benefits and the potential barriers of this technology usage.

2.1. Methodology of survey

The target group consisted of the firms or experts who dealing with the design of civil engineering, road engineering, hydraulic engineering, structural and MEP systems. The survey was conducted by questionnaire. Within the description of target group of respondents was analyzed a time of design work, focus of firms, location of firms and type of used software. Subsequently, the questionnaire was divided into two branches, according the fact that the company designs through BIM platform.

The filling out of the questionnaire did not take more than 5 minutes. The question was created by the multiple choice answers. The respondents could also add own answer. The questionnaire was distributed by e-mail to design firms from Slovakia. They filled out the submitted questionnaire and sent it back. Questionnaire was sent to 300 companies. The 62 companies was attended to the questionnaire survey, it present almost 21%.

2.2. Results of survey

The results in the field of participating respondents according their activity (fig. 1) were expected because the design and construction process of civil engineering is the most widely used. The participated firms which deal with urbanism, road engineering, hydraulic engineering and MEP systems were significantly lower. Due the expanding of road infrastructure in Slovakia, we expected greater participation of road engineering designers.

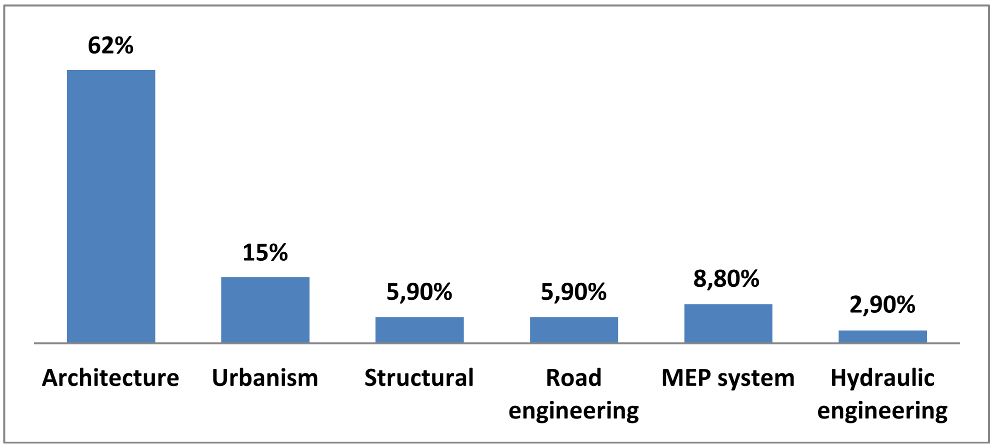

Figure 1: The main activity of the respondents participating in the survey

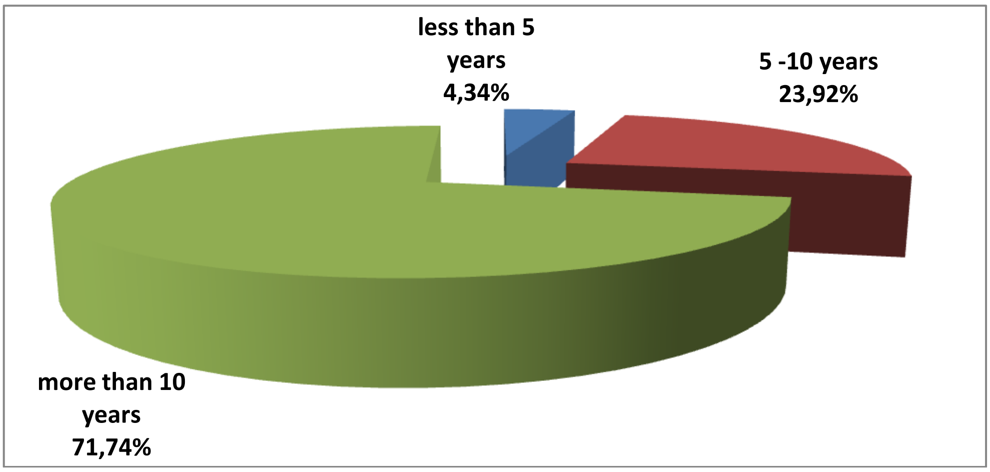

Figure 2: Length of participants design practice

We suppose that the traditional system of designing is difficult to change in terms of design practice length (fig. 2) and the results relating to use of BIM technology in Slovakia (fig. 4).
The designers, who long working in the same stereotype, do not need to design through BIM technology. Certainly, the lack of time for the adoption of new technology has a considerable importance for unwillingness to adopt the new approaches. On the other hand, the designers, who

design less than 5 years, have a potential to use BIM technology. They are younger and they know the new technologies from schools.

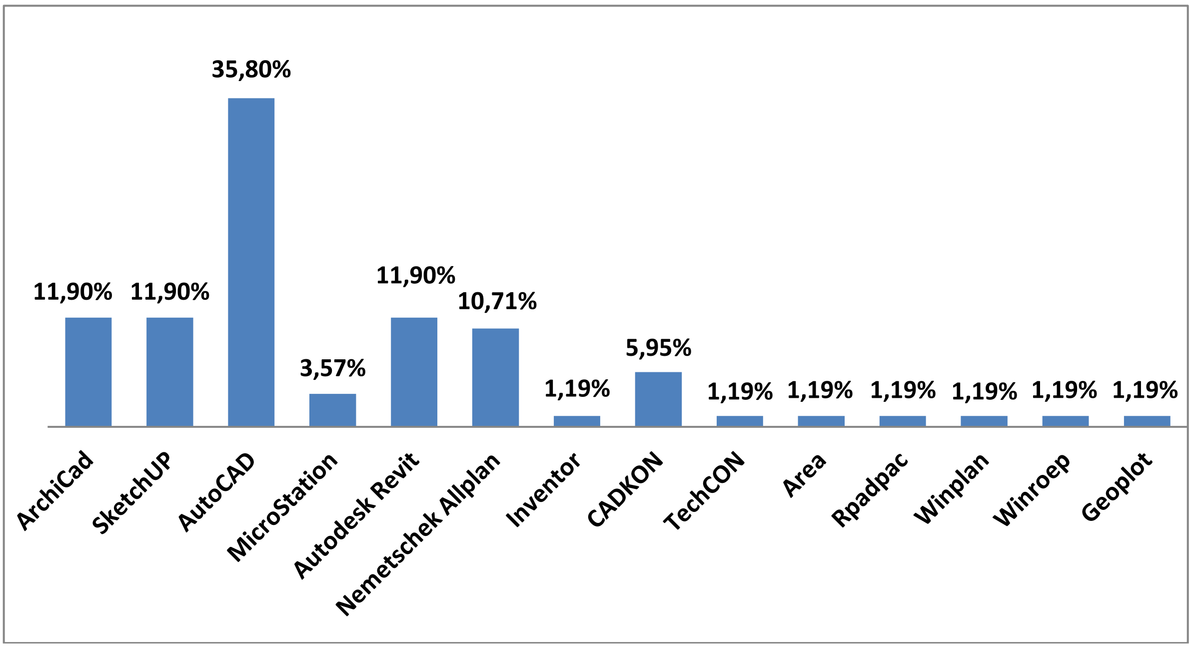

Figure 3: Usage of software for designing

Figure 3 shows the percentage of particular software used for the design of constructions. The survey results determine software – AutoCAD as the most used software by Slovak designers. Given that this software began to use in 2D CAD as first, it was also expected result.

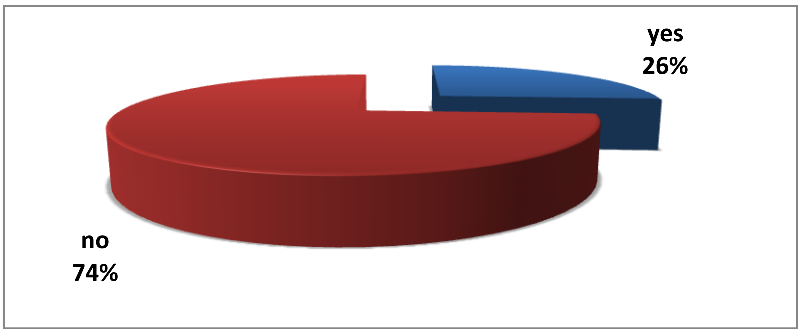

Figure 4: Usage of BIM platform for designing

Figure 4 describes the percentage of design based on the BIM platform. It presents a milestone of questionnaire where the following questions are divided into 2 groups – for the respondents who use BIM technologies and who do not. The figure 4 shows that only 26% of designer use a BIM environment which is quite a low number of participants. On the other hand, 76% of respondents do not use this BIM technology. According this result, there is a potential for expansion of BIM technology during design activities.

After this question, the questionnaire is divided into two parts – for the users of BIM technology and respondents who do not use the BIM. For both case, the responses are expressed as a percentage of the total number of respondents in particular groups. The answers of BIM users are shown in table 1.

Table 1: Responses of BIM users

Length of BIM use	
more than 3 years	85%
2-3 years	8%
less than 1 year	7%
Percentage of projects created through BIM	
more than 60%	58%
30% - 60%	9%
less than 30%	33%
Fields of the most BIM usage	
construction solutions	36%
conceptual design	27%
reinforced concrete structures	13%
MEP systems	9%
steel structures	6%
timber structures	6%
other	3%
The main benefits of BIM	
effective work	36%
better quality of construction projects	29%
compatibility of the project processed in BIM	18%
organization of work in BIM	14%
other	3%
The barriers for the implementation of BIM	
significant financial costs for implementation of BIM to the practice	47%
need of training for employees work in BIM	32%
incomprehensibility of outputs	21%
other	10%

These responses can be summarized in the following results:

- the majority of respondents – BIM users (84,61%) use BIM technology more than three years,
- the designers who begin to work by the BIM platform will stick on it,
- almost 59% of designers (BIM users) use the BIM as a tool during more than 60% of their work,
- the main benefit of BIM technology for Slovak architects and designers is more effective work and better quality of construction projects,
- the biggest barrier for the implementation of BIM into practice is the significant financial costs for it.

The need of the finance for the implementation of BIM into practice has two points of view. The designers, who have designed for many years, will need to invest to finance for the implementation of BIM to their practice. On the other hand, the BIM technology can save a large amount of money. BIM is able to avoid the mistakes in construction projects, conflicts during the realization of construction or insufficient list of materials, machineries, etc.. The second case is the young designers or the graduates who are going to buy new software. There the price of BIM software is not important, because the price of traditional 2D CAD software and software based on the BIM technology is almost the same.

The answers of respondents who do not use a tool BIM are given in table 2.

Table 2: Answers of respondents who do not use a BIM

Do you know the concept BIM?	
yes	50%
no	50%
The reason for disuse BIM	
they use and are satisfied with other software	40%
they do not know BIM	25%
they do not have the employees who can use this software	20%
they use other software and do no have enough finance for implementation of BIM	15%
The main barriers for the implementation of BIM	
price	53%
difficulty of use	34%
software availability	13%
Do you plan to begin the design through BIM?	
yes	78%
no	22%
Can BIM make more effective your work?	
I do not know	69%
yes	19%
no	12%
Are you interested in training of usage BIM technology?	
no	60%
yes	40%

The purpose of the first question “Do you know the concept Building Information Modelling?”, was to find out whether the architects and designers know the concept BIM and use the BIM technology. The result was that only 50% of Slovak architects and designers know the concept Building Information Modelling. This number is alarming. This number can be an indicator in the field of architecture and designing in Slovakia and in issue of modernizing and creating of conditions for better design which are provided very slowly.

Another question was focused on the respondents who know BIM, but do not use it for design. According the answers, the architects and designers use other software and are satisfied with its. This is the biggest reason why they do not use the BIM technology. We assume that there is lack of information about BIM technology because BIM has a huge usage and benefits for designers.

In the groups of architects and designers who do not use BIM, the main barrier to working with this environment is its the price. As mentioned above, this argument is relatively. 79% of respondents answered that they will not change the used software and will not use a BIM technology. The result is surprising, but considering the ignorance of BIM technology benefits, it is acceptable. We also expected that the respondents did not know the benefits of BIM technology usage – the effective work. It was confirmed. This answer indicated even 67% of respondents. They do not know BIM, so they cannot benefits of BIM for their practice.

Last question in the questionnaire was related to architects´ and designers´ interest in training where will be presented BIM technology. 60% Slovak architects and designers, who are not users of BIM, are not interested in training in this issue. Only 40% of them would participate in training about BIM. This result can by largely connected with the result that 40% respondents are satisfied with their current software. The reluctance to learn other, more effective technology can be an indicator that many Slovak architects and designers do not have the willingness to next education and modernize their design process.

Conclusion

The submitted paper, based on the questionnaire survey, analyzed the usage BIM technology in Slovakia and points to level of information about this technology. The paper was also aimed to stimulate the interest of designers in new, more progressive and more effective technologies which will support its work. Despite of all benefits of this technology, only a quarter of designers use BIM technology. Many designers are not going to use BIM environment for designing. According the responders, the main reason of this fact is high price of BIM tools and need to train the employees. Many designers have never known the concept BIM technology, what is alarming. They are authorized designers in the difficult construction field so they have continually to learn in the issue of the latest trends not only in particular constructive and materials base, but also in the issue of software environment and progressive tools for designing. Next result is that the most designers work in the 2D-CAD software environment because they are in practice more than 10 year and they hardly change their habits. There is lack of designers´ awareness and there are not willing to improve their work and constantly to learn the latest tools of software designing. On the other hand, the young designers are able to use the most comfortable and the most effective design tools for their work.

Acknowledgement

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INVESTIGATION ON KEY RISKS IN CONSTRUCTION PROJECTS *

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Abstract

A construction project naturally implies a wide variety of risks. The successful projects are those where risks are effectively managed; early and effective identification and assessment of risks is essential. The owners as well as other construction project participants are required to understand the risks involved in construction project in order to reduce them to good effect. Unfortunately, for the mentioned participants is typical a lack of knowledge about the ways to prevent and manage the risks. Moreover, regarding their low awareness, they usually underestimate the value of effective risks management. A construction project accomplishment surely depends on right and early allocation and exploration of risks as well as their significances appreciation. The aim of the paper is to indicate the level of awareness in construction process risks understanding and managing and to present the results of studies intent on key construction projects risks determination, classification and their significances scaling.

Keywords: construction projects, key risks, risk management, construction aspects, project risk, risk factor

* The complete text is available on CD-ROM / Kozlovska, Strukova

Introduction

Risk has been part of everyday life for as long as we have been on this planet. The definitions of risk range the spectrum, with some focusing primarily on the probability of bad events occurring to those that weight in the impact of those events to those that look at both upside and downside potential (Holton, 2004). The construction sector, involving diverse stakeholders, long production duration and a production system inducing significant interaction between internal and external environments, is considered as a risky business. The complexity and the strategic nature of products are typical for the industry. Construction projects are well known for their unique and uncertain characteristics. No construction project is risk free. At any stage of a life cycle, a project is troubled with various risks. Risk is manageable, diminishable, transferable or acceptable; it cannot be ignored (Latham, 1994).

During the lifecycle of construction projects, especially in the planning phase, the participants are confronted with enormous risk-based decision making problems, which are usually addressed through identifying, analyzing and responding to potential risks, and ultimately optimizing solutions (Zeng et al., 2007).

Regardless of the project size, risk management should be emphasized and implemented in construction projects, to assure the achievement of project objectives. Effective management of project risk can improve project performance. The critical components of the overall risk management process are risk analysis and risk assessment. There are several factors that affect construction project risk, such as construction time, construction site location, the characteristics of the work site and project team and the time.

Unfortunately, the construction industry world over has a poor reputation in risk analysis when compared with other industries such as finance or insurance (Laryea & Hughes, 2008). The adoption of the available tools and decision support systems is quite limited. There is a heavy reliance on practical experience and professional judgement when assessing construction risk.

Risks are harmful to construction projects themselves by causing failure or loss, but it should be noted that contractors also suffer from those risks, particularly uncertainties that have dramatic impacts on their own benefits, making them evaluate the situation and potential risks thoroughly before making decisions. Underestimating of risk management in construction projects may affect adversely the profit of company involved in a project as the contractor. It is not rare that risk slight results in company decay.

2. Critical aspects of construction projects management

Construction Project Management is the application of knowledge, skills and techniques to project activities in order to achieve the objectives of the project. A direct relationship between effective risk management and project success is acknowledged since risks are assessed by their potential impact on the project objectives.

2.1. General construction projects

In Technical University of Košice (Faculty of Civil Engineering, Institute of Construction Technology and management), we have been dealing with analysis of risks in construction projects, especially with those resulting from construction time reducing. Within the research, the critical aspects of construction projects management have been studied. The examination is based on multiple methodical levels, dealing with construction processes issues. On the basis of the model, respecting the intersection of different methodological levels of:

- project objectives management,
- construction process arrangements,

- technological instructions,
- processes relating to project management (under ISO 10006 standard),
- integrated management system,

the critical aspects of construction projects were found. The aspects were determined upon frequency of an aspect in specific methodical level (Tab. 1). From the research study is evident that within the frame of common methodical approaches applied in construction project management, the aspect of risk figures rarely, even though risk aspect threaten each of other aspects.

Each project, as a unique complex of activities aimed at the objectives achievement, inclusive of activities related workforce, resources, communication ... ranges some risks which should be identified and managed. In regard to the implication, we can hypothesize that all aspects of a project implies some risk potential. This potential may have different probability in different aspects. It depends on personal ability of people identifying and eliminating the risks. In order to risks reducing, all the aspects should be managed by the well-functioning system and by skilled persons with high understanding and awareness of the aspects. Naturally, the aspects are interdependent. That is why, for risks reducing is essential to manage the project interactions. This implies that as all the factors are professionally provided, but the "rules" of mutual relation in the project are not noted in advance, or the relations are not managed mutually, parameters of the project objectives may fall off or fail.

Tab.1 The construction aspects prevalence in the context of methodical levels of construction process examination

	Project objectives management	Construction process arrangements	Project management processes	Integrated management system	Technological instructions	**Aspect frequency**
Cost	x	x	x	x		**4**
Time	x	x	x		x	**4**
Quality	x		x	x	x	**4**
Resources	x	x	x		x	**4**
Workers		x	x	x	x	**4**
Technologies		x		x	x	**3**
Work environment		x		x	x	**3**
Environmental protection		x		x	x	**3**
Occupational safety		x		x	x	**3**
Coordination	x		x			**2**
Communication			x	x		**2**
Risks			x	x		**2**

However, the construction parameters which are contractually agreed are indeed critical for construction projects management. It is concerned:

- contract sum,
- construction time,
- subject-matter of a contract,
- quality (parameters specification).

While in terms of threats to treaty commitments, a number of risks can arise for contractor.

The contract sum may be broken on account of:

- wrong estimated construction cost,
- inaccurately assigned resources requirements,
- change of technology-organizational variants (methods) ,

- estimated cost overrun,
- penalties,
- price changes, ...

The construction time may extend because of:

- subcontractors delay,
- climatic conditions,
- inaccurately estimated time of construction works performance,
- material and products supplies delay,
- incomplete project documentation,
- archaeological finds , ...

The subject-matter of a contract may be influenced negatively by:

- incomplete project assignment,
- incomplete building documentation,
- frequent changes during project execution

The construction quality may decrease because of:

- technological instructions violation,
- insufficient competence of workers,
- insufficient quality of construction material and products, ...

Moreover, occupational health and safety and environmental protection also belong to critical aspects of construction process. Generally, these aspects are not definite from contractually agreed parameters point of view, but they are obligatory in terms of law. They surely include a number of risks, similarly as before mentioned crucial aspects. The contractors as well as clients (investors) often "follow" the mentioned situation by their approach to occupational health and safety and environmental management. They usually save the money (reduce construction cost) and reduce construction time at the expense of these "non-committal" (not contractually agreed) aspects.

Other aspects of construction, presented in Tab. 1: resources, workers, technologies, and work environment belong to aspects which influence markedly the aspects listed above (price, time, amount of work, quality, occupational safety, environmental protection) and similarly involve various risks in a broad. Rest of the construction aspects - coordination and communication – may be characterized as so called management-administrative environment of construction management. Naturally, they also imply some risks.

2.2. Development projects

In another research study, centred on the added value of development projects in Slovakia (Kozlovská, 2009), we found the construction aspects the most important according to Slovak developers. Following the results of the study, the most crucial aspects of development projects preparation and execution include: management of interdependencies, quality, strategy and cost (Fig. 1). Almost the same frequency of the aspects in the survey results is noticeable. The communication and time aspects are slightly less rated as the most important construction aspects. Low frequency of risks in the aspects indicated as crucial construction aspects shows evidence of risks issues underestimating by developers in Slovakia. Moreover, the result of occupational safety aspects and environmental aspects as well as aspects related to human resources mention underestimating of important factors of projects management.

Fig. 1 Importance of factors influencing development projects

3. Factors influencing decision makers` risk attitudes in construction projects

Reviewing the foreign literature shows that construction risk has traditionally been perceived as the variance of cost or duration estimation. Gradually, there has been a shift in perception towards seeing it as a project attribute. As a project attribute, risk is mainly modelled as a multiplication of probability of occurrence and impact. In terms of risk impact assessment, it is noticeable how neglected the analysis of project quality risk is; the attention is still focused on cost risk or duration cost. Literature lacks an assessment methodology that is capable of understanding risk impact on all project success objectives. Taroun (2013) suggests using risk cost, as a common scale for measuring risk impact on various project objectives, within an analytical approach which structures and facilitates the experience and personal judgement of construction professionals for assessing construction risk. Risk cost, a percentage of project initial cost for instance, is believed to be a convenient and practical measure of risk impact. It presents a common language understood by all parties involved in construction project.

Wang and Yuan (2011) adopted several statistical analysis techniques, including ranking analysis and factor analysis, to identify the critical factors affecting contractors`risk attitudes in construction projects. The identified critical factors (according to the ranking results) imply: i) consequences of decision making, ii) engineering experience, iii) completeness of project information, iv) sensitivity to external information, v) decision motivation, vi) professional knowledge, vii) education background, viii) scope of knowledge, ix) boldness, x) judgment ability, xi) company`s economic strength, xii) social experience, xiii) values, xiv) interest in the engineering, xv) desire for decision objectives, and xvi) external economic environment.

Sixteen factors among the initial 26 factors are determined as critical. From the results is evident that among the 16 important factors, only 4 are regarding the external environment, while other 12 factors highly depend on contractors` experience and personal characteristics. Internal factors play a dominant role in affecting contractors` risk attitudes in risk-based decision making in construction projects.

4. Enquiry into risk management in construction projects

In order to manage a project, risk management must be used as one of the essential parts in project management. Nowadays, risk management in construction is acknowledged as a very important part of project management and a very important part of project management and a very interesting subject to write about as well. It is frequently discussed, but the practice is still at an inadequate level (Burcar Dunovic et al., 2007). Reasons vary from the lack of knowledge to implementation of risk management or the lack of resources. Generally, the reasons are mostly related to a poor knowledge of risks per se.

In order to recognize the state-of-the-art in research centred on construction risk in Slovak Republic, we have reviewed of the published literature of construction project risk management in the country. We found that there is the absence of a complex literature on risk in construction projects. The conference and journal papers and some book publications dealing with approaches to specific risks management (safety, environmental, financial, ...) are sporadic. In Czech Republic, there is only little better situation. In the methodical set of recommended standards, developed and published in 2000 by the Czech Chamber of Authorized Engineers and Technicians in construction (Kupilík et al., 2000), is stated that the research on risk management in Czech Republic is neither developed or is insufficient. However, this publication provides a holistic analysis of construction risk modelling and it is considered to be the turning point of trend in research related to construction risk in Czech Republic. The all parties involved in construction projects are asked to deal intensely and systematically with risk assessment, modelling and management.

The coming globalization brings some changes to project management in construction. Primarily, the "new" risks (till then substandard or just ad-hoc managed) start to range in construction projects. Next, the globalization involves different pressures on ready identification and rational management of risks in projects. However, in construction industry in Slovakia, the term risk is still understood too much "generally". The risk is understood to be just an event causing some material or other loss, nothing more. The risk management is not well-practised in the sector due to the lack on risk management knowledge. It is important to understand risk management knowledge amongst the construction practitioners in order for them to practise the risk management in handling their projects. The risk awareness in advanced countries is much better. In these countries, the Risk Management presents an inseparable part of project management. The lasting market environment in advanced countries is due to the fact that risk management presents the natural integral of each activity related to construction in these countries. There is the big amount of published contributions, as conference papers, journal papers, case studies, books ... and specific internet portals involving different approaches and studies relating to risk assessment and modelling (e.g. Construction Risk Management Library, WBDG Risk Management, IRMI - Construction Risk Management ...).

Abroad, researchers have investigated many different theories, tools and techniques for aiding risk assessment. Even if, Taroun in his insights from a literature review (2013) stated that there is still a plain gap between the theory and practice of risk modelling and assessment. In order to review the historical development of risk modelling and assessment, he conducted the search targeted all of the available articles in the databases. According to him, it is of crucial importance to understand the actual practice of risk analysis and review the development of construction risk modelling and assessment in an attempt to research viable alternatives that may contribute to closing this gap. The review made by Taroun demonstrated a remarkable contribution of the researchers towards advancing risk modelling and assessment. The existing body of knowledge demonstrates a sound basis from which to investigate novel alternatives that can bridge the existing gap between theory and practice. Moreover, he found that there was an evident shift from perceiving risk as an estimation variance towards considering it as a project attribute. Unless, his review has confirmed that the literature lacks a comprehensive risk assessment framework which considers the different types of impact of a risk on different project objectives simultaneously.

5. Key risks and risk factors in construction projects

There are many different risk sources in the construction projects and some approaches have been suggested in the literature for classifying them. Sources of risk have been investigated in many past studies conducted by foreign researchers. Frequent identified categories of risk factors/dimensions for construction projects are listed in Tab 2.

Tab. 2 List of risk factors/dimensions for construction projects

Risk dimensions	Author(s)
Ten dimensions: Owners, Designers, Contractors, Sub-contractors, Suppliers, Political, Social and Cultural, Economic, Natural, Others	El-Sayegh (2008)
Five dimensions: Contractor capability related, Contractual and legal related, Economic related, Physical related, Political and societal related	Lam et al. (2007)
Eight dimensions: Technical risk, Managerial risk, Resource risk, Productivity risk, Design risk, Payment risk, Client risk, Subcontractor risk	Dikmen et al. (2007)
Five dimensions: Cost related risks, Time related risks, Quality related risks, Environment related risks, Safety related risks	Zou et al. (2007)
Five dimensions: Estimator related, Design related, Level of competition related, Fraudulent practices related, Construction and economic related	Baloi and Price (2003)

In order to understand the key risks in construction projects in China and to develop strategies to manage them, the researchers from Australia and China (Zou et al., 2007) realized a postal questionnaire to the Chinese construction industry practitioners, a statistical analysis of the survey data and a systematic exploration of identified risks from the perspectives of stakeholders and life cycle. Moreover, a comparative study for the risks in Chinese construction industry to those in Australian construction industry was conducted. The aim of the comparative study was to highlight the unique risks associated with construction projects in China. The purpose of the investigation was not only to generate a list of risks but also to identify the key risks that can significantly influence the delivery of construction projects. On the basis of the data collected by postal questionnaire surveys a total of 25 key risks influencing the achievement of project objectives in the Chinese construction industry were ascertained.

The postal questionnaire carried a total of 85 risks associated with construction projects and asked respondents to review and indicate the likelihood of occurrence of these risks as "highly likely, likely or less likely" and the magnitude of consequence on each project objective:

- time,
- cost,
- quality,
- occupational safety and
- environmental sustainability.

that would result in as "high, medium or low". The 85 risks were sourced from a wide range of worldwide literature as well as those specifically focused on the Chinese industry. After collecting the data from 86 responses, the significance score for each risk assessed by each respondent and the average score for each risk considering its significance on a project objective were calculated. This average score is called *the risk significance index score* and it was used to rank among all risks on a particular project objective. So, risks were ranked in accordance with their significance index in association with each project objective, and this is done in turn on the five categories: cost, time, quality, safety and environmental sustainability respectively. In the results of the ranking, many risks are repeated among the five categories. For example, "tight project schedule" can influence all project objectives (cost, time, quality, safety and environmental sustainability). With the repeated ones filtered, a total of 25 factors were highlighted as key risks to impact the project delivery. These risks with their recognized impacts on project objectives are presented in Tab. 3. The aim of our review of this one research study is to present the survey results, to mention the key risks of construction projects, we did not wanted to explain the rationale of the significance index score estimation.

Tab. 3 Key risks influencing project objectives (Zou et al., 2007)

The 25 key risks identified	With significant impact on				
	cost	time	quality	occupational safety	environmental sustainability
Tight project schedule	●	●	●	●	●
Project funding problems	●	●	●	●	●
Variations by the client	●	●	●		●
Design variations	●	●	●		
Inadequate program scheduling	●	●			
Inadequate site information (soil test and survey report)	●		●		
Incomplete or inaccurate cost estimate	●				
Contractors` poor management ability	●	●	●	●	●
Contractors` difficulty in reimbursement	●	●	●	●	●
Poor competency of labourer			●	●	
Unavailability of sufficient professionals and managers			●	●	
Without buying insurance for major equipment				●	
Without buying safety insurance for employees				●	
Inadequate safety measures or unsafe operations				●	
Lack of readily available utilities on site				●	
Unavailability of sufficient amount of skilled labourer			●		
Prosecution due to unlawful disposal of construction waste					●
Serious air pollution due to construction activities					●
Serious noise pollution caused by construction					●
Water pollution caused by construction					●
Low management competency of subcontractors			●		
Suppliers` incompetency to deliver materials on time		●			
Bureaucracy of government	●				●
Excessive procedures of government approvals	●	●			
Price inflation of construction materials	●	●			

Upon the results of the presented study, we estimated the average significance index scores of different key risks categories ranked as per their significance on individual project objective. The scores are following:

- 0,43 for cost related risks,
- 0,48 for time related risks,
- 0,38 for quality related risks,
- 0,28 for environment related risks
- 0,37 for occupational safety related risks

The graphical understanding of the average significance index scores of different risk categories is presented in the radar graph (Fig. 2).

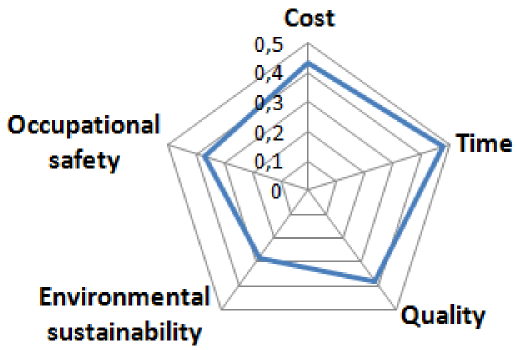

Fig. 2 The average significance index scores of different risk categories
(According to the research study of Zou et al., 2007)

From comparison of the results of two before presented studies (chapter 2.2 and Zou et al., 2007) is possible to state that the construction project aspect as time, cost and quality appear to be almost equally eminent in Slovak and in China construction industry. Unlike, environmental sustainability and occupational safety are recognized in China research study as more significant aspects having greater impact on construction projects success.

As it was mentioned before, in the results of the ranking, many risks are repeated among the five categories. "Tight project schedule" can influence all project objectives (cost, time, quality, safety and environmental sustainability). In our institute, we have dealt with the risks relating to construction time reducing. The results of our study acknowledged that the schedule pressure involves the significant impact on all the other factors of construction. This is confirmed by the presented study (Zou et al., 2007), as the "tight project schedule" risk is found in all the risks categories.

Kuo and Lu (2013) employed a fuzzy multiple criteria decision making approach to systematically assess risk for a metropolitan construction project. They measured and investigated the relative impact on project performance of twenty identified risk factors included in five risk dimensions. Potential risk factors impacting on metropolitan construction projects were carefully selected and synthesised from the literature review and several expert interviews. They were classified into five dimensions: i) engineering design (ED), ii) construction management (CM), iii) construction safety-related (CSR), iv) natural hazards (NH), and v) social and economic (SE). The proposed risk assessment approach was demonstrated using data from a metro system construction project in the city of Taipei. Five experts with more than fifteen years experience in construction project management and being familiar with construction project risks were recruited to participate in the demonstration. The estimated levels of risk for the investigated risk factors are presented in Tab. 4.

Tab. 4 Overall project risk and individual risk factors (Kuo & Lu, 2013)

Risk factors	Risk dimensions	Estimated level of risk	Ranking order
Ground water seepage	NH	0,1047	1
Typhoon	NH	0,0502	2
Conflicting interfaces of work items	ED	0,0480	3
Design drawing errors	ED	0,0471	4
Heavy rainfall	NH	0,0410	5
Increases in prices of construction materials	SE	0,0222	6
Inadequate worker safety	CSR	0,0216	7
Poor construction site surveys	ED	0,0165	8
Insufficient protection of adjacent buildings and facilities	CSR	0,0138	9

Earthquake	NH	0,0138	10
Poor construction plan	CM	0,0079	11
Insufficient experience and skill in construction works	CM	0,0063	12
Political interference	SE	0,0056	13
Inappropriate design and poor engineering	ED	0,0052	14
Protest and interference of nearby residents	SE	0,0050	15
Ineffective control and management of traffic	CSR	0,0050	16
Increases in labours and employee salaries	SE	0,0044	17
Delay in relocating existing pipelines and facilities	CM	0,0039	18
Ineffective protection of surrounding environment	CSR	0,0030	19
Unstable supply of critical construction materials	CM	0,0008	20

Karim et al. (2012) in their study focused on investigating risk factors from the perspectives of the contractors involved in construction projects. In order to identify common risk factors that may occur in construction projects, an extensive literature review was carried out by the researchers. This resulted in identifying a total of 25 factors categorized in five groups as: construction (10 factors), politics and contract provision (7 factors), financial (3 factors), design (2 factors) and environmental (3 factors). Then, in order to understand the perception of the practitioners to the risk factors among different contractors in Malaysia, the questionnaire survey was conducted. The data gathered from the survey were analysed statistically using Relative Important Index (RII) to determine the relative significance and ranking of risk factor.

According to result of the ranking study (Tab. 5), the five most important risk factors in construction project are: i) shortage of material, ii) late deliveries of material, iii) shortage of equipment, iv) poor quality of workmanship, and v) cash flow difficulties. These significant factors are from two groups, i.e. “construction” (i, ii, iii and iv) and “finance” (v). The most significant category of risk factors is “construction” (Tab. 6).

Tab. 5 Ranking of risk factor (Karim et al., 2012)

Risk factor	RII	Rank	Group
Shortage of material	0,735	1	Construction
Late deliveries of material	0,733	2	Construction
Shortage of equipment	0,721	3	Construction
Poor quality of workmanship	0,720	4	Construction
Cash flow difficulties	0,712	5	Finance
Insolvency of subcontractors	0,700	6	Construction
Inadequate planning	0,700	6	Construction
Insolvency of suppliers	0,691	7	Construction
Change in law and regulation	0,688	8	Politics and Contract provision
Bureaucracy	0,688	8	Politics and Contract provision
Lack of financial resources	0,682	9	Finance
Site safety	0,674	10	Construction
Delay in payment for claim	0,671	11	Finance
Change scope of work	0,671	11	Design
Poor supervision	0,657	12	Politics and Contract provision
Weather	0,647	13	Construction
Compliance with government	0,629	14	Politics and Contract provision
Delay in project approval and permits	0,624	15	Politics and Contract provision
Land acquisition	0,618	16	Construction
Inconsistencies in government policies	0,612	17	Politics and Contract provision
Pollution	0,606	18	Environmental
Excessive contract variation	0,594	19	Politics and Contract provision

Ecological damage	0,589	20	Environmental
Compliance with law and regulation for environment issue	0,577	21	Environmental
Improper design	0,463	22	Design

Tab. 6 Ranking of risk category (Karim et al., 2012)

Risk Category	Mean	Rank
Construction	0,714	1
Politic and Contract provision	0,713	2
Design	0,712	3
Finance	0,706	4
Environment	0,583	5

Conclusion

The risk factors are the critical component in achieving project objectives. To minimise the chances of failure of the construction projects, the significant risk factors should be properly handled in managing the risks.

Managing risks in construction projects is recognized as a very important process in order to achieve project objectives particularly in terms of time, cost, quality, safety and environmental sustainability. The different risks in construction projects may relate to contractors or subcontractors, to clients or designers. The model of integrated building design and delivery of construction project appears as the suitable situation for early cooperation of clients, designers and contractors in order to manage potential risks effectively and in time. Mostly, contractors with rich construction as well as management skills and knowledge could be employed early to reduce construction risks and make precise preparation for carrying out safe, efficient and quality construction works.

The paper mentioned the projects risks awareness in the construction sector and dealt with the results of studies intent on determination of key risks and risk factor in construction projects as published in the literature. Moreover, the researches of key risks in construction projects appear from the analysis of key factors of theoretical and methodical levels relating to construction processes examination. The brief comparison of different studies results (Slovakia and China) suggests the very similar perception of key risks in construction projects and importance of the risks appreciation. Right identification, analysis as well as importance of risks appreciation are inevitable for construction project objectives achievement.

Acknowledgement

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SUSTAINABLE CONSTRUCTIONS IN TERMS OF ENERGY EFFICIENT BUILDINGS AND COSTS*

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Abstract

In total energy consumption in Europe are buildings involved up to 40%. One potential for the energy saving is construction of sustainable buildings. Sustainable buildings have low costs for energy consumption and operations, they are environmentally friendly, able to save natural resources and they are comfortable and healthy for their users. The European Union supports this trend through its Initiative 2020, respectively with document Energy Roadmap 2050. The paper is focused on the research and comparative effectiveness of low-energy and passive houses against the house in usual standard. In the survey were analyzed the parameters of floor space, built-up space, cost and energy consumption. The analysis was carried out on a sample of 20 low-energy buildings and 20 buildings proposed in the current energy standards, in order to ascertain the impact of insertion (intended) budgetary costs for the energy saving, based on the floor area. For both groups of energy standards were processed dependences of budgetary costs on floor area. The research has shown that currently with the same initial costs we can build a house in a higher energy standard, which can save about 60% energy.

Keywords: energy efficiency, low energy house, analysis

* The complete text is available on CD-ROM / Kozlovska, Župova

Introduction

In December 2008 the European Commission ("EC") adopted The Climate and Energy package. This document deals about energy savings and the member states of European Union are forced to:

- reduce greenhouse gas emissions by 20%
- increase energy efficiency by 20%
- ensure share of 20% renewable sources in overall energy consumption

In November 2010, The EC adopted document Energy 2020–A strategy for competitive, sustainable and secure energy, and next year, in 2011, The Energy Roadmap 2050. Booth of these documents affecting the construction industry and are key elements to make construction industry more effective. The results then are energy-efficient buildings.

Various literatures serve a variety of definitions what energy-efficiency is. Slovak technical norm STN 73 0540-1: Thermo-technical properties of engineering structures and buildings [1] defines energy-efficiency building as building that is needing only a small fraction of the energy needed to ensure the comfort and functionality of the current building. We know four types of buildings according to their energy efficiency: low-energy, passive, zero-building and building with almost zero energy. **Low-energy building** needs about 30 to 70 kWh of energy per year of floor area. **Passive building** (energy passive building) has the energy demand for the heating below 15 kWh per square of floor area per year. **Zero-building** needs for its comfortable operating power supply from current sources or during the year it produce at least as much energy as it consumes. **Building with almost zero energy** is a building with a very high energy performance. Almost zero or very small amount of energy required for use shall be provided with an effective thermal protection and a high rate of energy supplied from renewable resources in the building or nearby.

The specific extra costs [2] related to passive houses compared with low-energy houses and standard houses can be broken up into seven categories, e.g., costs for heating, ventilation, isolation, air tightness, ground works, differentiation in net floor surface and miscellaneous costs. There is a difference in net surface of the building because of the thicker walls in a passive house and the low-energy house. Figure 1 shows a graphical reflection of the different extra costs divided into these seven categories. The additional costs for isolation and ventilation result in the biggest surplus cost for the passive house of, respectively, 64% and 27% of total costs.

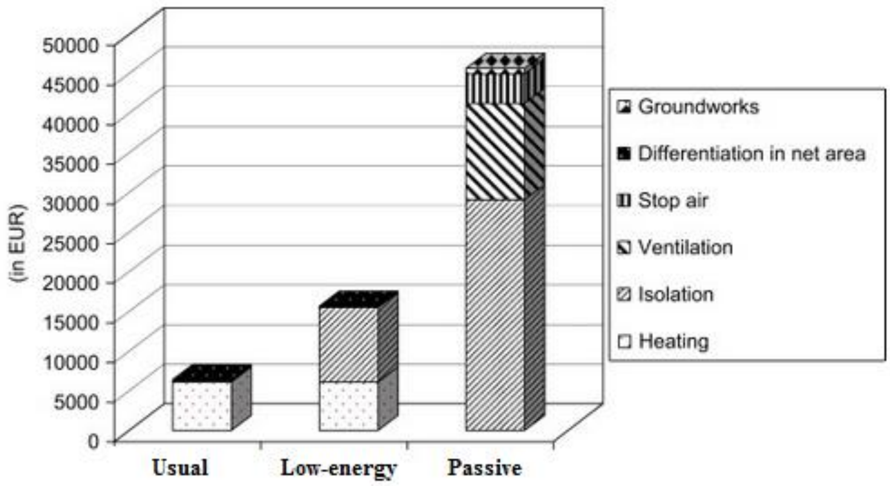

Figure 1 Analysis of the specific additional costs of three building types [2]

As shown in Figure 2, the process of increasing energy demands began in 1984. Since 2002 (when Slovakia became a state member of European Union) this process gained greater expansion.

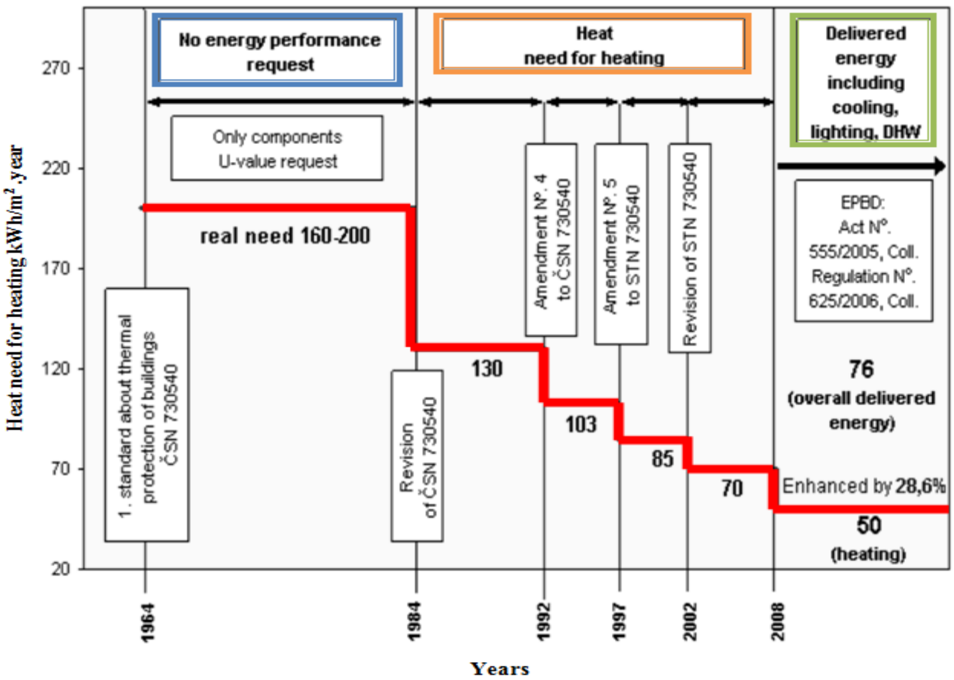

Figure 2 Evolution of requirements for building energy-saving [3]

2. Buildings energy efficiency in Slovakia

Slovak Republic deals with the issue of buildings energy saving since year 2005 adopting of the Act No.555/2005, Energy Performance of Buildings. According to this Act there are calculated energy performances of buildings and expose the building energy certificates. From 1.January 2009 without the energy certificate investor does not get building permission. Building Energy Certificate is a certificate containing the calculation of the energy performance of buildings in accordance with the methodology of calculation procedure. Certificates are issued only from persons authorized to perform this action. With the energy certification [3] is building categorizes into class energy rating from Class A (most energy efficient) to Class G (low efficiency). Calculation methodology for determining the energy performance of buildings is provided in the Decree Law Code No.311/2009 (includes heating, cooling, ventilation, hot water and lighting). It is expressed through the supplied energy (total energy needs), primary energy and CO_2 emissions. This calculation is based on the full implementation of European standards. National Annex processed to ISO 13790 has incorporated data on climatic conditions, structures and properties of materials and other. Figure 3 shows that the largest share in the distribution of energy certificates in Slovakia are having a new single (family) houses.

The Act amending and supplementing Act no. 555/2005 and consequential amendments as later amended, is the Act No.300/2012 about The Energy Performance of Buildings. The main content of the amendment is to transpose Directive of the European Parliament and the Council 2010/31/EU. Through this will be achieved fulfillment tasks arising from the Kyoto Protocol to the United Nations Convention on Climate Change UNFCCC, by achieving the energy from renewable sources accounted for 20% of total energy consumption by 2020.

This Act No.300/2012, in Slovak law, has an effect from 1 January 2013.

The most significant changes are [4]:

- drawing up national plans for increasing the number of building with almost zero energy
- a major renovation of the building are structural modifications of an existing building, implementing intervention into its packaging design of more than 25% of its area (mainly insulation facade and roof deck and replacing the original doors and windows)
- cost-optimal level of minimum energy performance requirements for buildings means the energy performance level which leads to the lowest cost during the estimated economic lifecycle of the building
- designer is obliged within the technical, functional and economic conditions of building, to design new buildings and major renovation of existing buildings with the use of appropriate building construction, alternative energy systems based on renewable energy and automation, control and monitoring systems

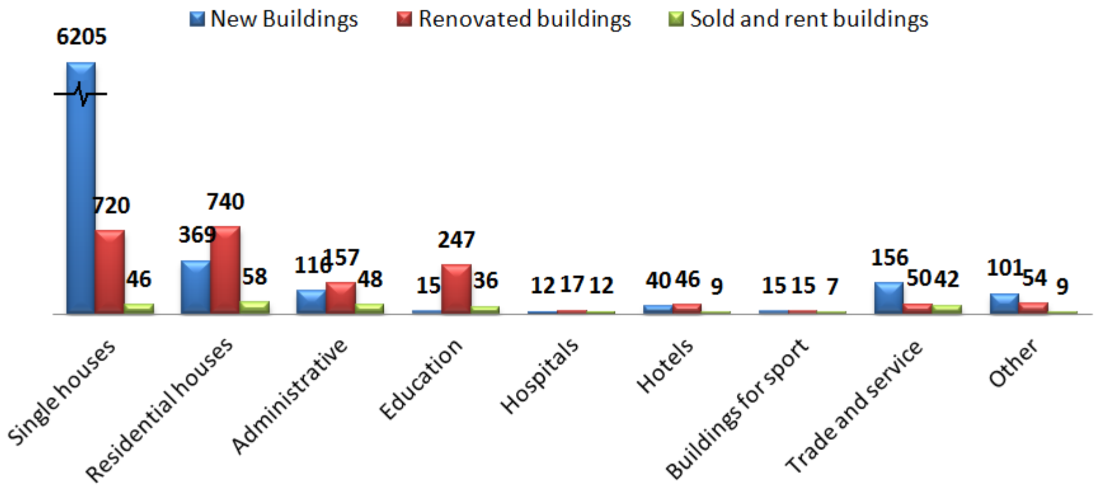

Figure 3 Distribution of energy certification of buildings by years 2009-2011 [3]

3. Buildings energy efficiency from the perspective of costs

Through information available from source of the company eurolineslovakia.sk [6] on examples of houses with different energy standards (usual house, low-energy house, passive house) can be demonstrated how the type of buildings in terms of energy standard and the requirements affect investment in construction.

3.1. Compilation of usual house vs. low energy house vs. traditional house

For comparison were selected three houses representing different types of energy standards. One house is designed in usual energy standard, second in low-energy standard and third in passive standard. Parameters (showed in Table 1) of floor area (m^2) are almost the same. The differences are in energy consumption per m^2 and little difference is also in building space (m^3).

	Building space (m3)	Floor area (m2)	Estimated energy consumption per year (m2)	Total estimated costs in EUR	Building material costs in EUR
Usual	783,3	111,7	98	140 675	78 000
Low-energy	767,8	113,5	32	139 000	77 000
Passive	730,5	115,5	8	159 600	115 000

Table 1 Parameters of the buildings

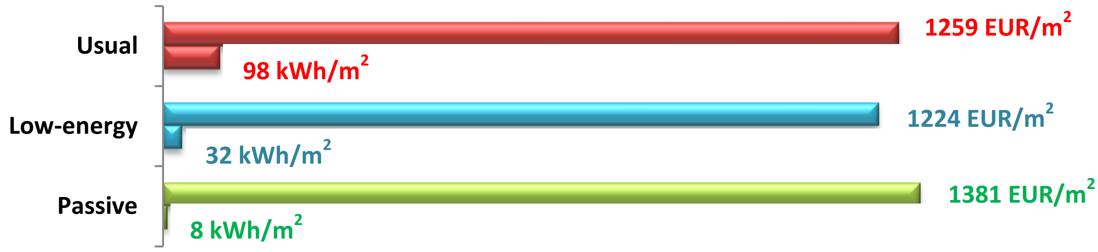

Figure 4 Energy consumption and total estimated costs per m^2

Figure 4 presents energy consumption and total estimated costs per m^2 on selected types of houses. From the foregoing the energy consumption of a passive house is the lowest but the estimated costs are the highest. The costs of a usual and low-energy house are comparable, even costs for the low-energy house in this case are lower than in usual house.

Investor can save among 67% of energy if he chooses a house in low energy standard. Highest energy saving has passive house. This type can save among 92% energy saving compared with the house in usual standard and 75% energy saving compared with the house in low-energy standard. The estimated costs per m^2 by house in usual standard are 1259 EUR, by passive house there are 1381 EUR per m^2, which means an increase about 9%.

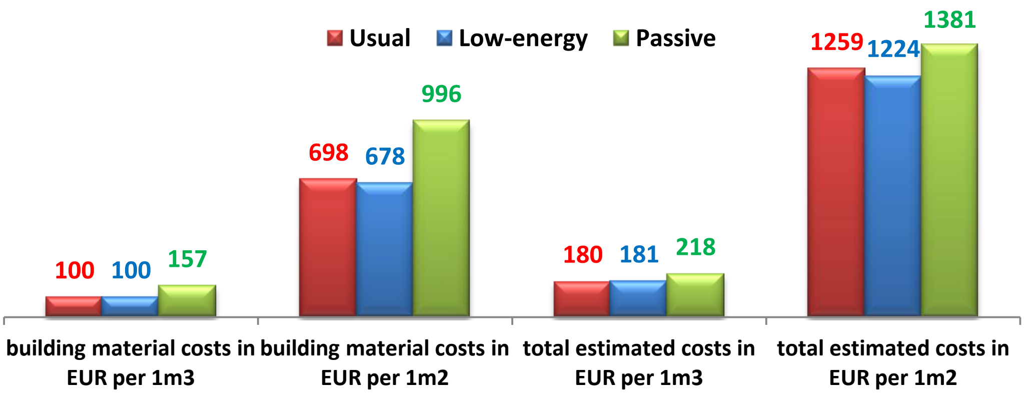

Figure 5 Overall summary and comparison of costs parameters

In overall summary of costs parameters per floor area and per building space, the differences between usual house and low energy house are very slight. Passive house needs higher cost for its realization, which results from the high energy savings.

3.2. Comparison of objects groups in different energy standards

The following analyzes are based on a statistical comparison two groups of 20 family houses type of bungalow proposed in the low-energy standard and usual standard (based on documents eurolineslovakia.sk). Were studied these parameters: estimated costs (EUR), building material costs (EUR), floor area (m^2), building space(m^3), estimated energy consumption (kWh/m^2).

3.2.1. *Estimated costs vs. energy consumption vs. building space*

In a group of 20 houses in usual standard were investigated energy consumption, building space and total costs per square meter. On figure 6 are values arranged from smallest to largest building space. Energy consumption is almost the same, ranges from 89 to 98 kWh/m^2. Budgetary costs per m^2 are already showing different values.

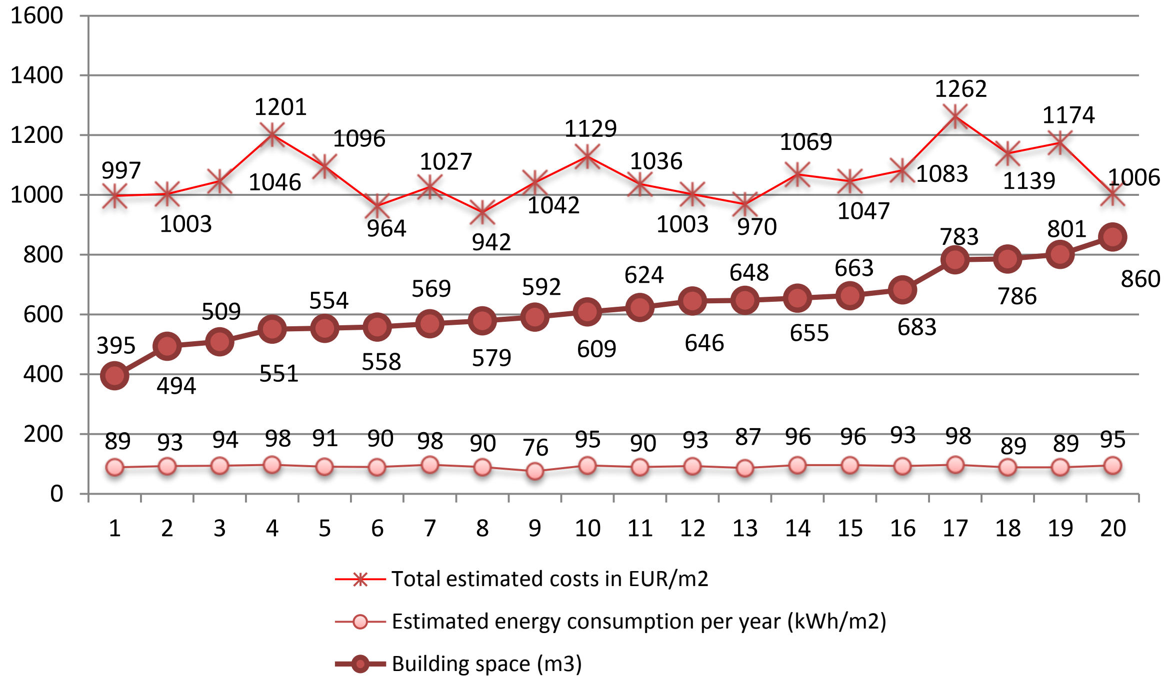

Figure 6 Costs, energy consumption and building space of houses in usual energy standard

Figure 7 shows the cost, energy consumption and building space by low-energy houses. The budgetary cost exhibit different values, but in terms of energy point of view, this type of house shows a higher energy saving for a similar building space as by houses in usual standard.

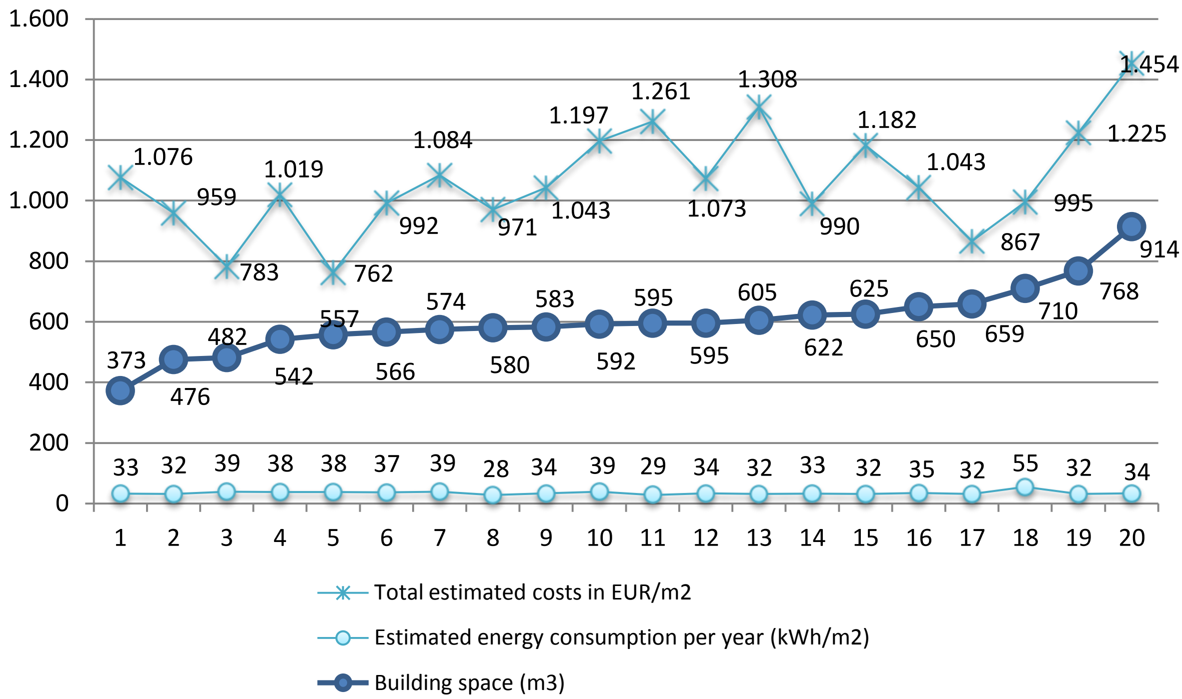

Figure 7 Costs, energy consumption and building space of houses in the low-energy standard

Table 2 presents a summary of characteristics as a result of estimates variance based on a sample, standard deviation based on the sample of houses given as arguments and average values. Estimates variance based on a sample of 20 houses presents arguments corresponding o a sample of houses. The standard deviation is a measure of how widely values are dispersed from the average value (the mean). Standard deviation is expressed of estimated costs and energy consumption, assuming on a sample of 20 houses.

	ESTIMATES VARIANCE		**STANDARD DEVIATION**		**AVERAGE VALUES**	
	estimated costs in EUR/m2	energy consumption (kWh/m2)	estimated costs in EUR/m2	energy consumption (kWh/m2)	estimated costs in EUR/m2	energy consumption (kWh/m2)
Usual	942 – 1 262	76 - 98	82	5	1 062	92
Low-energy	762 – 1 454	32 - 55	167	6	1 064	35

Table 2 Statistical parameters of the buildings

The differences in estimates variances by costs per m^2 are 320 EUR in houses of usual standard and 692 EUR in low-energy standard. By comparing average estimated costs per m^2 the difference is minimal, even 2 EUR/m^2 in favour of house in usual standard. But by comparing average energy consumption the difference is 57 kWh/m^2 which presenting 62% of energy saving by low-energy house. For the investor, as well the environment is more effective investment in low-energy houses.

3.2.2. Estimated costs vs. floor area

Graphs on figure 8 and 9 are showing the dependence of budgetary costs and the total floor area for low-energy houses and usual houses. The horizontal axis represents the estimated costs, the vertical axis, floor area in m^2. Through data from the groups of 20 houses in usual and low-energy standard was tested the linear direction using the trendline. Trendline is most accurate when its R-squared value equal to 1 or close to 1. These charts can serve as a guide for the investor (when he has a cost budget) for reading the relevant maximum floor area which he can get for his money.

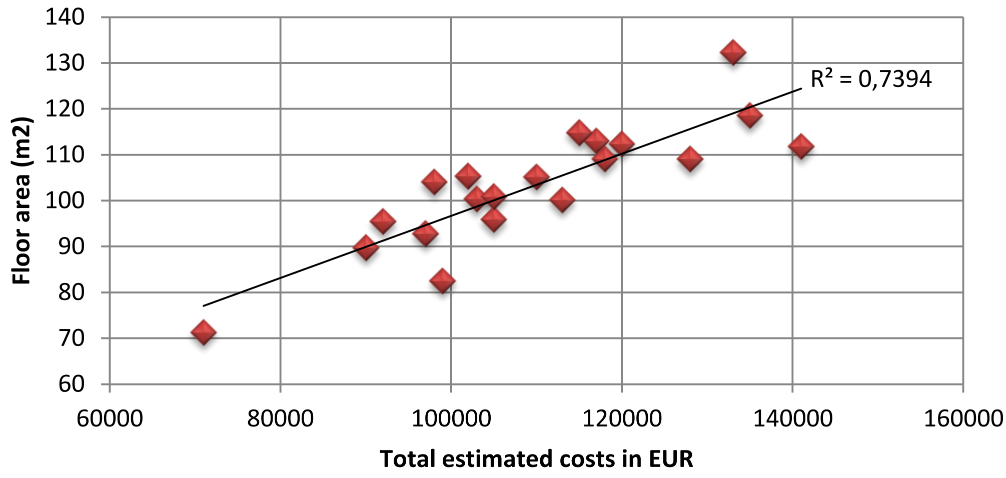

Figure 8 Costs and floor area by houses in the usual standard

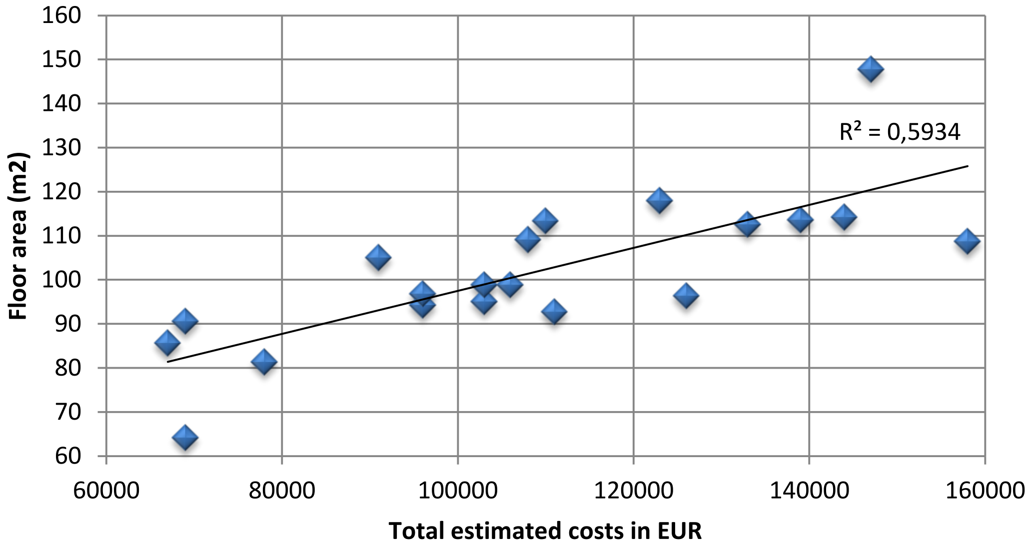

Figure 9 Costs and floor area by houses in the low-energy standard

For example, if the investor has available 100 000 EUR, chart shows that he can obtain a house on the current floor area of about 100 m^2. The budgetary cost and floor space are comparable in both types of houses, but it is better and more economical to go low-energy house way, which provides better energy savings than with lower operating costs than standard house.

Conclusion

Article deals about the issue of building energy efficient houses in context of their estimated costs of realization. It talks about current legislation in this area in Slovakia and provides research focused on comparison of effectiveness of low-energy and passive houses against the house in usual standard. In the survey were analyzed the parameters of floor space, built-up space, cost and energy consumption. The analysis was carried out on a sample of 20 low-energy buildings and 20 buildings proposed in the current energy standards, in order to ascertain the impact of insertion costs for the energy saving, based on the floor area. For both groups of energy standards were processed dependences of budgetary costs on floor area. The research has shown that currently with the same initial costs we can build a house in a higher energy standard, which can save about 60% energy.

The article presented a partial research result of project VEGA 1/0840/11 "Multi - dimensional approaches supporting integrated design and management of construction projects".

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DAILY MONITORING BY IIS*

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Abstract

The IIS – Integral Information System- influences the communication components of a business system in terms of both the organization and the information flow. Nowadays, the construction production or, rather, its management still prefers the most the use of summary data at the level of the whole building over the measurement unit such as m3, m2, m’, kg and other units.
This kind of monitoring-and especially where large investments are concerned- not only imposes significant risks but can cause significant losses as well. This is why, along with the development of the vectoral organization structure, the monitoring of an investment is enabled via the IIS, the monitoring based not on the level of a period, a month or a week but on a daily level.
This kind of organization requests educated personnel which is in turn not welcomed by the management as the decision-making centre is shifted to experts and thus the daily monitoring system does not develop as it should. The effects or the results of the IIS are therefore not so efficient but doing business without the IIS has become impossible.

Keywords: organization, flow, control, regulator, daily monitoring, IIS

* The complete text is available on CD-ROM / Križajić

INTRODUCTION

IIS has provided for an integration of an organization and data flow within a business system as a whole.
The structure of an organization –the IIS data model, that is-is defined through the forming of components of the technological processes within the system whereas the flow (the relations) of the structure reflects the functioning of the system (organization). The vectoral organization theory was developed as a by-product of the forward-backward method [1,2].
Such theory, based on technology and technology scheme data model, was supplemented by a foreign outer planning system, Borland SuperProject, and later on by MicrosoftProject that in turn provided for monitoring projects on daily level in Oracle Database with Devenloper developing system.

PROBLEMS

The system that has been used to monitor and control projects up to now has proven non sufficient, especially in the projects where large sums are involved.
The monitoring of a project by means of the data at the level of the whole building over the measurement unit such as m3, m2, m', kg and other units is considered trustworthy. This kind of management that is based on experience gives a misleading Fig. of the process of the development of a project and thus all control over expenses and time-the two key project monitoring factors-are lost.
This kind of monitoring not only imposes significant risks but can cause significant losses as well
This is why the development of information systems provides for the monitoring of large quantities of data on all the productivity indicators concerning both the financial and the process ones so that failures in the realization of a project can be detected faster and easier at the level of at least the process and weeks.

MONITORING A PROJECT IN THE VECTORAL ORGANIZATION STRUCTURE

IIS – the integral information system of the construction executi provides for monitoring a project up to the level of resources. The resource axis is added to the matrix axis as the third spatial (vectoral) axis and thus the term vectoral organization structure[3,4] (fig.1).

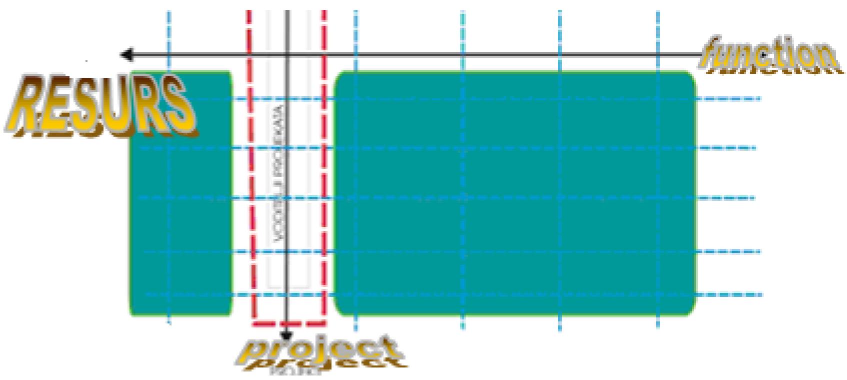

Fig.1 - Vectoral organization system or the matrix with the project-process orientation to resources

By means of the further gradual branching of the system from processes to operations, procedures and movements, the respective coordinate system starts to show an n-dimensional system, i.e. the vectoral scheme of an organization or a construction system. However, the construction industry is presently still content with this level of operation.

MONITORING A PROJECT ON A DAILY LEVEL

Further detailed modelling of the technological processes of the construction systems' executi, i.e. the realization of projects leads to an integration with the environment, which means with foreign software solutions (fig.2)

It is desirable to integrate a well-engineered graphic software solution with the IIS system (fig.2).

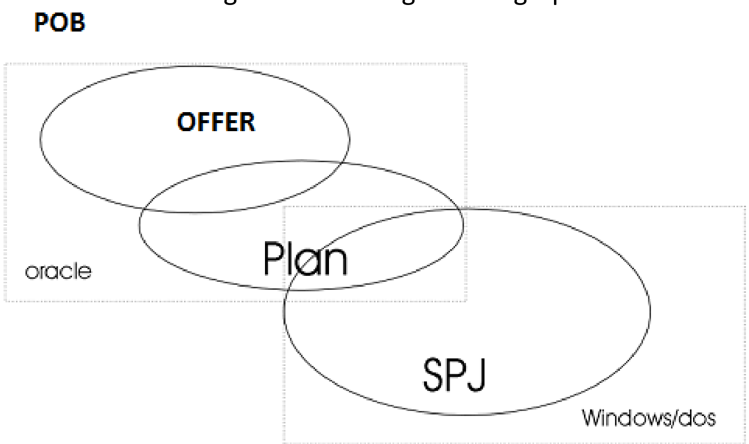

Fig.2 - Integrating the domestic software with the foreign one

The integration is provided for by the foreign software tools to use ODBC bases or the recent XML Internet technology.

There are other possible solutions as well, based on operational research through the software combinatorics.

However, the graphics features used by domestic engineers are inferior to the above-mentioned one, so the Microsoft graphics has been integrated into the domestic software and a report done in a combination with the Microsoft tools is presented in (fig.3).

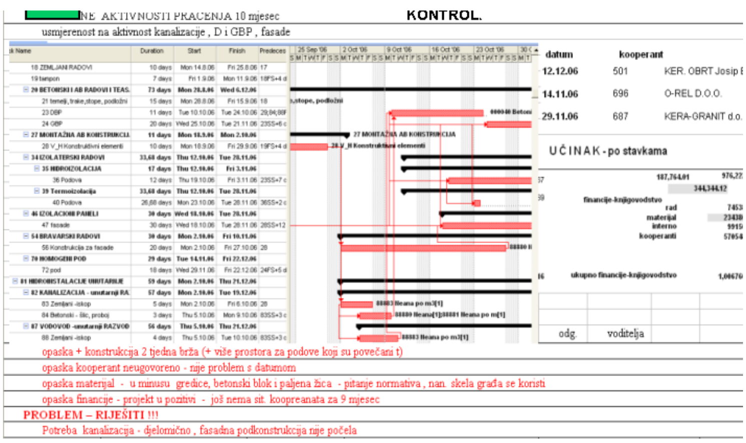

Fig.3 - A report made by the Project Monitoring and Control Service

The system provides for the monitoring the resources efficiency by activities and on a daily level through the shown data model (fig.4).

The normative and financial indicators monitoring is enabled in turn and this provides for an increase, i.e. a rationalization, in the resources control by projects that have been monitored by means of periodic financial basis up to now, on daily basis from now on and on the basis of the normative indicators in the future.

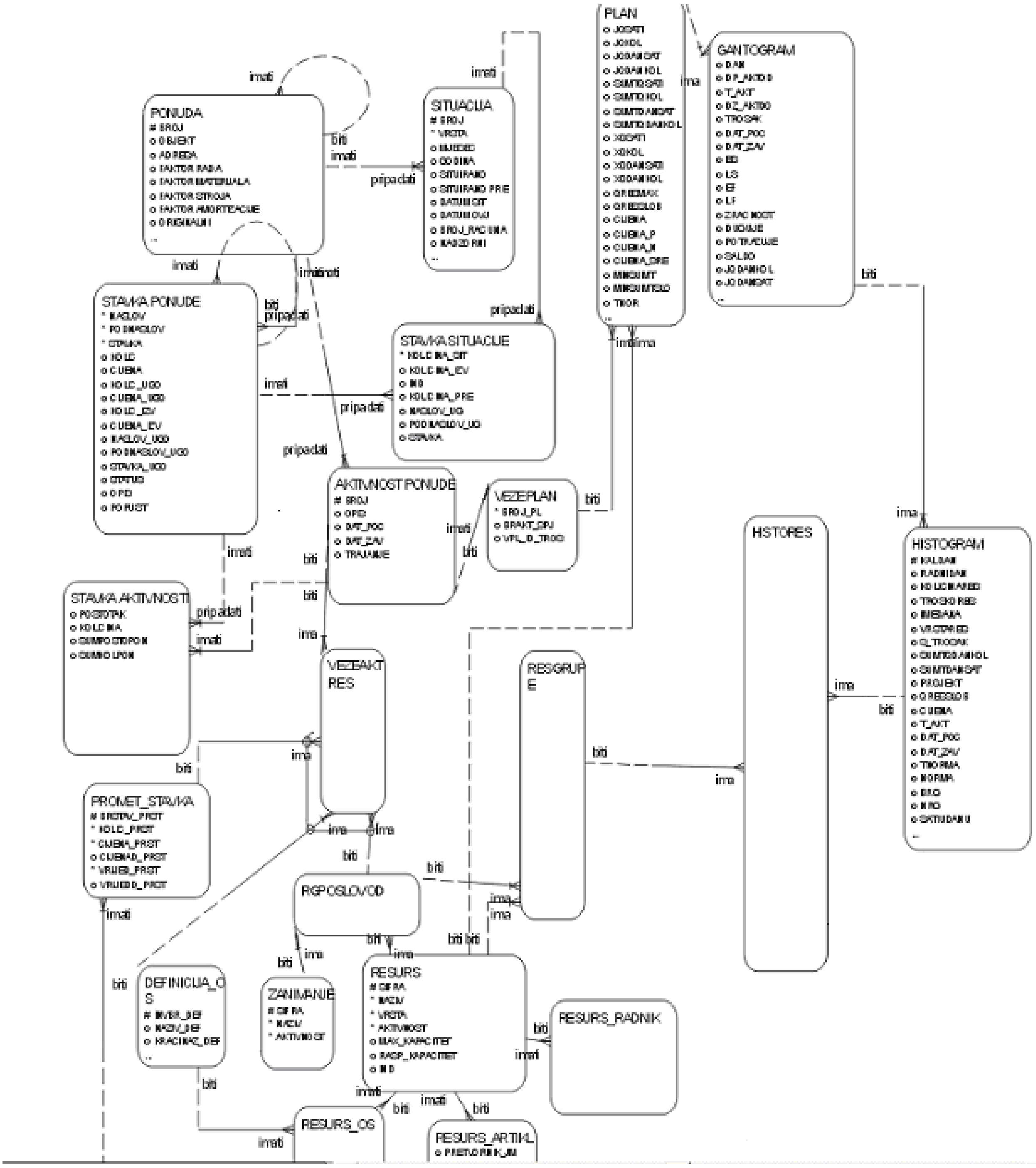

Fig.4 - IIS data planning model

This supplement contributes not only to a company but to the society (the wider community) as well. A rational decision-making procedure teamed with the new scientific approach to the component that is crucial in each society, namely human labour value, would yield more humanistic results. Once norms have been objectively set, the humanistic solutions are yet to be reached as soon as we enter the realm of humanistic and humanity, the qualities we lack today.

CONCLUSION

In order for a company to have a proper control, namely to have a rational, higher form of the resource management regulation, the resource efficiency data model should be upgraded. This in turn leads to the realm higher than the one of the system control and this is the business system iteration regulation system[5] (fig.5).

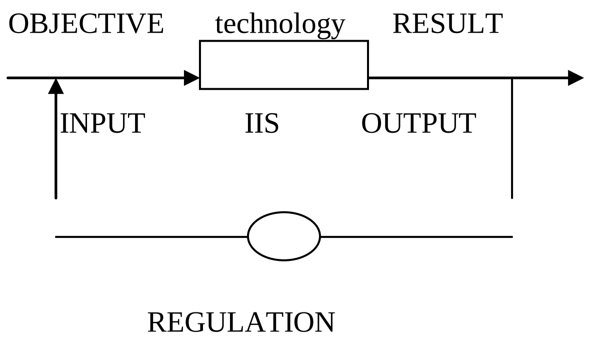

Fig.5 - IIS regulation technology iteration element

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DIFFERENTIAL ROOF GEOMETRY*

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Abstract

Timber roof truss constructions usually feature a standard cross-section that characterizes a roof plane. However, the roof construction of manor castle Veliki Tabor in hilly Hrvatsko zagorje region does not fit in any roof simplicity principle; thus every centimetre of increment along the roof features a different roof construction cross-section. This causes a tremendous work not only for designers but for work performers as well as they have to draw (define) a series of cross-sections and to create a series of truss patterns instead of one, respectively. Modelling faces the same obstacle as well. However, the state-of-art acad technology in conjunction with plotters is capable of solving the problems swiftly. Generally, the problems are solved by means of the differential geometry, i.e. supporting the drawing technology with mathematical equations.

Keywords: roof, plane, cross-section, truss pattern, designing, dimensioning, work performing, differential geometry

* The complete text is available on CD-ROM / Križajić, Hranj

MANOR CASTLES OF HRVATSKO ZAGORJE – introduction

The conservation works that have been performed on manor castle Veliki Tabor in Hrvatsko zagorje region of the Republic of Croatia have resulted in a series of by-projects.

Prior to the conservation works, as required by the Law, the location and building permits were obtained. Then the investigation works commenced and were followed by the respective architectural and construction works. Palas, the central hall, or rather its roof is specially interesting as it features a roof construction stunning for the times, namely the five-way hipped type construction. Besides interesting statics models, an interesting physical model was created as well to present the beautiful construction; however, the refurbished manor testifies of its beauty in reality today (fig. 1).

Fig. 1) Conservation works on Veliki Tabor and on the roof of Palas hall

ROOF OF MANOR CASTLE Veliki Tabor IN Desinić

The roof of Palas hall does not fit in any of the standards. Its construction's system is of a five-way hipped type (fig. 2). Grids are used as pillars and the rafters are of twin type both in terms of their stiffening function and in terms of geometry, so every element has at least a double function. The rafters are not the only joining element, there are collar beams as well which make the construction peculiarly interesting not only in terms of architecture and the task it gives to roof constructors but in terms of geometry as well [5] as any change of spatial dimension creates a new feature of the roof, i.e. creates a new roof construction cross-section image.

Fig. 2) Model and physical model of Palas hall

The above mentioned changes are defined by the pentagram-shaped attic and the changes in the geometrical dimensions of the attic plane cause an automatic change in the attic height which, in turn, requires the inclination angle of the roof planes to remain the same.

However, the above mentioned characteristic of the roof is not evenly distributed, so the main problem related to the designing of the roof is its quality of being differential (fig. 3). It causes problems in plotting the roof design and defining its dimensions.

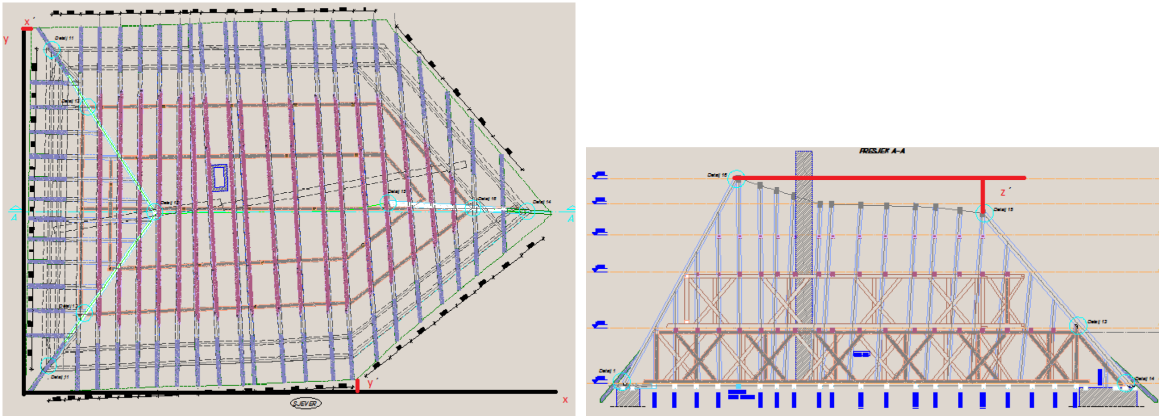

Fig. 3) Differential layout and model of the roof construction

DIFFERENTIAL ROOF GEOMETRY

The new way of defining roof features provides as well for a new technology and a new way of organization of works for the product implied.

Thus the rapidity and preciseness of designing is achieved at not only standard operations but at capacitive elements as well because the distance from the reference axis suffices for a cross-section to be defined and therefore all the dimensions from planes $Z_{L,D(x,y)}$ [4] are obtained (fig. 4).

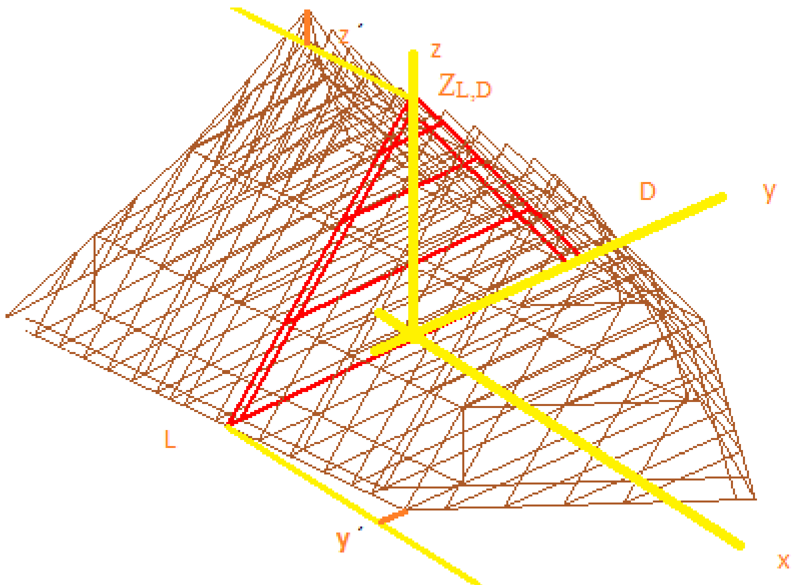

Fig. 4) Differential outlay and cross-section of a physical truss model

The equity of plane [2] of the area of a standard hipped roof (1).

$$z_{L,D} = \pm ax + Z_{\max} \tag{1}$$

Differential equity [1] of plane of the area of a hipped roof (2).

$$z_{L,D(x,y)} = \pm \frac{z' y \ \pm Z_{\max}}{x' y \text{ - } X_{\max}} x + (-z' y + Z_{\max}) \tag{2}$$

MathCAD procedure of defining the dimensions of a roof.

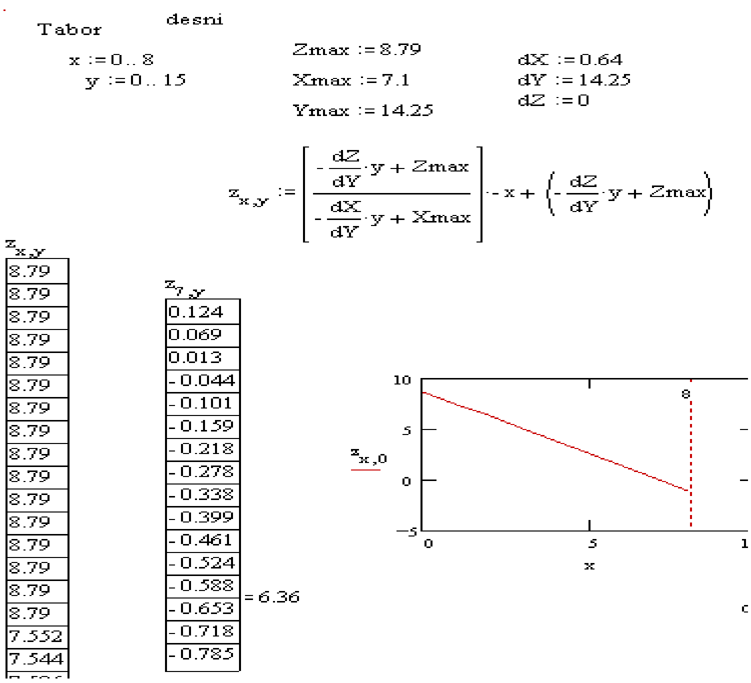

Fig. 5) MathCAD calculation of the roof dimensions

By means of defining a system of equities for the plane constants x or y = 0 or C with the roof area, cross-sections (i.e. straight lines) that define the characteristic feature of a constructive element (fig. 5) of a raft. In this way, all the elements can be defined and this makes designing of a roof possible without using truss patterns.

DIFFERENTIAL ROOF GEOMETRY – conclusion

The differential roof geometry provides for speeding up the processes of designing and constructing. By means of defining all the constructive elements with the new dimensional characteristics obtained from differential calculus equations, it is not only possible to evade the truss pattern methodology but as well to robotize the processes of constructing the objects implied. The idea has been developed ever since author's employment in the construction company Međimurje – Graditeljstvo (former GK).

Besides the gain at construction works, rationality is achieved in designing as well, especially when ArchiCAD or aCAD software technologies are used and it is because the mathematicizing of construction elements provides for the creation of models and simulations and, of course, for real world construction works and physical models making.

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THE ROLE OF THE SUPERVISOR AND THE ENGINEER BY THE FIDIC IN POLISH CONSTRUCTION PROJECTS*

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Abstract

The paper describe the scope of contract engineer responsibilities in FIDIC contracts in relation to construction supervisor responsibilities. The authors compare the range of their responsibilities based on the requirements set by the authorities. Authors in the article present statistical data of number of contract engineer and site inspector public service contract. Authors presents the role of investor's supervision inspector in Poland and its responsibility in the aspect of Construction Law and regulations in Poland. Contract Engineer in accordance with the Polish Construction Law is not a participant in the construction process. The authors therefore define the role of contract engineer in the Polish legal situation.

Keywords: construction law, contract engineer, supervision inspector, FIDIC.

* The complete text is available on CD-ROM / Leśniak, Zima

Introduction

The investment and construction process is a series of decision-making relationships and due to their specific nature and character it is very complex. It is related to participants of a construction project who are directly involved in the whole process of the investment [Gołaszewski et al., 2011].

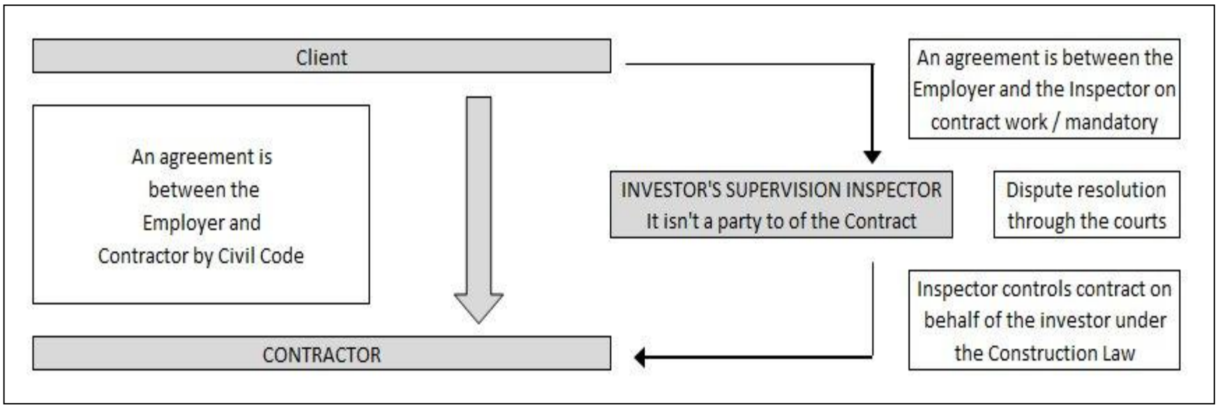

Fig. 1. Contract participants under Polish Construction Law (own source).

The participants of the construction process (under Construction Law) in Poland are:
1) investor;
2) investor's inspector;
3) designer;
4) the site manager or foreman.

Relationships between Investor, his inspector and contractor are shown in figure 1. A diagram of relationships between them is shown in figure 1. Each participant has his/her own rights and duties that are described in detail by Polish constructional law. Meanwhile in Poland, many investments (including public investments) are carried out in accordance with FIDIC contract templates. According to the most popular FIDIC Contracts patterns (red and yellow book), the participants of a construction process are:
1) Ordering Party;
2) Contractor;
3) Engineer;

Relationships between them are shown in figure 2. The Arbitration Committee, shown in the diagram is not mentioned above. Although it is indicated by FIDIC templates, it is not an obligatory participant of the contract and the parties need not include this entity.

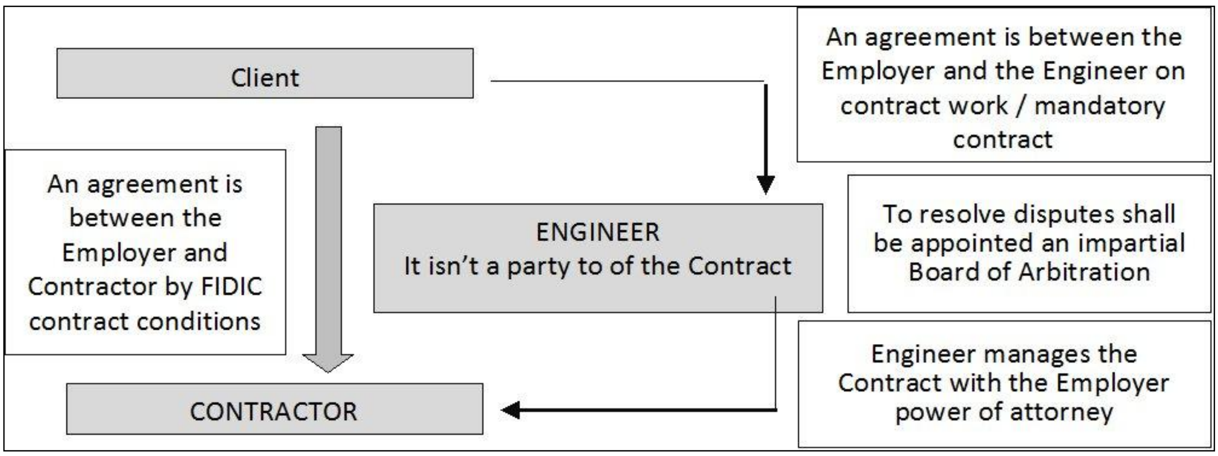

Fig. 2. Contract participants in FIDIC conditions (own source).

As it can be seen, the Investor (under Polish law) is understood by FIDIC as a Client. The construction manager, under Polish law, should be identified with the Contractor who is responsible for the completion of works, according to FIDIC. The Designer is a separate participant under Polish law. While the Designer (in accordance with FIDC patterns and depending on the investment system) is related respectively to: the Ordering Party - in the implementation system of the Design-Bid-Build or with the Contractor – in the Design & Build system. Additional participants who represent the Customer are: Investor's inspector, under Polish law, and the Engineer—according to FIDIC. The scope of their duties is roughly described respectively in: Polish Constructional Law for the Inspector and in FIDIC General Templates for the Engineer. However, in each of these cases, the client may implement additional duties that will be entered into the Contract.
In this paper, authors will focus on the role of the investor's inspector and engineer during the execution of Polish investments. On the basis of awarded contracts concerning investor's inspector function and engineer, their duties imposed by law, General Conditions of the Contract in accordance with FIDIC and by Ordering Parties themselves in case of public investments in Poland have been analyzed.

2. The rights and duties of the investor's inspector in Poland, under the Construction Law.

The primary responsibility of the investor is to organize the construction process, taking into account OHS provisions, in particular ensuring:

- development of a building permit design and, if appropriate, other designs
- Taking the construction management by the construction manager,
- Development of a safety and health protection plan,
- Performance and acceptance of the constructional works,
- In cases justified by a high level of works' complexity or subsurface conditions, supervision of the construction works by persons with relevant professional qualifications.

The investor can always establish a investor's inspector who will be his representative on site, and may require the designer to carry out author's supervision. Pursuant to Article 19. item 1. of Constructional Law, the competent authority may in its decision concerning building permission impose on the investor a duty to establish an investor's inspector, as well as the obligation to provide the author's supervision, if justified by a high level of facility complexity or constructional works or estimated impact on the environment.
In addition, some kinds of building facilities have been specified when during the execution it is required to establish investor's inspector as well as the list of building facilities and technical criteria that shall be taken into account when imposing a duty concerning the establishment of investor's inspector. The Project Supervisor was defined as an organizational entity paid by and acting on behalf of the Client, responsible towards him for the organization and coordination of all parties involved in the project [Leśniak et al., 2012]
Pursuant to Article 25. of Construction Law, the essential duties of investor's inspector comprise:
1) investor representation at the construction site by controlling the conformity of activities with the design and build permission, regulations and technical knowledge;
2) inspection of the quality of works and installed construction products, in particular the prevention of the use of defective construction products and items not permitted to be used in construction;
3) testing and commissioning of constructional works to be covered up or backfilled; participation in testing and technical acceptance of installations, machinery and chimney ducts; preparation and participation in the activities of finished works commissioning and allowing them for use;

4) confirmation of actually performed works and defects removal as well as inspection of building site financial settlements upon investor's demand.
The rights of the investor's inspector are defined in Art. 26 of the aforementioned Act. Investor's inspector has right to:
1) give commands to the construction manager or foreman, confirmed by an entry in the building log, concerning: the removal of incorrectness or risks, tests or researches, including those requiring uncovering installations or items covered; production of and expert's opinion concerning construction works and permissions for building products and technical devices to be used in construction engineering;
2) demand the site manager or foreman to fix or re-execute defective works and to suspend further works in case their continuation may cause unacceptable risk of non-compliance with the design or construction permission.
In the case of construction of a building facility that requires the establishment of more than one investor's inspectors in various specialties, the investor shall appoint one of them as a coordinator of the activities carried out by other inspectors on site.

3. Analysis of the investor's requirements for investor's inspectors.

Researches were focused on public contracts awarded in April 2013 to Poland concerning the investor's inspector function during the construction of building facilities. In the analyzed period, 123 public procurement contracts have been awarded in the specific period. 61 procurement contracts were awarded to investments executed with the usage of EU funds. Orders were executed mainly for local governments. Distribution of contracting types is shown in the figure 3.

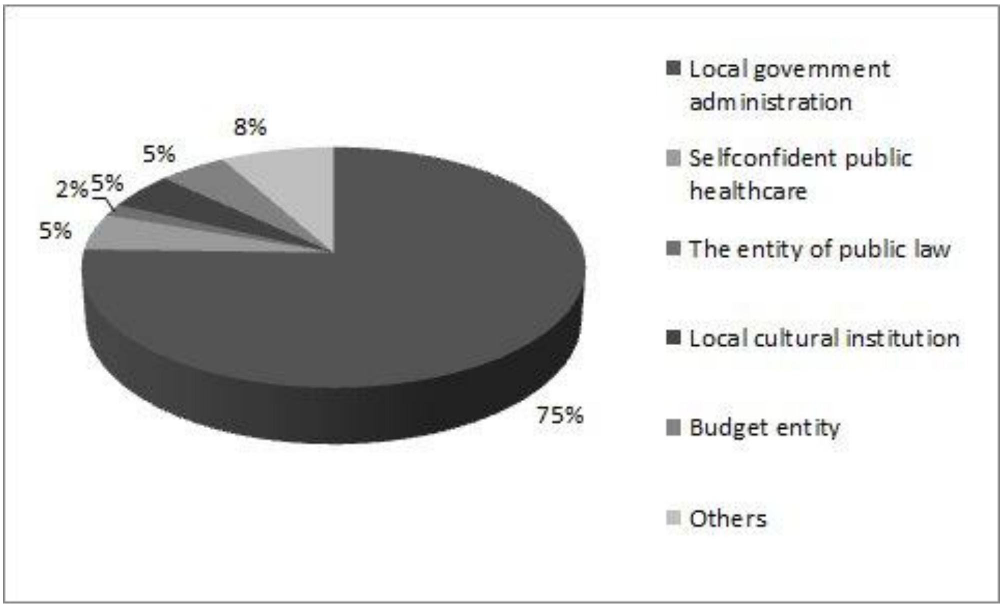

Fig. 3. Types of investor's inspectors who order the service (own source).

Public procurements concerning investor's inspector services as shown in the figure 4 were carried out mainly through tendering (95.1%), and in other cases under unsolicited contracts (4,9%).

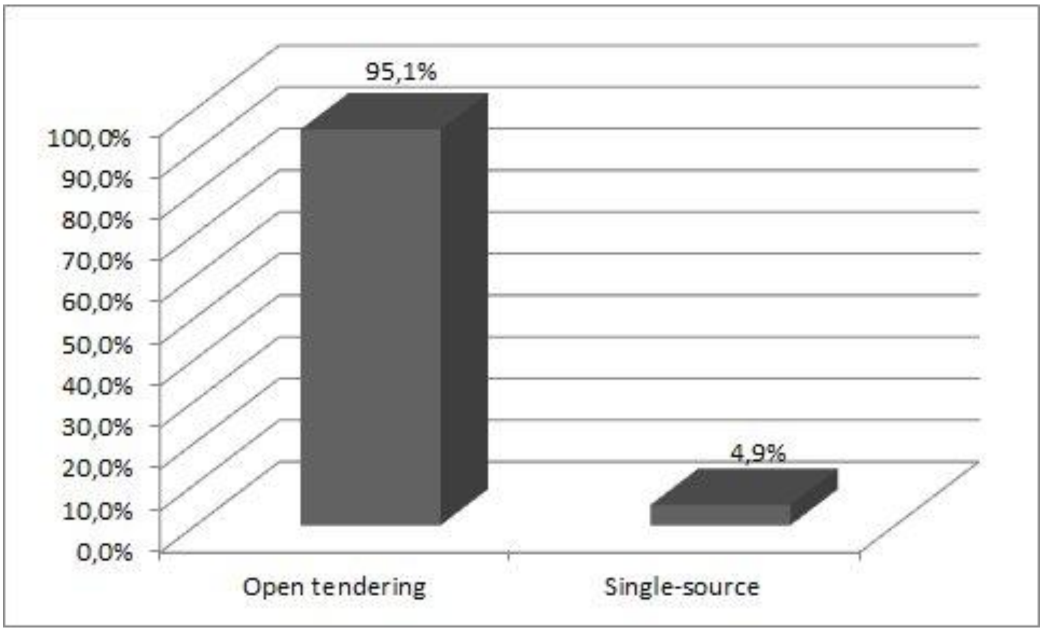

Fig. 4. Methods of ordering services of an investor's inspector (own source).

The bid selection criterion was the lowest price for each analyzed case. The minimum value of the winning bid was PLN 1.238,44 and a maximum of PLN 420.000,00. There was also a large number of people interested in submitting bids for investor's inspector function. The average number of bids was 7. The lowest number of submitted bids was 1 and the biggest number – 34. Submitted bids were in 55 cases lower than the estimated value of the contract, in 5 cases higher, and in one case, the estimated value of the contract was identical with the submitted bid (in this case only one bid was submitted in an open tender).

There were significant differences between the price of the chosen bid and the price estimate (fig. 5). The maximum absolute value of the difference between the price of the selected bid and the price estimate was 97.1%, the average difference is 44%. Similar differences are between the price of the selected bid and the maximum price. In this case, the maximum absolute value of the difference was 92.9%%, the average difference is 60.2%. This reflects the major problems in estimating the bid price, both estimated by the investor as well as bid price, by investor's inspectors.

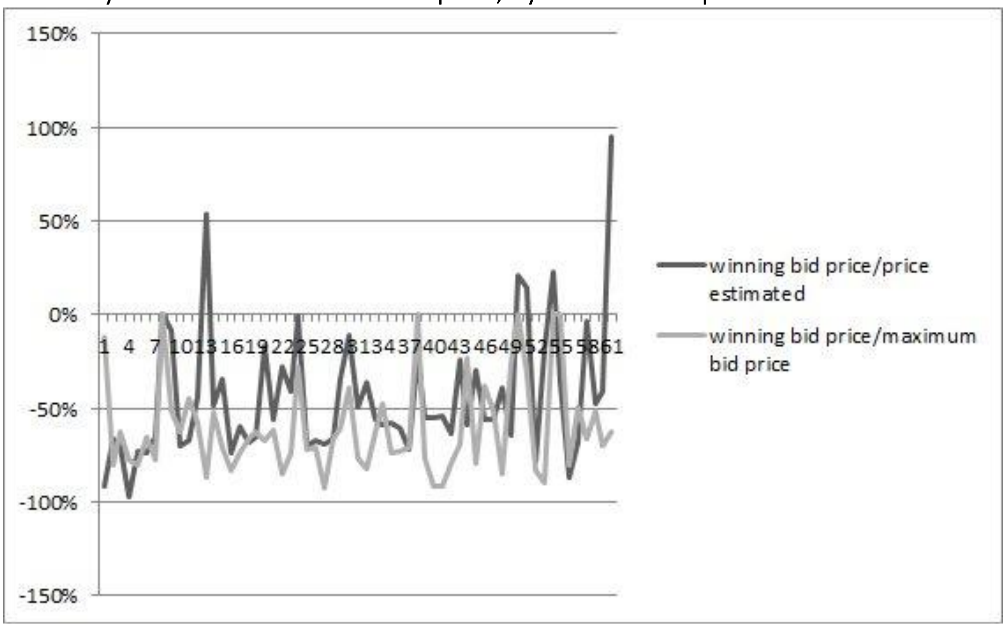

Fig. 5. Differences in estimated and bid prices for the service of investor's inspection on site (own source).

The main factors that affect the bid price are, inter alia, the requirements of investors regarding their duties. As a result of the analysis of duties imposed on the investor's inspectors, 70 different duties were distinguished. The scope of responsibilities described in contracts by the investors has been divided by authors into 2 groups:
- compliant with the duties imposed on the investor's inspectors by Construction Law (Table 1),
- the duties imposed on the investor's inspectors not mentioned in Construction Law (Table 2).

Table 1. Duties of the investor's inspection in accordance with Ordering Parties requirements, compliant with Construction Law (own source).

Responsibilities according to Construction Law	**Requirements of the Employer**	**The frequency of occurrence [%]**
investor representation on the construction site by checking conformity of its implementation with the design and the construction permit, the rules and principles of technical knowledge;	conformity checking of the works with the design documentation, rules of technical knowledge and the contract	89%
checking the quality of the works and the built construction products, in particular the prevention of the use of defective construction products and banned from use in construction	checking the quality of the works and the built construction products, in particular the prevention of the use of defective construction products and banned from use in construction	100%
testing and reception of of construction works to be covered up or disappearing, to participate in the testing and technical acceptance of installations, machinery and chimneys and the preparation and participation in the activities of receipt of finished works and distributing them to use	testing and reception of of construction works to be covered up or disappearing, to participate in the testing and technical acceptance of installations, machinery and chimneys	93%
	participation in inspections during the warranty period and the statutory warranty and controlling the removal of defects disclosed	50%
	completing documentation related to the final acceptance	46%
	confirmation of readiness to the receipt of work	29%
	participation in proceedings relating to the commissioning of an object or its parts to use	18%
confirmation of actually performed work and removed defects and, at the request of the investor, controlling of construction settlements	controlling of construction settlements	50%
	confirmation of actually performed work and removed defects	46%
	checking the bid cost estimation submitted by the Contractor	39%
	final settlement of investment	39%
	preparation of protocols in the case of additional works or replacement works	36%
	preparation a written report including opening report, quarterly reports and the final report	32%
	checking the documents attached to the settlement of works	25%
	confirmation of the scope and quantity of performed work, as the basis for the payment of contractor wages	18%

Table 2. Other duties imposed on the investor's inspector by Ordering Parties, not mentioned in Construction Law (own source).

Requirements of the Employer	The frequency of occurrence [%]
verification of compliance works progress with the schedule of works and financial schedule	64%
Employer-to-date informing on the progress of works and detected irregularities or risks in the execution of works	57%
organizing and participating in co-ordination meetings (Building Counsil) and to ensure the implementation of the findings and decisions of the Building Counsil	54%
control over the correctness of the execution of works in accordance with the terms of Health and Safety	54%
getting there and staying on-site with a specific frequency, and in particularly justified cases, on every Employer's call	46%
preparation of actual photographic documentation during the execution of the works	32%
issuing opinions on proposed changes in production technology and materials proposed by the Contractor and the Employer	29%
cooperation with the project architect's supervisor and the Contractor during the execution of the works	29%
agreeing on with the Employer of any changes to the value and scope of supervised works	29%
opinions on the proposals for additional works and replacement works and the verification of the relevant cost estimations	29%
coordination of the work of many investor's supervision inspectors	25%
checking the completeness and accuracy of the documents prepared by the Contractor	25%
read the design and cost documentation and eventual contribution to comment on it	25%
participation in coordination meetings with the Employer	21%
estimation and verification of additional works or replacement works proposed by the Contractor to the extent physical values and financial	21%
strict control of the invoice of performed work	21%
protocolary transfer the construction site to Contractor, with the participation of the Employer,	21%
cooperation with the Employer in enforcing the contract provisions	18%
representing the Employer at the construction site in all the technical issues related to the implementation of investment, problem solving and approving changes	18%
checking the material scope and value of the works before receiving an item or object of the contract	18%
administration and management of works which are the subject of a contract for construction work	14%
substantive assistance in the preparation of tender documents (including updates investor cost estimation) and participation in the work of the tender committee	14%
getting familiar with the agreement between the Employer and the Contractor	14%
verification and acceptance of subcontractors	11%
removal request from the construction site of an incompetent or other persons not employed by the contractor	11%

explanation of complaints and disputes and claims relating with investment realization	11%
in case of design defects or necessity to introduce changes during the execution of the works - the preparation of a written request to the designer	11%
substantial involvement in the preparation of grant applicationsaddressed to government investment funding institutions	11%

4. Templates of FIDIC Contractual Terms – Polish reality

In recent years, a system with the participation of a manager, based on Templates of Contractual Terms, elaborated by the International Federation of Consulting Engineers (FIDIC) became a popular system in the execution of public investments in Poland. FIDIC contracts are not specified for use under any Polish law provisions. By recognizing the provisions of Polish civil law in accordance with the Civil Code [The Act of 23 April 1964] concerning the freedom of contract conclusion, they can be classified into the category of mutual agreements that are subject to the provisions of Section III of the Civil Code. Taking into account article 3531 of the Civil Code [The Act of 23 April 1964], concerning economic freedom and the principle of liberty to conclude contracts, any written agreement that is not in discrepancy with the principles of communal cohabitation and provisions of Section XVI of the Civil Code [The Act of 23 April 1964] is binding for the contracting parties to a building permit contract. As a result of concordant acceptance of contractual terms by both parties, the contractor is obliged to deliver the agreed facility in accordance with the design and so-called best constructional practices and the investor is obliged to pay the agreed remuneration,

The increased popularity of FIDIC contracts in public procurement is associated with the Polish accession to the European Union (2004), because very often they are recommended for use in construction designs financed from EU funds. The use of these templates is described, inter alia, by article 3c on public procurement [The Act of 29 January 2004]. FIDIC contractual terms were known and used in Poland previously but mainly in private sector investments.

These contracts are known and distributed worldwide as examples of good practices, established on the basis of many years of experiences [International Federation of Consulting Engineers]. They are famous for the fact that they reasonably maintain balance between the requirements and interests of the parties and, depending on the approved contract model, they fairly distribute risks, threats and responsibility.

In Poland, there are two commonly used models of FIDIC contract terms:

- Conditions of Contract for Construction. For Building and Engineering Works designed by the Employer [Conditions of Contract for Construction For Building and Engineering Works Designed by the Employer, 1999] so-called „red book".
- Conditions of Contract for Plant & Design-Build (First Ed, 1999). For Electrical & Mech. Plant & For Building & Engineering Works Designed by the Contractor [Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Works Designed by the Contractor, 1999]. so-called "yellow book".

In these contract templates, an additional entity (managing company, called herein the Engineer or the Contractual Engineer in Polish conditions) is introduced to the organizational structure. The Engineer is not a party to the contract concluded between the contractor and the ordering party. Therefore, it not possible to correct this contract or exempt any party from its obligations stated in this contract. During the investment preparation, the execution of works and within the period of notification of defects, the Engineer acts (administers and coordinates the contract) on behalf of the ordering party and is his plenipotentiary, which results in a number of rights and responsibilities.

Powers and duties of the Engineer result from the type of selected contract template (red book or yellow book). The structure of Contractual Terms templates is also significant. This structure is divided into two parts: part I – General conditions, part II – Specific Conditions.

Part I – called as **General Conditions – these are regulations contained without modifications in the Contract.** They should always be attached to the tender documents as published by FIDIC. General conditions are intended for use in an unchanged form.
Part II - called as **Specific Conditions – covers regulations connected to particularization of the Contract.** It contains amendments or additional clauses in relation to the original version (i.e. Part I) that was decided to be included by the Ordering Party. These include regulations concerning contract particularization. It means that they complement, correct and introduce additional clauses (sub-clauses) to the General Conditions in order to:

→ unambiguously specify the duties and powers of the parties - changes that have decided to be included by the Ordering Party
→ Define some terms or give them due appropriate meaning
→ Take into account the appropriate law regulations (in case of Poland – Civil Code,
→ Construction Law, possibly – Public Procurement Law in case of public sector investment)

Part I and II jointly comprise rights and obligations of the parties. In relation to the above – also in case of duties or powers of the Engineer, the Ordering Party may also include certain provisions in order to specify them. Then, they are included in the agreement between the Ordering Party and the Engineer. It may be based on templates of Contractual Terms of FIDIC Client / Consultant Model Services Agreement (the White Book) [White Book, 2006]. In Polish conditions, the ordering parties often prepare own agreement drafts related to the Engineer function that are previously described agreements containing fiduciary features (under the Civil Code).

5. Analysis of investor's requirements for Engineers on contracts executed in accordance with FIDIC

A key player on the above-mentioned patterns of FIDIC Contracts is the Engineer. His main task is objective administration of the Contract in the interests of both parties, so that the works shall be carried out in accordance with the material scope of the contract and the contractor shall receive appropriate remuneration for performed works. The engineer fulfils its obligations by giving commands, making decisions, opinions, consents and approvals in oral or written from, which are applicable to the Contractor, and always in accordance with the Contract.
Research concerned public procurement contracts awarded in April 2013 to Poland to perform the Engineer function (under FIDIC) during the construction of building facilities. Within the analyzed period, 15 public procurements were awarded, of which only one was carried out with the use of EU funds. Orders were carried out mainly for local government (40% of orders). Distribution of ordering parties' types is shown in Figure 6.

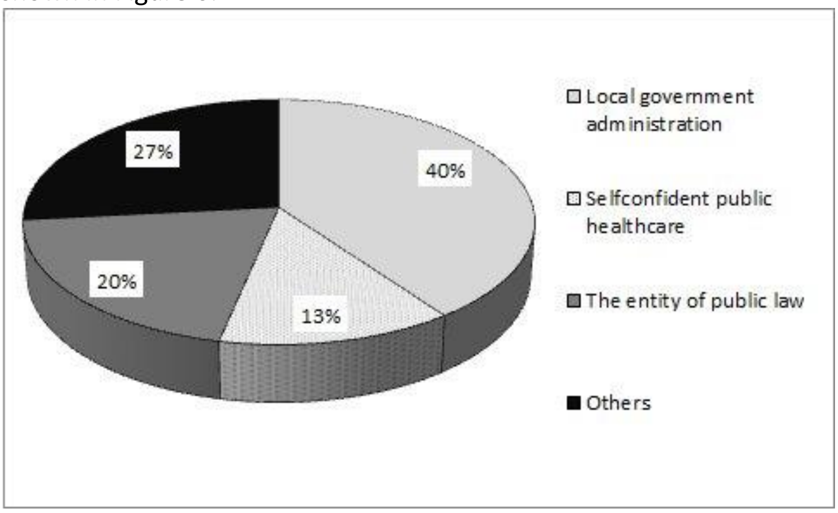

Fig. 6. Types of parties ordering investor's inspector services (own source).

Public procurement concerning the Engineer services (according to FIDIC), as shown in Figure 7, were carried out mainly in the open tender manner (80%). Other manners are negligible.

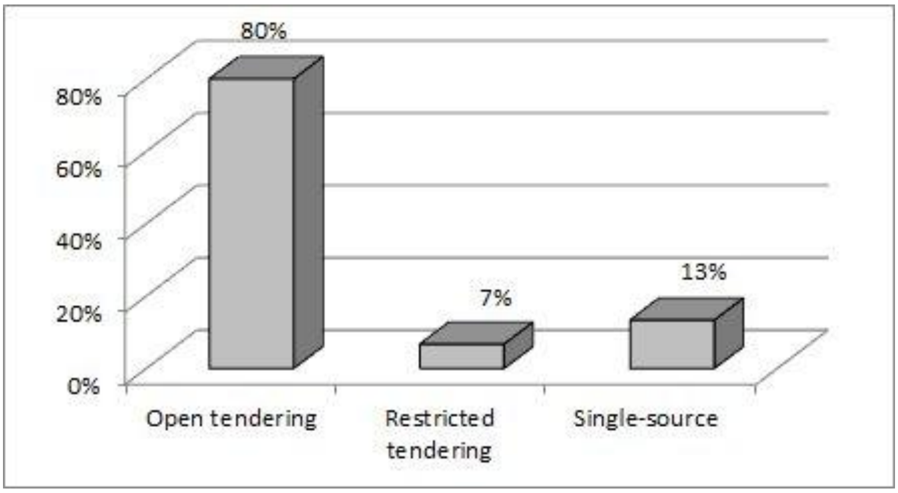

Fig. 7. Manners of ordering Engineer's services under FIDIC (own source).

The bid selection criterion was the lowest price for each analyzed case. When choosing the best bid in all proceedings, only one criterion has been used - the lowest price criterion. It should be noted that service contracts in accordance with the Public Procurement Office are second-tier contracts where ordering parties use a larger number of criteria. However, this is not confirmed in the analyzed cases where the services relate to the construction industry.

In the proceedings, 4 offers were submitted on average. The minimum number of bids was 1 and the maximum was 12. Submitted bids in 47% cases were lower and in 40% higher than the estimated contract value. In two cases it was the same value. It is therefore difficult to determine a pattern here.

There were significant differences between the price of the chosen bid and the price estimate (Fig. 8). The maximum absolute value of the difference between the price of the selected bid and the price estimate was 90%, the average difference is 42%. Smaller differences (insignificantly) are between the price of the selected bid and the maximum price. In this case, the maximum absolute value of the difference was 76%%, the average difference was 30%. This demonstrates problems to estimate the bid price, both estimated by the investor, as well as by potential contractors - Engineers.

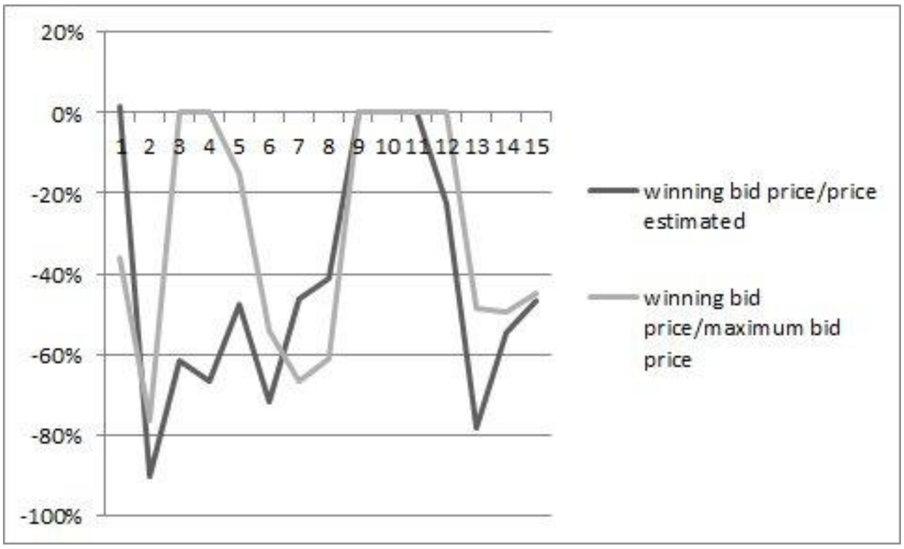

Fig. 8. Differences in the formation of estimate and bid prices for the Engineer services under FIDIC (own source).

The main factors that affect the bid price are, inter alia, the requirements of investors regarding their duties. As a result of an analysis of 15 awarded procurement contracts, the duties appearing most frequently, and imposed on Engineers in accordance with FIDIC were indicated. In this case, the scope of responsibilities described in procurements by investors can be divided into two groups
- obligations imposed by the General Contractual Terms FIDIC
- obligations arising from Specific Terms of the prepared Contract,
These terms are presented in table 3.

Table 3. Engineer's duties in accordance with FIDIC and ordering parties' demands (own source).

Examples of obligations imposed by the General Contractual Terms FIDIC	**Obligations arising from Specific Terms of the prepared Contract (clients requirements)**	**The frequency of occurrence [%]**
◆ acceptance of the contractor's staff on the construction site with the ability to remove persons in the case of negligence	◆ act as supervisor,	100%
◆ approving subcontractors entering on the construction site,	◆ test and evaluate the design and technical documentation held by the Employer,	47%
◆ approving the contract key documents: the program, the payment schedule, the quality assurance program,	◆ technical assistance related to the construction, evaluation of the proposed changes to the original assumption,	87%
◆ issuing decisions on the contract terms,	◆ organize construction meetings,	100%
◆ deciding on admission to use or to reject materials and all prefabricated components and devices provided to execution of the works,	◆ activities related to the preparation and conduct of procurement procedures for construction works and supply,	47%
◆ approving the amount to be paid in the temporary certificates of payment,	◆ occurrence on behalf of the the Employer with the application for a permit to use the building.	33%
◆ interpreting the claims of the parties and the settlement of the terms of the contract agreed,		
◆ issuing commands the contractor.		

Summary

Analyzing awarded public procurement contracts concerning services in construction industry, the two most common functions in Poland were distinguished, which are related to the management during the investment execution. The Investor's inspector - resulting from the provisions of Polish law and the second – the Engineer function, in accordance with FIDIC contractual terms. Both entities are supposed to represent (but not replace) the customer and ensure the correctness of construction. According to Polish law, the inspector's scope of duties is smaller than that of the Engineer, according to FIDIC. However, they are usually extended by additional requirements of the ordering parties. In case of the investment execution in accordance with FIDIC templates, the Engineer's obligations arise from the contract template (red or yellow book). In most cases, they are expanded in the Special Conditions. Next, they are jointly entered into the contract between the ordering party and the engineer. Among these additional responsibilities in all analyzed cases, the actions of inspector under the Polish law were included in the extended scope of duties of the Engineer, and the service order was limited in this case only for the choice of the Engineer. With regard to the imposed duties, these entities do not exclude themselves but mutually complement each other (Fig. 9).

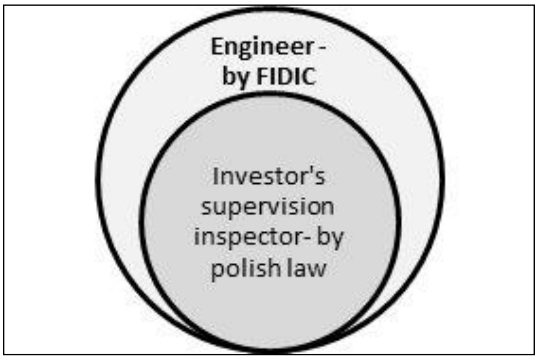

Fig. 9. Engineer's duties (own source).

It was noted that in both cases, one of the main ways to grant this type of contract is an open tender, which does not require the existence of certain factors specified by regulations and bids may be submitted by all interested contractors. This form of inspector or engineer selection should not arouse any reservations, but the fact of using only one criterion (the price) is disturbing. Taking into account that these entities (on behalf of the ordering party) coordinate the course of works and contractors' activities, the quality criterion shall also be taken into account. Especially FIDIC publications [Guidelines for the Selection of Consultants, 2003] clearly show the necessity to choose the Engineer mainly on the basis of the quality criterion, which seems to be unnoticeable by public ordering parties. Such attitude often leads to the selection of incompetent companies and further problems with the investment execution, which can be in practice experienced by both parties: the ordering party and contractor.

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PREDICTING FUTURE PERFORMANCE BY LEARNING CURVES*

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Abstract

Mathematical learning curve models can be used in construction to predict the time or cost required to perform a repetitive activity. In this study, we evaluated mathematical models for different learning curves for flat roof insulation reconstruction work. Our evaluation was based on a survey conducted in the spring of 2009 in Budapest and data obtained from literature. Several mathematical models, Wright model, DeJong model and Stanford B model, were identified and used for prediction. The objective of this paper is to describe the results of an exploratory study to evaluate the predictive capabilities of various learning curve models and data presentation methods for labor-intensive construction operations.

Keywords: learning curves, exponential average, construction time estimation

* The complete text is available on CD-ROM / Malyusz

Introduction

The objective of this paper is to contribute a development of algorithm for predicting construction activity time based on learning curve theory. Learning curves imply that when numerous similar or nearly identical tasks are performed, the effort is reduced with each successive task (Fabrycky et al., 1972, Oswald, 1974, Oglesby et al., 1989, Drewin 1982, Teplitz 1991, Everett and Farghal, 1994,1997 Lutz et al. 1994, Lam et al., 2001, Couto and Teixeira, 2005). Learning curve theory can be applied to predicting the cost and time, generally in units of time, to complete repetitive activities. The cumulative average time method was used in the original formulation of the learning curve method, referred to as Wright's model, in Wright's famous paper on the subject in 1936. A number of researchers have suggested that Wright's model is the best model available for describing the future performance of repetitive work (Everett and Farghal 1994, Couto and Teixeira 2001). In (Malyusz and Pém, 2012) the exponential average method with α =0.5 yielded the most accurate predictions. In this study, we evaluated Wright model, DeJong model and Stanford B model for prediction of future activities. Moreover we investigated data presentation models based on (Farghal and Everett,1997 and Mályusz and Pém , 2011).

2. Theoretical background

2.1 Mathematical models

Learning curve theory is applicable to the prediction of the cost or time of future work, assuming repetitive work cycles with the same or similar working conditions in terms of technology, weather, and workers, without delay between two consecutive activities. The direct labor required to produce the (x + 1)st unit is assumed to always be less than the direct labor required for the xth unit. The reduction in time is a monotonically decreasing function, an exponential curve, as described in (Wright 1936) paper.
In this study, we calculate the labor hours/square meter for each repeated activity.
Wright's linear log x, log y is as follows:

$$\ln y = \ln a + b \ln x; \vee y = ax^b = ax^{\log_2 r} \quad (1),$$

where ***x*** is the cycle number, ***y*** is the time required to complete cycle *x* in labor hours/square meter, **a** is the time required to complete the first cycle, ***b*** is a learning coefficient, and r is the rate of learning. For example if r=0.9 (90%), then b=-0.151. Wright discovered that when the labor cost decreases at a constant rate, that is, the learning rate, the production/cycles doubles. So learning rate is the constant rate with which labor time/cost decreases when the production/cycles doubles in a linear log x, log y model. This feature of the learning rate comes from the logarithms nature and true only in linear log x, log y model. We do not define the rate of learning in the other models.
Dejong model is a generalization of Wright's model based on the assumption that there is a minimum required time (a_0) to complete a cycle. Sometimes it is expressed with a so-called factor of incompressibility M.

$$y = a\left(M + \frac{1-M}{x^b}\right) = a_0 + (a - a_0)x^{-b}$$

Where M is between 0 and 1 where M = 0 represents a complete manual operation, and M = 1 describes a completely automatic operation, (Gottlieb and Haugbølle, 2010).

Stanford B model is another generalization of Wright's linear-log model based on the assumption that workers have experience. The experience is expressed with a so-called B-factor:

$$y = a(x+B)^{b},\ \ln y = \ln a + b\ln(x+B)$$

Where B expresses the number of units produced before the first unit. The value of B will be in the range of 0-10 (Gottlieb and Haugbølle, 2010; Kara and Kayis, 2005: 209).
S curve model consists of both the incompressibility M and the effect of experience factor B.

$$y = a_0 + (a - a_0)(x+B)^{-b}$$

2.2. Data presentation methods

The unit is the data item that represents the time required to perform one cycle of the insulation work.
Wright (1936) discovered that the cumulative average **(CA)** time decreased by a fixed percent when the output doubles. CA represents the average time or cost of different quantities (x) of units.

$$CA_t = \frac{(Y_1 + Y_2 + \ldots Y_{t-1} + \ldots + Y_t)}{t}. \quad (2)$$

where t is the number of cycles, CA_t is the cumulative average in cycle *t*, and Y_t is the unit time or cost for cycle *t.*
The moving average **(MA)** in this paper is the average time of the last 3 cycles. Although the MA is an average like the CA, the MA represents the most recent data. More points will help smooth the curve.

$$.\ MA_t = \frac{(Y_t + Y_{t-1} + Y_{t-2})}{3} \qquad (3)$$

The weighted moving average (**WMA**) is a generalization of MA.

$$WMA_t = \frac{(tY_t + (t-1)Y_{t-1} + (t-2)Y_{t-2} + \ldots + Y_1)}{(t + (t-1) + (t-2) + \ldots + 2 + 1)}$$

A weighted moving average has multiplying factors to give different weights to data at different positions.
The exponential average **(EA)** is a weighted average of the most recent data and the previous average.

$$EA_t = \alpha Y_t + (1-\alpha)EA_{t-1}$$

$$EA_{t-1} = \alpha Y_{t-1} + (1-\alpha)EA_{t-2}$$

$$EA_{t-2} = \alpha Y_{t-2} + (1-\alpha)EA_{t-3}$$

That is,

$$EA_t = \alpha Y_t + \alpha(1-\alpha)Y_{t-1} + \alpha(1-\alpha)^2 Y_{t-2} + (1-\alpha)^3 EA_{t-3} \text{ (4).}$$

where $\mathbf{EA_t}$ is the exponential average time for cycle *t, EA_{t-1}* is the exponential average time for cycle t-1, $\boldsymbol{Y_t}$ is the unit data (time to perform an activity) in cycle *t*, and **α** is a coefficient. If **α** is greater than 0.5, then the effect of new data is greater than that of older data if **α** is 1 then older data has no effect and we give back unit data. In this study, some values of **α**, were examined.
The relationship between log *y* and log *x* described by equation (1) can be plotted as a straight line on log-log paper, and all the regression formula apply to this equation just as they do to the equation. Mathematically, when x and y are given it is solvable for parameters *a* and *b* using the least squares method.

2.3. Description of the project

The data for this study were collected by writers in a real roof insulation work. The surveyed project was a reconstruction of flat roofing. During the reconstruction process, the circumstances and the weather were ideal for roofing (sunny, 26–33°C, no wind). The same workers performed the entire project. The technology was repetitive within one part. The workers knew that they were being monitored, but they were not informed as to what was being measured, and they were not disturbed. In the part of the reconstruction process that was studied, the work under consideration consisted of the following activities: slicing up the old waterproofing, laying down 10-cm-thick heating insulation and attaching it to the roof using screws, spreading one layer of rubber waterproofing, and melting it to the cape of the screws. The joining, the fixing of the edges, and the changing of the roof windows were not surveyed. The timer was stopped whenever the workers took a break or performed any activity that was not being studied. Time to complete one cycle was measured only. The timer was stopped when workers took a break. The roof of the hall building was divided into 7 sections. The areas of the sections were not all the same, so during the evaluation, we calculated the labor hours/square meter.

3. Learning analysis of Hall building

3.1. Input data

In Table 1, the input raw data for the hall building are in the "Unit" column. The units of the numbers in the Unit, CA, MA, WMA, and EA(0.5) columns are labor hours/square meter.

Cycle	Unit	CA	MA	WMA	EA(0.5)
1	**2.132**	**2.132**	**2.132**	**2.132**	**2.132**
2	**1.789**	**1.961**	**1.961**	**1.903**	**1.961**
3	**1.588**	**1.836**	**1.836**	**1.746**	**1.775**
4	**1.54**	**1.762**	**1.639**	**1.663**	**1.658**
5	**1.575**	**1.725**	**1.568**	**1.634**	**1.617**
6	**1.546**	**1.608**	**1.554**	**1.609**	**1.582**
7	**1.541**	**1.558**	**1.554**	**1.592**	**1.562**

Table 1: Raw input data of hall building (in labor hours/square meter)

3.2. Analysis and results

In next tables we summarise the results of our investigation.

Results for hall building:

There are accuracies of the different data presentation methods for Wright model in table 2. The more less is the more precise to fit.
Wright model , B=0, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,025	0,055	0,186	0,047	0,257	0,227	0,162	0,095	0,052
4	0,075	0,066	0,489	0,048	0,564	0,427	0,221	0,100	0,069
5	0,246	0,12	0,578	0,148	0,845	0,574	0,220	0,193	0,207
6	0,355	0,176	0,605	0,251	1,199	0,681	0,251	0,278	0,322
SUM	0,701	**0,417**	1,858	0,494	2,865	1,909	0,854	0,665	***0,650***

Table 2: Predicting historical data for Wright model

Best fit for historical data is CA.

Stanford B model , B=10, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,053	0,031	0,194	0,036	0,137	0,115	0,060	0,008	0,029
4	0,222	0,159	0,368	0,167	0,254	0,151	0,069	0,130	0,190
5	0,429	0,379	0,401	0,387	0,305	0,160	0,222	0,364	0,412
6	0,553	0,587	0,649	0,582	0,339	0,207	0,355	0,515	0,550
SUM	1,257	1,156	1,612	1,172	1,035	**0,633**	0,706	1,017	1,182

Table 3: Predicting historical data for Wright model

The most precise is the EA with **α**=0,25.

DeJong model , B=0, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,053	0,069	0,191	0,068	0,257	1,814	0,182	0,123	0,082
4	0,061	0,088	0,518	0,079	0,584	0,910	0,283	0,141	0,084
5	0,199	0,096	0,625	0,132	0,855	0,459	0,304	0,194	0,192
6	0,29	0,138	0,628	0,182	1,269	0,973	0,305	0,242	0,273
SUM	0,603	**0,391**	1,962	0,461	2,965	4,156	1,074	0,700	**0,631**

Table 4: Predicting historical data for DeJong model

The most precise estimation is CA for historical data.

S curve model, B=5, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,011	0,007	0,177	0,002	0,157	0,143	0,098	0,051	0,014
4	0,145	0,084	0,432	0,088	0,314	0,239	0,111	0,066	0,107
5	0,352	0,25	0,45	0,266	0,415	0,262	0,176	0,255	0,322
6	0,463	0,404	0,591	0,412	0,549	0,269	0,245	0,384	0,445
SUM	0,971	0,745	1,65	0,768	1,435	0,913	**0,630**	0,756	0,889

Table 5: Predicting historical data for S Curve (B=5, a_0=1) model

EA with =0,5 is the most precise estimator.

S curve model , B=10, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,022	0,018	0,185	0,015	0,157	0,127	0,084	0,037	0,003
4	0,169	0,114	0,409	0,115	0,274	0,195	0,087	0,072	0,134
5	0,378	0,303	0,411	0,306	0,335	0,202	0,186	0,291	0,356
6	0,491	0,472	0,592	0,467	0,409	0,211	0,275	0,428	0,478
SUM	1,06	0,907	1,597	0,903	1,175	0,735	**0,632**	0,829	0,970

Table 6: Predicting historical data for S curve (B=10, a_0=1) model

EA with =0,5 is again the most precise estimator.
Among mathematical models DeJong model gives the best estimation.

Best predictor for next cycle:

Wright model , B=0, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
4	0,063	0,051	0,408	0,006	0,377	0,272	0,119	0,008	0,040
5	0,142	0,059	0,187	0,105	0,371	0,199	0,001	0,104	0,134
6	0,104	0,114	0,023	0,153	0,418	0,175	0,033	0,103	0,110
7	0,101	0,161	0,150	0,195	0,452	0,144	0,065	0,109	0,106
SUM	0,410	0,385	0,768	0,459	1,618	0,790	**0,218**	0,324	0,390

Table 7: Accuracies for predicting next cycle for Wright model

EA with =0,5 is the most precise estimator for next cycle.

Stanford B model , B=10, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
4	0,158	0,189	0,228	0,179	0,167	0,092	0,027	0,111	0,145
5	0,223	0,359	0,065	0,324	0,101	0,029	0,159	0,218	0,227
6	0,163	0,456	0,284	0,381	0,088	0,069	0,183	0,197	0,181
7	0,149	0,539	0,387	0,427	0,082	0,108	0,203	0,189	0,164
SUM	0,693	1,543	0,964	1,311	0,438	**0,298**	0,572	0,716	0,716

Table 8: Accuracies for predicting next cycle for Stanford B model

EA with =0,25 is the most precise estimator for next cycle.

DeJong model , B=0, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
4	0,033	0,079	0,429	0,042	0,377	0,280	0,137	0,033	0,010
5	0,110	0,009	0,217	0,057	0,381	0,215	0,025	0,073	0,101

6	0,075	0,048	0,019	0,094	0,428	0,199	0,003	0,071	0,078
7	0,074	0,084	0,099	0,127	0,462	0,176	0,029	0,076	0,078
SUM	0,292	0,220	0,764	0,320	1,648	0,870	**0,194**	0,253	0,268

Table 9: Accuracies for predicting next cycle for DeJong model

EA with =0,5 is the most precise estimator for next cycle in DeJong model.
Among mathematical models DeJong model gives the best estimation.

S curve model , B=5, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
4	0,093	0,097	0,297	0,088	0,217	0,140	0,031	0,048	0,078
5	0,160	0,229	0,040	0,207	0,161	0,043	0,085	0,146	0,158
6	0,111	0,288	0,155	0,244	0,178	0,019	0,103	0,129	0,122
7	0,103	0,350	0,252	0,279	0,182	0,008	0,121	0,127	0,113
SUM	0,467	0,964	0,744	0,818	0,738	**0,210**	0,340	0,450	0,471

Table 10: Accuracies for predicting next cycle for S curve (B=5, a_0=1) model

EA with =0,25 is the most precise estimator for next cycle in S Curve model.

Best predictors for the rest of the work:

Wright model , B=0, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,736	0,338	1,529	0,665	3,088	1,726	0,264	0,460	0,661
4	0,539	0,469	0,317	0,673	1,841	0,822	0,117	0,472	0,535
5	0,248	0,331	0,185	0,425	1,050	0,399	0,112	0,255	0,263
6	0,456	0,337	0,755	0,447	1,651	0,825	0,316	0,387	0,428
SUM	1,979	1,475	2,786	2,21	7,630	3,772	**0,809**	1,573	1,887

Table 11: Accuracies for predicting whole work for Wright model

EA with =0,5 is the most precise estimator for next cycle.

Stanford B model , B=10, a_0=0.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	1,526	3,403	0,795	2,894	1,228	0,218	1,000	1,444	1,528
4	0,935	2,348	0,994	1,968	0,471	0,282	0,883	1,021	0,986
5	0,403	1,296	0,833	1,056	0,220	0,217	0,490	0,496	0,446
6	0,702	1,126	1,036	1,009	0,421	0,315	0,558	0,704	0,714
SUM	3,566	8,173	3,658	6,927	2,340	**1,032**	2,931	3,665	3,674

Table 12: Accuracies for predicting whole work for Stanford B model

EA with =0,25 is the most precise estimator for next cycle.

DeJong model , B=0, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9

3	0,485	0,172	1,727	0,308	3,158	0,182	0,440	0,288	0,412
4	0,391	0,175	0,371	0,39	1,881	0,283	0,053	0,320	0,382
5	0,178	0,16	0,109	0,265	1,080	0,304	0,034	0,175	0,186
6	0,364	0,222	0,727	0,31	1,731	0,305	0,334	0,318	0,351
SUM	1,418	0,729	2,934	1,273	7,850	1,074	**0,861**	1,100	1,330

Table 13: Accuracies for predicting whole work for DeJong model

CA is the most precise estimator for next cycle.

S curve model , B=5, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,888	1,912	0,734	1,578	1,748	0,670	0,422	0,785	0,871
4	0,606	1,433	0,474	1,194	0,851	0,130	0,467	0,634	0,628
5	0,267	0,813	0,482	0,664	0,450	0,023	0,276	0,317	0,293
6	0,566	0,754	0,843	0,691	0,731	0,277	0,366	0,511	0,558
SUM	2,327	4,912	2,533	4,127	3,780	**1,100**	1,531	2,248	2,350

Table 14: Accuracies for predicting whole work for S curve (B=5, a_0=1) model

EA with =0,25 is the most precise estimator for next cycle.

S curve model , B=10, a_0=1.

cycles	UNIT	CA	MA	WMA	EA; 0,1	EA; 0,25	EA; 0,5	EA; 0,75	EA; 0,9
3	0,969	2,395	0,677	1,879	1,398	0,398	0,562	0,904	0,965
4	0,652	1,735	0,573	1,379	0,591	0,072	0,579	0,705	0,685
5	0,288	0,978	0,575	0,763	0,300	0,081	0,332	0,352	0,318
6	0,601	0,878	0,877	0,783	0,521	0,259	0,416	0,566	0,598
SUM	2,51	5,986	2,702	4,804	2,810	**0,810**	1,889	2,526	2,567

Table 15: Accuracies for predicting whole work for S curve (B=10, a_0=1) model

EA with =0,25 is the most precise estimator for next cycle.
Among mathematical models Wright model gives the best estimation.

Based on this survey a conclusion is that EA with **α** =0,25 and **α** =0,5 is the best estimator for the future. If **α** = 1 then there is no average because unit data is given back. If **α** is less than 1 there is a trend.

4. Conclusions

In this paper we investigate future prediction of construction activities by different mathematical models and data presentation method mostly focusing on exponential average method with different parameters. Four mathematical models, Wright, DeJong, Stanford B ans S curve moreover five data presentation methods, unit, cumulative average, moving average, weighted moving average and exponential averages with different parameters are identified, and each are used in prediction. Best fit for completed activities is cumulative and exponential average methods and best fit for prediction of future performance is exponential average method. Among mathematical models DeJong model gave slightly better result than Stanford B, S curve and Wright models.

Further investigation is necessary involving not only mathematical issues but engineering also with more data and with more sophisticated mathematical and learning curve models.

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INFORMATION AND COMMUNICATION TECHNOLOGIES FOR DATA EXCHANGE AND MANAGEMENT OF INFORMATION FLOWS IN CONSTRUCTION PROJECTS*

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Abstract

New technologies, methods and techniques in designing, project planning and project realization are used across the wide range of construction processes during the lifecycle of construction projects. These factors have significantly increased the amount of information that professionals in the construction industry need to identify, acquire and use in their job. There is also a growing need for their effective exchange, especially with the increasing number of stakeholders in construction project. The increasing importance of information management and integration requires the information strategy for social and technical integration and management of information.

The aim of this paper is to show the need for the use of information and communication technologies in the construction and mapping relationships between construction companies and other parties in the construction and identify options for exchanging data between them. The study examines various methods (UTAUT) and technologies used in data flow design and management. They might be used in process of acquisition, storage and subsequent use of data throughout the construction projects. The paper examines the importance of information technologies and methods in effective management of information flows in construction projects and summarizes the factors affecting the effective information flows between stakeholders in construction projects.

Keywords: information technologies, information flows, construction projects

* The complete text is available on CD-ROM / Mesaroš, Mandičak

Introduction

Currently, the construction industry is in decline. This situation occurred despite the fact that nowadays it is possible to use new technologies that increase productivity. The whole construction process is faster and easier. The construction industry faces many challenges at the beginning of the 21st century as it is forced to change and to incorporate new advanced technologies into the construction process to gain a competitive edge in the market (Abduh, Skibniewski, 2003). Many research and industry reports emphasized the relationship between technology investment and productivity gains in manufacturing, civil engineering, banking, and insurance (Park, 2003). The construction industry is multidisciplinary in nature, relying heavily on timely transfer of information among the parties involved such as owners, project managers, design consultants, contractors, subcontractors, and suppliers (Rojas, Songer, 1999).

Innovations are recorded only in the hardware options, but are progressing well and software solutions and applications (Dugas, Ferencz, 2012). For the effective and full use is needed internet. The web has become an important channel for sharing project information and providing an up-to-date communication platform (Sarshar, 2002). Information technologies can assist project and construction managers to standardize routine tasks so that available organizational resources are utilized both effectively and efficiently (Adam, 2007). Information technologies are often implemented as to facilitate communication and improve integration as well as enhance productivity and service delivery (Bjork, 1999).

2. Participants in construction, information flows and relationships between them

Introduction of innovations in the field of information and communication technologies is given the global potential unsatisfactory. This is particularly true for technology, which requires special organizational skills for their subsequent effective implementation (White, 2002; Mesároš, 2010). Within an efficient information exchange digital form most commonly occurs for bookkeeping of construction company, billing and so on. However, using the most modern forms of technology (eg SAP, Ukis etc.) based on the software platform is much more frugal (Samuelson, 2002; Čarnický, 2012). Most frequent form of communication by ICT is just one-way communication of construction companies to clients. But due to the potential is much more necessary to focus on the possibility of data exchange between all participants in the construction process, where the effective exchange of information can mean cost savings of building projects, better quality construction process, acceleration of individual processes and meet deadlines. Within this framework it is necessary to define the relationships between them are exchanged information (Fig. 1) (Stavební komunita, 2012).

The main parties to the project (direct):

- investor,
- designer,
- contractor,
- subcontractors.

Intervener participants (indirect) are:

- construction supervision,
- construction authority,
- other participants.

The very nature of work requires innovative technology could be used under different conditions. The current organizational structure of the construction enterprises and their difficult relationship between them (long supply chain and subcontracting) make it difficult to effectively disseminate information and thus suppresses the implementation and application of these technologies (Veshosky, 1998). The American National Institute of Standards and Technology compared the economic performance of construction companies and their projects. Statistical analysis was performed on selected projects within the construction industry benchmarking. Projects which were used ICT to the greatest extent possible, achieve much better results than projects where the use of ICT was at a very low level (Thomas, 2000).

Under examination were several technologies: integrated database, the electronic data exchange (EDI), 3D CAD modeling. In terms of examining the effective use of ICT for data exchange is necessary to draw attention to integrated databases and electronic data exchange. At the same time the levels of usage as well as cost and schedule performance. This framework provides the user to identify the correlation between the use of information and communication technologies and the results of the project. It was confirmed that the projects for which data are exchanged through ICT, the results were better. Effective the electronic data exchange shortened time certain activities, resulting in easier to meet deadlines, which ultimately led in some cases to reduce costs.

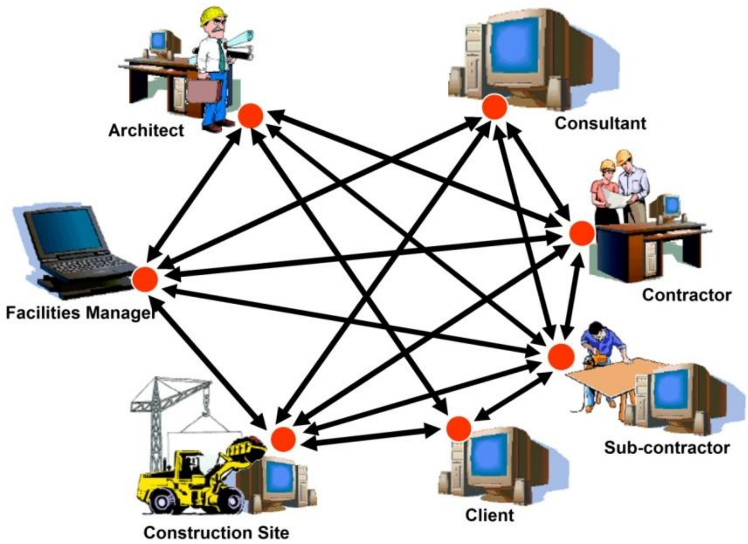

Fig. 1: Participants in construction, information flows and relationships between them

2.1. *Information flows*

Utilization of information technologies in the construction industry and primarily in the multienterprise scenario of project management requires readiness not only within one organization (contractor, project developer), but also within all the organizations involved in the construction processes (Nitithamyong, Skibniewski, 2006). Information flow consist of four components: source of information, receiver of information, a path (interaction), and a mutual relevance of information. There are two types of entities that can serve as sources or receivers of information (Phelps, 2012):

- People - everybody involved in process of generating, acquiring, sharing and usinginformation. A person’s role in information flow is determined by their contractualrole, their informal technical role, and their social role within the project. These roles determine the types of information that are expected from a person, the type of information that the person can contribute, how that information is shared, and how it is received.
- Boundary objects (i.e. tools such as drawings, reports, requests for information, building information models and other documents that enable communication between groups of people). Boundary objects affect information flow through their structure.

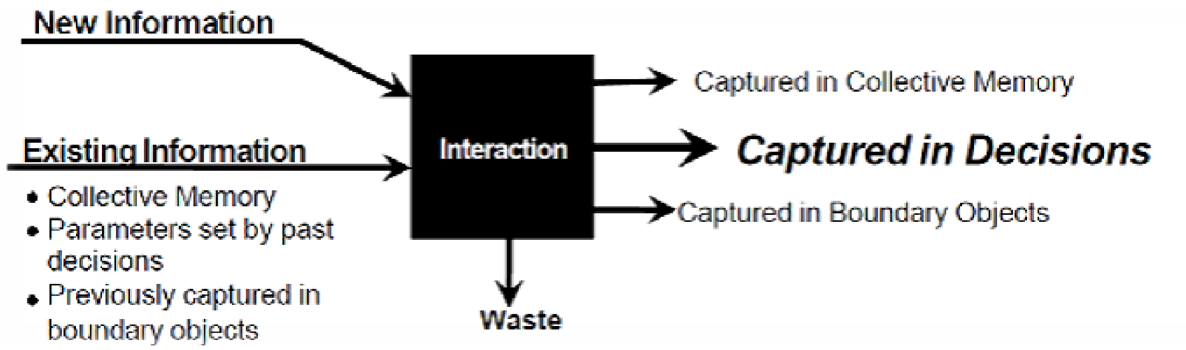

Fig. 2: Using of information in decision process in collaborative construction project (Phelps, 2012)

Based on types of interactions, information can either be accepted, rejected, or ignored. It is necessary to share the information by an individual on the project team. Then the shared information needs to be accepted by others on the project team. Information that is ignored or rejected becomes waste and essentially disappears from the project unless shared again inderdifferent circumstances. Information that is actepted by others is cuptured tacitly in the collective memory of the project team and can be captured explicitly in boundary objects. However, acceptance of information does not automatically add value to a project. Building project management requires effective communication management between all the project team members leading to required coordination and collaboration. At all stages of a building project, information is generated, stored and communicated by all the supply chain members. So, to have effective communication, all the members should follow the accepted methods of communication or communication protocols.

3. The current status and potential uses of ICT

Exchange of information between enterprises, can be performed in several ways. Many construction companies that refuse to implement ICT use traditional methods of information exchange. It means that there is less use of ICT and documents are physically shared in printed form. However, current trends and possibilities point to the inefficiency of this method of data exchange.

There is already sufficient nor exchange of information, especially documents, email communications (Mesárošová, 2012). Despite the advantage that the documents must be electronically exchange and is thus relatively quick and inexpensive, the fundamental problem is unsystematic solutions. It occurs due to the duplication of data, causing significant inconvenience and, indirectly, the increased costs. The problem may occur if one of the parties has updated a document, which is due to an increased risk of misinterpretation of the fact that the construction projects can have fatal consequences.

One of the possibilities is the use of the intranet. At the individual organization level, intranets are commonly used. Intranet is defined as an internal network using internet and web protocols located within an organization's IT security domain and Intended Primarily for use by the organization's members (Slyke, Bélanger, 2003). Normally, it has e-mail functionality and electronic templates for disseminating corporate documents, providing departmental or divisional information, as well as enabling searches through an in-house directory of information for knowledge sharing.

Extranet has the potential to fill the gap between internet and intranet networks (Finch, 2000). Project partners can exchange information securely by providing access to a portion of an organization's intranet or by using a common network that links all the business partners (Wong, 2007). Some companies use extranet through virtual private network–secure socket layer to allow secured access by external collaborators via the worldwide web to implement work flow processes such as the proposal of variation orders by project consultants for approval by clients.

The large potential for increasing the efficiency of the management and exchange of data are ERP

(Enterprise Resource Planning) systems and the applications that interact are systematic management solutions and data communications, information within the enterprise and between enterprises and all parties to the construction project. ERP je typ aplikačného softvéru, ktorý umožňuje riadiť a koordinovať všetky aktivity a podnikové disponibilné zdroje (Čarnický, 2009). On the one hand, ERP systems are considered as applications that presented software solutions designed to manage enterprise data while helping to plan the entire logistics chain, starting with the purchase, storage, transportation, contract management, the actual planning of activities and each activity associated with it. On the other hand, the ERP system can be seen as a finished software that allows the company to integrate and optimize the main enterprise, or project processes, share relevant data and information and, very importantly, to enable their availability in real time (Basl, 2008).

In the construction company with integrated ERP system, there are many information flows. These information flows and their interrelations are described in figure 3.

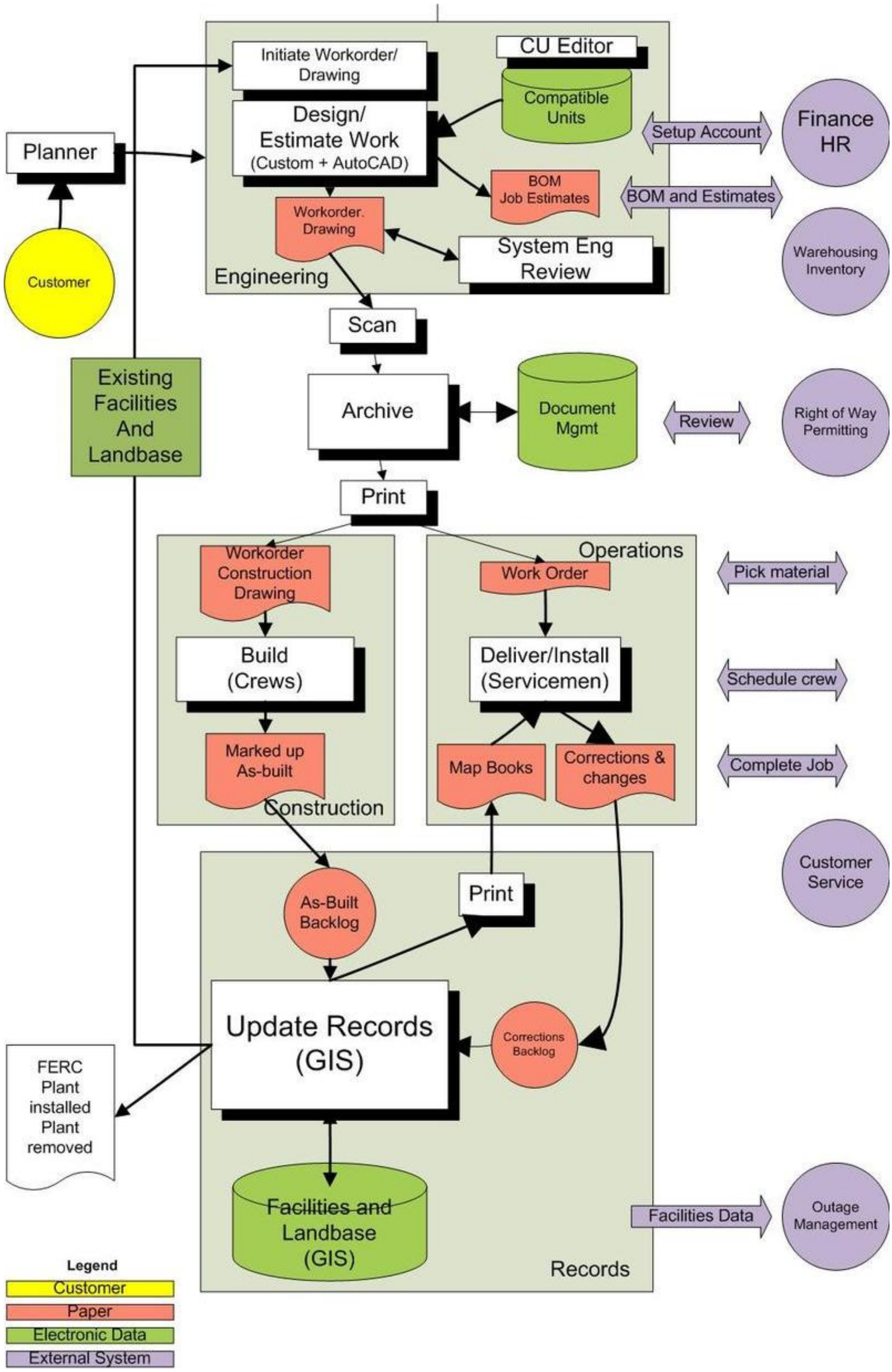

Fig. 3: Typical engineering design information flow (Zeiss, 2012)

For example, according to a study carried out in a Swedish construction company, which has 20 000 employees, is used to 60 information systems. It includes a 4000 user accounts. The big problem is just the distribution of the agenda relating to the Company and the agenda of the project, where it enters a large number of stakeholders. Whether, it's supply chain relationships, or even investor relationship - contractor of the project, which is given by the company. Here is just a risk of compatibility of systems and risk management organization and poor communication between companies alone with each other (Jacobsson, Linderoth, 2010). The essence of ERP system in the said company is the main information system, which is supported by five sub-modules (systems):

- module CRM (customer relationship management),
- two different subsystems designed for project planning (one is for larger projects, one for smaller projects),
- module for calculating the cost of project implementation,
- subsystem e-comerce, which is linked to the main contractor.

Effective solution is based on an external stakeholder approach. The basis is a software platform, which must be compatible with the company's information system, or ERP system. An essential requirement is the server. This represents a sort of virtual workplace where you can work and data management information. In terms of use of the software solution is appropriate if it is "open source" solution, a solution which can be adapted to the specific requirements of their own needs.

4. Model for setting effective information flows and acceptance and use of Technology

For the efficient exchange of data and information is an important question, how to set up information flows so that the whole system has brought the greatest benefits to all stakeholders. In other words, set the rules and conditions for maximum utilization and efficient operation of the entire system, which includes new technology in the form of hardware, appropriate software solutions and applications, and not least its users. It is therefore necessary to address this issue and find an appropriate solution that is beneficial to all participants of construction. The use of ICT has to be the most effective. One possible approach to set these flows and to achieve efficient use of available ICT represents a model UTAUT. This model highlights the factors that influence the successful use of ICT in all areas, not excluding construction.

According to Venkatesh (2003), The Unified Theory of Acceptance and Use of Technology (UTAUT) is a useful starting point to investigate technology adoption. The model UTAUT was developed by Venkatesh and it can be used to identify factors that influence the intention to use information technology to be adopted by an organization. Moreover, the UTAUT model attempts to explain how individual differences influence technology use. More accuratelly, the relationship between perceived usefulness, ease of use, and intention to use can be moderated by age, gender, and experience. For example, the strength between perceived usefulness and intention to use varies with age and gender such that it is more significant for male and younger workers. The effect of perceived ease of use on intention is also moderated by gender and age such that it is more significant for female and older workers, and those effects decrease with experiences (Marchewka, 2007). UTAUT model was shown to be a good predictor of user acceptance and adoption of information technologies (Sargent, 2012). Venkatesh defines these constructs that were found to be significant determinants of intention or usage in one or more of the individual user acceptance models examined:

- performance expectancy,
- effort expectancy,
- social influence,
- facilitating conditions.

UTAUT to examine IT adoption in construction management, but we also include two important constructs TMS and resistance to change which have also been identified as important to IT adoption (Sargent, 2012).

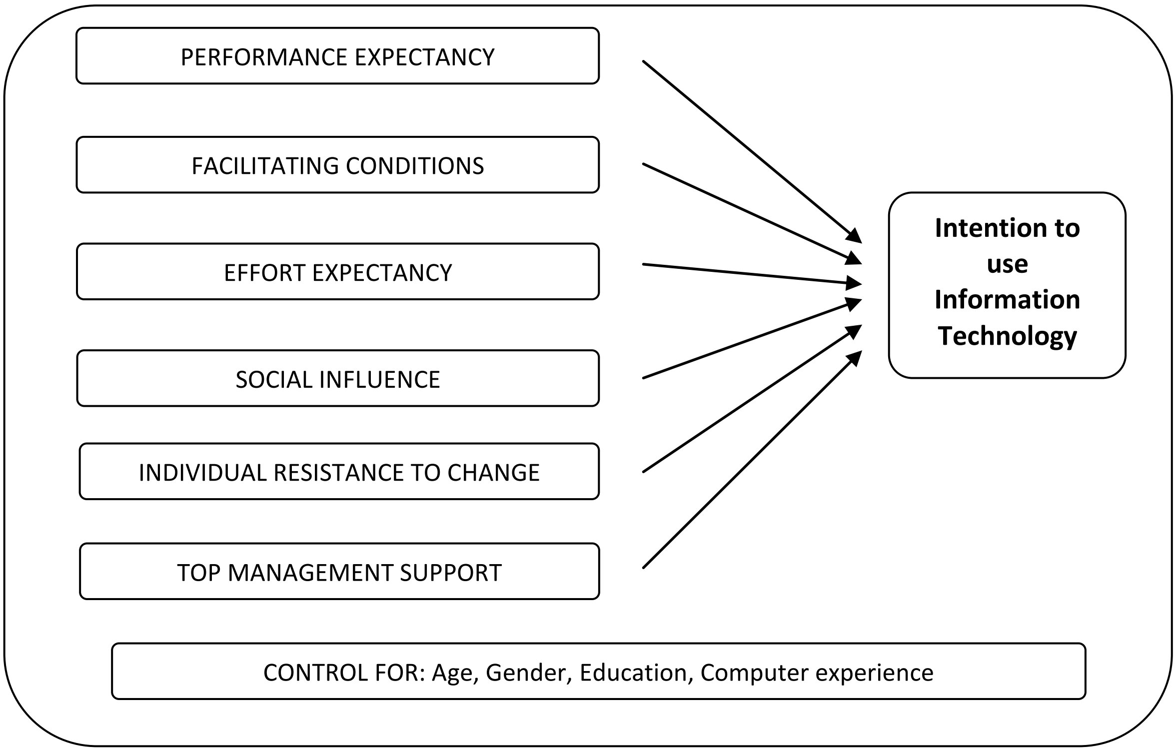

Fig. 4: shows the effect of various factors on the adoption and use of ICT in construction company flow (Sargent, 2012).

As shown in figure 4, there are many factors affecting the use of ICT and its adoption, which directly affect the setting of effective information flows within and outside the organization. These include: age, gender, education, computer experience, and so on. Within of the said there are general rules for how to set up a system of information flows to the benefit of each of the parties:

- First of all rules must be made for access to documents and the possibility of change. This means that each person must have a clearly defined scope of authority and responsibility that may take place in the documentation.
- It must be clearly defined way to add new data and information into the system and when. Ideally, to obtain new information, this information immediately incorporated into the system and the information was updated and available on time.
- It is important to determine who will be the use of the information and to be accessible, it is necessary to determine the presentation and accessibility. It is best if the ICT and information used comprehensively. This means that ICT can also be used for construction workers, both directly and work with them. However, access to it must be simple and inexpensive to operate.
- System and service must be simple and intuitive. The information system and working age diverse staff. Although their positions differ.
- Information flows should be short and simple.

Conclusion

The use of ICT is increasing every day. This also applies for the construction industry. However, despite the clear advantages of the use of ICT brings, there are certain barriers to their implementation and maximum utilization. In construction projects, many participants from different organizations have to work together. One result is that a huge amount of information has to be communicated (Dawood, 2002). Rapid evolution of information and communication technologies (ICT) offers opportunities to enhance communication between participants in construction projects and to enable more effective and efficient communication (Egbu, 2001). The effectiveness of utilizing ICT in construction projects may be hindered by the inability to share electronic data between organizations (Hassan, 2002; Mohamed, 2003). Within the use of ICT can shorten and simplify information flows. It is very important to set these information flows as efficiently as possible. The use of ICT must take benefit all participants in the construction. Therefore, it is necessary to draw attention to the factors that most influence the implementation and effective use of ICT in construction. Model UTAUT indicates the factors that influence the effective use of these tools, respectively, provides insight on how to set the flow of information and system efficiency. Optimization of these processes is simplified information work, including its exchange.

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MULTI-CRITERIA COST MANAGEMENT MODEL FOR CONSTRUCTION ENTERPRISES*

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Abstract

Cost management and cost optimization is an essential function and purposeful activity of enterprises which carry out their activities in the current market environment. Currently, one of the factors affecting the level of profit achieved and gaining competitive position on the market is the strategic approach in cost planning and cost management. The aim of this paper is to point out the possibility of using the multi-criteria model of strategic cost management, constructed on the basis of exact approaches as well as the needs of the cost management identified in the survey in Slovak construction enterprises. The model consists of several variables (criteria) that were selected and assessed as significant and important in our theoretical and empirical research. For designing the model through four main criteria, it was necessary to quantify the weights of 15 sub-criteria and 102 sub-sub-criteria specified from the data collected by questionnaire investigating. To quantify weights of criteria for the model, we used Analytic hierarchy process method and the Entropy method as exact methods used for complex decision-making.

Keywords: construction enterprises, cost, cost management model, exact methods of complex decisions

* The complete text is available on CD-ROM / Mesaroš, Purcz

Introduction

Methods to reduce costs in construction industry must adapt to special conditions, which are quite specifics for the industry. Most distinction lies in the fact that the building production is based on certain building project. Also, the mobility of building production, which is significant for implementation the building project in different conditions, depending on the particular building location. Lots of production processes increase the demand for coordination and complicate the organization and management of the entire construction process (Kozlovská, Mesároš, Čepelová, 2003).

One of the important issues in searching a suitable management approach to optimize the cost of construction companies (contractors) is to create a suitable model describing approaches to managing costs in order to optimize the costs of construction works. The cost management model should be based on the identification of areas of importance in the optimal management costs (Dugas, Ferencz, 2012). By studying the current state of affairs at home and abroad (Post, Preston, Sachs, 2002; Radiszevska-Zielina, Mesároš, 2010; Selín, 2012), we have created a basis for carrying out questionnaire survey in selected Slovak construction enterprises in order to analyze the current situation planning, monitoring and evaluation of construction costs and cost of subsequent processes to achieve the objective - develop the managerial model for cost management. Considering the inputs of the model, care should be taken not only in reducing the costs, but also the way how this reduction was achieved. We may consider the lower cost consumption at higher level of utiliztation the material and other resources, higher technical level and product quality, but also changes in structure of the production and performance may lead towards lower cost requirements (Mesároš, F. Mesároš, P., 2009; Mesároš, 2008).

When designing the cost management model, several areas (criteria) for cost management construction company were identified. Then we had to quantify the importance of the various criteria and sub-criteria of the proposed model using exact mathematical methods. They are applicable in solving of decision problems and they are based on the examination of importance of individual factors, criteria that form the decision problem. The purpose of using exact methods in the design of the model was to avoid of subjective valuation of several areas in managing costs, identified on the basis of research results.

In our case, the main research issue was to determine the weights of individual areas of cost management, which were identified by evaluation of research results. To analyze and identify the weights for each area and criteria of cost management, we used entropy method (Ching-Lai, Kwangsum, 1981) and the AHP (Analytical Hierarchy Process) method (Saaty, Tran, 2007). The reason for the application of these two methods was to determine the importance of individual criteria (weights) with the possibility of a fair comparison between the results and the verification of the correctness of the procedure to consider the construction management model (Selín, 2012).

2. Selection of criteria for cost management model

The first step in creating the model was the selection of criteria, which form the inputs to the decision model. Based on the evaluation of data from the questionnaire investigation, as part of broader research (Mesároš, Purcz, Selín, Selínová, 2012) we have grouped the answers thematically related to areas of our inquiry. The sample consisted of 41 Slovak construction companies (10% large sized, 39 % medium sized, 51 % small sized).When choosing the key areas and criteria, we grouped the 102 sub-questions (sub-sub-criteria), semantically linked with issues of cost management for 15 sub-criteria that allow us to identify four basic areas (criteria), which constitute the model, and that we consider as key elements in model creating in order to manage the cost from strategic perspective.

Criterion A - The collection and use of information about costs
- Sub-criterion A.1 (Tracking actual costs)
- Sub-criterion A.2 (Obtaining the cost information from accounting)
- Sub-criterion A.3 (Obtainingthe cost information from accounting -identifying the share of the cost on certain projects or activitiers)
- Sub-criterion A.4 (Responsibility for obtaining information in the company),
- Sub-criterion A.5 (Using of modules of enterprise information system for cost tracking and cost management).

Criterion B – Using the tools for managing
- Sub-criterion B.1 (Using the data about cost)
- Sub-criterion B.2 (Using the tools to manage costs)
- Sub-criterion B.3 (Using the new tools to manage costs)
- Sub-criterion B.4 (Reasons of unit costs tracking).

Criterion C - Cost optimization
- Sub-criterion C.1 (Monitoring the cost of construction),
- Sub-criterion C.2 (incidence of problems in identifying the cost of construction),
- Sub-criterion C.3 (The frequency of problems with optimizing resource costs)
- Sub-criterion C.4 (The frequency of problems with cost optimization of construction processes).

Criterion D - Business strategy (optimization)
- Sub-criterion D.1 (The frequency of problems with optimizing the portfolio of contract in construction)
- Sub-criterion D.2 (Identification of problems with a portfolio of customers in construction)

3. Multi-criteria decision methods used in cost management model

The formulation of the basic model is based on multi-criteria decision-making methods respectively. Several methods are known in multi-criteria analysis. To create the cost management model, we used two different methods which differ not only externally but also internally, the very essence of the approach followed by possible solution being considered issues. Finally, we compared these results with the normal processing (descriptive statistics) of the questionnaire responses multiplied by the number of points (1-5 as indicated by responses in this column) and then divided by the maximum possible number of points for each question.

3.1 Entropy method

It is a mathematical-statistical method described by the authors Ching-Lai and Kwangsun (1981). Entropy (in information theory) measures the information content of a data set. The criterion for the amount of uncertainty represented by a discrete probability distribution. It can be used to determine the weights for the decision-making table respectively or for the above mentioned individual evaluation criteria in cost management model.
Questionnaire answers within one category represent one data set (column vectors forming the matrix of the decision table). This file contains the same amount of information. The method used in determining the weights based on the "amount" of information that contains. The more information the file contains (values of all categories), the more important will be the criterion. If the answer to each question show different values, it is logical that this will increase the importance of the criteria. If the answers are irrelevant (or in equilibrium, exhibit almost the same number of all possible

answers) for one issue, then the question is losing its informative value and its omission of the value function changes resulting either very little or not at all. Thus, the criteria with greater information value are more important so they have a higher weight and higher impact when used in cost management model.
Let´s have input values r_{ij} of the decision matrix $R : m_x n$. Subsequently we normalize the values entered by the new matrix $P : m_x n$:

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \text{; } i=1,\dots,m; j=1,\dots,n.$$

The we calculate the degree of diversification of the information provided j-th attribute:

$$d_j = 1 + \frac{1}{\ln m} \sum_{i=1}^{m} \frac{p_{ij}}{\ln p_{ij}} \text{; } j=1,\dots,n,$$

where formula:

$$\frac{1}{\ln m} \sum_{i=1}^{m} \frac{p_{ij}}{\ln p_{ij}}$$

is called the entropy of the normalized j-th attribute. We normalize the result and we get searchedweights:

$$w_j = \frac{d_j}{\sum_{i=1}^{m} d_i} \text{; } j=1,\dots,n,$$

where:
$R = (r_{ij})$ - decision-making matrix
$i = l, \dots m$ - in our case m = 5, is related to the five possible types of responses)
$j = l, \dots n$ - n - number of questions in the same rating categories
p_{ij} - standard values of decision-making matrix,
E_j - entropy standardized set of j-th attribute,
d_j - degree of diversification of the information provided j-th attribute
w_j - weight j-th attribute

It should be noted that the use of the described method for determining the weights of criteria is one of the possible methods which might be used in multi-criteria decision problem. There are several possible methods for determining weights for the model, one of which we describe in the next section. Entropy method is distinguished strictly objective by using only statistical methods without input of human judgment. Calculation of weights thus depends only and only from data collected in individual issues. All calculations related to the use of entropy method to determine the weights were performed in Microsoft Excel using Visual Basic programming language.

As a mathematical result in this case is considered objective function form:

$$Y = w_A.A + w_B.B + w_C.C + w_D.D$$

Where A, B, C, D are the names of the categories (main criteria) considered, and w_A, w_B, w_C, w_D are their corresponding weights. In entropy method, weights were calculated as follows (see Table 3):

$$w_A = 0.6211 \ w_B = 0.0892 \ w_C = 0.2331 \ w_D = 0.0567$$

Then there is a possibility of forming the objective function as follows:

$$\boldsymbol{Y=0.6211\cdot crit.A+0.0892\cdot crit.B+0.2331.crit.C+0.0567\cdot crit.D}$$

3.2 Analytic hierarchy process (AHP method)

The AHP is a flexible and yet structured methodology for analyzing and solving complex decision problems by structuring them into a hierarchical framework (Saaty, 1980). Thomas L. Saaty is an American mathematician acting as a university professor at the University of Pittsburgh. He is the author, architect and founder of the theory of analytic hierarchy process (AHP), a large area of decision-making, multi-criteria decision analysis, analytical network process and its generalization to decisions with dependence and feedback (Saaty, Tran, 2007).
The AHP procedure is employed for rating/ranking a set of alternatives or for the selection of the best in a set of alternatives. The ranking is done with respect to an overall goal, which is broken down into a set of criteria (objectives, attributes). AHP can be used in several different areas. It is used worldwide in various decision-making situations, in the fields such as government, commerce, industry, health, education. It is a suitable method for the evaluation of companies, where several criteria lead to objectification of their opinions. The factors that make the AHP probably the most popular method of decision-making in the world, is that it adapts to a fixed data, such as price, delivery speed, as well as personal experience and not least the intuition. It allows us mathematically to derive the weight of each criterion, although the first stage, before the actual methods, the valuation entity (expert, organization) to define a hierarchy of mutual relations between all pairs of criteria (sub-criteria, etc ...), on the basis of which the evaluation of data will be performed.

The AHP procedure involves three major steps (Saaty, 1980):
1. developing the AHP hierarchy,
2. pairwise comparison of elements of the hierarchical structure,
3. constructing an overall priority rating.

Selection of criteria and sub-criteria is based on the existing knowledge and experience of each reporting entity. In our case, we have examined the theoretical approaches in cost management, information management and strategic management, as well as the questionnaire data to select the criteria that Slovak construction companies consider as important in cost management. We have identified four main areas (criteria) and 15 sub-criteria, build up on exact questions from our research (see chapter 1). After sorting out own set of criteria and the establishment of a hierarchical structure at all levels of evaluation they compare different alternatives or criteria that affect the evaluation through verbal explanations and numerical values. As a means of evaluation, questionnaires are mostly used. Typically, the questionnaires mostly use numerical scores, it can also be verbal - but the responses must be verbally translated into numerical scores. The Saaty´s scale (Table 1) identifies the relations between variables in pairwise comparison.

Table 1 The 1-9 point ratio scale devised by Saaty (1977)

Intensity of importance	Definition	Definition, based on experience and judgment
1	Equal importance	Two activities considered equally important
3	Moderate importance of one over another	One activity is marginally favoured over another
5	Essential or strong importance	One activity is strongly favoured over another
7	Very strong importance	One activity is strongly favoured and its dominance is demonstrated in practice
9	Extreme importance	The evidence favouring on activity over another is of the highest possible order
2,4,6,8		Intermediate values between two adjacent judgments

Source: Saaty, 1977

For our research, we modified the philosophy of the variables (criteria of the model based on questions in our questionnaire) rating process. We have not used the Saaty´s 1-9 scale, but we considered the answers on each question from questionaire as a direct "expert" rating (we formulated most of the questions to get answers in Likert scale). Then we had 41 experts represented by companies. All alternatives at the request were compared on the basis of pairwise allocation weights (Table 2). Using numerical questionnaire is a good solution if you have a large number of respondents. In pairwise comparisons, the two criteria are placed in opposite ends of the line against each other and compared that is important. In the middle row is the number 1, which means that the comparison criteria are equally important. Values along the line numbers indicating the importance of one criterion over the other. Information on the significance of criteria derived on the basis of pairwise comparison of the values rij, which all together form the basis of an evaluation matrix R, and the ratio between the importance of the evaluation criteria for criterion k_i k_j, where i, j = 1,2, ..., m. required that the variables r_{ij} satisfy for all i, j = 1,2, ..., m , where m is the number of evaluation criteria, the following conditions $r_{ij} > 0$, $r_{ij} = r_{ji}^{-1}$, $r_{ii} = 1$.

The following Table 2 shows for better illustration looks of one particular input matrix relative significance of our role.

Table 2 Example input destination weights

Question 13	a	b	c	d	weights
a	1	1.576	1.358621	1.223602	0.6187
b	0.634518	1	0.862069	0.776398	0.3926
c	0.736041	1.16	1	0.900621	0.4554
d	0.817259	1.288	1.110345	1	0.5056

Source: own research

The next was using mathematical software MATLAB and methodology described in the previous paragraphs to calculate consecutively the weights of each sub-criterion and sub-sub-criterion related to the questions of the questionnaire and further down the same way then the resulting weights for each category A,B,C,D. As a mathematical result in this case, we have objective function form:

$$Y = w_A.A + w_B.B + w_C.C + w_D.D$$

whereas in the case of using the method of AHP weights are calculated as follows (see Table 3):

$$w_A = 0.2674 \;\; w_B = 0.2651 \;\; w_C = 0.2322 \;\; w_D = 0.2352$$

4. Results

Comparison of the results (Table 2) using all considered methods, it is clear that for certain categories of weight value came the same (or very similar), but for others it quite different. This significant difference in results is due to the different methodology used in determining the significance (weight) of the criteria. In the case of multi-criteria decision-making process it is not unusual, since the process is very sensitive to the philosophy of the principle of creating preferences for each criterion, so each, even a subtle change of method has resulted in any change resulting prioritization of criteria considered. Comparing the weights calculated by entropy method and AHP method, we observed the considerable differences in criteria A, B, D. Method of AHP and its mathematical structure is already partly eliminates this subjectivity, even if the input data is of course the same. Therefore, we performed the simple calculation of values (weights) obtained by direct treatment of questionnaire. When interpreting the results, we

Table 3 Weights of criteria and sub-criteria in cost management model

Criterion and Sub-criteriondescription	*Weights calculated by Entropy method*	*Weights calculated by AHP method*	*Weights calculated by direct processing of research data*
Criterion A - The collection and use of information about costs	$w_A = 0.6211$	$w_A = 0.2674$	w_A= 0,3431
Sub-criterion A.1 (Tracking actual costs)	0.5124	0.2364	0.2501
Sub-criterion A.2 (Obtaining the cost information from accounting)	0.1520	0.2464	0.2191
Sub-criterion A.3 (Obtaining the cost information from accounting - identifying the share of the cost on certain projects or activitiers)	0.0397	0.2087	0.2331
Sub-criterion A.4 (Responsibility for obtaining information in the company)	0.0656	0.1193	0.0981
Sub-criterion A.5 (Using of modules of enterprise information system for cost tracking and cost management)	0.2374	0.1892	0.1993
Criterion B – Using the tools for managing	$w_B = 0.0892$	$w_B = 0.2651$	$w_B = 0.2254$
Sub-criterion B.1 (Using the data about cost)	0.3364	0.3130	0.2835
Sub-criterion B.2 (Using the tools to manage costs)	0.0222	0.2401	0.2388
Sub-criterion B.3 (Using the the new tools to manage costs)	0.3983	0.1634	0.2065
Sub-criterion B.4 (Reasons of unit costs tracking)	0.2432	0.2835	0.2768
Criterion C - Cost optimization	$w_C = 0.2331$	$w_C = 0.2322$	$w_C = 0.2324$
Sub-criterion C.1 (Monitoring the cost of construction)	0.5950	0.2614	0.3489
Sub-criterion C.2 (incidence of problems in identifying the cost of construction)	0.0658	0.2327	0.1805
Sub-criterion C.3 (The frequency of problems with optimizing resource costs)	0.1660	0.2551	0.2354
Sub-criterion C.4 (The frequency of problems with cost optimization of construction processes)	0.1732	0.2508	0.2377
Criterion D - Business strategy (optimization)	$w_D = 0.0567$	$w_D = 0.2352$	$w_D = 0.1937$
Sub-criterion D.1 (The frequency of problems with	0.7083	0.4854	0.5042

optimizing the portfolio of contract in construction)			
Sub-criterion D.2 (Identification of problems with a portfolio of customers in construction)	0.2917	0.5146	0.4948

Source: own research

Conclusion

Main research results supported by the statistical analysis confirmed that cost control and cost management is a very important business tool for small, medium and large enterprises as well as enterprises with domestic or foreign capital. Information about costs are often used in managerial decision making. The use of information about real cost when preparing construction budgets is important in treated firms (small, medium and large, with both domestic and foreign capital. The use of cost data in the management of construction costs for construction companies (small, medium and large as well as domestic and foreign capital) is very important.

The proposed multi-criteria model may highlight critical areas where sufficient attention should be paid in order to manage costs. The model consists of several variables (criteria) that were examined by theoretical and empirical research (statistical analysis) and assessed as significant and important for practice. In the construction management model management and cost optimization exact methods were used to determine the importance of individual variables (criteria). We calculated the common weights for all sizes of companies, because our sample was not representative (4 large sized companies, 16 medium sized and 21 small sized companies), although we observed some differences in importance sub criteria due to company´s size. We might consider the size of the company in future broader research.

TAs for the results, the highest importance was clearly (even when compared using the two methods with a significant difference) associated with Criterion A - The collection and use of information about costs. It is understandable mainly because the relevant and current information base is the basic input for each decision-making process by which optimization of cost certainly is. Depending on the type, quantity of cost information, it is possible to define a process for obtaining and processing of specific information, as well as its use in determining the cost. Basically, the weights of criteria in our model indicate, which cost area, what type of information on what resources and what the frequency of obtaining and evaluating information on the cost (criterion A), as well as the using of tools and methods for managing the cost (criterion B), optimizing the cost (criterion C) and align these actions with business strategy (criterion D), affects the cost management of construction enterprises. To verify the correctness of results used in developing the model, we used two exact methods as well as direct calculation using data from the questionnaire investigation, which verified that AHP method results are more precise. The fact we have used different methods with results concerning the weights of individual criteria and sub-sub-criteria (with few exceptions very comparable) allows us to generalize certain findings and draw the practical recommendations on cost management from the perspective of the managers in Slovak construction companies.

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CRITICAL RISKS IN SERBIAN INFRASTRUCTURE PROJECTS*

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Abstract

Infrastructure projects are usually followed by numerous standard, but also specific risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects, as well as with other, non-tangible factors. They, if not timely identified, treated and controlled cause that project actual performance significantly varies from planned values. This paper presents results of a conducted infrastructure construction project risks survey for projects settled in Serbia. The survey includes evaluation of major risks in relation to infrastructure project cost and schedule performance and the analysis of usage, necessity and problems with construction Project Risk Management (PRM) practice in Serbia. Risks in the offered risk list were divided into: General Market Risks, Risks in Feasibility and Design Phase and Risk in Construction Phase and evaluated using Probability-Impact matrix. Based on the results, the proposal is given for the development of an advance planning cost and schedule performance prediction model.

Keywords: Infrastructure, Risk, Project Risk Management

* The complete text is available on CD-ROM / Mikić, Petojević, Ivanišević

Introduction

The realization of an investment project, especially large one, is an extremely complex undertaking both from technical and technological, as well as the organizational, legal and financial standpoint (Ivkovic & Popovic, 2005). Such organizational and technological complexity causes great amount of risks (Zou et al. 2007). Project risk is defined as an uncertainty with a possible positive or negative impact on at least one project objective (PMI, 2008; BS 2010). Risk has traditionally been described with a probability of event occurrence and a possible impact that it might have on project goals (Bunni, 2003).

Success in a project can be regarded as provision on time, on budget, of a required performance or achievement (Williams, 1995). Managing risks in construction projects has been recognized as very important for achieving project success (Zou et el. 2007). As one of construction project management (PM) areas, Project Risk Management (PRM) in construction is extended well beyond the confines of insurance and helps to analyse, mitigate and control risks associated with project cost, schedule, quality, performance, health and safety aspects, environmental aspects but, as well, with other, non-tangible factors, such as corporate image, employee satisfaction, increased customer service (Williams, 1995; Ali, 2005; Mikic & Arizanovic, 2012).

On figure 1, the PRM procedure is shown as defined by *Project Management Institute* (PMI) (PMI, 2008; PMI, 2009).

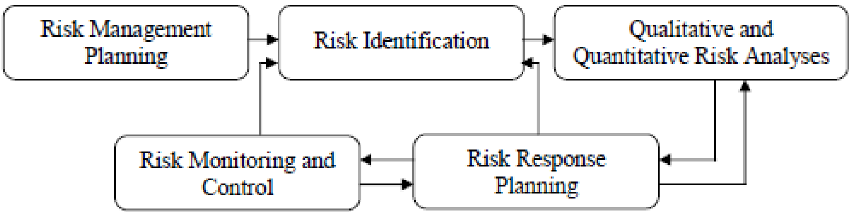

Fig. 1) (adapted from PMI, 2009)): Project Risk Management (PRM) Processes

Risk Management Planning is the process of defining how to conduct risk management activities for a project. In Risk Identification, it is determined which risks may affect the project. Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. Quantitative Risk Analysis is numerical analysis of the effect of identified risks on overall project objectives. Risk Response Planning develops options and actions to enhance opportunities and to reduce threats to project objectives. Finally, Risk Monitoring and Control is the process of implementing risk response plans, tracking residual and new risks and evaluating risk process effectiveness throughout the project.

2. Background of the study

Large infrastructure projects, due to their nature, specific construction sites, project surrounding, numerous stakeholders, multidisciplinary character, being often complex and international are followed by many uncertainties. When considering project costs, the recent literature confirms that the cost overrun in transport projects is a global problem. In the work of Jenpanitsub (2011), the review of recent researches in relation to cost overruns in transport projects is given. Most of the studies focus on the problems on a national level and it is showed that the problem exists – in the U.S., Canada, the Philippines, South Korea, India, Sweden, England and Slovenia. In road projects, the mean cost overruns range between 4.5% (2,668 road projects in Indiana, USA) and 86% (8 road projects in Sweden). In rail projects, the cost overruns are between 14% (rail projects in Sweden) and 95% (122 railway projects in India). Only one of the researches is across continents, looking at 258 infrastructure projects (i.e., roadways, rail, fixed links) worldwide (Flyvbjerg, 2003). It reported that 90% of the projects experienced cost overrun with an average cost escalation of 27.6%. The average escalation for roadway projects was 20.4%.

In Serbia, as a developing country, heading towards EU, there is a need and a plan for upgrading infrastructure capacity and availability. Although Serbia is in the process of a constant infrastructure upgrading and development, significant infrastructure works are still to come. If example of highway network is considered, Serbia at the moment possesses a highway network of 650 km, of which 188 km is constructed in period from 2009 until 2012. Additional 700 km is still to be constructed, of which 165 km is designed and is in the construction phase at the moment, for 290 km there are designs, but construction has not yet started and the rest of 240 km is planned in the Spatial Plan of Republic of Serbia (1996).

In feasibility, design and construction phases of an infrastructure project, it is very important for all stakeholders to be aware of possible threats to the project goals and overall project success. This is especially important for advance planning stage (Figure 2), in which up to 98% of all savings on the project could be made (Ivkovic & Popovic, 2005). Much more attention in project management research and practice has been paid to construction, while much less has been focused on advance planning and design phases (Le *et al*., 2009). It is showed in recent researches, that it is possible to predict project cost and time performance even in these, early project phases, by using the Project Development Rating Index (PDRI), developed by Construction Industry Institute, USA (Le *et al*., 2009; Son *et al.* 2012; Wang & Gibson 2010).

This paper seeks to identify sources of risks affecting cost and time goals of infrastructure construction projects in Serbia. It further analyses the usage, necessity and problems with Serbian construction Project Risk Management (PRM) practice. Finally it explores the possibility of using PDRI for the front-end cost and schedule performance prediction model development.

The remainder of the paper is structured as follows: firstly we develop a research question through a salient literature review; next we set out the method employed for the survey; thirdly, we present the findings of the survey; the findings are then discussed, followed by some concluding remarks, limitations and areas for further work.

3. Risk Identification Studies

Previous surveys in relation to construction risk management based on questionnaires and interviews were done in direction to:

- Examining tools for risk management (Raz & Michael, 2001; Lyons & Skitmore 2004; Ali, 2005; Adams, 2008). Since the authors started from the hypothesis that construction PRM practice in Serbia is generally at the basic level, no PRM tools were examined in the survey. Only the existence and the problems with PRM practice at general level were explored, comparing it to the project management practice.
- Examining sources and priority of risks. Major outcomes of these attempts are the identification of the project objectives related risks and the project phase related risks (Zou et al. 2007). Some of the previous surveys on construction projects risk perceptions, based on questionnaires with predefined risk list were those conducted by: Adams (2008), comparing perceptions of risks between UK and Ghana contractors; Andi (2006), exploring the importance and allocation of risks on projects in Indonesia; De Camprieu (2007), examining the perceptions of risk among Chinese and Canadian large-scale projects practitioners; and Zou *et al.* (2007), identifying the key construction projects risks in China and Australia. Thomas *et al.* (2003), and Bryde and Volm (2009) explored, respectively, the

most critical risks of an Indian BOT road projects in an unstructured interview and perception of risks of owners in German construction projects in a semi-structured interview based surveys. However, in predefined risk lists in these researches there is a lack of advance planning phase risks consideration. In this survey, risks in all phases of infrastructure construction projects were analysed, with special attention to project early phases risks and market risks in Serbia. For predefined risk list generation, apart from mentioned, researches which employed construction risk modelling using Analytical Hierarchy Process (AHP) (Zayed *et al*. 2008), Analytical Network Process (ANP) (Bu-Qammaz *et al*., 2009) and Alien Eyes-Risk Model (Wang *et al*., 2004) were also studied.

4. Methods

In order to provide the opinion of construction professionals on potential risks sources regarding infrastructure project cost and time performance, as well as about risk management practice, a survey of the Serbian market is conducted. Within this research, infrastructure projects were defined as: road, railroad network projects, water supply and sewage system, gas infrastructure, electricity and telecommunication projects. Although some of recent scholars underlined there is a lack of researches that look at two sides nature of risks, as uncertainties that could have either positive or negative impact on project objectives (Bryde & Volm, 2009; Zou *et al.,* 2007; Ward & Chapman, 2003), for the purpose of the survey, risk was defined only as a threat, i.e. only as an event with possible negative impacts.

In the survey, existence of risk management practice in Serbia was examined through the structured questionnaire. The most significant goal was to identify major risks to infrastructure project performance. The questionnaire in this research consisted of four parts:

- The PART 1 contained 7 general questions.
- In the PART 2, there were 11 questions which examined the practice of construction project management in Serbia, as well as the usage, necessity and problems related to construction project risk management practice.
- 5 (five) questions in the PART 3 aimed to point out the main sources of risks on infrastructure construction projects in Serbia.
- The PART 4 consisted of 6 questions which analysed the problems and potential application of BIM (Building Information Technology) technology as a risk avoiding technique. Results of this part will not be presented in this paper, but are given by Mikic *et al*. (2012).

After initial structured questionnaire forming, to get feedback on the questions, the questionnaire was taken by three construction professionals with both practical and scientific experience in construction project management of more than twenty years. Based on this feedback, slight modifications to the wording of some questions were made.

In order to conduct the third and crucial part of the survey, identification of potential risks was performed prior to the survey, through a literature review and an iterative process of predefined risk list generation. In a literature review, similar previous surveys stated in section 2 were studied. Existing risk lists, developed in considered literature, were the basis for a risk list for the survey, which was made to fit infrastructure construction project surrounding and specific conditions of Serbian market, similar to the conditions in other developing countries, especially in South East European region. After initial risk list forming and construction professionals' feedback, definite predefined risk list was offered for a qualitative risk analysis in the third part of the survey.

Risk list consisted of risks grouped into three risk areas: General market risks, Risks in Feasibility and Design phase and Risks in Construction phase (Figure 2). Apart from the cited literature, this type of risk division was partly also based on chronological risk classification, suggested by Bunni (2003), supporting the plan to examine risk sources in pre-construction phases more carefully.

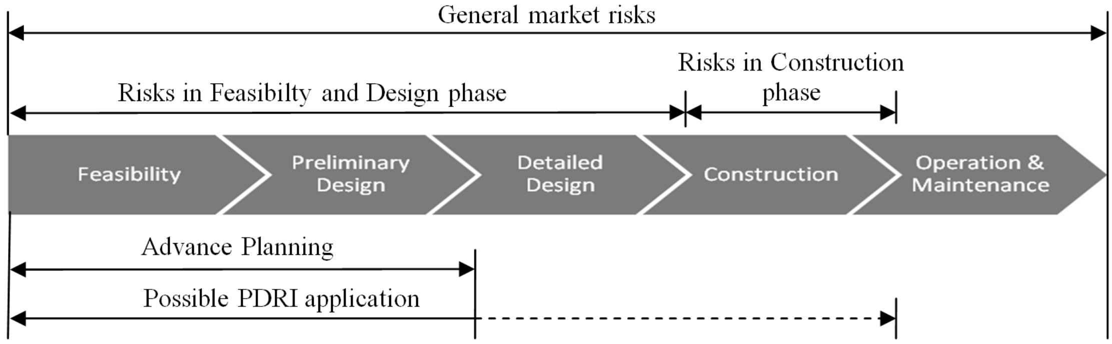

Fig. 2) (adapted from (Le et al., 2009)): Infrastructure construction project phases, risk areas and phases of possible PDRI application

As general market risks, the following were in the list:

- Political risks in Serbia (instability of political conditions, political pressure and impact)
- Domestic market financial risk (instability of economic conditions)
- Legal risk in Serbia (change of regulations, delay of approvals)
- Corruption

As risks in Feasibility and Design phase, there were:

- Inadequate initial surveys conducted (location, geology, geotechnics, hydrology)
- Inadequate Terms of Reference
- Design contract issues (deadline, price)
- Design company organizational issues (weak design project management, lack of qualified design engineers, lack of business standards and organization)
- Design technology issues (lack of standards and technical guidelines, lack of knowledge and appliance of advanced methods, technologies and software)
- Inadequate control from customer in design phase

As risks in Construction phase, in the list there were:

- Unforeseen ground conditions
- Design defects (incl. BoQ) which lead to numerous changes and variations
- Contractual issues (inadequate contract model, strict conditions towards contractor, tight deadline, low prices, inadequate advance payment structure, bad wording, incompleteness, potential claims and disputes)
- Contractor company organizational issues (weak project management performed by contractor, lack in management and engineers skills and know-how, lack of business standards and organization)
- Construction technology issues (lack of knowledge and application of advanced methods, technologies, equipment, materials and software)
- Resource issues (problems with borrow pits, specific materials and equipment procurement, change of material prices, lack of engineers, lack of qualified labour force)
- Bad quality of materials
- Lack of control and support from the Engineer, Engineer's incompetence
- Expropriation problems
- Unforeseen extremely adverse climatic conditions
- Accidents on construction site (health and safety issues, environmental issues)
- Force Majeure

The survey feedback in the third part included two groups of data, the probability of occurrence of each risk and its impact of consequence on basic project objectives (cost and time). The respondents were asked to evaluate the probability of occurrence and the impact of risks from the list on infrastructure construction project cost and time performance. The qualitative five-point scales were offered for evaluation of each risk in both of these groups of questions. Data analysis method, adopted as the method from previous researches (Camprieu *et al*., 2007; Zou *et al.,* 2007; Baccarni *et al.*, 2001) is further described.

The qualitative scales were converted into numerical scales, where both for probability and impact "very high" takes value of 1, "high" takes value of 0.75, "medium" takes value of 0.5, "low" takes value of 0.25 and "very low" takes value of 0.1. Further steps were: 1) averaging the evaluated probability for occurrence of each risk; 2) averaging the evaluated impact of each risk on project cost, and time; 3) deriving a risk rating, separately for cost and time, by multiplying their respective probability and impact average scores.

The survey was distributed to 85 construction professionals with experience on infrastructure construction projects in Serbia. It was also available for the Linkedin IPMA and PMI Local Chapters Serbia and Association of Consultant Engineers of Serbia (ACES) group members to take part in. In the survey 46 respondents took part, 37 of which responses were complete. Only complete responses were analysed. Both the reliability and the validity of the survey data were checked, where methodology of Andi et al. (2006) was applied and minimum response rate has been considered. Because of that criteria, there was no possiblity to compare risks evaluation of different groups of respondents.

Preliminary results of the survey, while the survey was still on-going, were published by Mikic *et al*. (2012). The results of the survey for Serbian market, regarding sources and priority of risks, are in the section 5 of this paper compared to the results of some of the previous studies.

5. Results

5.1. Results of General Questions

In the first part, respondents were asked about their profession, professional experience, types and values of infrastructure construction projects they have taken part in. 95% of respondents were construction or civil engineers. The rest were architects and electric engineers. 54% of all respondents confirmed that in their career they have worked as a project manager, 41% that they have worked as a designer, 38% confirmed they have worked as a contractor, 38% as a consultant, 24% in company management team, 24% as a supervising engineer, 22% as an investor, 16% have worked the other as well.

In Figure 3(a) working experience of respondents is presented, in preparation of studies and design and, separately, on construction sites and related activities. The lack of respondents could be noticed in the group 10-15 years of experience, and this could be, at least partly explained by the “brain drain” phenomenon that has been significantly present in Serbia and the region in the last twenty years. As seen, the highest response rate was among the younger professionals, as the 32% of respondents have less than five years of experience.

Figure 3(b) shows that 71% of respondents were involved in road projects, 43% in water supply & sewage system, while significantly less have participated in railroad network, electricity and telecommunication and gas infrastructure projects (14% of respondents for each).

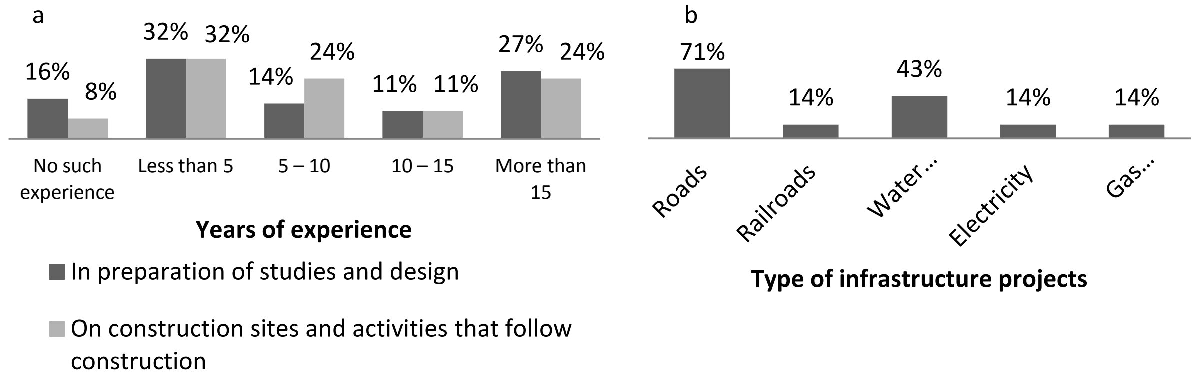

Fig. 3: a) Work experience of respondents (% of respondents); b) Engagement on different type of infrastructure construction projects (% of respondents)

The value of the largest infrastructure projects they have taken part in, for 76% of respondents, was more than 10 EUR millions.

5.2. Analysis of Project and Risk Management Practice in Serbia

Almost all participants agree or strongly agree that project risk management is an important area of project management (98% of respondents), that project risk management application is important for success of the construction project (97%), and that project risk management should be applied on construction projects in Serbia (94%).

However, although the awareness of the project risk management importance and the need for it exist, there is a lack of knowledge on the subject in Serbia. From figure 4(a) it is notable that only 38% of respondents is very familiar or familiar with Project Risk Management (PRM) tools. To compare, 81% of respondents is very familiar or familiar with Project Management (PM) tools. Also, there is a significant difference between the number of domestic companies which have implemented PRM system/standard, comparing to those which have implemented PM system/standard. While more than half of respondents (54%) answered there are some techniques or full system for PM implemented in their company, for PRM it is only 21% (fig.4 (b)).

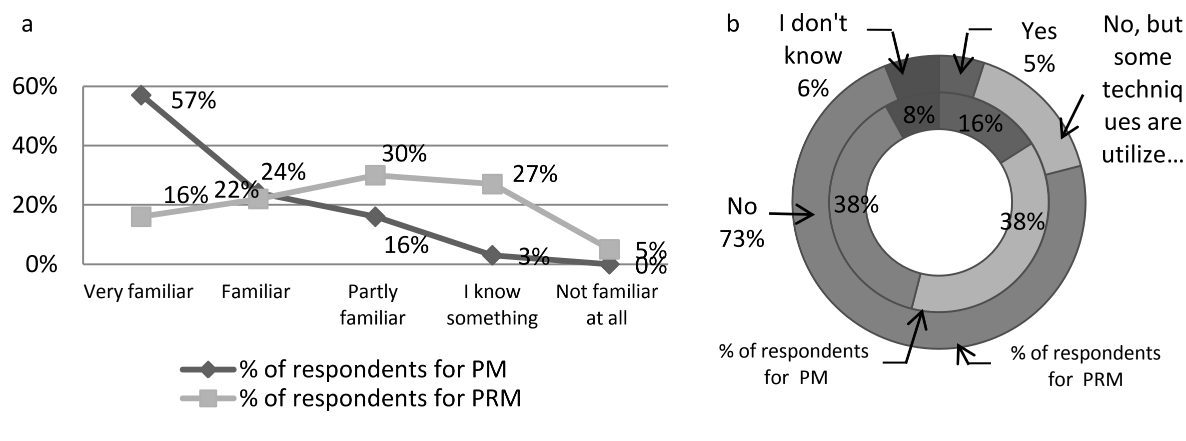

Fig. 4: a) Personal familiarity with PM/PRM tools and techniques; b) Answers to the question: "Does

your company have implemented PM/PRM standard/system?"

The major problems of PRM practical application on projects in Serbia are, starting from the most significant, evaluated as: organizational problems, no recognition of importance from top management, political, legal and financial problems. The level of interest in finding out more about PRM on a scale from 0 (no interest) to 4 (very interested) among respondents has a high mean of 3.46.

5.3. Evaluation of Major Risks in Relation to Infrastructure Project Cost and Time Performance

Data analysis method for identification of major risk has been explained in part 3 of this paper. The rating of all risks, separately for project cost and time performance is shown in table 1.

Tab. 1) Ratings of risks for Serbian infrastructure projects

LIST OF RISKS		**RISK RATING**	
No.	RISK	COST	TIME
1	Political risks in Serbia	**0,55**	**0,56**
2	Domestic market financial risk	**0,57**	**0,59**
3	Legal risk in Serbia	0,42	0,44
4	Corruption	**0,57**	**0,54**
5	Inadequate initial surveys conducted	0,49	0,48
6	Inadequate Terms of Reference	0,47	0,45
7	Design contract issues	0,40	0,39
8	Design company organizational issues	0,35	0,35
9	Design technology issues	0,27	0,26
10	Inadequate control from customer in design phase	0,48	0,43
11	Unforeseen ground conditions	0,40	0,41
12	Design defects (incl. BoQ)	**0,52**	0,48
13	Contractual issues	0,47	0,44
14	Contractor company organizational issues	0,44	0,48
15	Construction technology issues	0,33	0,35
16	Resource issues	0,28	0,30
17	Bad quality of materials	0,19	0,18
18	Lack of financial resources for project realization	**0,57**	**0,64**
19	Lack of control and support from the Engineer, Engineer's incompetence	0,31	0,31
20	Expropriation problems	0,48	**0,50**
21	Unforeseen extremely adverse climatic conditions	0,12	0,14
22	Accidents on site	0,17	0,17
23	Force Majeure	0,09	0,11

The risks with ratings above 0.5 are considered critical and their ratings are presented in bold letters in table 1. Since the value "high" in qualitative scales responds to the value of 0.75, the most critical risks are those with values of both probability and impact "high" or "very high", which, because of multiplication, gives ratings of at least 0.56. The highest rating regarding possible project cost

overrun have the risks: Domestic market financial risk (0.57), Corruption (0.57) and Lack of financial resources for project realization (0.57). Then come Political risks in Serbia (0.55) and Design defects (0.52). Inadequate initial surveys conducted, Inadequate Terms of Reference, Inadequate control from customer in design phase, Contractual issues and Expropriation problems are also highly rated.
The risks with highest rating regarding project time performance are: Lack of financial resources for project realization (0.64), Domestic market financial risk (0.59), Political risks in Serbia (0.56), Corruption (0.54) and Expropriation problems (0.50). Then come: Inadequate initial surveys conducted, Design defects and Contractor company organizational issues, as also highly rated.

6. Discussion

The highest ratings considering both project performance indicators (cost and time) has, as seen, the Lack of financial resources for project realization, after which comes the Domestic market financial risk, Political Risk and the Corruption. The top rated risk is an internal project risk, while the other three are of external nature.
The highest ratings from the internal risks, apart from the top rated, have: Design defects, Expropriation problems, Inadequate initial surveys conducted, Inadequate Terms of Reference, Inadequate control from customer in design phase, Contractual issues and Contractor company organizational issues.
Received results mostly correspond to the results of previous surveys of construction projects risks in developing countries. The highest rated risks for China were, regarding project cost performance: Price inflation and Design variations, regarding time - Project funding problems (Zou et al., 2007), where a significant correspondence was noticed. For Indonesia, the Inflation, Defective design, but also Unforeseen Site conditions were evaluated as risks with the highest impact on construction projects (Andi, 2006), while for Indian road projects the most significant risks were: Delay in land acquisition, Delay in financial closure, Direct political risks (Thomas *et al*., 2003), which are all risks also rated very highly in this study. In relation to highly rated risk of corruption, it is said that the construction industry is the most corrupt industry and there are strong incentives in the sector to engage in collusion (Brockmann, 2009).
Flyvbjerg *et al.* (2003) claims the main shortcoming of the conventional approach to infrastructure megaprojects appraisal and development is the absence of, on the one hand, clear objectives and, on the other, arrangements for: (i) measuring how objectives are being met; and (ii) rewarding good and penalising poor performance. Therefore, they set out four basic instruments for enforcing the accountability: Transparency, Performance specifications, Explicit formulation of regulatory regime and Risk Capital. With this instruments applied, external risks, that could not be controlled from the project team and require not only technical solutions, could be, at least partly mitigated. Other possible solutions for external risks mitigation include developing proactive project team, which can recognize and prepare for risks in the first place, but also, as stated in FIDIC (2012) lead an infrastructure project as a complex adaptive system which responds adequately on uncertainties and is more resilient. These solutions can help for internal risks, as well.
On the other side, all of the highest rated internal risks can be successfully managed by the project stakeholders, and for about all of them, proper Client's and/or Project Manager's involvement is of very high importance. Results presented in part 4.2 in this paper, showed there is a strong support and interest for PRM among construction professionals in Serbia. It was also proved there is a lack of PRM knowledge and practice in the market, mostly because of organizational problems, no recognition of importance from top management and political problems. Therefore, the authors have, in separate research, started with examining the applicability of a front end scope and risk

assessment tool - PDRI for Infrastructure. As said, in some of previous researches it is showed that together with data mining tools, it can be used for the front-end cost and time performance prediction model for construction projects (Le *et al*., 2009; Son *et al.,* 2012; Wang & Gibson, 2010). PDRI basically consists of a list of project scope elements, including descriptions, which are organized in categories and sections. Categories include, *inter alia*, Project Strategy, Project Funding and Timing, Site Information, Project Design Parameters, Land Acquisition Strategy, Procurement Strategy, Project Control, Project Execution Plan, which are all in this research evaluated as areas with sources of highest risks in Serbia. Using a rating mechanism for each element's definition inside the categories, the PDRI allows the project team to determine the level at which a project is defined at any given time during the front end planning process (Le et al., 2009).
Although the PDRI methodology can be applied in different project phases (fig. 2), to measure how project team advances in project development, it puts the highest accent on examining Client's early phase preparation and issues proved as of the highest importance in this research. Because of this, the hypothesis of applicability of a composite PDRI-Data Mining Tools Model for prediction of cost and time performance on infrastructure projects in Serbia has been made.

7. Conclusion and recommendations

In this paper, results of the infrastructure construction project risks survey for projects settled in Serbia are presented. Construction PRM practice in Serbia was analysed and evaluation of major risks in relation to infrastructure project cost and schedule performance was performed. Although there are more advanced techniques for risk analysis and evaluation, in this research Probability-Impact analysis was applied, as a first step toward more complex risk modelling.
It was found out that there is a strong support and interest for PRM application on projects in Serbia, but lack of knowledge on the subject and poor practical application exist. Among the 23 risks in the predefined risk list, domestic market financial risk, corruption and lack of financial resources for project realization were the highest rated regarding possible project cost increasing. Regarding project time performance, it was the lack of financial resources for project realization, domestic market financial risk and political risks in Serbia. The major problems in relation to PRM practical application in Serbia are identified as organizational and no recognition of importance from top management. The study revealed that by perception of construction professionals, the highest risks on infrastructure projects in Serbia come from external environment. Other highly rated risks are mostly from feasibility and design project phases. The limitation of number of respondents did not allow any comparative analysis of different respondents groups view on the subject.
The significance of this result is that it provides an empirical basis for the development of more complex risk models and further systematic analysis and management of infrastructure construction project risks in Serbia. Results of the study provided a base for a new model proposal for an early phase prediction of cost and time performance on infrastructure projects. It is recommended the model should include PDRI methodology and Data Mining Tools. The results can also contribute to developing a basis for more adaptive project teams.
Although the study reported here has to be placed within a clear context of its limitations, it could be recommended for further researches that this type of surveys should be conducted in other developing countries, especially in countries in the South East European region. In that way, the results could be compared and more general conclusions could be made. It is also recommended that future studies in the same area include a qualitative survey as a method.

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ANALYSIS OF SOURCES OF INFORMATION ON TECHNOLOGY FOR PROJECT MANAGERS IN CIVIL ENGINEERING*

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Abstract

In everyday work, civil engineers are forced to search for technological information. Out of the many available sources of information, there is no one perfect source. The speed of finding the required information has often a key impact on the quality of their work. In this paper, the ways in which selected representatives of the group of civil engineers gain information on technology are analyzed, their grading of various sources of technological information, as well as the advantages and weakness of each of them. As a conclusion, recommendation for the preparation of an optimal source of information on technology for this specific civil engineering field is given.

Keywords: technology, information, internet

* The complete text is available on CD-ROM / Petronijević, Arizanović, Kovačević, Ivanišević

Introduction

Changing trends in the investment project market during the first decade of the 21st century, clearly show a reduced demand and an increase in requests for implementing the latest technological innovations and materials or the most efficient energy supplies in the construction process. These trends are expected to continue as the market develops a segmentation process in which only construction companies willing to meet the strict requests of investors will survive. The development in the field of high tech construction machinery and equipment means that there is a need for a high quality of work construction capacity so the comparative differences (advantages) of companies operating in this sector will imply the employment of highly skilled workers. Consequently the costs of hiring this type of workforce is increasing, which in turn implies less is being saved on construction material which is being used ...... and they are becoming more expensive.....

This state of affairs requires synchronically adjustments and the constant modernization of the majority of segments of the construction industry. The basis of all successful business processes is information flow and consequently the speed at which a company acquires information and its flow will be equal in importance to the effects of a company's flexibility (adaptability), management's ability to reduce or eliminate the supporting costs in the production of objects and services (lean construction) and the degree of financial turnover.
How does one survive in such a market environment? From who can one expect salvation? At the end of the 20th century and the beginning of the 21st century "the rescuers" were recognized as knowledge assets[*]. The ability to quickly receive, process and implement knowledge was a key factor in deterring the profitability of a company and therefore the effectiveness of management. In order for this to influence the production process, the knowledge team had to accumulate data, sort and extract relevant information to resolve a problem. However, this new flow of information or wave of data was often the opposite of the conclusions reached and more often than not it was shown that the collected information, which was recognized as new and viable, was not applicable from the technological standpoint.
The exchange of information in the modern world should not be the ends to itself, nor should it be used as the means to an expansion of formal knowledge. The use of information exchange should be, above all, directed towards the increase of efficiency in both production and technological processes in the industry. Unfortunately, technological information is often acquired too late, which in turn implies a waste of time in its collection and acquirement, the information acquired can be unreliable and is often in various formats. Technology is a wide area and yet company managers are especially interested in a specific or specific field. The most frequently encountered problem is locating and finding information for a particular field. The real problem is how to acquire information fast and which at the same time is reliable and a usable source.

[*] the knowledge economy stands on three pillars. The first: Knowledge has become what we buy, sell and do. It is the most important factor of production. The second pillar is a mate, a corallary to the first: Knowledge assets – that is, intellectual capital - have become more important to companies than physical or financial assets. The third pillar is this<. to prosper in this new economy and exploit these newly vital assets, we need new vocabularies, new management technigues, new technologies, and new strategies. On these three pillars rest all the new economy's laws and its profits." {Stewart, T.A (2001) The Wealth of Knowledge: Intellectual Capital and the Twenty-first Century Organization, Currency Doubleday, 2002, 320 pages}.

Existing solutions

The first thing that comes to mind when one hears the term "source of technological information" is the internet. Specialized fairs, technical literature, seminars and cooperation among colleagues and the like rank far behind as sources of information gathering. However, an obvious problem with the „net" is that information is available in such vast quantities and there is absolute chaos that recognizing and/or selecting the relevant information creates a greater problem than the attainment of such information. This is not an organizational problem but more of individuals within it because it is not the organization which has to learn how to survive, but those who run it. It is these individuals, surrounded by chaos which threaten and prevent the recognition of rules and schemes......this in turn influences the company's ability to change its procedures, rules and schemes.

The learning process is a strenuous and intellectually demanding process with clearly defined rules. When a manager or engineer runs into an unknown problem they can choose either one of three possibilities. The first option is when searching for information to resolve a problem to check whether there were events which were similar if not the same as the one they are trying to resolve(if they have been in such a situation previously, this refreshes the memory, reminds them, but if the problem is a novelty than the individuals learn information from the experiences of others). The second possibility is based on determining the similarities between the existing problem and previous ones. From a variety of "similar" events they use bits of applicable information or knowledge and make a combination which in itself represents new knowledge. The third and final option is to obtain new knowledge by the method of trial and error (that is to say, taking actions which we are sure to be effective because they have been tried and tested before) and checking the outcome of these effects. In order to avoid this option from becoming the "futile attempt method" it is necessary to isolate the planned procedure from the "parasitical" effects effectively, since even with the simplest of processes the results or our actions cannot be seen from the forest of filtering through effects.

The first two options have been used exhaustively before the results are presented to management, the third less so, since the third (scientific-experimental approach) is more demanding than the first two, both from the viewpoint of time and ease of obtaining formal knowledge. The second option leaves room for creativity because you have to combine different sources of knowledge, but it requires an analytically trained mind (which from various "similar" events, sorts and separate the one option which will be the optimal combination). Consequently it is available to a smaller number (subsets) of decision makers.

The first option remains as the most used – search on the internet (with the natural state of affairs this option appears to be poor, non-constructive and partial....). The prejudicial assumption that that the internet offers a quick and reliable solution to a pressing problem is a byproduct of a worldwide consciousness that the internet is the best source for research and viable solution because of its scope is, as any knowledgeable user of the "pyramid of wisdom" knows , useless without the correct tools and know how.

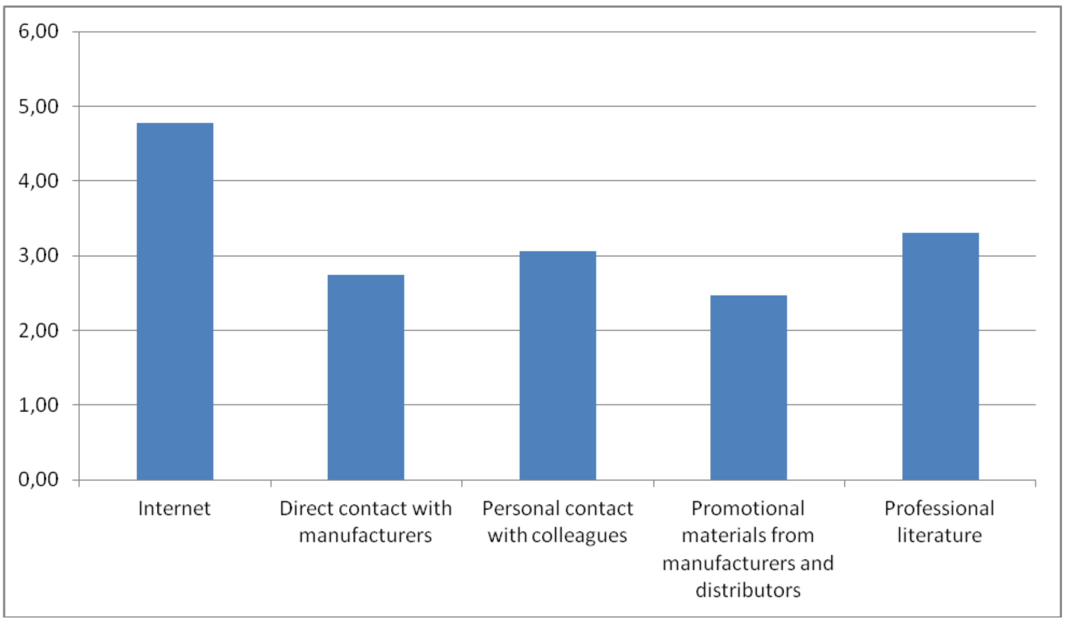
Proposed solution

In order to analyze the habits of civil engineers, it is necessary to analyze their needs and habits in connection to technological information and on the basis of this come up with the optimal information research device. To this end, a survey was conducted on a selected number of experts from the practice and academia. The results of this analysis will serve to form the optimal research device in the field of technology.

The survey was conducted during June and July of 2010 in order to gather information about the requirements and habits of civil engineers in the domain of technological information. Participants were chosen from a pool of professionals in the area of building and construction. The aim of the survey was to determine how these experts obtain and gather the necessary information for their work. The survey also looked at the problems which they might encounter during their research as well as determining the “ideal” search engine, in particular in the specific specialized technical domain of the profession.

Analysis of the results from the query

The survey was limited in scope with a division of professionals into two groups. The first group consisted of five researchers from the academia. All participants were interviewed during the International Conference on Computing and Civil and Building Engineering (ICCBE), which was held in June 2010 in Nottingham, Great Britain. The participants from this group come from a disperse range of universities; Purdon University and Longborough University in Great Britain, the Ball State University in the USA and the Civil Engineering Faculty at the University of Belgrade, Serbia.
The second group consisted of nine participants, all experts in the domain of civil and building engineering with hands-on, practical experience in the area. The group consisted of four consulting companies, four construction companies and one architectural design and planning company. The market area in which these companies work is vast: Avistum Ltd. (England), Montagna SM (Italy), Parsons Brinckerhoff (UAE), STRABAG (Germany), ZAO “Strabag” Moscow (Russia), two companies from Serbia – the Consortium Eptisa, Royal Haskoning and VNG and Gemaks, and Alpine and VT Real Estate (Austria).
The survey shows that each of the participants of the survey has a frequent and great need for technological information. Six of the surveyed search for data on a daily basis, six regularly during the week, whereas only two require the use of technological information at least once a week. Therefore, all surveyed need technological information with 86 per cent searching several times a week and 43 per cent searching on a daily basis. It should be noted that those in the market have a frequent need for this information (average score 1.56 on a scale of 1 to 4) compared to those in the academia (average score 2 on a scale from 1 to 4).
The participants in the survey were also asked to rank the sources of data collection on a scale from 1 to 5 (5 being the maximum number of points). The Internet, as a source of information, ranked high at 4.57. The academia graded the Internet at 4.8 whereas their market counterparts at 4.44.



Graph 1- Sources from which engineers acquire the required information on technological issues

The participants did not rank manufacturers of building material highly as a source of information. The academia only gave a score of 2.4 whereas the experts in the market gave an average score of 3.11, giving a total average score of 2.86 (Graph 1).

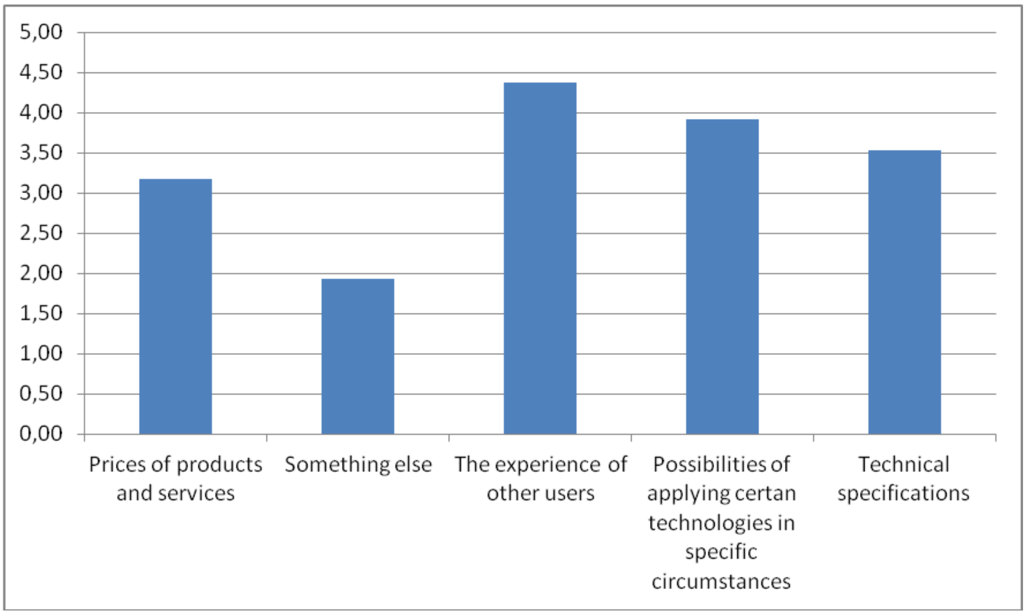
Experts in the market viewed personal contacts with fellow colleagues in the area of building and construction at 4.0 as a source of information, compared to 3.0 by the academia, resulting in a final grade of 3.64.

A similar result emerges when considering advertising material, manufacturers and distributors as sources of information. A very low score was given by the academia (2.0) compared to the experts in the market (3.0). Consequently, this source of information was given the lowest total score of 2.54 compared to the other sources of information.

Technical literature as a source of technological information was given an almost uniform score by all participants. This source received a total average score of 3.36, with the average score of 3.2 from the academia and 3.44 from experts in the market.

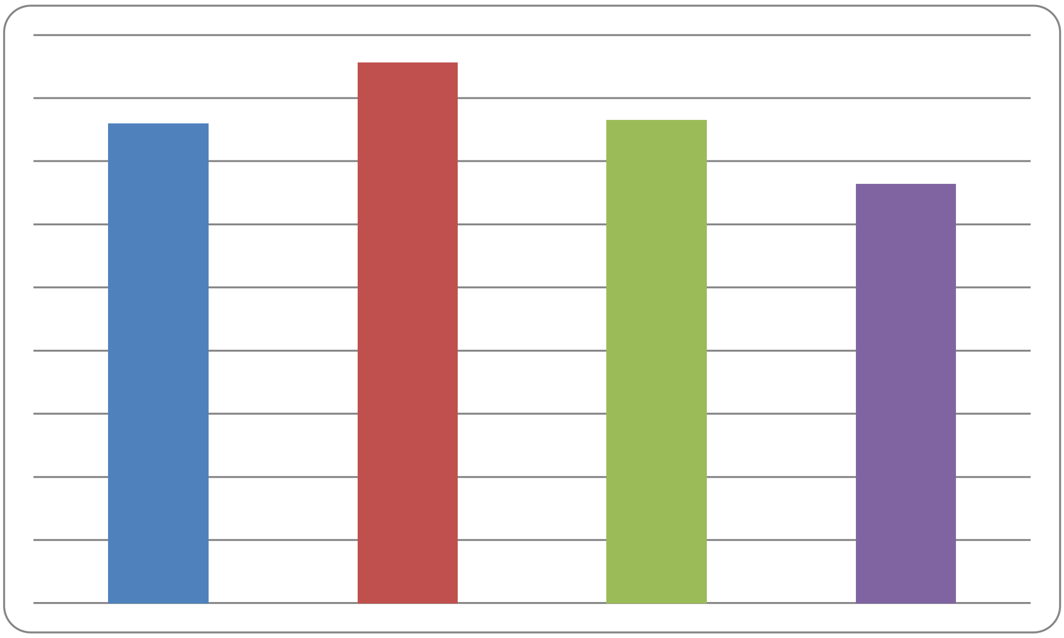
Therefore we can conclude that the Internet as a source of technological information is judged to be by far the best source from both the standpoint of the academia and experts in the market. Apart from the Internet, but viewed slightly less resourceful, are personal contacts (ranked higher by the experts in the market than by the academia), then comes technical literature, which is equally viewed as a solid source of information, and finally the least resourceful are contacts with manufacturers and advertising material of companies in building and construction as sources of information.

As to the types of technological information required (Graph 2), all participants in the survey agreed that the most common requirement is the exchange of experiences and knowhow with other users (average score 4.21, where the academia gave 4.40 compared to 4.11 from the market). The possibility to apply certain technology under specific circumstances was also ranked high at 4.07, where those in the market ranking this at 4.22 compared to 3.8 from the academia. A somewhat lower average score (3.5) was given to technical specifications with both groups producing similar scores. As for information concerning the price of products and government services, there appears to be less interest (average score 3.29) with the academia being less interested (3.0) compared to the experts in the market (3.44), who require this type of information more often. The choice of type of information was based on what the participants required the most, considering that the option “something else” was given a score of 2.15. On the basis of these findings it can therefore be concluded that the participants mostly need the exchange of knowhow and experiences of other users, followed by the application of certain technology under specific circumstances as well as technical specifications (This is interesting considering that much of this information can be found on the Internet, thereby reaffirming the status of the Internet as the best source of information).



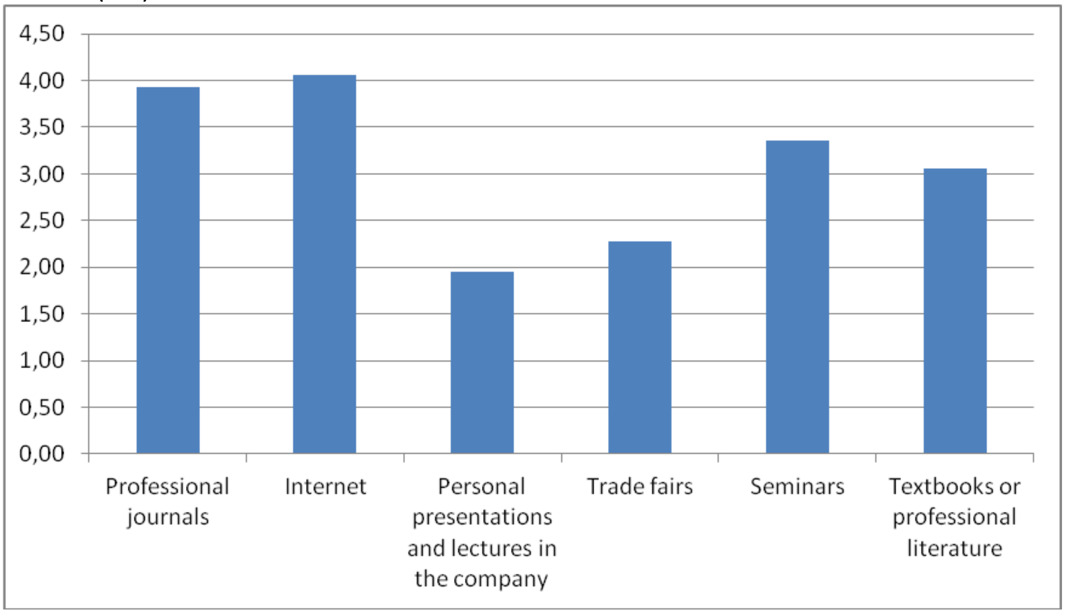
Graph 2 - Types of information on a particular technology are often difficult to find

In defining problem areas when obtaining technological information there appears to be no major problem area which stands out (Graph 3). All seemed to be ranked equally according to the survey. The participants were given a choice of a score range from 1 to 5, with 5 being the maximum. The lack of current and up-to-date information came in slightly higher (3.86) compared to a lack of appropriate working conditions on building sites at 3.71. This was followed by the problems which may arise by prolonged searches at 3.64 compared to a score of 3.36 for a lack of time. All aforementioned problems were given a slightly higher score by the academia compared to the experts in the market.



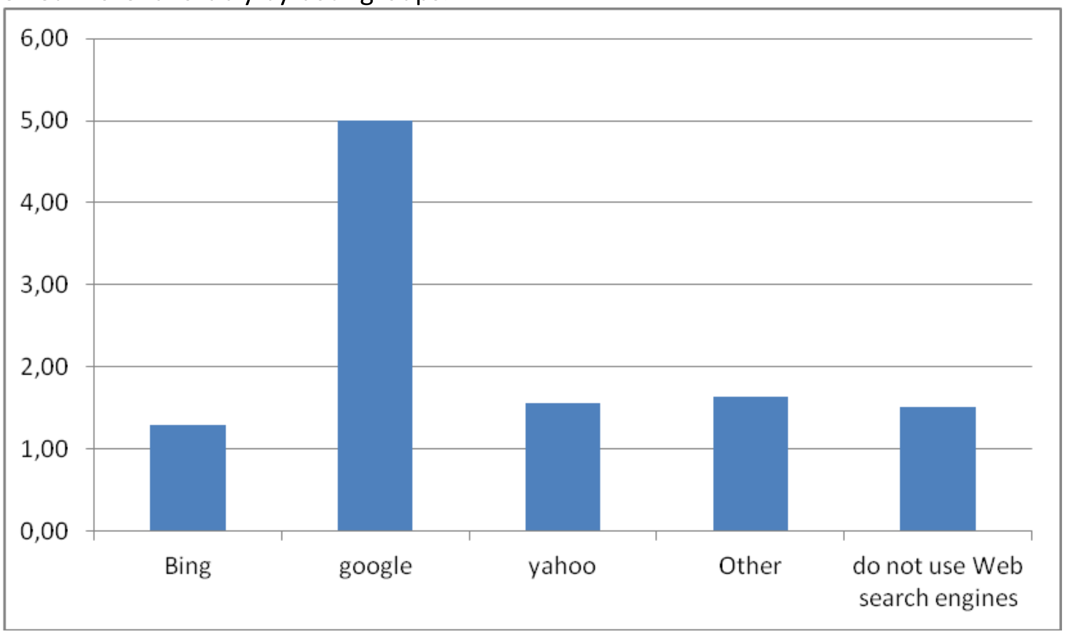
Graph 3 – Obstacles for acquiring information on technology issues

Participants were also asked to rank the media (or the ways, methods in which the media…) could lead to an optimal use and improvement in the use of technological information (Graph 4). The Internet again received the highest score (average score 4.14), with a very high score from the academia, 4.4 compared to 4.0 from the experts in the market. Technical journals also received a high score (4.07) with the academia viewing this media slightly higher (4.2) compared to the experts in the market (4.0).



Graph 4 – media ranking for technological training and information gathering

It is interesting to note that the average score for the experts in the market is similar for the Internet and technical journals. Seminars in the domain of building and construction were given a lower score (average score of 3.5). Textbooks were not popular (average score (3.15), particularly among experts in the market (average score 3.0). The least evaluated an active presence at trade shows (average score 2.79) and here a major difference emerges between the academia and experts in the market. The academia gave a score of 1.4 compared to 3.56 from the experts in the market which was to be expected. The trade shows offer information which is essential to the market compared to the academia. The survey also showed that a media which could adapt to changing environments quickly, be up-to-date (the Internet and technical journals) and follow new technological innovations was viewed more favorably by both groups.

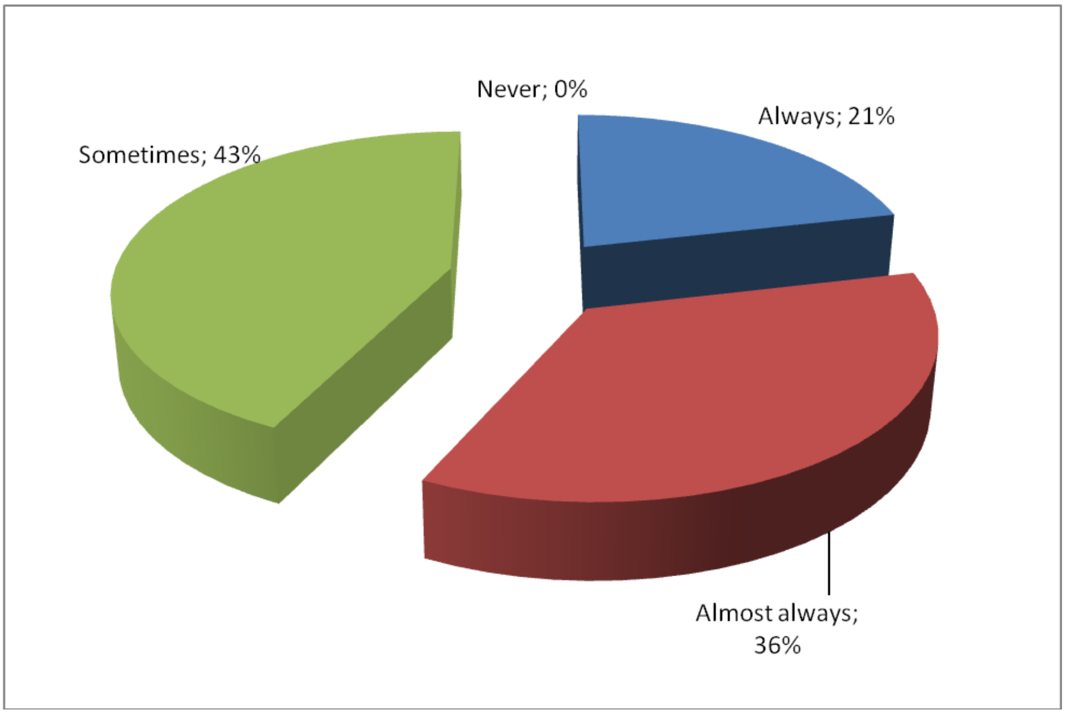


Graph 5 – Favorite search engine

The successful use of the internet and finding the relevant information to a great extent depends on the quality of the search engine being used (Graph 5). Google is the most frequently used search engine and has the highest score (average score 5.0). Other search engines were similarly appraised: Bing 1.58, Yahoo 1.67 while the rest were given a score of 1.5. The option "*I do not use the WEB search engine*" received a score of 1.33, which suggests that the participants to a great measure use the Internet as a resource of information. Apart from the offered search engines, participants also used commercial databases or specialized search engines (e.g. http://scholar.google.com). On the basis of these findings, therefore, we can conclude that Google is the number one reference point as far as search engines are concerned. In order to appraise the quality of a search engine (be it general or specialized) it is therefore necessary to conduct a comparison to Google.

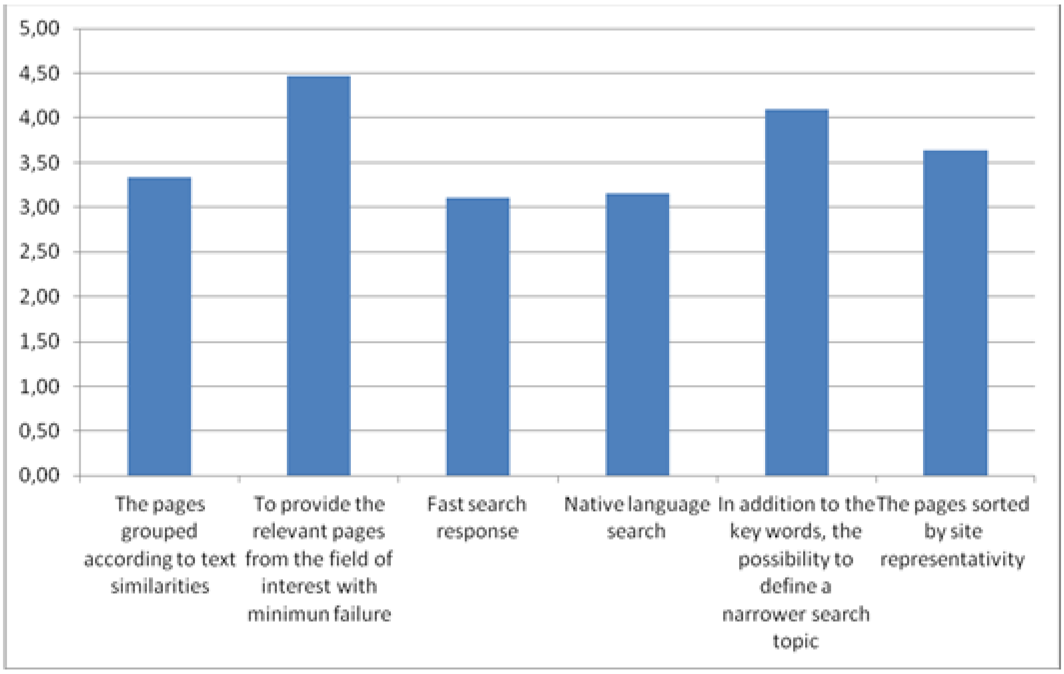
Even though Google is ranked highly as a search engine, all participants in the survey admitted that at some point they could not acquire the necessary information from this search engine (Graph 6). Only 21 per cent of the participants said they could always find the information they were searching for, 36 per cent admitted that they usually acquired the required information while 43 per cent said that they sometimes obtained the information they required. These kinds of answers suggest a collision with the previous question where Google was assessed highly by all participants. Almost 80 per cent of the participants admitted that they could not always find the required information (even with the help of Google), with almost half admitting that they only sometimes obtain the required information. This in turn implies that despite Google being the leading search engine, it still does not give perfect results, particularly in the domain of specialized technological data.

When using a search engine all participants said they used two or more key words. Seventy-nine per cent said they used terms which contain three or more key words, while 36 per cent used more than three key words. It is obvious that even with a search engine like Google all of the participants have to use multiword forms in order to get the relevant technological information. Even with such complex word forms, Google does not always come up with the results.



Graph 6 – Answers to the question " If you use Web search engines, could you successfully find the technical information you need?"

As far as problems both groups encounter when searching, the major drawback according to the participants was classification – data was not classified according to kinship (score 3.71 out of 5). Similarly, another difficulty is that many pages must be opened in order to find the relevant and required information (score 3.5). In spite of this many of the participants do not view these problems as major obstacles, considering their use of complex word forms in the search engine. This should not come as a surprise considering all of the participants surveyed are experienced professionals and in the academia where excellent knowledge and research skills are the norm and at a much higher level compared to the average Internet user.



Graph 7 – Ranking the characteristics of the "ideal" search engine for technical information

The final section of the survey dealt with the “ideal” characteristics a search engine should possess (Graph 7). The highest score (4.14) was given to the characteristic “that it gives the relevant page in the area of interest with the minimum of misses”, which should be the basis of any competent search engine. The academia gave this characteristic a score of 4.8. The second characteristic “that apart from the key words, I can choose a much specific and specialized terminology” received an average score of 3.93.

A slightly lower evaluation was given to the characteristic “that it finds are sorted according to the representativeness of the site” (average score 3.79). The characteristic “that its finds should be grouped according to similarity of text” was given an average score of 3.5. The characteristic “the search engine should use the mother tongue” received the lowest score (although its average was high) of 3.21. All the characteristics were ranked according to the real needs of users, as well as this all the characteristics received high scores and were recognized as being important for any search engine to be relevant and well resourced with data.

Conclusion:

On the basis of the findings in the survey it can be concluded that civil engineers in all aspects of building and construction have a need for technological information. All surveyed had a requirement to at least once a week use the Internet, with half requiring the Internet every day. Most commonly the information searched for are comments of experts with experience in the area and the possibility to apply certain technology under specific circumstances. The survey commented that the biggest problem which is encountered in searches is locating and finding current data. The surveyed in their searches relied heavily on the Internet. Google was convincingly the most used search engine,

although it should be noted that other search engines were used. Despite this, only 21 per cent said they could always found what they were searching for in Google. During searches, two or more key words were used. Classification according to similarity of text was viewed by many users as a problem they encounter when searching. According to the surveyed the ideal characteristic of a search engine should be “that it gives the relevant page in the area of interest with the minimum of misses” and “that apart from the key words, I can choose a much specific and specialized terminology”.
This questionnaire represents the first phase of the research whose goal was to create an optimal data browser for a specific technological area. Consequently a website http://machines.grf.bg.ac.rs was created which is used for searching for data on construction machinery.

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LIMIT STATES DURING COMPANY VALUATION*

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Abstract

The basic division of company valuation methods are the cost, yield and comparative methods. For all these methods, it is important to quantify the real estate assets, which will be adjusted according to new information using limit states. This requires intervention in the mathematical process that is typically used to quantify the value of movable assets. Currently, in the yield methods the value of real estate in the total company value is reflected using cash flow, the cost methods using brutto substantial value, a specially their assets; and in the comparative methods using coefficient and its relation to the company. The task of solution is to compare the new results of value determination using limit states with usual, already used methods.

Keywords: company valuation methods, real estate, functional parts, limit states

* The complete text is available on CD-ROM / Puchyr, Korytarova, Šimačkova, Špiroch

Introduction

The company in general is a complicated organism and to determine the limit states of individual units of company is not easy target. To continue the issue we should know some basic terms and their interrelationships. This article aims to describe the relations between real estate and their limit states during the companies' valuation and try to determine the basic intervals of repairs or replacements of functional parts of residential buildings.

2. Basic terms

"In structural design, design constraints are frequently referred to as **limit states**. Limit States are conditions of potential failure. Failure being defined as any state that makes the design to be infeasible (i.e. it will not work for its intended purpose).

Limit states take the general form of: Demand < Capacity. Structural limit states tend to fall into two major categories: strength and serviceability. (Quimby, 2008)

The term company is defined differently in literature, but for the valuators is the most important definition quoted in the Commercial Code, § 5, which define company as:

"… set of tangible and intangible business components. To the company belong objects, rights and other asset values. These business components belong to company owner and used to company operating or due to their character they serve to this purpose. The company is a matter of composition…" (Mařík, 2007)

Construction differs fundamentally from all other industries because in a "normal" industry the product changes its place and the production factors (people and machinery) are static. In construction it is the opposite – "the product (the site, the building under construction) is static and does not change its place. When the "production process" is finished "the product" stays where it was made, while the production factors (people and machinery) move on to the next location – to the "next product". (Katavić, Bošković, 2008)

Construction company differs from other companies mainly by their participation in the construction market. The main activity of construction company is building production (fabrication and delivery) and the manufacturing process is timed. Construction company outsources its prosperity reaching the profitability of building production, which is influenced by many factors. In the company we are meeting with financial, movable and immovable assets.

The term **value** can also be called ideal price. It means that at this price the buyer and seller have agreed (to the mutual satisfaction). The value is not identical to the real price; it's only an estimate. The value of company is divided differently. The basic division is the brutto (the value of the company as a whole) and netto (equity valuation) value. The Commercial Code deals with this division. (Šimáčková, 2012)

Real estate is defined by Civil Code (Act No. 40/1964 Coll., The Civil Code as amended, § 119) as follows: "Per real estate are regarded lands and buildings connected by solid foundation with the surface." (The Act No. 40/1964 Coll., 2013)

"**Functional part** represents the compact part of the building that performs one or more specific specially determined functions." (Marková a kol., 2011)

Technical lifetime is mainly defined as the period from the date of construction to the dilapidation and technical termination, assuming outgoing maintenance during the whole cycle.

Economic lifetime is the period from the date of construction to the moment of loss of economic usefulness. However, this condition is associated with a permanent loss of income due to the disproportionately high costs or is a single purpose building that lost its economic usefulness due to the change of external conditions (in this case, the cost of maintenance or for new and better utilization were unreasonably high).

3. Methods of the company valuation

- Company valuation of the yield method

  The yield method of valuation works with potential returns (expected incomes) of company and it's one of the most important methods to determine the company value. In this type of valuation we take into account events which may arise in the company in the future (increase profit, decrease profit or persistent state). To determine the present value of profit in the company the most commonly we use the income statement (summary of the costs and revenues for particular period => reporting on the profit or loss).

- Company valuation of the cost method

  This method answers the question for how much the property was actually originally acquired and valued by current accounting principles. The result is a balance sheet where equity (net value) is the accounting valuation of the company.

- Company valuation of the comparative method

  The joint-stock company, whose shares aren't commonly traded, or another company we value by using the comparative method. This method is applied at the level of comparable companies, comparable transactions and sectorial multipliers.

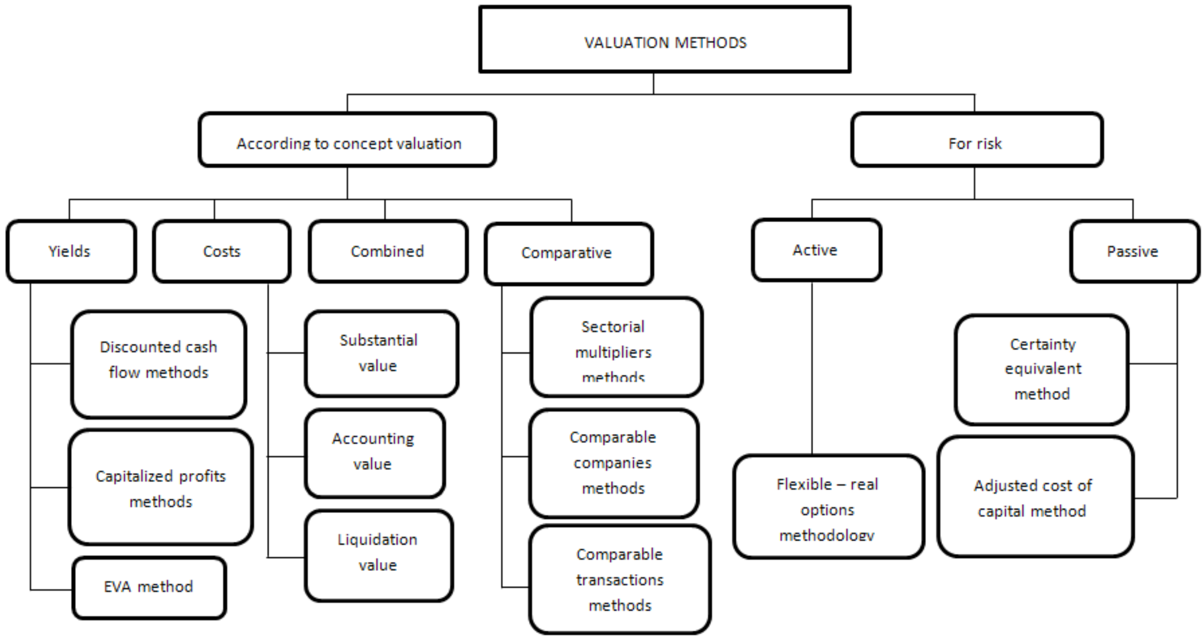

Fig. 1: *Methods of the company valuation,* (Mařík, 2007; Dluhošová, 2006)

Real estates are items of company property, which have greatly affect to the final value of the company during its valuation. In the balance sheet, these items are on the asset side, ie. contributes to the overall condition of the property company.

Real estate valuation:

$$Replacement\ value = OP(m^3) \times Replacement\ value\ (CZK/m^3) \quad (1)$$

$$Wear\ of\ building \Rightarrow O = {}^{S}/_{\check{Z}} \times 100 \quad (2)$$

where: *OP* .... Building volume
O .... Wear of building in %
S .... Age of the building
Ž .... The total life cycle of building
ČHS .... Time value of construction
HP .... Value of the land in CZK

$$Time\ value\ of\ construction\ (CZK) = Replacement\ value\ (CZK) - O \quad (3)$$
$$Material\ value\ of\ real\ estate\ (CZK) = \check{C}HS + HP \quad (4)$$

Methods of the company valuation are closely interconnected with individual real estates and their technical lifetimes, their intervals of repairs and replacements through functional parts of real estates.

4. Real estates and their limit states

The company in general includes two groups (assets and liabilities). Determining the limit states might be unclear at first sight. However, for this approach is necessary to realize that a big part of company consists of assets (owned by a company) including several sub-parts. In our case I will concentrate on one particular part of the assets, namely real estates.

Definition of real estate I wrote already in the subchapter "Basic terms". It says that the real estate is considered, with specific conditions, land and building. In this article I will concentrate only to building and their functional parts.

Limit state of functional part (FP) is closely related to its technical lifetime, so with "quality of materials, quality of construction work, conditions which occur during using the building (or their functional part) in operation, maintenance and repairs throughout the lifetime of the functional part, placement of the FP and climatic conditions." (Marková a kol., 2011)

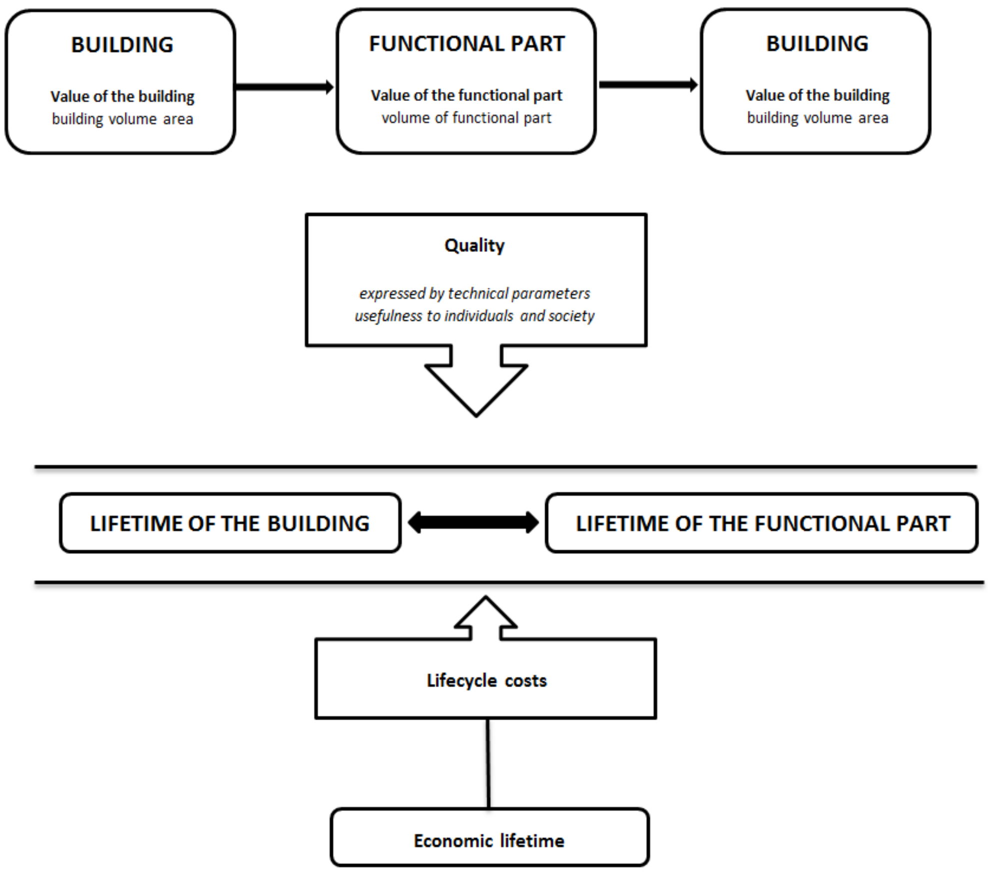

Fig. 2: *Relation: quality – life cycle costs,* (Marková a kol., 2011)

The lifetime of construction object we perceive as a lifetime of a whole. Construction object can be divided into functional parts (constructions) and you could perceive their individual lifetime (which can have a great time variance). In this article I use the idea that total physical lifetime of construction object determines the lifetime of its main components (vertical and horizontal constructions). Functionality of other components is extended by their repair or replacement. We can say that the limit state of function part occurs at a time when the functional part is not identical with its own technical lifetime.

Functional parts have specific lifetime and for elongation this lifetime is necessary to provide repairs or replacements of individual function parts. At the next table (Tab. 1) I present overview of technical lifetime of individual function parts according to the decree of Ministry of Finance (Decree 460/2009 Coll.).

Tab. 1: Technical lifetime of certain functional parts and equipment, (The decree of Ministry of Finance, 2013)

Title	**Lifetime in years**
Foundations including earthworks	150 - 200
Vertical structures	80 - 200
Ceilings	80 - 200
Roofing outside of coverings	70 - 150
Coverings, roof	40 - 80
Tinsmithery	30 - 80
Modifying internal surfaces	50 - 80
Modifying external surfaces	30 - 60
Internal ceramic tiles	30 – 50
Stairways	80 – 200
Doors	50 – 80
Gates	30 – 50
Windows	50 – 80
Floor surfaces	15 – 80
Heating	20 – 50
Electrical installations	25 – 50
Lightning rod	30 – 50
Internal water systems	20 – 50
Internal canalization	30 – 60
Internal gas pipeline	20 – 50
Hot water heating	20 – 40
Kitchen equipment	15 – 30
Internal sanitary equipment, including toilets	30 – 60
Elevators	30 – 50
Others	-----
Precast installation (core)	15 - 25

4.1. Influence of limit states of functional parts during company valuation

<u>The basic equation of balance sheet:</u>

Property structure of company Financial structure of company

ASSETS = LIABILITIES

⇩

$$\underbrace{\textit{state of company property} = \textit{state of the coverage property resource}}_{\text{at the relevant time}}$$

Fig. 3: The basic equation of balance sheet

Relationship between limit states of functional parts and companies valuation arises on assets side (property structure of company), specifically in real estate. The value of company real estates has a great influence on valuation of the company; such as construction company; because real estates and their part (functional parts) by their repairs and replacements intervals significantly affect overall value of the company assets.

5. Determining average intervals of repairs and replacements functional parts of residential buildings (according to a survey in 2005)

According to the survey of residential buildings was found the time intervals of the repairs and replacements of functional parts. The survey was conducted in family houses, residential buildings up to 25 residential units, residential buildings up to 40 residential units and residential buildings over 40 residential units. According to the material's characteristics of the structure has been residential buildings divided on the brick, panel, wireframe, wood, metal and others. It was also noted about each buildings their location (city, street), the year of buying and the size of building volume.
Buildings were divided in this research to the functional parts:

- vertical non-structural structures (walls and partitions)

- external cladding (exterior plasters, insulation)
- interior plasters
- balconies, loggias (plasters, insulation)
- stairway (construction, surface)
- roofing (roof timbers, flat roof)
- covering (hard, cardboard, metal, other, inclusion insulation)
- tinsmith elements (galvanized sheet steel, copper, other)
- flooring (parquets, PVC, tiles)
- cladding (ceramic, others)
- windows (wood, plastic, other)
- doors (interiors, entrance doors)
- plumbing (water distribution and sanitary ware)
- canalization
- distribution of gas
- electrical installations
- central heating (pipes and facilities, instrumentation, boiler, heat exchanger)

The selection of respondents (86) was random and the realization distribution was 80 units in Czech Republic and 6 units in Slovak Republic. The survey of each building included year of buying, repairs and replacements of individual functional parts. From the obtained results were evaluated the average intervals of repairs and replacements for the individual functional parts. (Marková a kol., 2011)

Tab. 2: Intervals of repairs and replacements of functional parts of residential buildings, (Marková a kol., 2011)

Representative	***Family house***		***Residential building up to 25 units***		***Residential building up to 25 units***		***Residential building from 25 units to 40 units***	
material characteristics	***brick***		***brick***		***panel***		***panel***	
type of innovation	***repair***	***replacement***	***repair***	***replacement***	***repair***	***replacement***	***repair***	***replacement***
functional part	***years***	***years***	***years***	***years***	***years***	***years***	***years***	***years***
vertical non-structural structures	*41*	*60*	*52*	*57*	*25*	*25*	*-*	*-*
external cladding	*37*	*54*	*55*	*-*	*22*	*25*	*26*	*32*
interior plasters	*35*	*44*	*32*	*-*	*19*	*-*	*14*	*26*
balconies, loggias	*-*	*-*	*45*	*-*	*-*	*28*	*22*	*34*
stairway	*34*	*35*	*54*	*-*	*23*	*-*	*-*	*-*
Horizontal structures	*39*	*53*	*57*	*-*	*-*	*-*	*-*	*-*
roofing	*39*	*56*	*38*	*-*	*14*	*24*	*14*	*16*
covering	*25*	*38*	*47*	*61*	*17*	*24*	*11*	*20*
tinsmith element	*19*	*43*	*43*	*51*	*25*	*24*	*-*	*23*
flooring	*21*	*40*	*-*	*45*	*6*	*27*	*12*	*19*
cladding	*17*	*42*	*-*	*45*	*-*	*26*	*17*	*36*
windows	*20*	*42*	*25*	*55*	*13*	*26*	*28*	*30*
doors	*29*	*38*	*-*	*60*	*-*	*27*	*-*	*23*
plumbing	*29*	*39*	*-*	*39*	*14*	*23*	*21*	*26*

canalization	*37*	*50*	*-*	*45*	*19*	*27*	*-*	*26*
distribution of gas	*17*	*23*	*14*	*51*	*19*	*-*	*19*	*23*
electrical installations	*29*	*48*	*36*	*44*	*-*	*-*	*26*	*-*
central heating	*15*	*32*	*-*	*41*	*19*	*21*	*20*	*27*

From the survey are revealed that intervals of repairs of functional parts are depending on the intensity of use these parts. Intervals of replacements of functional parts such as covering, tinsmith element, flooring, windows, plumbing, canalization, distribution of gas, electrical installations, central heating and external cladding approximately correspond with technical lifetime which are defined by decree of Ministry of Finance in Czech Republic. In the other of functional parts are required replacements in shorter timeline than it is defined by decree of Ministry of Finance in Czech Republic.

Conclusion

In this article we are finding the relations of real estates and their limit states using the limit states of individual functional parts. In functional parts that need to be replaced earlier than their technical lifetime defined by decree of Ministry of Finance in Czech Republic; the limit states occur in shorter timeline than we presumed.
The article deals with the determination of price of the real estates; it is reflected to the price of the company => price of real estate respects the technical condition of this real estate (during every valuation methods). The technical condition of real estates is characterized by the technical condition of individual functional parts; and for needs the determination of limit states we have founded interval of repairs, eventually replacement this functional parts. Most of the functional parts in this article are found in the range of standards of repairs and replacements. Other functional parts affect the price of the real estate which is determined using valuation methods.
For other applications of the expected goals, it was necessary to implement the findings into an emerging, new methodology.

The research results were affected by the choice and number of respondents. This was the initial information which after detailed analysis was used as input for parameters setting of other researches. Their implementation took place in two more rounds.

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CONSTRUCTION PROJECT SCHEDULING USING BUILDING INFORMATION MODELING*

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Abstract

This paper presents the construction project scheduling using building information modeling (BIM) approach. The construction project scheduling process by BIM technique can be performed through five steps. In the first step, a 3D model of the construction object is developed using modeling software. After that, in the next step, the 3D model is imported into suitable BIM construction management software where the project activities are then defined and linked to the construction elements of the 3D model. The activities are then, in the third step, mutually connected together into the project network plan by taking into account relevant precedence relationships. When the network plan is completed, the fourth step is to allocate the production resources, quantities and work times for the purpose of determining the durations of project activities. In the final step, the BIM model of the construction object is completed by upgrading the 3D model with defined scheduling data. An application example is presented in the paper to demonstrate the advantages of BIM implementation in architecture, engineering and construction industry.

Keywords: construction management, project scheduling, building information modeling, BIM

* The complete text is available on CD-ROM / Pučko, Šuman, Klanšek

INTRODUCTION

The main stream for development of software, that can simultaneously manage building, scheduling and cost data as well as to be suitably applied in the architecture, engineering and construction (AEC) industry, originated in the year 2004 with the introduction of BIM (Building Information Modeling) (Eastman at al., 2011). At the beginning, the BIM was used to form virtual 3D building models that were able to visualize the construction objects and make their design more understandable. For this purpose, different modeling software, such as AllPlan, ArchiCAD, Bentley Architecture, Revit Architecture, Tekla among others, were put forward and successfully applied in practice (CAD Addict, 2013).

Over the years, the modeling software has been upgraded with different modules for handling structural design, analysis of reinforced concrete, mechanical design, energy and environmental issues, visualization, facility management, product and technical information for manufacturers and distributors, etc. Today, some of them use external applications in which the interoperability is often enabled by statical work with import and export of data. Synchronization of multiple data formats for the purpose of executing the work between the modeling software and the other applications in a dynamical manner is still a great challenge of managing the construction projects using BIM.

Scheduling plans for the construction object frequently represent an outcome of common work of different experts. They may incorporate the information about execution of project activities, application of materials, assignment of workers, employment of machinery, etc. Classically used software for project scheduling includes computer applications such as MicroPlanner, MS Project, Planisware, Primavera, SuperProject, Teamwork, X-Pert among others (Wikipedia, 2013). On the other hand, the basic aim of the BIM software is to combine 3D building models with scheduling data to produce 4D models in which the fourth dimension is time. The results may include an animation of the construction execution as well as the scheduling data connected to the 3D model. After the construction costs are also identified and connected to the construction elements and scheduling data, the 5D building information model is created.

Recently, the BIM applications have been combined with scheduling and other software (Brisk, 2007; Rundell, 2006; Rundell and Stowe, 2007; Tulke and Hanff, 2007; Muhič, 2008). However, the combinations between different software were oftentimes unique and hardly generally applicable. Several published works also reported that the converter must be applied for data synchronization between the BIM and the scheduling software. A step forward to enable the combinations between BIM and scheduling software more employable for wider use was done by the developer Vico Software Ltd. The purpose of this paper is to give an insight into the construction project scheduling process using the BIM approach. The contribution presents a step by step implementation of BIM on an actual construction project using Vico Office R4 software application as an interface for project scheduling. The example demonstrates the advantages of BIM approach and possibilities for its wider integration in AEC industry.

2. CONSTRUCTION PROJECT SCHEDULING BY BIM TECHNIQUE

The project scheduling process by BIM technique can be performed through five steps. In the first step, a 3D model of the construction object is developed using modeling software. Here, the 3D model of the construction object can be formed in multiple formats such as Revit, Tekla, ArchiCAD, CAD-Duct, IFC files, SketchUp and 3D DWG files that are supported by Vico Office R4, see Figure 1.

Figure 1. Vico Office R4 format support

The second step is to import the 3D model into the Vico Office using an installed add-on in the appropriate modeling software (Revit, Tekla, ArchiCAD) or by the additional importers for Google SketchUp, CAD-Duct, 3D DWG, and IFC files. As soon as the 3D model is imported, the project activities can be defined and linked to the construction elements. Here, the quantities are determined by the geometry of the 3D model elements and linked to the project activities. It is important to define the project activities correctly because the main scheduling method employed within Vico Office R4 represents the flowline theory and not classical critical path method (CPM). Namely, when the project scheduling is handled by the CPM, the durations of activities are known and they are treated as input data. On the other hand, in the flowline theory, the durations of project activities are calculated and this means a calculation of quantities per location divided by the productivity rate of the crew.

The construction activities are then, in the third step, mutually connected together into the project network plan by taking into account relevant precedence relationships. Alongside the project network plan, the links are defined between the construction activities to obtain also an appropriate flowline diagram or Gantt chart. In the context of Vico Office R4 software, this step can be made in a module called Vico Office Schedule Planner.

After that, in the fourth step, the resources and the crew sizes are allocated to the project activities. As soon as the crew productivity rates are correctly determined, the durations of construction activities are calculated and the project duration is attained. BIM applications represent location-based systems (LBS) for project management which are oriented on planning, scheduling and controlling the project by the location. So, it is significant to achieve the work crew's productivity rate by moving from location to location and to minimize the waste of time, possibility of conflicts etc.

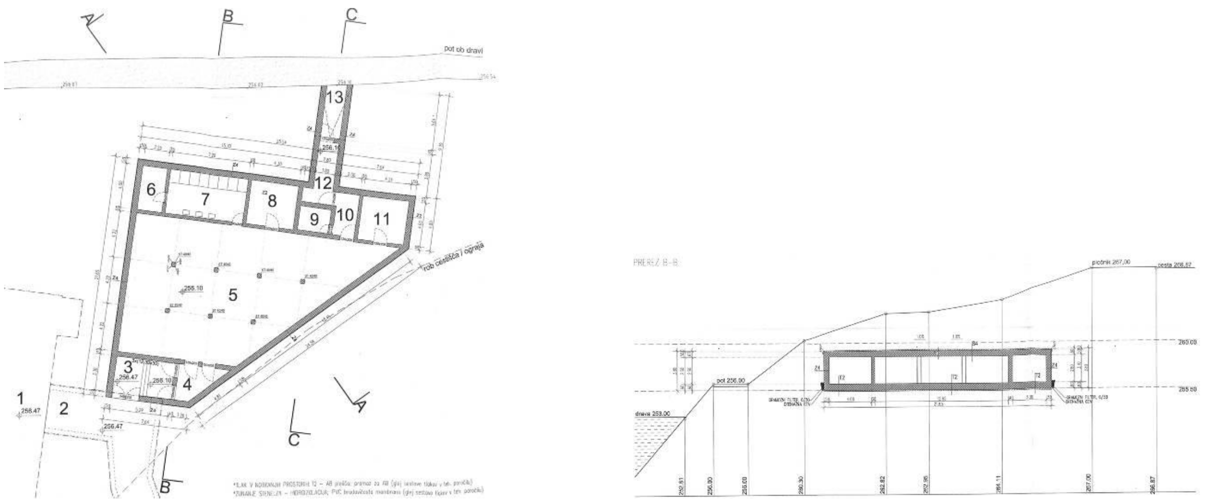
In the final step, the BIM model of the construction object is completed by upgrading the 3D model with defined scheduling data. At the end of the fifth step, the project scheduling process by BIM technique is completed and the 4D model is developed. In the module 4D view, i.e. a part of Vico Office R4 software, an animation of the scheduled construction can be made and presented.

3. APPLICATION EXAMPLE

In this section, an application example is presented to demonstrate the advantages of BIM technique implementation in AEC industry. The considered example is based on the Vico Office R4 software application. Here, the construction project scheduling by BIM technique was performed for a shelter building of the Medical Faculty that was recently built in Maribor, see red shaded area in Figure 2.

Figure 2. Location of Medical Faculty shelter building in Maribor

The shelter building is a part of Medical Faculty complex that also includes the main building and the corridor to the University Clinical Centre of Maribor. It is a reinforced concrete structure composed from the foundation concrete slab, the ground slab, the retaining external walls, the internal walls, the internal columns and the roof slab. Figure 3 shows the architectural design of the shelter building with main construction elements.



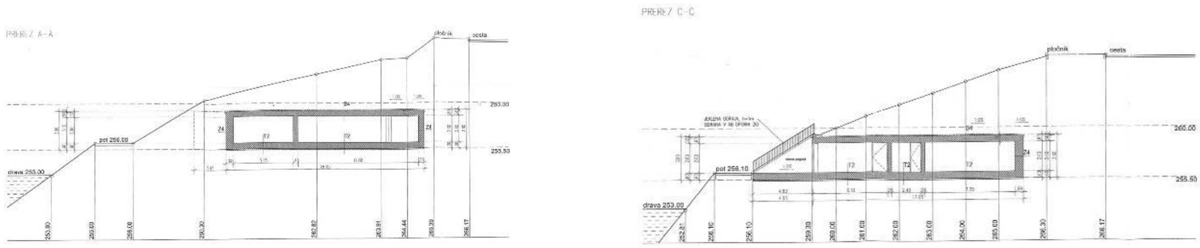


Figure 3. Architectural design of shelter building (Razpet et al., 2009)

The BIM-based project scheduling for the shelter construction was executed through five steps. In the first step, the 3D model for the shelter building was developed using ArchiCAD modeling software. Figure 4 shows ground floor plan for the shelter building and its 3D model.

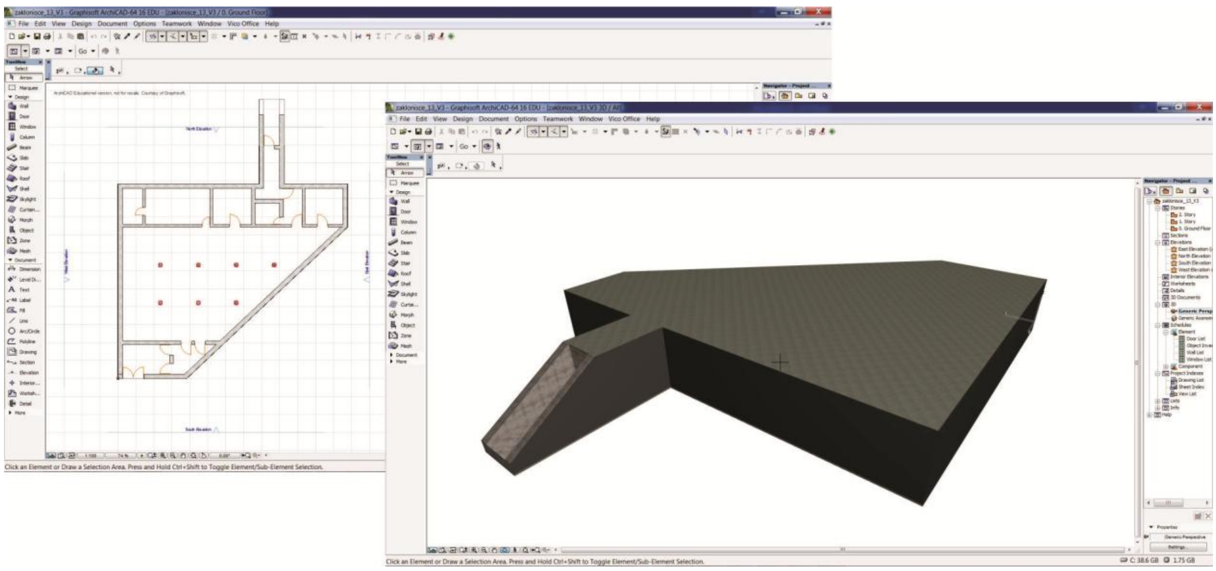


Figure 4. Ground floor plan and 3D model of shelter building

Afterwards, the second step was to import the 3D model of the shelter building into the Vico Office R4 over the added menu in the main modeling software ArchiCAD, see Figure 5.

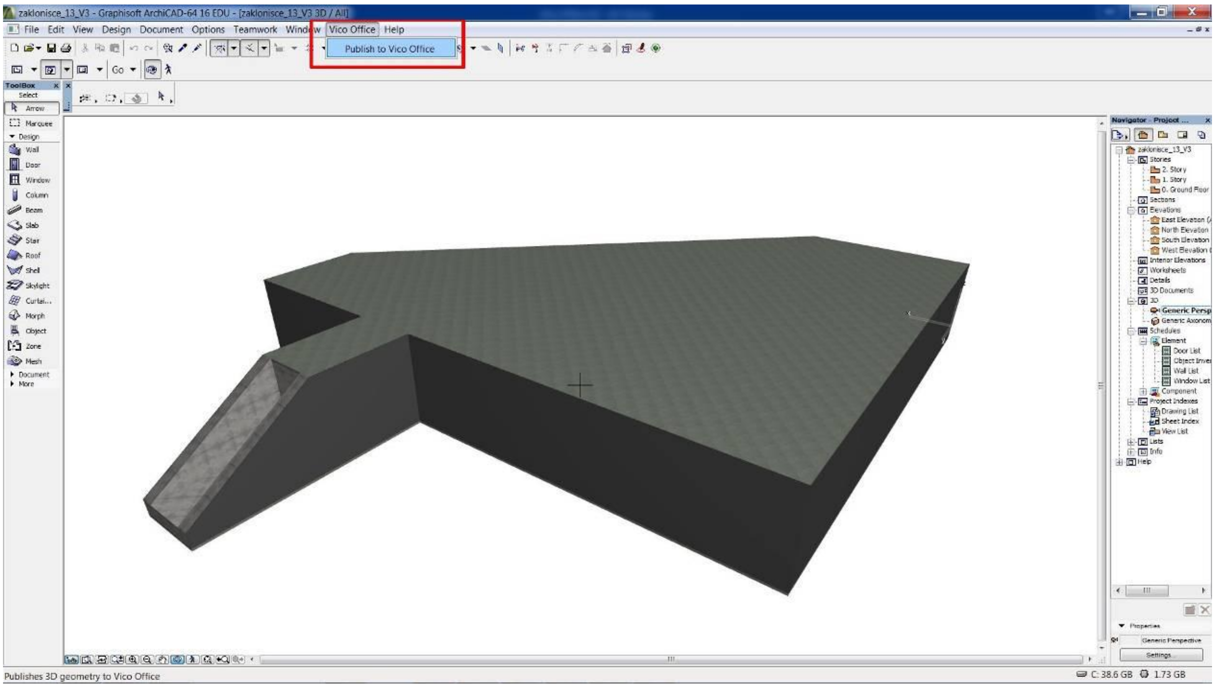


Figure 5. Published 3D model of shelter building

As soon as the import procedure has been completed, the 3D model of the shelter building was activated within Vico Office R4. The activation process used the selected element properties (Element Type, Layer, ID, etc.) to create Takeoff Items, see left side of Figure 6. Afterwards, the shelter building elements were listed in the Takeoff Manager module and the developed 3D model appeared in Vico Office R4 as it is shown on the right side of Figure 6.

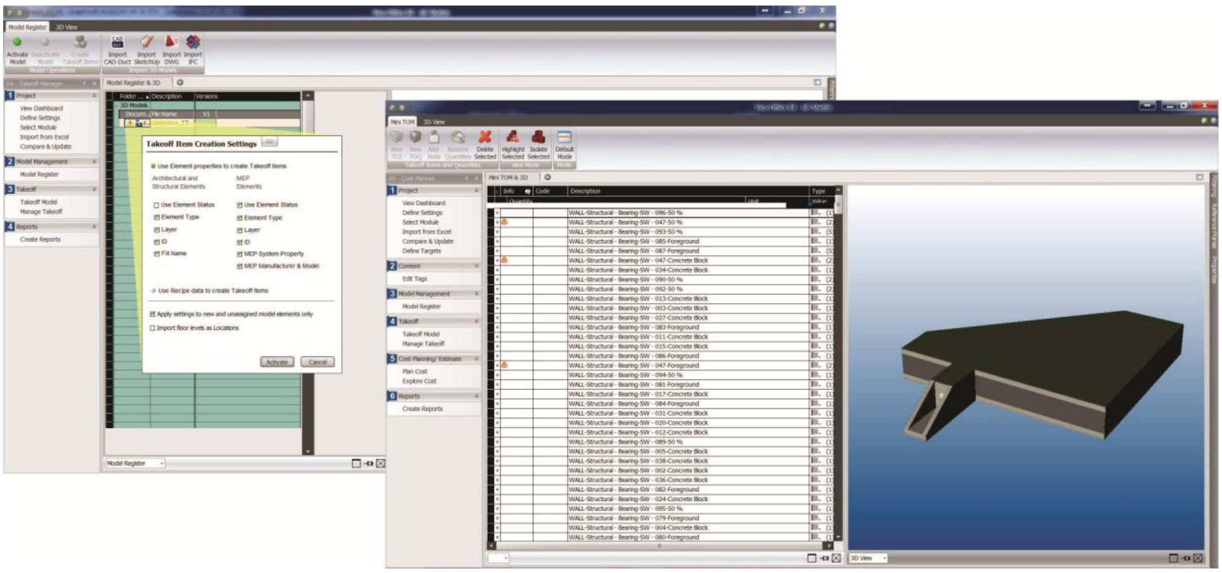


Figure 6. Activated 3D model, building elements and 3D model of shelter building in Vico Office R4

In order to define the construction project activities correctly, the shelter building elements were rearranged into several different groups of building elements. Figure 7 shows determined groups of shelter building elements and information about their geometrical properties.

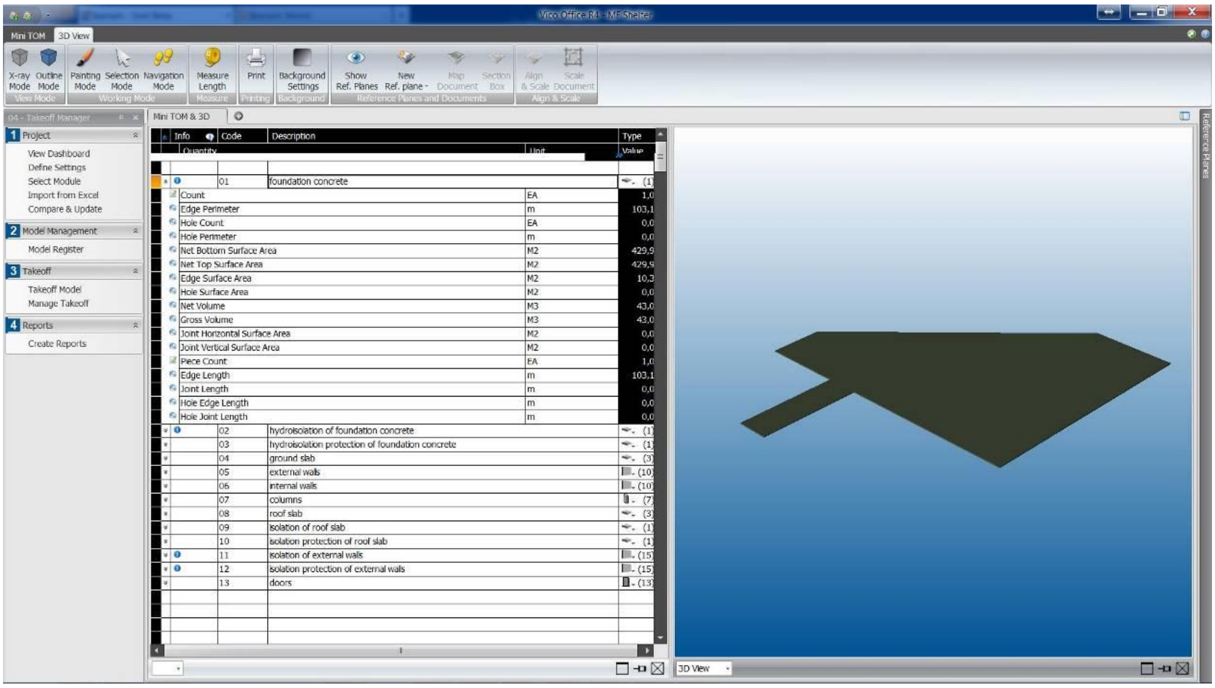


Figure 7. Grouped building elements and information about their geometrical properties

As described in section 2, the main project scheduling method of the Vico Office R4 application is based on the flowline theory. Thus, it was important to include the building locations into the project scheduling process. In the 3D model of the shelter building, the three different locations were defined in the module LBS Management, i.e. Upper part, Middle part and Lower part, see Figure 8.

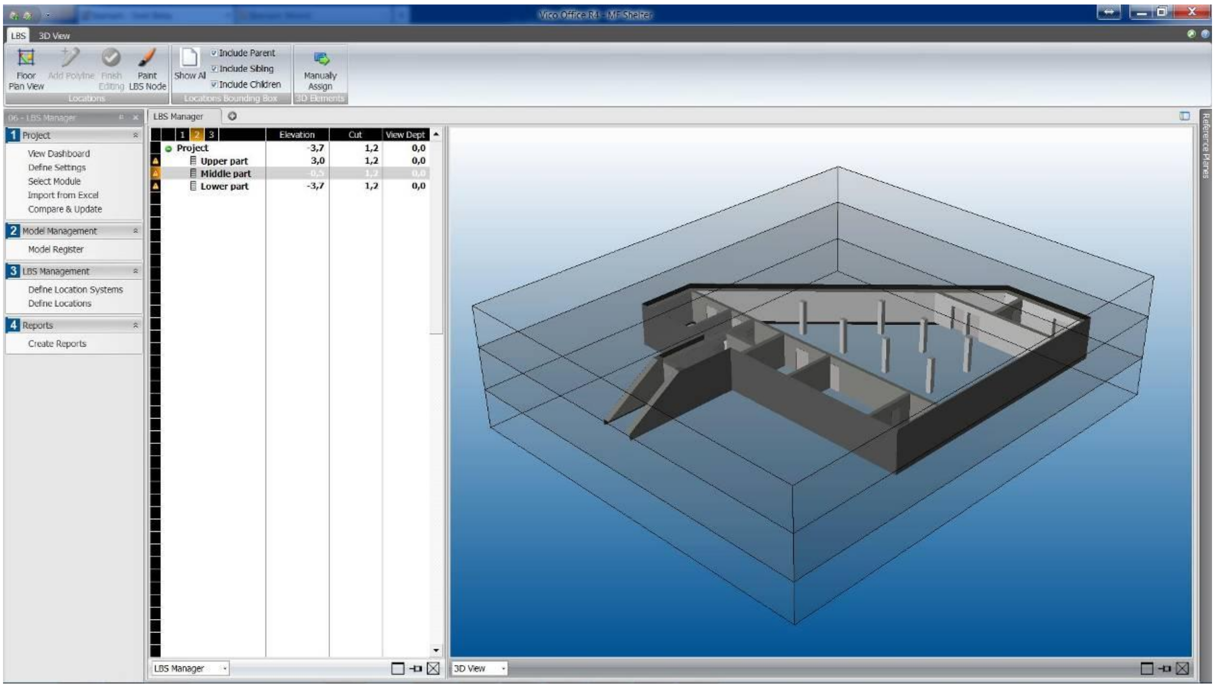


Figure 8. Locations of shelter building in LBS Management module

As an example, Figure 9 shows the building element Columns with information about geometrical properties incorporated into the location Middle part.

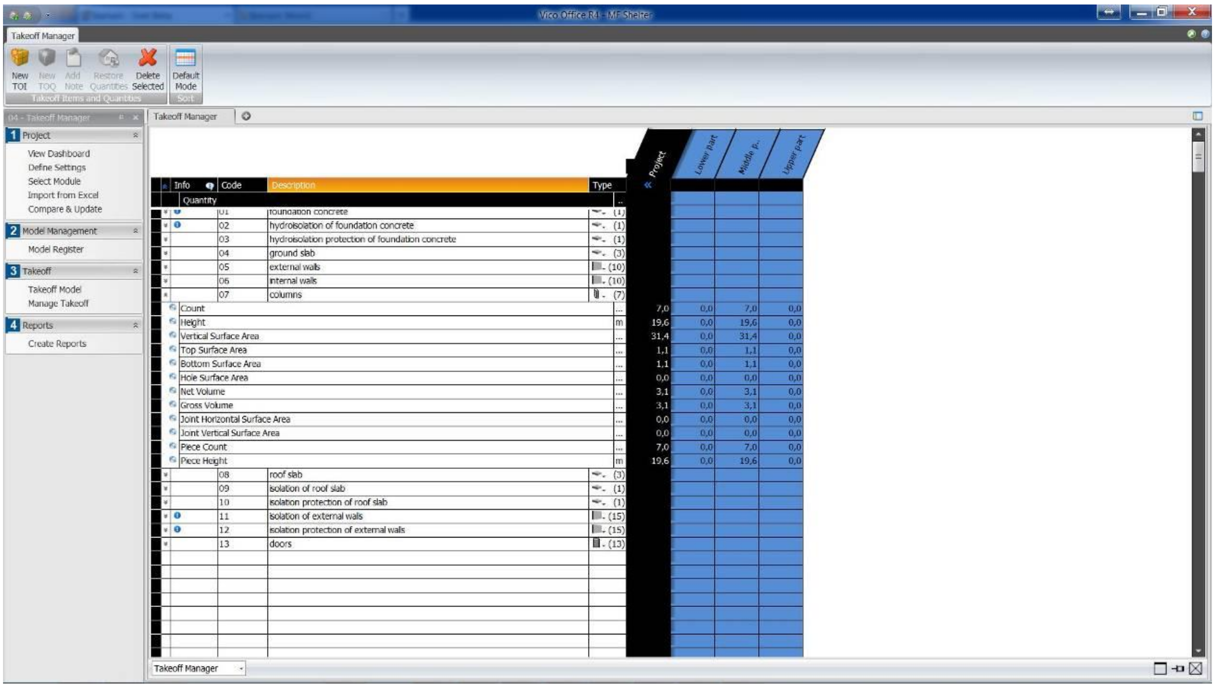


Figure 9. Building element Columns and geometrical properties in location Middle part

Thereupon, the project activities were determined in the module Task Manager taking into account the construction works to be done, see Figure 10.

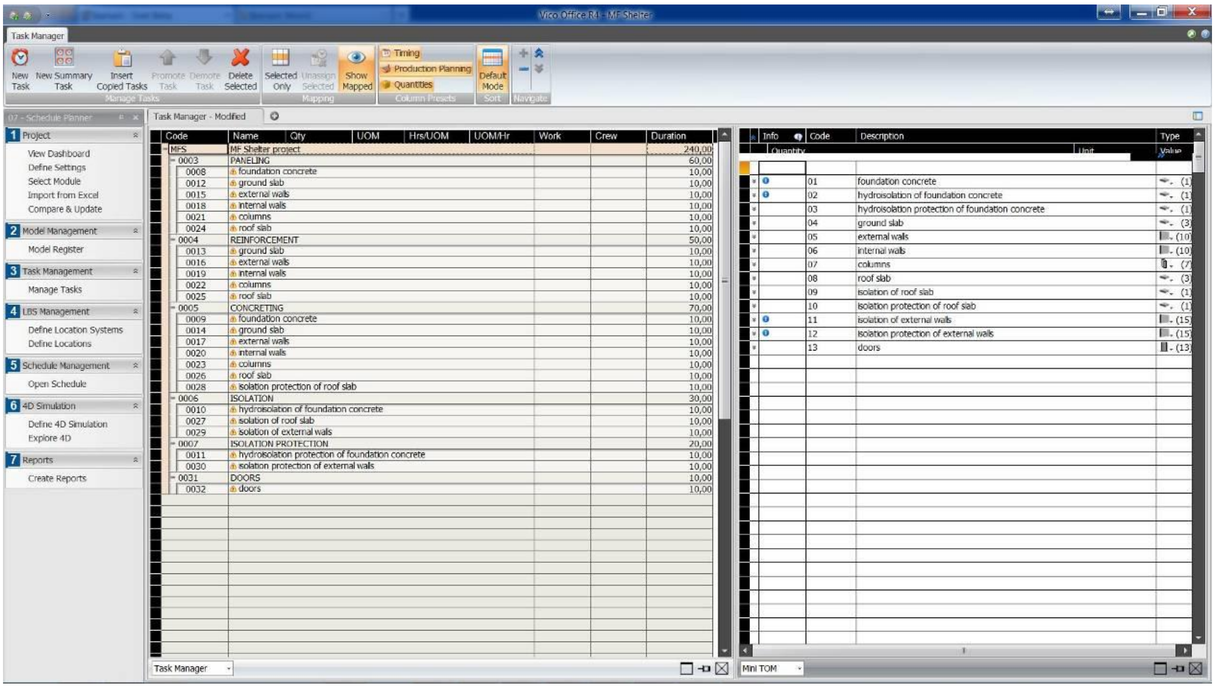


Figure 10. Activities on building elements in Task Manager module

The third step was to activate the Schedule Planner, a module in Vico Office R4, and to define the precedence relationships between the project activities. Figure 11 demonstrates the construction work Paneling on the building element Columns with defined Successor and Predecessor.

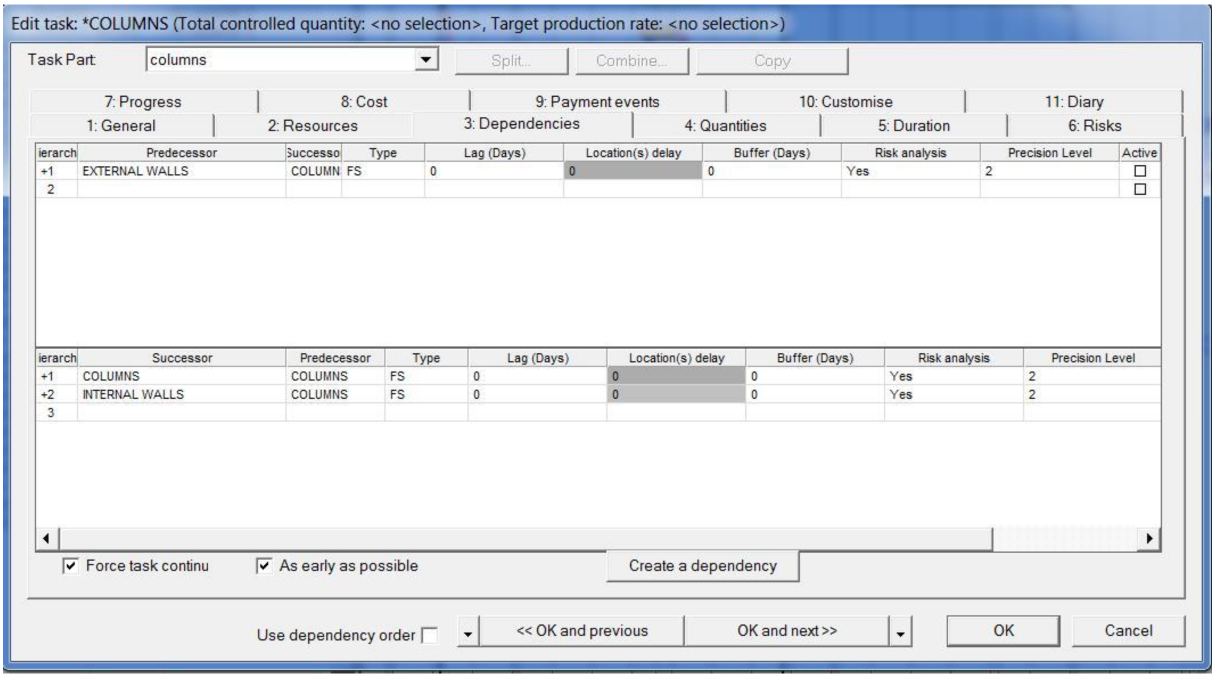


Figure 11. Construction work Paneling on element Columns with Successor and Predecessor

In the fourth step, the resources and the crew sizes were allocated to the construction project activities. For example, Figure 12 shows the construction work Reinforcement on the building element Roof Slab with allocated eight reinforce man.

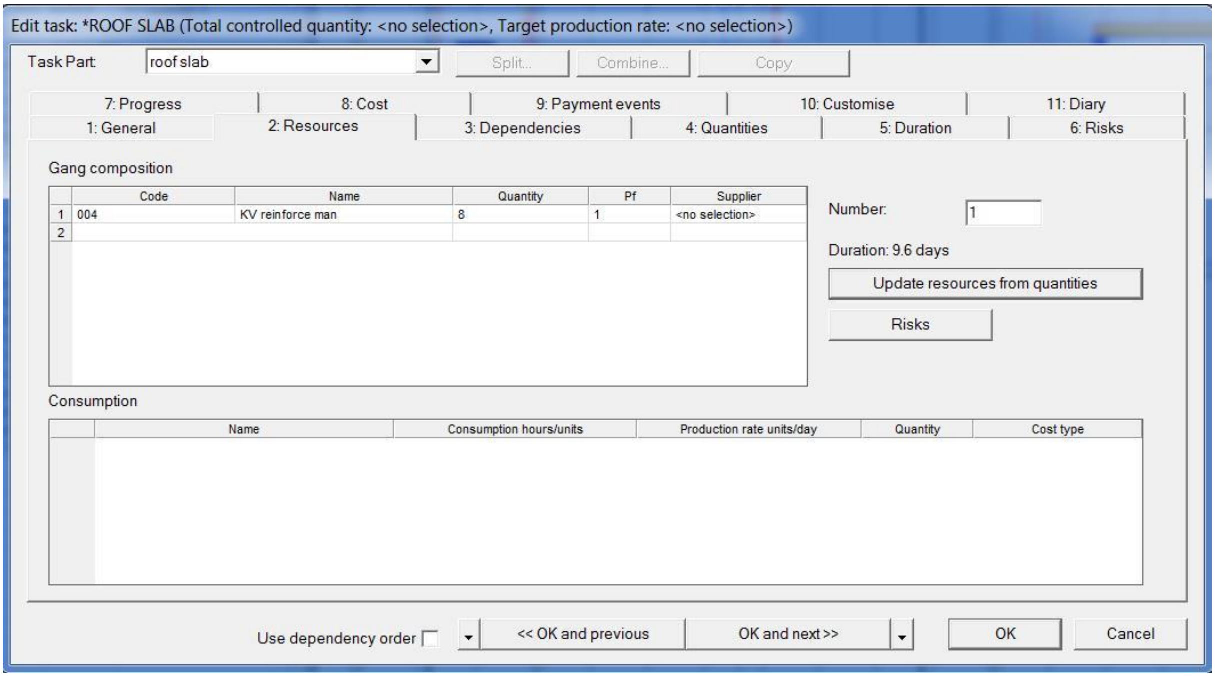


Figure 12. Allocated workers for construction work Reinforcement on element Roof Slab

After the crew productivity rates have been defined, the durations of activities and the project duration were calculated. The final results of the steps three and four were presented as network plan, flowline diagram, gantt chart and target bill of quantities, see Figures 13–16, respectively. The considered activities of this particular example project and their colours used for construction works in graphical reports were defined as follows:

- paneling
- reinforcement
- concreting
- isolation
- isolation protection

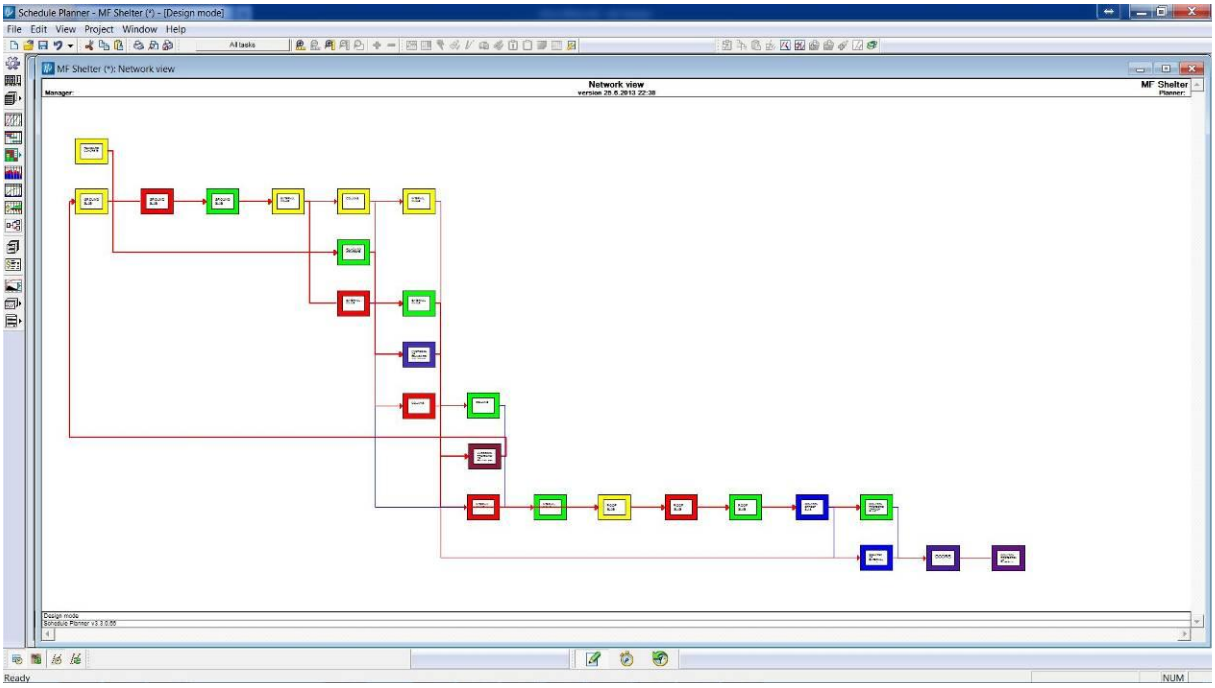


Figure 13. Network plan for shelter building construction project

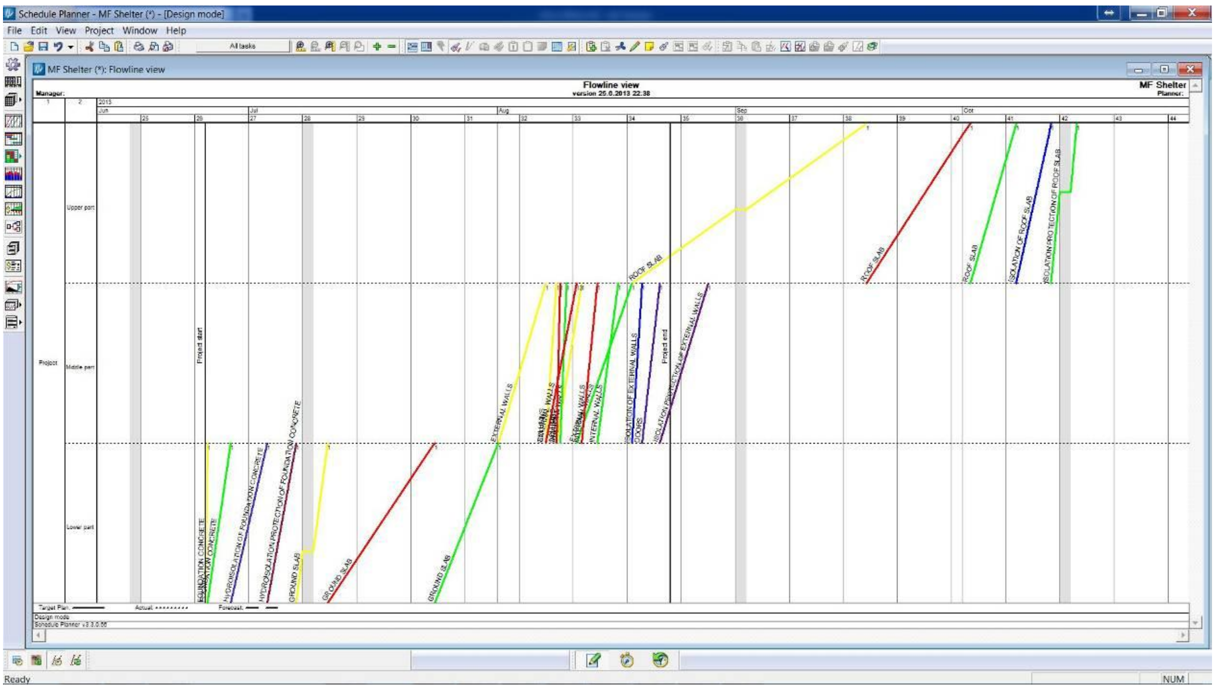


Figure 14. Flowline diagram for shelter building construction project

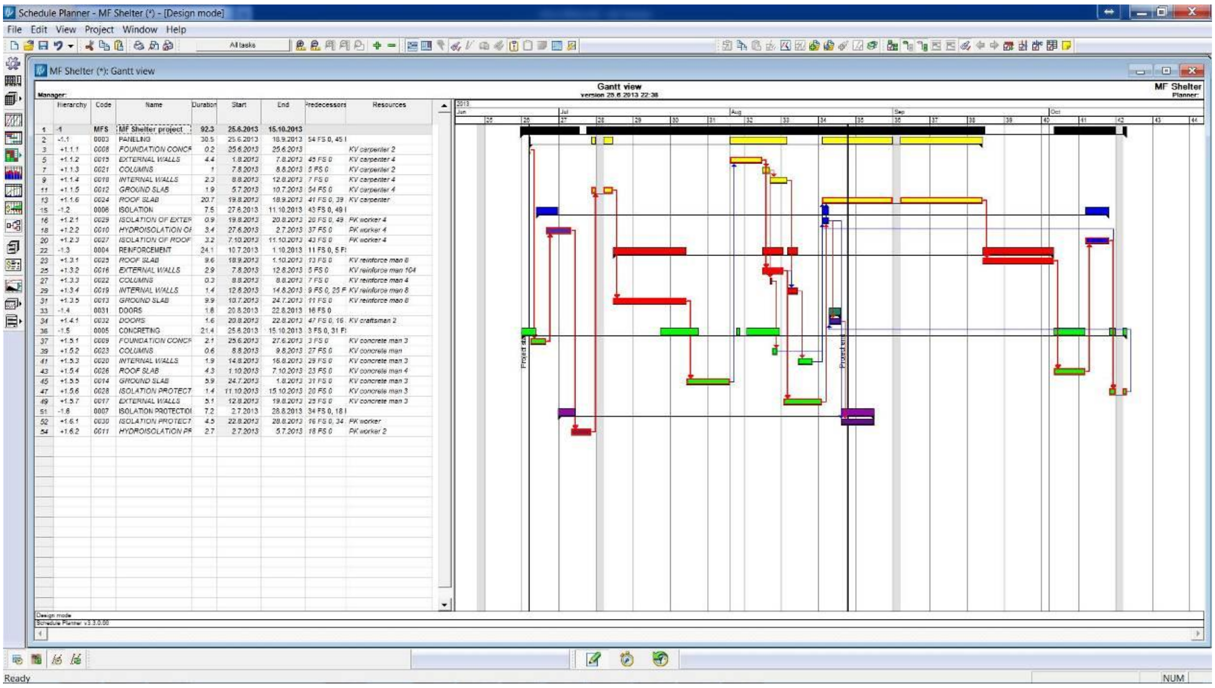


Figure 15. Gantt chart for shelter building construction project

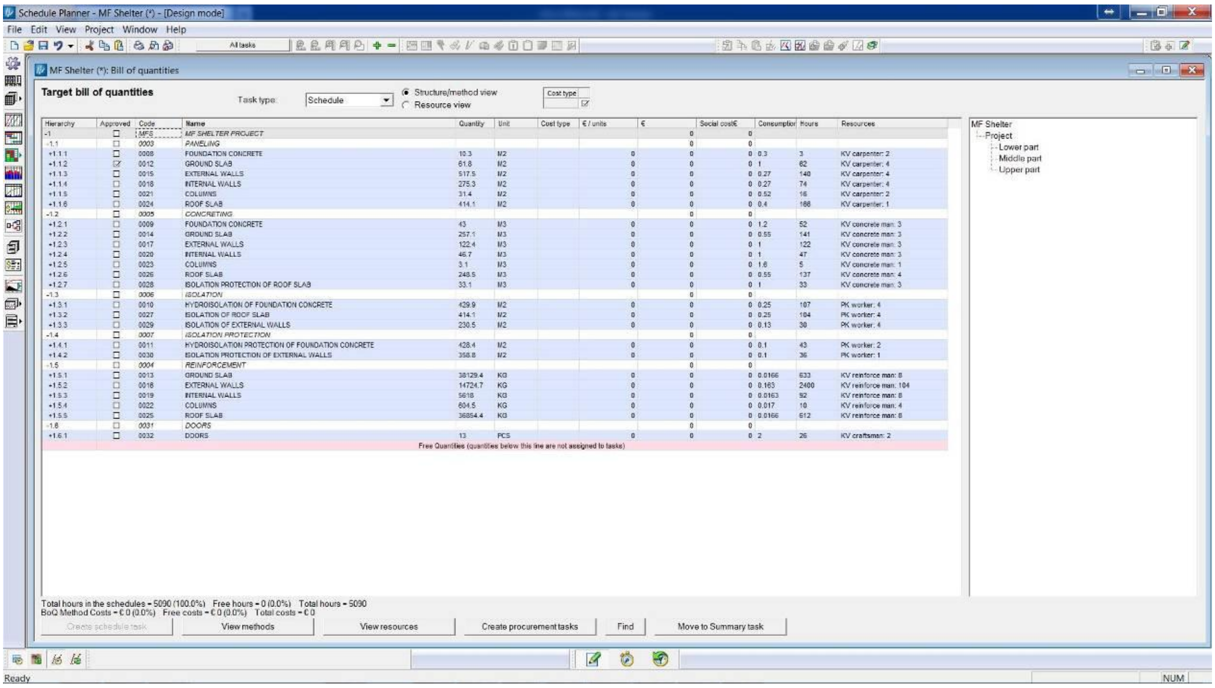


Figure 16. Target bill of quantities for shelter building construction project

The final step was to upgrade the 3D model of the shelter building, which was incorporated in Vico Office R4, with the scheduling data from Schedule Planner and to develop the 4D model. This was executed automatically due to dynamical link that was established between Schedule Planner and Vico Office R4. In the 4D Simulation module, a part of Vico Office R4, an animation of the construction process for the shelter building was made. A part of the construction process animation for the shelter building is presented in Figure 17.

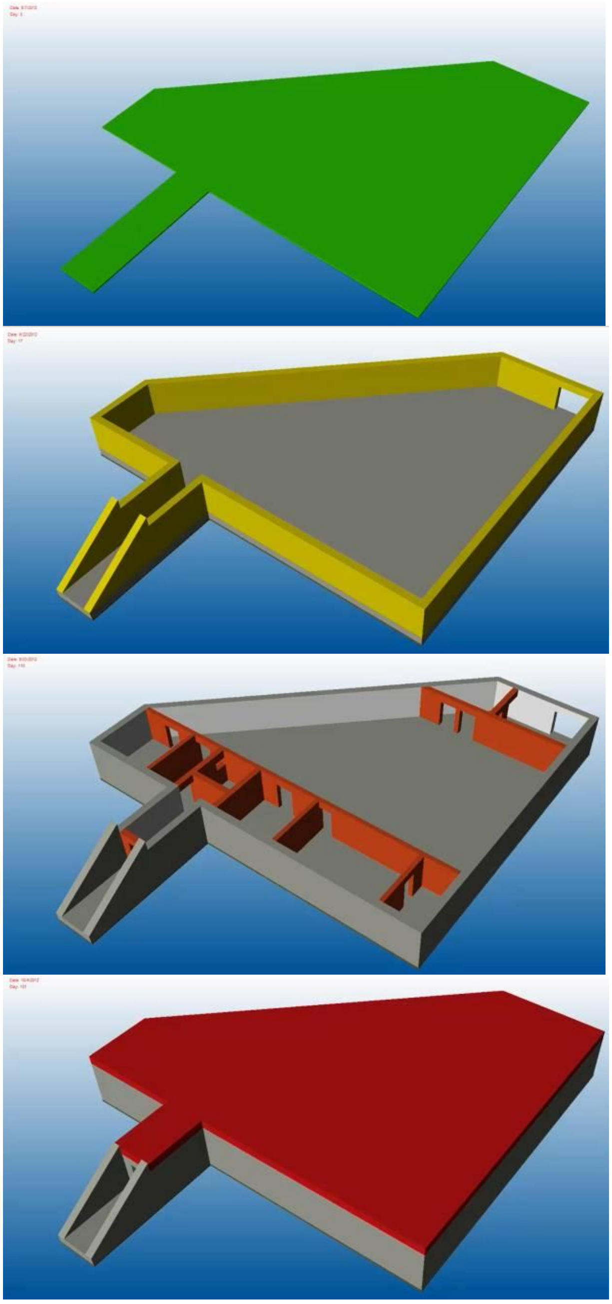


Figure 17. Construction process animation for shelter building in 4D Simulation module

Different manually selected colours were defined within 4D Simulation module and used in animation to achieve better visualization of single building elements. Moreover, the actual dates were continuously reported during animation in the left upper corner of the screen. Figure 18 demonstrates an actual phase of the shelter building construction and its finalization.

Figure 18. An actual construction phase and finalization of shelter building (PROPLUS, 2013)

The presented Vico Office R4 software application indicates possibilities for project participants to contribute to a better management of construction process by implementing BIM technique in their practice. However, the project participants must be willing to make changes in their current work methods and to adopt new approaches. The main advantages of incorporating BIM approach into the construction project scheduling can be summarized as follows: i) all of the information is collected in one place and kept up to date, ii) the conception risk is minimized, iii) all changes in construction automatically influence on other related parts of the model data, iv) all of the information is dynamically linked to the building model, v) the geometrical quantities, the number of items, the required resources, the execution times of project activities, the costs and other data are available to be used in any time. The advantages of construction scheduling using BIM may significantly improve the project management, especially in cases of large and complex construction projects in which the project goals are usually related to the quality of the building, short construction time and cost effective realization of the project.

CONCLUSION

The aim of this paper was to give an insight into the construction project scheduling process using the BIM technique. For this purpose, the steps of BIM based project scheduling were introduced. An example based on the Vico Office R4 software application was presented in the paper to demonstrate the advantages of the proposed approach.

When the initial design phases are executed to be incorporated into BIM application, the architects have to develop the 3D building model and to determine a required construction works. Here, the design work is not executed through 2D drawings, but the 3D model of the construction object is created on the basis of geometrical and material properties of building elements. The setup of geometrical characteristics of building elements result in basic quantities such as side length, object surface area, and object volume.

Thus, the 3D model of the building can be modified in a user-friendly manner during the design process because the basic quantities will be automatically updated. After the architectural design is completed, the engineers can upgrade the 3D model with a wide variety of different information related to structural analysis and design, HVAC, energy and environmental issues, visualization, facility management, product and technical information for manufacturers and distributors, etc.

As soon as the 3D model of the construction object is completed, the bidders/contractors may execute the cost estimates and the project scheduling. When the building model is upgraded with suitable input data, the bidders/contractors may obtain in each moment, for each building element, a relevant information that is important for the work execution. Such model of the construction object can contain information about the type of building elements, the geometrical quantities, the number of items, the resources needed for implementation, the execution times of project activities, the technology implementation, the costs, etc. The biggest advantage of BIM is that the information about the construction object is stored in one place and kept up to date.

Hence, the use of modern software that allows BIM in construction projects represents a technological progress with many advantages for all participants. In this way, this paper intends to provide valuable information for construction management experts as well as it will serve as the basis for further research in the field of BIM based project scheduling.

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IMPORTANCE OF INNOVATIONS IN CONSTRUCTION PROCESS*

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Abstract

Innovations in construction industry are important both during the construction process as well as during the use of the built objects. Innovations during the construction process include innovations in planning and building processes and also in the process of production of building materials and products. Hence, the aspect about the influence of innovations on the success of AEC companies is given. In order to introduce innovations, two external elements are listed which majorly influence them. In the article special emphasis is put on two approaches for expanding non-technological innovation that ensure acceptation of innovation. During the use of the built objects discussed within the facility management, the importance of technological innovations is presented as a support for object maintenance and management. This is a modern approach of monitoring of built objects for which a measurement system for monitoring of the build object in its lifetime is presented. The example of innovation introduction during the construction phases in order to reduce the costs and material consumption is also presented.

Keywords: innovation, construction process, participants, partnership, supply chain management, monitoring of built objects

* The complete text is available on CD-ROM / Semič EL-Masri, Šuman, Štrukelj

Introduction

According to Blayse and Manley (2004), innovation has been one of the sources of productivity and economy in the past. Nowadays, it is also the source for achieving systemic quality, which includes perfect or adequate quality, choice and unique offer.

In terms of competition in the market, we believe that innovation is one of the possibilities to achieve further growth of construction industry in planning and building processes performed by AEC companies and companies producing building material, as well as in process of facility management. They are not only necessary for individual AEC companies, and companies for producing building material to survive, but represent a driving force of the entire economy.

This is confirmed in numerous studies by Desphande (2000), who confirmed a robust positive connection between technological and non-technological innovation in construction process and the success of companies in different contexts. He also found out that the number of innovations is positively connected with the success of AEC companies. Jimenez-Jimenez (2008) and Vazquez (2001) also agree with Desphande et al (2000) and claim that the "innovation degree is positively connected with the success of construction companies, especially by achieving goals connected to the profit of investments, profit margin, sales figures and the success of new products".

The purpose of this article is to discuss and present the importance of innovation for construction industry both during the construction process as well as during the use of the built objects. The aspect of the impact of innovations on the current business process and consequently on success of companies and importance of technological innovation in construction process is given. In terms of innovations in construction process we discussed the external elements like participants and the factors which significantly influence the phenomenon of innovation. We also presented two approaches for spreading non-technological innovation with an emphasis on partnership and supply chain management, which are a powerful tool for reducing risk and collecting the necessary funds for innovation.

Moreover, technological innovations during the use of the built objects are discussed within the facility management. They are addressed as modern technological approaches for monitoring the built object and as a support for object maintenance and management. The meaning and the usage of measurement equipment for object monitoring and for improving the efficiency of construction process is presented. The presentation is designed on examples of good practice.

2. The importance of innovation in construction process

2.1. The impact of innovation on the success of the company

For the construction industry it has become essential to promote and invest in innovation because this factor brings prosperity builders and without it the construction companies in today's turbulent, changing environment, cannot survive.

Usefulness of innovations does not show only the above mentioned advantages, but also profit maximisation of the AEC companies which design, provide engineering support and construction services, and companies for producing building material. After the implementation of innovations, the innovative companies assure with their sale an advantage in the market and, in this way, create profit maximisation. Consequently, implementation of innovations could increas companies' reputation and recognisability, and creates better general opinion about them among the customers and other public. New business possibilities are being opened, which can influence the increase of the market share and result in better reputation. Those benefits are being shown in the spotlight of innovative and successful companies, which do not follow the changes in the market, but rather create them.

2.2. The importance and problems of introduction of technological innovations

In the period of economic crisis, technological innovations in construction of common objects rarely appear. The companies mostly use traditional technological solutions which are already available and do not demand extra investment or additional knowledge and engagement. New technology and materials are used only if they bring direct and immediate savings. In terms of economy this is understandable because unfavourable economy situation and fierce competition bring lower income, and little or no reserve remains after all costs are covered to be spent on extra activities for object completion. For the same reason designers introduce little technological innovations because this means deviation from usual construction and higher project costs which leads to lower chances of winning the project competition. Therefore, less interest in introduction of new technology, materials and knowledge result into deadlock or even decline in the profession. Often the companies agree to take over a business, knowing that they will end up with a loss. In long term this leads to liquidity problems which end with debt settlement or bankruptcy. Among others, one of the important reasons is wrong investment policy in public and other tenders which contributed to today's construction situation where the most successful tenderer is chosen on the basis of the lowest price. Each investor should manage the available means with due diligence. Thus, he should take care to get for his inputs a quality and modern structure which will be functional during its lifetime and will require as less maintenance costs as possible. It is unlikely to get this for much less money than normal. As a rule, the quality of construction and other accompanied works is lower, resulting in lower quality; maintenance and rehabilitation works are necessary before the warranty period is expired or immediately afterwards.

3. The external elements for introduction of innovation in construction process

Below are given two elements for introduction innovations: participants and factors which result from external environment and have the significant influence on its success.

3.1. The participants of innovating

Participants in construction process are one of the most important elements for introduction of innovations that result from external environment and have the significant influence on its success. Blayse and Manley (2004) named following participants in construction process who can contribute to induction of innovation, including planning and building processes as well as the process of production of building materials and products. These participants are: investor; companies, which produce the construction materials and products; architects and engineers; designers and providers of technical support; and main building contractors.

The main initiative for innovation in the construction industry is attributed mainly to the clients and investors, who have the leading role in the introduction of innovations, or the participants, who are included in the construction processes and in activities that support innovation. The more the investor demands and is experienced, the greater is the likelihood of stimulating innovation at the projects level.

The main contractor has also high impact on introducing of innovations. It can encourage the frequency and direction of communication in the higher- or in the lower-lying construction processes. This can create a basis for the development of trust, constant improvement at the reduction of costs and add greater value to the external investors.

In the construction processes, the subcontractors and suppliers have an important role, too. They form project groups with the main contractor and represent the unrealised potential at implementation of innovations. But Jones and Saad (2003) warn on several obstacles which prevent the subcontractors and suppliers from contributing to greater effectiveness. Most of them boil down to a lack of trust and understanding of the risk, which leads to disagreements, tight contract terms and unjust risk spread, inappropriate selection of procedures, inappropriate procedures for making payments and inefficient communication with investors or clients.

We can conclude that the relations among all participants of construction process in the construction projects are often bad. This results in disagreements, bad performance of projects and also negative influence on innovation.

3.2 The factors of innovation

Another important element for introduction of innovations that have significant influence on their success and result from external environment are factors of innovation. Thus, innovativeness does not come on its own, among other, we need to be familiar with the factors which influence innovativeness and determine the competition advantages of companies. The first factor is cooperation between the university, research institutions and the AEC companies, as well as with the companies for producing building material and products. Hence, companies have primarily many benefits of cooperation with the university which is also the creator and provider of knowledge.

Moreover, the financial aspect is very important as well. Cooperating with AEC companies and companies for producing building material essentially contributes to the university's ability for development of intellectual property, its protection and application.

The next important factor for innovation in companies is research institutes. Specific research is undertaken there, which, due to a lack of specialised staff or equipment, is not carried out at universities or companies.

Finally, according to Konda (2005), another important factor of innovating is the modern market economy, which demands a comprehensive system of cooperative laws, guarantees for the intellectual property, a well-developed transport and IT infrastructure and a comprehensive education system, which enables the state to keep up with the pace of the development in the fast changing circumstances.

4. Expanding of non-technological innovation in the construction process

According to Jones and Saad (2003) expanding non-technological innovations is a process through which the manager ensures that individuals and groups accept innovation within their companies, projects and supply chain. However, we need to keep in mind that these processes can take a lot of time mainly due to resistance and fear of changes, adversarial relationships, lack of learning and a culture of accusation, which is often present in the construction industry. In expending innovations in the construction industry, technological changes are among the most significant tools in developing competitive advantages and the main cause of industrial change, where technology cannot be monopolized, since knowledge constantly spreads from construction companies or institutions to other construction companies or even other countries.

Large and sustainable innovations in the construction processes have been achieved by non-technological innovations by developing close and long-term strategic relationships based on partnership and the adoption of supply chain management (Jones and Saad, 2003). The implementation of innovations in most AEC companies highly depends on their own readiness and responsiveness to change. Jones and Saad (2003) highlighted two non-technological innovations approaches that have already entered the construction industry. These are partnership and supply chain management, which contribute to greater equality and trust between partners.

4.1 Partnership approach

Partnership is, as we have already mentioned, a non-technological innovation and an innovative approach to deliver construction services. Partnership was defined by Myers (2004) as some type of cooperation in which the investors and contractors – in trying to achieve a common goal – tend to become increasingly sincere towards each other.

Partnership approach improves cost and time management, reduces the risk of excessive costs and delays; open communication and trust between the clients further fosters a climate that encourages innovation. Partnerships enable better planning, safer construction, easier adherence to deadlines and profit maximisation for all parties. The 'partnership approach' in Slovenia is not yet so widespread in the construction industry as in other countries.

However, in the construction industry partnerships can provide significant improvements. The Reading Construction Forum (Jones and Saad, 2003) has estimated that partnerships can reduce the cost of a specific project by 2 % to 10 %. A study of 200 examples of partnering has furthermore established that the right type of partnering can save up to 50 % in construction time and 30 % in cost. All these advantages contribute to a greater receptivity of innovation, as well as improved communication and responsiveness whenever problems arise. They also lead to the development of improved inter-personal and inter-organisational trust, more awareness for developing mutual advantages, and they promote a culture that supports innovation and learning.

4.2 Supply chain management approach

Supply chain management is also a non-technological innovation, just like partnership. In the construction industry, supply chain management is related to more advanced forms of partnership. It is being increasingly viewed as an innovation that can solve problems arising in the construction industry. Trontelj (2007) has defined supply chain management as a tool used by the AEC companies and companies of producing building material that enables them to rationalise their production and improve their cost-effectiveness. A supply chain is a network of companies that perform construction process, and companies of building material industry that are involved – through high-level and low-level connections – in various processes and activities. The results of those processes and activities are products and services for end users, i.e. investors or users.

Recently, in Slovenia has been an increase in the awareness of the supply chain management approach utilisation, but it is still too early to assess its broader implementation and its impact on the construction industry. It is, however, clear that the attributes like complexity, process fragmentation, mutual dependence, uncertainties and focus on investors will influence the way in which supply chains and other innovations will be implemented in practice.

5. Comparative analysis of Australian and EU construction market with emphasis on innovations

Comparison to Australia construction market reveals that the share of innovation active companies in EU is extremely small, fragmentarily or poorly connected, and focused mainly on the transfer of technology.

The implementation of innovations in EU is limited due to many obstacles. The major limitation for the development and launch of innovativeness in construction companies is the lack of capital and stiffness of the construction sector in which every novelty or innovation must go through a complicated and slow process of introduction for the market.

The same problem is also faced in Australia. In both construction markets, Australia and EU, government regulatory policies exert a strong influence on demand and play an important part in shaping the direction of technological change. Manning (2004) warns that government regulations and industry standards hamper innovation and have internationally negative influence.

The next obstacle for the development of construction companies and launch of innovativeness is cooperation between investors and companies producing the construction materials and products as the main participants in construction process. In contrast to EU, Australian investors and construction companies have enormous influence on innovation. Unlike Australia, EU countries have not yet realized that investors are able to enhance innovation in construction in a number of ways. For example, they could identify specific novel requirements for developers, building product suppliers, contractors and operators; they could exert pressure on project participants to improve buildings lifecycle performance. Generally, they can demand higher standards of work. The companies also influence construction innovation by providing innovative components and building products incorporated into building. Australia has already recognized this dynamics and has changed its policy to maximize the role of investors.

Australia introduced intangible organisational attributes that can be transferred to EU market. New way of working is not penalized if it is not successful; a culture of collaboration means that people are able to question ways of working without fear of penalty if they fail; and a shared perception involves all participants striving to achieve a greater understanding of each other's goals. Australians are aware that learning requires openness to new ideas and ongoing dialogue. Unfortunately, EU has not realized that yet.

To sum up, we can say that EU should take example from Australia construction market, which has strategically managed to maximise innovation outcomes.

We are aware that the operations in a dynamic climate are very demanding process, because there is no insurance for success. However, our advice to EU is to adapt to the dynamic environment in terms of an innovative approach to technology and a swift adoption of specialised technological knowledge. This presupposes a readiness to quickly respond and adapt to change and to focus on effective inter-organisational networking. Moreover, it requires the introduction of systematic thinking based on experience and analysis.

6. Meaning and some examples of technological innovations usage in construction process

Construction is a traditional activity with traditional technological solutions of object building which leads to relatively rare introduction of innovations into the process. If innovations are not introduced in construction process it is sensible to implement them in the period of object exploitation. In this

part of the paper it is emphasized the implementation of modern approaches for monitoring of built objects as a support for object maintenance and management.
These contemporary approaches are particularly suitable for monitoring and management of infrastructure objects and objects of wider social significance. Traditional technological solutions and lack of stimulation for introduction of new technologies, materials and knowledge in the construction process can result into lower realization quality and urgent maintenance shortly after the object's handover. Besides lower functionality, the safety of many users can be threatened, not to think about maintenance and rehabilitation costs of such an object. If accidents are result of low safety of a public object, the owner or manager cannot avoid criminal liability.
For example, in order to provide safety of bridging objects periodical controls are prescribed, but the practice showed that visual examinations are not enough. However, detailed controls with load tests and parallel comparative analysis demand temporary blocks of such an object and, besides higher costs, consequently traffic congestions and overload of other roads. Providing such measures on railway objects is even more difficult, since there are no alternative routes and interventions are limited to the periods of low traffic density. Some technological solutions for these situations are already developed and in use in some parts of the world, others are still in the phase of development. All of them present low costs in comparison to the price of the object.

6.1 Monitoring as the innovation for object maintenance and management support with the examples of the good practice

One of the most important data for object manager or owner, in particular for infrastructure objects, is estimation of safety and remaining lifetime of the object. Methods for estimation of lifetime of a structure are known in mechanical industry for a long time and are regularly in use in design and control of cyclic burden of machine parts. The same principle can also be used on structures, practically without modifications, especially on steel bridges and viaducts. Therefore, the monitoring system of deformation condition can be provided for key structural elements (Figure 1).

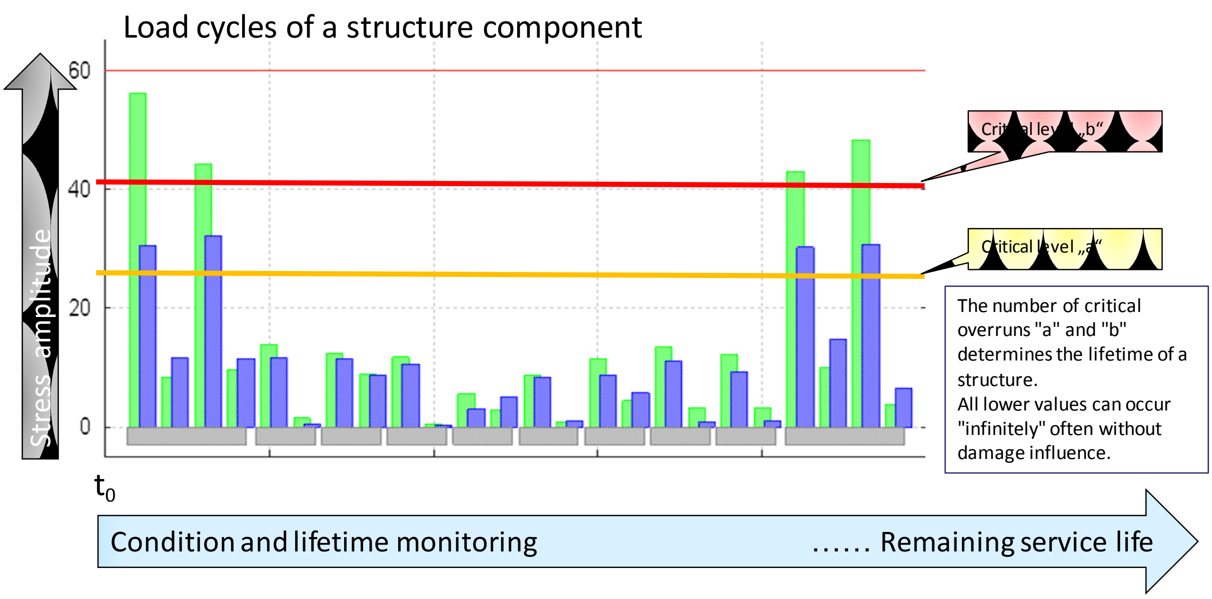

Figure 1: Estimation of remaining service life of the structure on the basis of condition and lifetime monitoring (Source: G. Gommola 2013)

Monitoring is a generic term for all kinds of direct systematic data collection about observed object. In terms of monitoring of construction objects we have in mind operation or procedure, performed by technical means. As a rule, modern measuring equipment monitors behaviour of a structure in longer period. Moreover, phenomena which impact the structure besides mechanical loads (temperature, wind, humidity) are usually observed and registered. The most important part of monitoring is periodical measurement procedure, prescribed by the examination programme, as well as timely and consistent processing and evaluation of results according to previous prepared analyses. Monitoring function does not mean only observation of structure response to certain loads but it also includes proper reaction if the of border limits of observed parameters are exceeded (Figure 2).

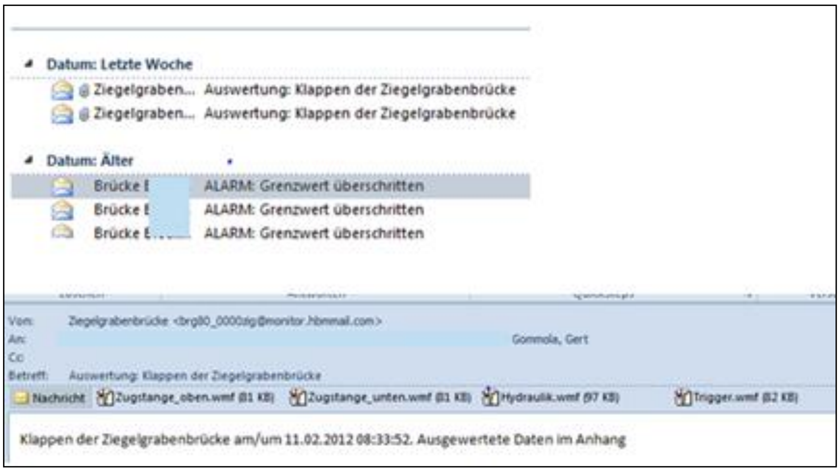

Figure 2: An example of information about exceeding of allowed loads of a lift bridge (Source: G. Gommola 2013)

Information can be given in the form of alarm signal for object management or automatically on properly set information panels or traffic lights on appropriate distance in front of the entry to the object. Also, video of the event which caused the situation can be recorded (Figure 3).

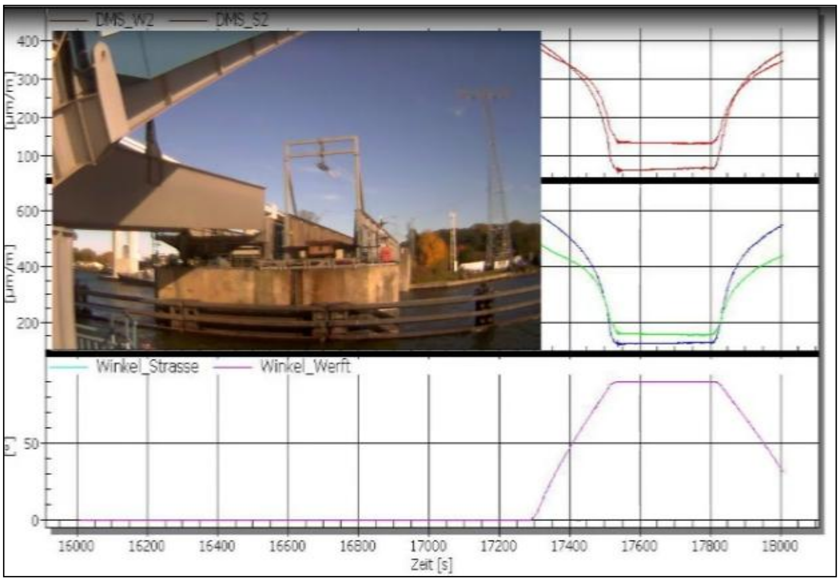

Figure 3: An example of regular strain measurements during lifting and droping of a lift bridge with simultaneously video recording of the event (Source: G. Gommola 2013)

In Slovenia, the need for regular performance of such researches is very high. Key railway connections run over steel bridging objects, which age is between 60 and 160 years. After long years of operation and mostly poor maintenance (Figures 6 and 7) it is clear that the question of safety and remaining lifetime of such objects is very topical. During the war, some of these objects were partially demolished and later more or less successfully renovated, which means that some of their structural parts were very overloaded and deformed (Figure 4). In most cases the only traces of such events are non-professional articles in the newspapers and a few photos.

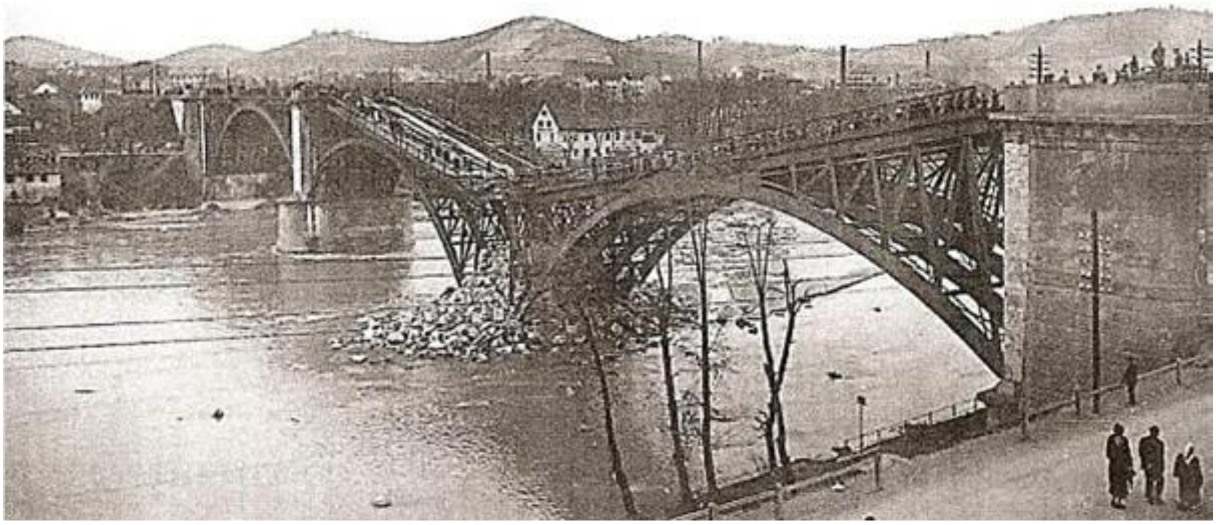

Figure 4: Railway Bridge in Maribor, demolished at the beginning of the World War 2

Therefore the reliable estimation of the current structure condition and its remaining life period without knowing anything about the loading history can be very uncertain and can lead to wrong decisions even if the regular monitoring is introduced in the later period (G. Gommola 2013).

Figure 5: Railway Bridge in Maribor today

Figure 6: Railway Bridge in Maribor: progressive corrosion on a joint of the main arch girder and vertical element

Figure 7: Railway Bridge in Maribor: progressive corrosion on a joint of the vertical, horizontal and diagonal joint elements

It must be emphasized that mentioned objects were designed for significantly lower loads than the loads they are exposed today. Therefore, the programme of integrated monitoring of steel bridging objects, tendered by a German company Deutsche Bahn, leads to important project results which present a great contribution to the development of the methodology of safety insurance of such objects. Also, advantages and disadvantages of single measurement techniques emerged. The whole-year monitoring showed, for example, that only strain gages can provide reliable results. They are in direct contact with the observed part of the structure and are properly protected against environmental influences (Figures 8 and 9).

Figure 8: The inside of the structure of the motorway viaduct (Lešnica) with a steel and concrete construction where the system of measuring points was installed for collecting of strain values

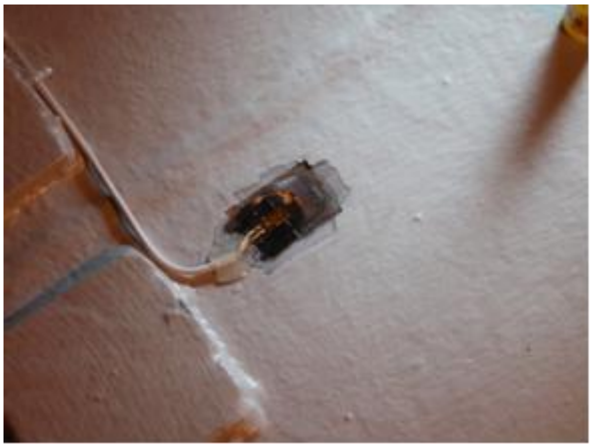

Figure 9: Viaduct Lešnica – one of the measuring points on the lower part of the construction

Constant power supply must be provided for measuring equipment; permanent internet connection must also be assured to control the measuring system and capture distance data. Moreover, automatic restart of the measuring system must be provided in the case of power interruption or any other event (except physical damage of the measuring point, measuring system or communication connections or power supply) which could interrupt the data performance. Authorized persons can access the measuring data every time from everywhere, also with smart phones and other communication means (tablet PCs or laptops).
Such measuring system can calibrate the mathematical model of the structure with gained measurement results at known loads (for example weighted trucks). What is more, it can estimate

the level of wear and tear of the object and its remaining lifetime upon long-lasting measurements of dynamic respond on usual load with the help of known algorithms (Rainflow analysis, Miner's rule). In the case of demanding construction technologies, it is meaningful to mount the monitoring measurement system in the period of the construction and to observe the loads of single structural parts in this period because loads can be much higher in some structural parts during the construction than the loads at normal exploitation of a built object (e.g. technology of incremental launching and balanced cantilever construction of bridging structures).

6.2 Using innovative approaches to reduce construction costs

Systems for the electronic measurement of mechanical quantities serves not only to observe the condition of facilities, monitoring and warning to certain alarming situation in their lifetime, but can also actively contribute to the implementation of the rationalization and reduction of the cost of each project. Because of the the fact that such procedures in everyday building practice are unusual and they are also associated with certain costs and demand some changes in the technological processes, usually an attempt to introduce these technologies immediately evokes resistance. Despite that in practice, it has been repeatedly shown that detailed investigations of local characteristics of the terrain or direct testing of the design characteristics of certain structural parts can contribute to significant material and time savings. An illustrative example for this is construction a cooling tower for the new block of a thermal power plant in Šoštanj, Slovenia. It is q64 m high and has a diameter of 100 m on the bottom and 6 m at the top. The whole structure is supported by 32 columns and each of them has deep foundations consisting of 6 piles. The planned length of each pile was 30 m and the idea of rationalization was to find out if the piles could be shorter without endanger the safety.

A pile is carrying the load over it's toe and through the friction between it's skin and the surounding soil. It is a difficult task to estimate the share of loading carried by friction. Therefore engineers in most cases design the piles to be long enough to reach the rock base below the poor soil, but that is not allways necessary. To get more information about the soil bearing capacity and the pile behaviour in most cases the load test of the pile built on site is the best solution.

In our example an inovative strain measuring system was developed. Strain measurements were performed in 8 levels with two measuring points on each level. Eeach measuring point was equiped with strain gages positioned on reinforcement bar inside the concrete. From the change of normal stress along the pile axis the shear stresses on the contact between the pile skin and the soil was estimated. The integral of normal strains along the pilot axis gives the estimation of it's axial contraction and therefore the settlement of the pilot toe and the resultant of shear stresses along the pile skin surface gives the estimation of amount of external loading carried by the friction between the pile skin and the surrounding soil. The distribution of shear stresses along the pile skin was also known.

The results of a load test and further analyses confirmed, that piles could be shorter (instead of 30 m their length was from 9 m to 22 m), because the shear stresses activated on the pile skin are big enough. Average savings in length were about 12m per pilot (totaly more than 2304 m). Since 1 m of pilot costs about 700 €, the savings were more than 1.6 milion € and the price of entire investigations did not exceed 45000 €.

7. Conclusion

This article presents the idea that innovations are a significant factor in construction process as well in a building lifetime process. We realized that innovations have an impact on business processes, the company's environment and all participants. Moreover, we recognized that technological innovations in construction process are rare, especially in the time of recession.

Thus, in the article two significant elements are presented that result from external environment and have the greatest influence on the success of innovations in construction process. The first element is participants, e.g. clients, investors, subcontractors, suppliers, and the second element is factors such as universities or research institutes. When implementing innovation into processes, we need to use a proper approach for its expansion. In the article two of non-technological innovations are presented, i.e. partnership and supply chain management.
Since the innovations in construction process are scarce, it is reasonable to introduce modern approaches for monitoring of built projects in the time of their exploitation. This enables better control over situation of the object and avoidance of subjective evaluations of the condition of the object or its structural elements. Implemented modern approach assures higher safety and lower sanitation costs, because minor repairs are already provided during the regular maintenance works, and the damage does not progress. What is more, appropriate measurement equipment enables provision of objective evaluation of global safety of the object.
Last, but not least, the introduction of measurement control in earlier phases of construction processes could lead to reduction of efforts, material consumption and costs. As said before, methods of structure condition monitoring are not generally innovative from technical point of view, but the introduction of these methods into planning and construction process in Civil Engineering represents a new approach leading to higher safety and quality standards.

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EMPLOYEE MOTIVATIONAL SYSTEM OF CROATIAN CONSTRUCTION ENTERPRISES*

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Abstract

The aim of this paper is to present the study of employee motivational system in Croatian construction enterprises.
The methodology used consists of: relevant literature review, questionnaire carried out on three categories of construction employees (manual workers, building site operatives and civil engineers, top management) and results analysis.
In Croatian construction companies, many modern motivational strategies are used, but employee satisfaction with them varies. There is a gap between the strategies that are being implemented, and the strategies that would really motivate people, as well as a major problem of non-transparency of the motivational system and belief that it is unfair. On the other hand, Croatian construction employees express predominant job satisfaction, while emphasizing the importance of good interpersonal relations, adequate salary, results recognition and positive feedback. Due to these results, there is a place for progress of existing and utilization of new motivational methods.

Key words: work motivation, motivational strategies, construction employees.

* The complete text is available on CD-ROM / Sjekavica, Završki

Introduction

Everybody wants more motivation, but is not completely sure what that means. Individuals would say they want to be more motivated. Managers and leaders would say they want to have more motivated team or group of employees, and employers want to hire a motivated person. Further, employers' requests are even bigger – for instance, the person they search for and want to hire should be self-motivated (Richard, 2000).

As this quotation shows, and as it is the case in any study of human interest, it is useful to define basic terms that would be used in this paper, so it could be more easy to approach to the results of the research carried out on the field of motivational systems in civil engineering enterprises in Republic of Croatia – which is the basic goal of this study.

In Croatian standard language, term motivation is defining "something what moves us to do some activity", and to motivate (someone/something/yourself) means "to give an incentive, a motive to something" (Anić *et al.*, 2002).

On the other hand, Psychiatric-psychological lexicon defines motivation as a behavior directed towards some goal, which induces needs produced in a person, and the reason of that behavior is needs' indulgence (Hudomil, 1968).

Motivation is the cognitive decision-making process, through which goal-directed behavior is initiated, energized, directed and maintained (Buchanan and Huczynski, 2010).

In the accordance to these definitions, motivation is possible to be observed as a group of motives – inner human needs and urges, which make a complex combination of causes of some human behavior or activity.

This point of view indicates two facts. First of all, in a root of every single human behavior or action is a certain reason – unfulfilled need. Needs affect formation of a wish for something. Non-fulfillment of that wish in this specific moment of time leads to inner tensions, which initiate a person to do an action with an aim to fulfill those wish in some future moment. Successfully executed action results with an adequate level of satisfaction. This process, need-wish-tension-action-satisfaction, Is known as a motivational chain (Buble, 2011).

Secondly, what emanates from the basic definition and previously explained motivational chain, is the fact that recognition and analysis of those needs in humans is a complex and hard work, which requires experienced manager with adequate knowledge, competences and so called *soft skills* – something which is nowadays measured with a high quotient of emotional and social intelligence.

Previous paragraph explained an important role that highly competent managers have in motivation of other people. This is especially important in context of work organizations, where two most pertinent concepts are the ones that deal with work motivation and employee motivational system.

Speaking of work motivation, reasons why somebody works, as well as how to make someone to carry out work assignments with more quality, are being observed. While doing so, an employee is accomplishing personal goals as well as goals of its enterprise.

Huge interest for the problem of work motivation in its basis has three main reasons (Bahtijarević-Šiber, 1999a):

1. An incensement of work production, efficiency and creativity.
2. An improvement of work atmospheres' quality in organizations.
3. Strengthening of concurrent capability and organization efficacy.

Everything achieved in or by an organization ultimately depends on human activity and so managers want subordinates who willingly channel their energies into their allotted tasks (Child, 1984).

In order to make this possible, it is needed to identify, encourage, control and improve work motivation through integral employee motivational system.

To make an employee motivational system tenable, it has to be:

- Suitable
- Fair

- Balanced
- Payable
- Encouraging
- Acceptable

Withal, in civil engineering, it is also distinctively specific and influenced by the following factors and sort of boundary conditions of its dimensioning.

2. Special features of construction industry as an influence factor on motivation

When we talk about motivation in the construction industry it is necessary to define different specificities, limitations and influence factors which are being imposed to the problem of motivation by the nature of civil engineering profession.
Focused only on the process of physical work and its transformation into a building facility, it is evidenced that very difficult and rough living conditions are present on site. Construction sites are often isolated from the world, so workers spend their free time in villages built on site, rather than at home. Organization of work and free time (food, social and cultural life) lies on managers.
This appears to be a specific problem in motivation and regulation of such relationships, as the average educational level of construction workers is low, a large part of them come from the countryside, there is a culture of machismo present, national and social workers' structure is diverse, large fluctuations exist (seasonal work), and common problems are also alcoholism, aggression, etc.
Motivation of manual workers is important to that level that it is even taken into consideration when calculating the effects of construction machinery operated (Vidaković, 2000).
Construction is also a dangerous activity. In United Kingdom 47% of deaths at work happen in construction industry (Antić, 2009).
Everything explained until now determined the stagnation of relations on the site, and consequently, different motivational techniques. Despite modern achievements, interpersonal relationships between manual workers, workers and construction site manager, did not significantly change from the ideological system of “carrot and stick”. Organization and discipline on site are similar to the military in the form of punishment, written orders, communications and reports.
Every construction project is a case for itself, unique and immobile, and it is impossible to build in a factory kind of way, as on assembly line. Entirely business operations must therefore be adjusted to the uniqueness of construction products, which has resulted in the need for its great flexibility, volatility and project orientation. Also, working groups of manual workers are temporary, not permanent, as in the factory. Building of sustainable motivational system within the business operating construction system is therefore especially complex.
The responsibility of building and maintaining of motivational system lies on managers. They have to know how to motivate each individual employee as well as techniques applied in the leadership of a team.

3. Motivational strategies as a key of successful motivational systems

To make a picture of motivated construction employee, we need a framework (which is represented by an employee motivational system) and a tool – a brush, consisting of motivational strategies. In principle, there are two basic groups of strategies used in order to motivate employees: material and nonmaterial.
Material motivational strategies are, as their name says, strategies drawn up in the form of insurance and improvement of financial status of employees and financial compensation for the work they do. According to the degree of directness, they are divided into: direct (immediate, given “on hands”) and indirect (intermediate); and according to the aspect of coverage level of organizing and distributing, they are divided into: those that are received individually and those that are received through the company.

A review of material motivational strategy is shown in the table 1.

Table 1 Material motivational strategies (Bahtijarević-Šiber, 1999b)

	DIRECT	INDIRECT
INDIVIDUAL	Basic salary Stimulating part of a salary Salary appendages Bonuses (for innovation, dissemination of knowledge and flexibility) Benefits Other stimulus (bonuses)	Grants and scholarships Study travels Specialization Paid absence and free days Company car Managerial benefits
COMPANY	Share of profit Ownership share (distribution of stock shares) Bonuses linked to performance and gain of organizational units	Pension insurance Life and other insurance Health insurance, occupational safety Occasional payments (Christmas,…) Care of children and elderly Vacation Unemployment benefits Education

Basic fixed salary is a standard compensation that employees get in a free market economy. Beside it, employees can receive: stimulating part of the salary (depending on work performance), various bonuses and benefits (for years of service, innovations, dissemination of knowledge, etc.), and can participate in the company profit/ownership via shares.
Beside standard indirect strategies, such as pension and health insurance, as well as Christmas bonuses, employees can get paid: expert travel and training, doctoral/professional study, courses, certifications, etc. Furthermore, company car, mobile phone, secretary, bigger office and parking lot, increase individuals' reputation inside the company, as an important motivational factor.
Though we cannot forget the power and importance of moneys' influence, people nowadays expect an added value obtained throughout their working environments. Work is not the only place where a person can engage in activities that satisfy needs, and although being an employee essentially involves exchanging labour for rewards, humans usually have more needs than money (Rollinson and Broadfield, 2002). The key of successful motivation is therefore, as always in life, in balance, equilibrium, and the familiar "golden middle" of human pleasure. Precisely here is the point where nonmaterial motivational strategies play an important role.
This category includes:

- Job design
- Different managerial styles
- Participation of employees
- Management by objectives
- Flexible working hours
- Recognition and feedback
- Training, specialization and career development
- Organizational culture

4. Research methodology for present motivational systems of Croatian construction enterprises

The aim of the research is to figure out if a human resource management is being used in entrepreneurship in construction companies in Croatia, if construction employees are satisfied and motivated, as well as what motivates them, considering their position in organization, salary and work conditions in a company.

From this point of view, following tasks are emanated:

- Identify the existence of organized human resource management in Croatian construction enterprises
- Identify motivational factors of Croatian construction enterprises' employees, which have following positions:
    - Middle and top management
    - Technical operative employees on site, engineers
    - Labor workers

The basic method used in this research is a poll of random sample and analyses of the results given on the basis of collected information.

Survey is a research process, which is defined as a technique of collecting pieces of information about different phenomenon and problems, by the use of a poll or questionnaire, whereby examinees are expressing their opinion and attitude by choosing among given alternatives or answers complement.

Questionnaire was mainly send via e-mail on over 35 addresses of construction companies, but was also partly filled up in a paper form. Relevant answers were given from 27 construction industry employees, which are considered to be a relevant research sample. In the tables given, sex and age structures can be seen, as well as individuals' positions and the size of the companies in which they work, as those are the most relevant parameters which influence on their motivational level.

Table 2 Age and sex structure of examinees

<table>
<tr><td rowspan="2">SEX</td><td colspan="3">M</td><td colspan="3">F</td></tr>
<tr><td colspan="3">89%</td><td colspan="3">11%</td></tr>
<tr><td rowspan="2">AGE</td><td colspan="2"><30</td><td colspan="2">30-50</td><td colspan="2">>50</td></tr>
<tr><td colspan="2">33%</td><td colspan="2">44%</td><td colspan="2">23%</td></tr>
</table>

As it can be seen from table 2, 89% of the examinees are males, which contributes the fact that construction business is still mainly marked by machismo culture and has a label of traditional male activity. The age division is relatively uniform, by which is a higher accuracy in results analysis assured, as well as the better understanding of a section which this sample presents in an framework of construction employees in total.

Extremely important sample homogeneity is also maintained during the selection of functions which examinees perform in their enterprises. Plenary results are interpreted in a cumulative form, with a retrograde review on differences between individual functional categories, seen in table 3, and dived into four categories:

1. CATEGORY: owners of construction companies, general directors, CEOs
2. CATEGORY: project managers, sector leaders
3. CATEGORY: project manager assistants, technical engineers, construction engineer assistants
4. CATEGORY: labor workers on construction sites

Table 3 Functional structure of examinees

CATEGORY	NUMBER OF EXAMINEES	PERCETANGE [%]
1. CATEGORY	5	19%
2. CATEGORY	7	26%
3. CATEGORY	8	29%
4. CATEGORY	7	26%

In table 4, further general inputs needed for results understanding, are given: the size of the company where examinees work and period of time within they do their job. Most examinees work in companies which employee among 10 and 50 people, and similar number of them work in companies with less than 10, i.e. more than 50 people.

Table 4 Information on companies' size and time period of employment

<table>
<tr><td rowspan="2">THE SIZE OF THE COMPANY</td><td colspan="2">< 10 employed</td><td colspan="2">10-50 employed</td><td colspan="2">> 50 employed</td></tr>
<tr><td colspan="2">26%</td><td colspan="2">46%</td><td colspan="2">28%</td></tr>
<tr><td rowspan="2">PERIOD OF EMPLOYMENT ON CURRENT WORK POSITION</td><td colspan="3">< 2 years</td><td colspan="3">> 2 years</td></tr>
<tr><td colspan="3">48%</td><td colspan="3">52%</td></tr>
</table>

After an examination of general information on employees' characteristics and job they do, which are needed for a purpose of results interpretation, a structure of a questionnaire is explained. A survey was divided into 6 parts:

1. Personal information
   Information on examinees' age and sex explained above belong in this category.
2. Job in general
   General information on job include questions about the size of the company, period of employment on current work position, function description, manner of employment, nearness of work place, professional training and development, fear of job loss, project importance and size, work in multinational environment, stress and job satisfaction in general.
3. Salary
   Although it is one of the basic material motivational strategies, due to its importance and influence primacy, salary is prominent as a special motivational factor. Considering this, examinees were answering on questions dealing with the size of their salary, salary satisfaction and subjective importance of the salary as a primary and existentially crucial motivational factor.
4. Business hours and working time
   This category includes questions on working days, working hours, vacation and contract extension on current position.
5. Interpersonal relationships

Examinees also gave their answers on questions about relations with colleagues, superiors, team building and bullying.

6. Motivational system
   a. Material motivational strategies
   b. Nonmaterial motivational strategies

   Examinees chose existing motivational strategies within their enterprises among offered ones. They also rated their subjective importance with a scale from 1 to 5.

In some questions, relevant answers were given with YES/NO, and in others a scale from 1 to 5 was used, where mark 1 represented the least value i.e. importance , and mark 5 stood for the greatest value i.e. importance.

After collecting all responses, result analysis was made, and is given in the following chapter. Answers on YES/NO question type are structured in a form of percentage of positive feedback; while those with 1 to 5 scale range, have an average rating as a result.

5. Application of methodology on the sample of Croatian construction enterprises and research results

The survey carried out among 27 Croatian construction industry employees, pointed out the following results, shown in tables 5, 6, 7, 8, 9 and 10.

Due to each table, a commentary is given, as well as a relevant intersection of individual table items and function which employees represent in their companies as a factor of influence, since a positive correlation between those two items is revealed.

5.1. Results display

Table 5 Survey results dealing with job in general

CATEGORIES	1.	2.	3.	4.	Average
Job satisfaction [1-5]	4.4	3.9	3.6	2.9	3.7
Professional seminars attendance in an own arrangement [%]	100%	71%	38%	0%	52%
Regularity of professional seminars attendance [%]	100%	57%	25%	0%	46%
MONTHLY	80%	40%	0%	/	40%
SEVERAL TIMES A YEAR (<10)	0%	60%	50%	/	37%
ONCE A YEAR	20%	0%	50%	/	23%
Help of seminars in carrier [1-5]	4.2	3.7	2.0	0.0	2.5
Level of job stress [1-5]	4.8	4.3	3.8	4.4	4.3
Wish for doing the same job for multinational companies [%]	100%	100%	60%	80%	85%
Mother language in a company as a motivational factor [%]	20%	57%	75%	86%	60%
Doing business with members of Croatian national group as a motivational factor [%]	0%	43%	75%	100%	55%
Enterprise participation on international projects [%]	80%	100%	63%	43%	72%
An experience of working with foreign citizens inside of corporation [%]	60%	71%	25%	57%	53%

The importance of project size on which company works for individuals [1-5]	4.6	4.4	4.1	3.9	4.3
Fear of job loss [1-5]	2.6	2.1	2.0	3.9	2.7
The importance of nearness of working place [%]	0%	43%	63%	86%	48%
The way of getting a job					
COMPETITION	0%	29%	13%	0%	11%
RECOMMENDATION	0%	29%	0%	57%	22%
ACQUITANCE, "CONNECTIONS"	0%	42%	74%	43%	40%
OTHER	100%	0%	13%	0%	27%
Motivational system existence in the company [%]	100%	100%	100%	100%	100%
Motivational system justness [%]	80%	43%	25%	57%	51%

Table 6 Survey results dealing with salary

CATEGORIES	1.	2.	3.	4.	Average
Salary satisfaction [1-5]	4.2	3.4	2.8	3.1	3.4
Salary motivation [1-5]	4.4	3.6	3.1	4.1	3.8
Overtime salary satisfaction [1-5]	3.8	2.4	1.5	3.3	2.8
Working on more challenging projects with the same level of responsibility and a higher salary [%]	100%	100%	100%	100%	100%
Willingness to accept more responsibility for a higher salary [%]	100%	100%	100%	86%	97%
Longer working hours with a higher salary [%]	80%	43%	38%	71%	58%
Shorter working hours with a lower salary [%]	0%	43%	38%	14%	24%
Better working environment with a lower salary [%]	20%	71%	88%	57%	59%
An amount of gross salary [kn, %]					
< 5 000 kn	0%	0%	0%	14%	4%
5 000 – 10 000 kn	0%	0%	62%	72%	33%
10 000 – 20 000 kn	20%	43%	38%	14%	29%
> 20 000 kn	80%	57%	0%	0%	34%
Satisfaction with a ratio between salary and work [%]	60%	57%	25%	43%	46%

Table 7 Survey results dealing with working time

CATEGORIES	1.	2.	3.	4.	Average
Satisfaction with working hours [1-5]	2.4	3.0	3.1	2.1	2.7
Vacation existence [%]	100%	100%	100%	100%	100%
Duration of annual leave > 18 days	80%	71%	62%	43%	64%

Working days within a week					
5	0%	57%	75%	0%	33%
6	100%	43%	25%	71%	60%
7	0%	0%	0%	29%	7%
Flexible working hours as a motivational factor [%]	100%	100%	100%	43%	86%
Time period of current contract [%]					
FOR AN INDIFINATE PERIDO OF TIME	100%	86%	62%	14%	66%
FOR A CERTAIN PERIOD OF TIME	0%	14%	38%	86%	34%
Contract extension as a motivational factor [%]	/	100%	100%	100%	100%

Table 8 Survey results dealing with interpersonal relations

CATEGORIES	1.	2.	3.	4.	Average
Satisfaction with superiors' relations [1-5]	/	3.7	4.1	3.3	3.7
Satisfaction with colleagues' relations [1-5]	4.4	3.6	4.6	3.0	3.9
Associate stability as a motivational factor [1-5]	3.4	3.6	3.6	3.7	3.6
Geographical mobility as a motivational factor [1-5]	3.6	3.7	2.3	1.7	2.8
Presence of an appropriate level of team building in a company [%]	60%	29%	25%	29%	36%
Presence of the employer bullying [%]	0%	0%	25%	43%	17%

Table 9 Survey results dealing with material motivational strategies

CATEGORIES	Strategy appliance [%]	1.	2.	3.	4.	Average
Individual salary	100%	4.8	4.0	4.1	4.2	4.3
Simulative part of a salary according to work efficiency	81%	4.8	3.7	4.5	4.3	4.3
Individual cash awards and bonuses	70%	5.0	3.7	4.5	4.0	4.3
Disposable, special programs of financial incentives	74%	4.4	3.4	4.5	3.5	4.0
Participation in company avail	52%	5.0	3.5	4.3	/	4.3
Participation in company profit	48%	5.0	3.7	5.0	/	4.6
Employee participation in company ownership	52%	4.6	3.7	4.5	/	4.3
Life insurance	56%	3.6	4.8	4.3	/	4.2
Insurance benefits in case of occupational	93%	3.6	3.3	3.0	4.0	3.5

diseases, accidents, etc.						
Social security (pensions and health insurance)	100%	4.4	3.4	2.9	3.1	3.5
Insurance benefits in case of unemployment	48%	3.6	3.0	/	2.5	3.0
Severance	52%	4.0	3.2	2.7	/	3.3
Vacation	100%	3.2	3.7	4.1	4.5	3.9
Holiday	100%	3.6	4.1	4.8	4.0	4.1
Excused absences	67%	3.2	3.8	4.3	3.7	3.8
Paid leave of absence	52%	4.4	4.7	4.7	/	4.6
Appeals and negotiations	44%	3.2	3.5	2.0	/	2.9
Paid period during training and education	74%	4.0	4.3	4.5	/	4.3
Aid and scholarships	74%	4.4	3.5	4.1	/	4.0
Loans to employees	70%	3.8	3.3	3.0	/	3.4
Meal service	74%	2.4	3.0	2.0	4.9	3.1
Company car	48%	4.0	3.6	4.0	/	3.9
Professional clothing	85%	3.6	3.6	3.0	2.0	3.1
Legal services	33%	3.8	3.8	4.0	/	3.9
Bank programs and savings	41%	3.2	2.8	/	/	3.0
Transportation and parking	59%	3.2	3.9	3.5	3.5	3.5
Organized care for children and elderly	41%	4.0	3.2	4.0	/	3.7
Various awards for service, probation and other occasions	63%	4.6	3.6	5.0	4.9	4.5
Recreation and health programs	52%	3.8	3.2	3.3	/	3.4
Social activities	48%	3.8	3.0	4.0	3.0	3.5
Costs of relocation and transfer	41%	2.4	3.2	/	/	2.8
Discount buy of company products	41%	2.2	2.6	1.0	/	1.9
Sales of written off equipment	37%	2.4	3.2	/	/	2.8
Holiday bonuses and gifts	74%	2.4	3.7	3.5	3.0	3.2
Counseling and various professional services	44%	3.4	3.8	4.5	/	3.9
Unpaid leaves due to family reasons	81%	3.8	4.2	4.5	4.5	4.3
TOTAL						3.6

Table 10 Survey results dealing with nonmaterial motivational strategies

CATEGORIES	Strategy appliance [%]	1.	2.	3.	4.	Average
Different approaches to work design	74%	4.5	3.4	4.3	4.3	4.1

Job enrichment	74%	4.3	3.6	4.5	4.3	4.2
Different managerial stiles	78%	4.3	3.2	4.2	3.3	3.8
Motivating people by managers	93%	4.6	3.8	4.0	3.4	3.9
Employee participation in decision-making and problem-solving	85%	4.2	3.8	4.4	4.1	3.1
Management by objectives	56%	3.8	3.4	3.7	3.5	3.6
Flexible forms of working time	52%	4.6	4.2	4.3	/	4.4
Success recognition	93%	4.8	4.0	4.0	4.9	4.4
Feedback	74%	4.8	3.8	3.8	4.0	4.1
The existence of organizational culture	67%	4.3	3.8	3.9	3.0	3.8
Self-motivation	100%	4.6	4.3	4.6	2.7	4.1
Career monitoring and development	59%	4.3	4.0	4.5	/	4.3
TOTAL						4.0

5.2. Results discussion

5.2.1. Job in general

Starting with consideration of general items related to work performed by examinees, the most important information is subjective rating of job satisfaction.

Contrary to our initial expectations and belief that people look at their job as a burden and strain, the average rate of job satisfaction is 3.7. Thereby, the most satisfied are company owners (4.4), and least satisfied are manual workers (2.9), which is a logical outcome considering the fact that the conditions of physical work have always been and remained the hardest.

With a regard to training outside working hours, only half of examinees attend seminars and workshops in their own arrangement, mostly company owners and project managers. This result is related to the fact that on the areas of their interest, a flow of information, new technologies, ideas and people during the year is the highest. In order to be able to keep up with them, professional seminars, conferences and symposiums are becoming more of a necessity and less an option for "those who want to know more" in today' business. With this being said, and therefore, in our opinion, a modest number of professional training participants, even more troubling is the fact that an average rate of such training usefulness in daily business and career development is only 2.5.

One of the benefits of participation in seminars is certainly an introduction to the best world, European and local practices and people who contribute to their creation. In the context of working with members of other ethnic communities, 53% of respondents recorded that experience, and 72% of companies have participated on international projects. Moreover, 85% of examinees would like to do the same job, but in multinational corporations, and while doing so, they are not concerned about the language barrier, since the work on the Croatian language is a motivating factor for 60% of them, and work with compatriots for 55%. Thereby, for cooperation with foreigners, the most willing are the members of top and middle management, and less likely to do so are manual workers. This situation indicates that our personnel can find their way in the business culture of other countries easily, has good knowledge of foreign languages and customs, but also shows an eternal Croatian conviction that "the grass elsewhere is greener."

An average rate of work stressfulness is 4.3. Company owners are the most ones who are being stressed-out (4.8), and the least ones are engineering operatives (3.8). This result can be explained

by the stability of working conditions of construction operative employees and an outstanding uncertainty and continuous risk to which managers are exposed.
In the first part of the survey respondents also answered questions on how important is vicinity of work place to home, how significant is the size and importance of the projects on which they work, and how many of them are afraid of losing their job.
Small distance of working place is one of the crucial factors for 48% of respondents, mainly manual workers, since the living standard of employees on higher positions involves owning a car, and thus greater mobility.
Fear of job loss is rated with low 2.7, whereby the most afraid are seasonal laborers (3.9), while the most secure fell operative engineers (2.0). Considering current economic situation in Croatia, we had expected greater worries for jobs, but we concluded that a sense of security is largely bonded with the name of employment. Namely, only 11% of respondents claimed that they were employed by the use of job competition. The remaining 89% were employed either through connections (40%), referrals (22%) or by the other way (establishment of their own businesses, work in the family business, etc. - 27%).
In order to introduce examinees to the issue of motivation, in this part of the questionnaire they were also asked about the existence of motivational system and its fairness within their companies. While all respondents confirm the existence of work motivational system, only 51% of them believe that it is fair. The fact that nearly half of respondents believe that the system is unfair, exposes a huge omissions that deal with it in the Croatian business organizations. Firstly, the motivation is clearly not approached on a structural, serious, professional and organized manner. When employees are being rewarded, they do not consider it appropriate, fair and/or transparent. Equity theory (Adams, 1965) used here, dictates that these problems can lead to reduced work productivity, sloppily done job assignments, tensions in interpersonal relationships, leaving of valuable working staff to the competition, industrial espionage, sale of ideas, etc. However, as usual in life, not everything is so black. To understand which components still function at a satisfactory level and which need restructuring and upgrading in order to create a happy and successful enterprise workers, respondents were asked detailed questions about their salaries, working hours and interpersonal relations. These three components, as crucial ones in job rating for the majority of individuals, are detaillier processed, and the results of this analysis are given below.

5.2.2. Salary

As in the beginning of previous part, respondents rated their general satisfaction with their salary. The average rating is 3.4, and only 46% of employees believe that they are paid fairly in relation to their contribution. With an overtime payment, quite less respondents are satisfied - average rating is 2.8. Salary, as the primary mean of work motivation, is an important motivational factor for the Croatian construction workers, but not to the point where we expected it to be - the average score of motivation incented by the salary is 3.8.
In order to make the following data more relevant for understanding within the Croatian standards of living and business culture, employees were divided into four grades according to the amount of salary received:
- Salary < 5 000 kn: 4% of respondents
- Salary 5 000-10 000 kn: 33%
- Salary 10 000-20 000 kn: 29% of respondents
- Salary > 20 000 kn: 34% of respondents

Responders were then asked a series of questions dealing with their agreement on doing the job whose inputs vary according to the amount of salary followed. 100% of them would agree to do more demanding job for a higher salary, and 97% of them are really ready to accept greater responsibility in that case. 58% of respondents would work longer for a higher salary, and 24% of them would accept a lower salary and shorter working hours. The most important information in a relation of this part of the study is the fact that 60% of employees would work for less money if they had better interpersonal relations! These results suggest that salary, although the safest, definitely is not the only aspect of work motivation. Humans are social beings, and after their basic needs are settled with money they earn, they expect to get more from the job they do. Working in a good team, with good friends and colleagues, among smiling, relaxed and conscientious people is a desire of many Croatian construction workers.

5.2.3. Working hours

With their working hours, respondents are mostly unsatisfied. Its average rating is 2.7. This result is not surprising, considering that only 33% of respondents have 5-days work week, and other work 6 or 7 days a week. Although all respondents have a vacation, for only 64% of them it is longer than 18 working days. It is no surprise that 86% of people are interested in different forms of flexible working hours (work from home, work measured by actual performance, not "sat" office time, etc.).

34% of respondents had to try to make their contract cross from permanent to indefinite. The moment it happened was a kind of a motivational injection for all of them - 100% of them declare that due to this fact, they improved their performance.

These results indicate that the average construction worker in Croatia is exhausted, crying for rest and relaxation. In this situation, the knowledge of the species and the possible usage of motivational strategies are absolutely necessary.

5.2.4. Interpersonal relations

Respondents are generally satisfied with the relationships they have with their supervisors (3.7) and colleagues (3.9). The stability of the work environment is assessed as important with a high grade (3.6), while business trips and geographical mobility of associates is not a strong motivational factor in average (2.8). However, there are considerable differences between the management, who live an active and mobile lifestyle, and are therefore motivated with it, and employees on the construction sites and in offices, who love proximity of their friends and family.

Disturbing data are given in a relation to team building. While 60% of top managers live in the belief that team building is on a satisfactory level, only 25% of other working staff think so. This figure indicates substantial communication barriers in the understanding and managing the work between the managerial vision and operational problems that arise when working on projects. In support of the thesis that management is unaware of the specific problems that occur on the lower company levels, is the information that 34% of employees were exposed to some sort of bullying by their supervisors, while managers do not have a clear idea about that.

5.2.5. Motivational strategies

In the following chapter, rate of satisfaction with individual strategies of material and nonmaterial motivation which are applied in Croatian construction companies, are given.

5.2.5.1. Material motivational strategies

What can be seen from Table 9 is the large discrepancy that exists between the present motivational strategies in companies and those that would really motivate people. This outcome is admittedly not unexpected, since the issue of motivation is often classified under less essential and non-priority topic of business policy and culture. As a logical consequence of such situation, a basic lack of appropriate managerial job triggers that arises from a misunderstanding of human nature is widely present.

Mostly it is seen in regard to the basic salary, bonuses, stimulating part of salary, prize money, etc. Although those factors are among the top reasons why people work, they are not the most important, as it is widely accepted in many enterprises. In the first place of importance are paid leaves, followed by participation in company profit and cash prizes for the internship, service, worker of the month, etc. And while the first data can be connected with prejudices about classical Croatian mentality, other information points to the fact that people find money significant, but as a mean which produces a felling of pride, respect and self-esteem, and above all, belonging to a certain social class, business or other group. The educational perspective of our working staff is explained by the fact that they find paid education, scholarships and training more important than a company car or a professional dress code. On the other hand, car or life insurance motivates employees much more than the pension scheme. This is due to the fact that people take pension and health insurance for granted, and they do not look at it as a special privilege. At the lowest point of the rank is the discount sale of company products, sale of depreciated dispatch, paid costs of transfer and legal appeals. Within a particular category of strategies, there are significant differences in terms of functions that employees perform. This is especially evident when talking about the motivation with a company car, paid education and scholarships, etc. - which motivate middle management layers; compared with the quality of meals or organized transfer that is irrelevant to them, but extremely important for labor workers. With direct monetary motivation, holidays and vacations, all of the employees' structures are approximately equally motivated.

5.2.5.2. Nonmaterial motivational strategies

As it was seen in the previous chapter, and considering data from Table 10, there is a gap between nonmaterial motivational strategies that people would like to have, and those that are used.
Many people yearn for flexible forms of working time; however, those are the least used in practice as a strategy to motivate. The largest number of responders placed the need for recognition of the results in the first place of importance. A high-ranking position is also given to a feedback, and different ways of career development. A large discrepancy is evident in employers' expectation of workers to be self-motivated, while they see their internal motivation more as company obligation to conduct business in accordance with their expectations. Extremely low rank is given to the organizational culture - i.e., its existence, acknowledgment and recognition by employees. This is the segment where our companies certainly must work harder in order to create a modern image, under which continuous business successes, subdued competitors and happy employees will be made.

6. Conclusion

In conclusion, we would like to emphasize the importance of its individual sequences. From the literature review, the importance of motivation is clearly shown, as an extremely interesting psychological concept, as well as one of the key factors of work performance and achievement of business and private prosperity. Motivation follows us our whole life, even before the conscious of reasons to take certain actions, our mechanisms of internal inputs do their job perfectly well.
In our study, we wanted to discover what motivates Croatian construction employees and how to make the existing motivational system better, more appropriate and more efficient. In order to do so, we carried out an extensive survey. Results of the survey, performed over business owners, project managers, civil engineers with operational responsibilities and manual workers, revealed that people are generally satisfied with their jobs, salaries and business relations, but in a much less extent than their colleges in other countries. The survey detected following problems in the motivational system that is currently present in our enterprises:

• The injustice of motivational system
• Lack of a good attitude towards symposiums and professional courses
• Common opinion that working for foreign companies / in foreign countries / with members of other nations is better
• High level of stress

• Getting a job mostly "through the links and connections"
• Mismatch of salary and work contributions, roles and responsibilities
• Too long working hours
• The presence of bullying and exploitation of workers on construction sites and in offices
• Team building at an unsatisfactory level
• Use of inadequate or insufficiently effective motivational strategies
• Lack of managerial knowledge about job triggers and lack of interest for the topic of motivation
On the other hand, the survey also showed the benefits of Croatian construction business:
• Overall job satisfaction
• Openness to work with other cultures, nations and on foreign languages
• Small fear of job loss
• Improved performance due to contract extension
• Correct and fair relations with superiors
• Friendly relations with colleagues
As it can be seen, place for improvement certainly exists. Firstly, managers must understand that money is not one and only mean of motivation. It can be a great business condiment, but it will not cause positive emotions as it could some, perhaps less expected, and usually free and simple motivational strategies. There certainly are:
• Recognition of success, feedback to employees about their performance
• Flexible working hours
• Awards for internships, special contribution, service, innovation, etc.
• Grants and scholarships for training and career development
• Improving interpersonal relationships in co-authoring methods of team building
• Stress relief methods and relaxation
• Creation of realistically sustainable, transparent and fair motivational system
During the work on this article, we became aware of the importance of motivation as a key to success. Successful and happy person becomes successful and happy employee, and his/her company can then be recognized as a leading one. The values that we obtain through such system of thought and action is bringing multiple advantages over those, motivational achievement deprived of, opinions, both for the prosperity of our working environments and also because of the growth and development of ourselves as whole human beings.

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MEASUREMENT OF CRITICAL SUCCESS FACTOR PRIORITIES FOR THE CONSTRUCTION CLIENTS IN WESTERN BALKANS?*

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Abstract

Importance of Critical success factors through value management workshops can be used to determine Client value system, which in turn will impact the success of the project in the implementation stage. This research investigates the impact of local knowledge to required client values on international projects where Clients lack specific and reliable local knowledge. Information on local market and construction industry specifics should influence client decision-making process. Workshops were organised in west Balkans region where Client's consideration of project Critical success factors – CSF was captured through paired comparison exercise. Changes to client understanding of critical success factors were measured. Results indicate that clients understanding of CSF were impacted by local knowledge.

Keywords: Value Management, Critical success factors, Local knowledge, International Construction Projects

* The complete text is available on CD-ROM / Surlan, Cekić, Torbica

Introduction

Utilization of value management process can be an effective tool to ensure that project requirements conform to client intentions for the project. This can be achieved by defining and measuring value parameters – Critical Success Factors (CSF) and aligning them with client understanding what must be achieved on a project. These CSF can be used to access project`s whole life cycle as indicated by Park (2009), particularly in project earliest stages. CSF can then be used to capture Client value system. Scope, cost, time and quality are key CSF or parameters for planning and assessing project success in the construction industry. Ogunsemi and Jagboro (2006) consider time as a project parameter a benchmark for measuring of performance of a project and the efficiency of the project organization. Chan and Kumaraswamy (1996) evaluated factors which affect the construction time performance in the construction industry.

The largest impact on the success of the project can be achieved in its earliest stages. As the project proceeds, the risk for the project failure reduces, however the opportunities for enhancing project success are also reduced. It can be argued that highest stakes for the project success exist in its initial, pre-construction stage, prior to definition of the design brief. In order to correctly interpret the Client expectations for the project, it is necessary to define project requirements through a design brief (Kelly et al., 1992; Yu et al., 2006; CIB, 1997; Kamara and Anumba, 2001; Kelly and Male 2004). CSF can be utilised to steer project brief in direction that will maximise desired expectation of the client. CSF determination through pre-brief value management workshop can substantially impact the brief. Yu et al. (2005) confirms in his research that value management is considered to be a beneficial application in the formation of the brief. They also confirm that this method is enabling the participation of the client creating a common language. Yu et al. (2006) concludes that value management is useful tool to overcome briefing problems.

Research Methodology

Value management is the name given to a process in which the functional benefits of a project are made explicit and appraised consistent with a value system determined by the client (Kelly et al., 2004). Male et al. (1998) defines value intervention opportunities at four points in project development: pre-brief, brief (charette), concept design and detail design stage to achieve maximum effect on any project during its life cycle. Kelly and Male (1993) define value management as a service in which the sponsor of a project, the client, transmits a clear statement of the value requirements of that project to the project designers. As the practice evolved, Kelly and Male (2004) define value management as a change oriented process that needs to be treated, designed and delivered as such. Thiry (1997) defines value as a very subjective concept as it has different meanings for different people. The goal in value management is not merely to reduce costs but to balance performance with cost. Although value is a subjective concept, it can be measured. The practice of value management is used to define, manage and assist in production of a favourable result to all project stakeholders. Guidelines to BS EN 12973 standard PD 6663:2000 (2000) defines that the concept of Value is based on the relationship between satisfying needs and expectations and the resources required to achieve them. Kirk et al. (2002) concludes that value engineering is not simply about money…it's about value. Based on literature review of different value parameter frameworks, the authors decided to adopt the CSF or value parameters as proposed by Park (2009). He undertakes a questionnaire survey to investigate a set of 188 individual factors that are finally grouped into eight critical categories (project scope, time, cost, quality, contract/ administration, human resource, risk, and health and safety). This is taken as the bases for value parameters to be used in defining client value system in the project initial stages. Even though there are different factors that contribute to client satisfaction, the early stages of construction projects are critical for overall project success. These factors should demonstrate value for money through the whole life of a project. There needs to be a balance of competing demands in terms of all project parameters. Chua et al. (1999) and Shen and Liu (2003) confirm that the identification of the critical success factors CSF should be performed as this will allocate the limited resources of time, resources, and money in the best way possible.

This research investigates the level of impact of local experience to the support to making of decisions in the project early stages. This is achieved through the application of value management processes on construction projects. In a previous research Surlan and Cekic (2011) conducted prior to this study, a set of significant value parameters (a selection model) was captured through the application of four rounds of the Delphi technique. These parameters were determined to be relevant by a group of 12 experts with local experience in the construction industry and local market conditions in the western Balkans region and presented in Appendix A, Tab. 7. Client value system is defined through CSF, and then supplemented with specific local construction knowledge and experience. Limited value management workshops were organised on 12 projects in Western Balkans region. SAVE (2007) defines value study as the formal application of a value methodology to a project in order to improve its value, and further details the process. Selection model is utilised as organised source of local knowledge that can impact client value system. Two-staged approach to investigate Client value system was organised: one before (paired comparison) and one after (EFTE) the presentation of local knowledge – selection model. Kelly at al. (2004) conclude that previous workshops have found the paired comparison approach a satisfactory method of deriving a client's value system judged by the fact that clients generally agree with the summary when it is read back to them. Kelly (2007) concludes that evidence supports that the value parameter can be ordered for preference through a process of paired comparison. However, Woodhead (2005) cautions that paired comparison should be considered within the overall framework of value management, or it will miss the point. The function of Paired Comparison is about communicating priority. Paired comparison method will be used to rank parameters by value (compare two parameters at the time). Sample results from one of the projects are presented in Tab.1.

									Score	**Weight**	**Weighted Score**
	B	C	D	E	F	G	H			**%**	1-10
A	B	C	D	E	F	G	A	1. Scope	1	3.57	**2**
B		C	B	B	B	B	B	2. Time	6	21.43	**9**
C			C	C	C	C	C	3. Cost	7	25.00	**10**
D				D	D	D	H	4. Quality	4	14.29	**6**
E					F	E	E	5. Contract-admin	3	10.71	**5**
F						G	H	6. Human resource	2	7.14	**3**
G							G	7. Risk	3	10.71	**5**
H								8. Health and safety	2	7.14	**3**
										100.00	

Table 1. Sample results of paired comparison exercise from a project in Western Balkans

A condensed version of Delphi method is the EFTE (Estimate, Feedback, Talk, Estimate). This method is also known as interactive Delphi as the proposed process includes face-to-face open debate segments between two rounds. An EFTE is commonly used is to substitute questionnaires with interviews to overcome the noted issues tied in with questionnaire surveys and its responses. Interviews are quicker and more effective in the opinion collection stage as well as more reliable in the information interpretation and synthesis stage. Nelms and Porter (1985) propose a process for EFTE exercise that is applied in this research to gather Client values during a value management workshop, as presented in Fig. 1. Sample results from a project are presented in Tab.2.

	WS Participants – 5 persons (1-5)													
	1st round scores							**2nd round scores**						
Value parameters	**1**	**2**	**3**	**4**	**5**	avg	rnd	**1**	**2**	**3**	**4**	**5**	avg	rnd
1. Scope	2	2	3	2	3	2.4	**2**	2	2	2	2	3	2.2	**2**
2. Time	9	9	8	8	9	8.6	**9**	9	9	9	8	9	8.8	**9**
3. Cost	10	10	10	10	10	10	**10**	10	10	10	10	10	10	**10**
4. Quality	7	6	6	8	6	6.6	**7**	6	6	6	7	6	6.2	**6**
5. Contract-admin	5	4	5	4	4	4.4	**4**	5	5	5	4	4	4.6	**5**
6. Human resource	3	4	3	4	4	3.6	**4**	4	4	3	4	4	3.8	**4**
7. Risk	5	5	5	5	5	5	**5**	5	5	5	5	5	5	**5**
8. Health and safety	3	4	3	3	4	3.4	**3**	3	3	3	3	4	3.2	**3**

Table 2. Sample results of EFTE exercise from a project in Western Balkans

A change to Client value system was measured before and after the exposure to local knowledge-selection model. The results of this impact are then recorded and discussed.

Results and Analysis

Workshops were organised on selected projects with available Client representatives present. In this exercise agreement was reached on priority of value parameters when pairs of parameters are compared. Summary results of Paired comparison exercise are shown in Tab.3.

Project	Project No 1	Project No 2	Project No 3	Project No 4	Project No 5	Project No 6	Project No 7	Project No 8	Project No 9	Project No 10	Project No 11	Project No 12	Average
1. Scope	6	10	6	8	5	6	2	6	6	4	2	5	**5.50**
2. Time	8	10	8	6	8	8	10	9	9	10	9	10	**8.75**
3. Cost	10	10	10	10	10	10	9	10	10	10	10	9	**9.83**
4. Quality	9	4	9	6	9	9	8	8	8	7	6	10	**7.75**
5. Contract-admin	2	2	0	0	0	2	3	2	2	0	5	5	**1.92**
6. Human resource	2	2	2	2	2	0	3	2	2	2	3	2	**2.00**
7. Risk	3	5	5	8	6	5	5	3	3	10	5	4	**5.17**
8. Health and safety	3	5	3	3	3	3	3	3	3	5	3	4	**3.42**

Table 3. Results of Paired comparison exercise

As initial step in second leg of the Workshop, local knowledge information was presented to Client representatives. Printed tables of value parameters were handed out and results presented, highlighting top scoring parameters. EFTE exercise with two rounds according to noted process was undertaken and final results obtained as shown in Tab.4.

Project	Project No 1	Project No 2	Project No 3	Project No 4	Project No 5	Project No 6	Project No 7	Project No 8	Project No 9	Project No 10	Project No 11	Project No 12	Average
1. Scope	7	10	7	8	6	7	4	8	7	7	2	6	**6.58**
2. Time	8	10	8	7	8	8	10	9	9	10	9	10	**8.83**
3. Cost	10	10	10	10	10	10	9	10	10	9	10	9	**9.75**

4. Quality	8	6	9	7	9	9	8	9	9	8	6	10	**8.17**
5. Contract-admin	6	2	4	4	4	3	5	2	1	2	5	5	**3.58**
6. Human resource	4	2	4	3	5	3	4	3	4	4	4	4	**3.67**
7. Risk	5	5	5	8	7	5	5	4	4	10	5	4	**5.58**
8. Health and safety	5	6	4	4	5	3	4	4	2	5	3	5	**4.17**

Table 4. Results of EFTE (mini-Delphi) exercise

Discussion

Parameters 5 (Contract-admin), 6(HR) and 8(Health and safety) have changes significantly as the result of highlighting shortcomings of local projects and generally low priority of these parameters in local construction industry practice. Contract-admin and Health and Safety are particularly neglected on local construction projects and particular care has to be taken to minimise this potential source of the risk. The HR issues are potentially challenging as regional construction market is lacking well trained “western style” managers which will lead the project through the local conditions and constructions. Parameter 1 (Scope) has also changed significantly as the result of local experience where scope creep occurs on more frequent level than on international projects, so additional care has to be made in this direction. Changes to remaining three parameters 2 (Time), 3 (Cost) and 4 (Quality) were not statistically significant as Client representatives have initially valued them high and their opinion was not changed.

Limitations

The study was undertaken in western Balkans region, and reflects particular experience of that local market. Prior to undertaking a similar investigating, it is important to capture the specifics of the local construction market. Connaughton and Green (1996) highlight that Client`s departments and project sponsors are committed to the introduction and implementation of value management. Only then can the techniques be effectively introduced and necessary resources and support provided. Regretfully, this was not applicable to Client organisations in Western Balkans. Interview was conducted with potential clients on the extent of willingness to participate in value management workshop. Due to regional client general lack of understanding of value management process and their basic value management experience only a limited exercise is value management was possible to be organised. Taking a lowest common denominator of interviewed clients of available projects, it has been decided that only an exercise in determining client value system through value parameters will be organised. It is suggested that more encompassing value management workshops are organised in future research.

Conclusion

The benefit of this research is manifold. Initially, CSF will assist Clients to improve understanding of local market conditions and fill areas of experience which they lack. In this way, different expectation from Clients and other local project participants will be decreased. This local knowledge supplement to Client value system expressed through CSF - value parameters should steer the project in the more favourable direction in the local market conditions. Successful project have many positive impacts. Client may decide for repeat business based on previous successful experience. Wider community would benefit from successful projects as they contribute to overall satisfaction and economic benefits providing job opportunities and development. Local companies and service providers to can be involved as outsourced elements to the project operation stage or as facilitators for certain operation requirements.

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IS IT POSSIBLE TO MAINTANCE BUILDINGS WITHOUT ASSURING OF SAFETY WORKS? *

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Abstract

The article is focused on health and safety issues during maintenance throughout the life cycle of the building. It points to the fact that the architectural design and construction projects quite often do not address the need for building maintenance, whether the life cycle or construction or it addresses only marginally or completely inappropriately.
If the project will be right from the start, a suitable safety equipment, maintenance work will not only safer but also more economical. The property owner by ensuring safe working conditions for easy maintenance and extend the life of structures.
Given the scale of this issue, the article focused mainly on work at heights maintenance of roofs and building facades

Keywords: Health and safety works, duties of employer, safety work systém, maintenance, work in height

* The complete text is available on CD-ROM / Svoboda, Parova

Introduction

The answer is simple and unambiguous: No, it is impossible! The due to assure safety works is done by the law. The working law says „employer musts assure a safety working conditions for every employee“. The Czech legislation specifies these requirements in detail. Legislation defines the employer´s duties of safety and protection during working process disambiguate and says how to prevent life-threating and health of works.

Duties of employer

The employer is bounding to assure safety and protection of health of all employees during work with regarding to risks of possible life and health-threatening. When employees of two or more companies are working in the same workplace employers have to inform to each-other about risks and action for protection against the risks by written form. The employers have to cooperate on assuring health and safety works for all employees on the workplace. Employers appoint responsible person who coordinates all these agreements.

As is written in previous paragraph the employer has to assure not only its employees are safe but all who work on the same workplace. Employer has to pay all costs to assure safety works and workplaces. These costs can´t be delivering to employees.
The employer is required to create a safe and healthy working environment and working conditions by suitable organization and prevents all risks. The employer is obliged to continuously search for dangerous factors and processes of the working environment and working conditions, to discover their causes and sources. By this he has to evaluate the risk and takes actions for their removing. If it is unable to remove the risks, the employer is required to evaluate and take measures to limit their exposure to threats to the safety and health of workers has been minimized.
Finally, the employer is obliged to adapt the measures to the changing realities, to check their effectiveness and compliance with and to ensure the improvement of the status of the working environment and working conditions.

The employer is obliged not to allow the employee does forbidden works and work whose performance did not match his abilities and medical fitness. In our case, the works in height only workers could do whose are able for this. For e.g. workers do not suffer from vertigo or epilepsy. Another of the obligations of the employer is to provide staff training on laws, regulations and other measures to ensure the safety and health at work.

If it is not possible to delete or sufficiently limit the risks by techniques for collective protection or measures concerning the organization of work, the employer is required to provide employees with personal protective equipment. Personal protective equipment are such which must protect the employees against the risks, not threat their health, shall not prevent the performance of the work and shall comply with the applicable legislation. The employer is obliged to maintain personal protective equipment in the usable condition and control their use.

As with planning for safe maintenance

In Czech by the decree-law no. 591/2006 „The specific minimum requirements for health and safety at work sites“ more in section which talks about works on the maintenance and repair of buildings and their technical equipment, establishes the need to keep the requirements of safety and health during this works.
It also specifies that the implementation of the work and activities of individual exhibiting an increased risk of life or injury arises he has to prepare a health and safety plan.
In the case of maintenance may refer to the following activities - works:
1. work related to the use of dangerous highly toxic chemical substances and preparations, or the occurrence of the biological agents according to the specific legislation (e.g.: asbestos-panels, air conditioning and other products containing asbestos).
2. sources of ionizing radiation if there are not any specific legislation.
3. over water level or close to the water proximity to the related to the imminent danger of drowning.
4. where there is a fall from a height or depth to free more than 10 m
5. within the protection exercised by the energy management or technical equipment.
6. diving
7. Assembly and dismantling of heavy structural building parts of metal, concrete, and wood intended for permanent installation in buildings.

How to prepare for a safe maintenance work

To sum up, in order to ensure maintenance work of these health threatening activities, in particular in relation to their possible frequency:

at the height
in the protection zones of energy cables and devices
associated with the assembly and disassembly of the construction parts

In this article we will cover the issue of maintenance associated with the performance of the work at a height. An additional area, i.e. works in the protection of energy management and work connected with the assembly or disassembly technologies or construction parts not listed here, because this issue has released on a small publication.

We will focus on regular maintenance of the outer envelope residential and civil buildings, where it is the control of roofing, lightning rods, plumbing components, chimneys and other building services installation, roof inlets or provided, technology (HVAC), skylights and washing of facades, etc. (fig. no. 1, 2, 3a, 4a)

Fig. No. 1: Sloping roof before maintenance

Fig. No. 2: anchor points for the worker

The designer should handle the project for a building permit to think these work connected with the maintenance of buildings and design security systems to assure maintenance workers against falling for the sloping and flat roofs include access paths (e.g. ladders, stairs). These design work require specific knowledge. If it is not designer familiar with this issue in detail design of safety systems, this process must consult with manufacturers or vendors of these systems.

Fig. No. 3: a) HVAC on flat roof with the need to ensure the workers;
b) This means that the anchor point on the steel construction system

Basically, when he designs a bad solution in good faith. Frequently occurring error is low load carrying capacity of the system, incorrect distances, i.e.. distance from the nearest and farthest point, where there is also a significant risk of incorrect determination of the distance between conjunction Inc. the length of the rope on which a worker provides, where combined with the fall may result in an extension so that the worker goes on the lower level, which would be the correct design did not get.
For this work are available on the market for different ways of locking devices. In this article are the basic ways to partition these devices. Point out how it is possible to include the building so as to make it possible to ensure the safe maintenance of the buildings, namely their coats and technology. As mentioned above, the employer is required to eliminate the risk of work for their employees in order to ensure a safe execution of the works, and in our case, safe maintenance; i.e. work at a height.

Fig.. No. 4: a) department store shopping in a skylight; in the right part of the picture you can see the suspended platform for repair, maintenance and cleaning; b) solution on the outer side of the skylight (source: TOPwet)

Systems differ according to the type of roof, that is, if it is a sloping roof or flat roof. In the case of flat roof is an important type of material to which gripper system will be anchor (concrete, wood, trapezoidal sheet, steel). In addition, it is the articles for the work in tow, for the washing of facades and roofs skylights (fig. 4a and 4b) or their minor repairs or cementing and control plating and last but not least the removal of snow and ice in the winter. Of course, manufacturers are coming up with this solution add-ins for safe maintenance. Other features which are include systems are ladders (mobile and fixed) and ensure the safe movement of after them, rail systems and mobile rail (fig. 6a and 6b).


Fig. No: 5 a) full body harness with anchor rope and suppressor, which is installed at the point of exit on the roof;
b) secured by a worker on the roof (source: TOPwet)

We need to realize that falling from a height occurs very often to severe accidents for example may cause hemorrhage, severe fractures, blood circulation and other life dangerous situations. In the event that the worker is using personal protective equipment for work at a height, specifically full body harness, rescue and relief does not last longer than 10-20 minutes. The boundary of 20 minutes

is imitated to save the worker's life, hanging in the harness. This would have every employer should recognize.
Other security systems are enclosing element and specifying the safe area from hazardous parts of a flat roof that is not built-in, but adjustable. This is the definition of work, where there is no fall from a height or forfeiture. This is the edge of the roof or the roof-lights, fire dampers, etc. This adjustable barrier must be placed according to the principles of work at a height at a minimum distance of 1.5 m from the edge of the roof or skylight, on which there is a risk of falling (fig. 6a, b).

Fig. No. 6 a) – b) Adjustable safe system which defined safety danger zone (source: TOPwet)

Information elements are used to indicate the dangerous zones, where these barriers are placed approximately 2 m from dangerous edges and the following information sheets with lyrics about the risks associated with potential movement along these dangerous zones.

Conclusion

When work on the maintenance of the building envelope is threatened with a possible free fall from a height of the worker. It is therefore necessary to make an analysis of the activities and the risks arising from a specific workplace for the maintenance operation. It is imperative before scheduled maintenance work at a height of evaluate:
way to provide output to the workplace and the descent from him;
the risk of the workplace; the worker's movement in the performance of maintenance activities and when changing the place of work, the possibility of anchoring PPE;
effect of mechanical, thermal, chemical, and climatic influences on the individual;
division of the workplace in track capturing the resulting from the fall of the (safe clearance);
determination of the optimum system to prevent free fall or a system to capture his downfall and evaluate the options and how to rescue the affected;

We need to realize that the belay device for work purposes may not be used without the personal fall arrest system. When the above works, when there is a crash when roping from a higher to a lower position or sticking out from a lower to a higher position is needed to equip the workplace survival by lift device.
For this specific work activities is therefore necessary, in order to ensure already in the preparation of project work which will subsequently be integrated, which is always problems and increased costs.

Some of this work can be addressed, for example mobile platforms or auxiliary constructions, etc. But even this solution is cost.

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MANAGEMENT OF WORKS CONTRACTS WITHIN PUBLIC PROCUREMENT PROCEDURES IN CROATIA*

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Abstract

Public procurement is an important segment of economy and its efficiency significantlly influences both performance of companies as well as macroeconomic indicators of national achievement.
Within the structure of public procurement in Croatia, works contracts have 21.13% share in total number of contracts concluded, representing 35.94% of total contracted value (Ministry of economy, 2012:11). Because of the importance of works contracts, starting research question of this paper are methods of efficient works contracts management and their application and results in Croatia.
Authors have used an interdisciplinary approach: based on the relevant literature review and by using analysis as an adequate scientific research method for the subject, both macroeconomic and microeconomic elements of the problem have been covered. Paper studies general Cohesion Policy goals, public procurement system in Croatia and repercussions of public procurement on civil engineering business. At the microeconomic level, case study of a randomly selected company was used to analyse works contracts management from the business aspect and ultimately prove dependence of construction business on public procurement procedures.
In conclusion, research results have shown good compliance of Croatian public procurement system with EU legislation and its functionality. Nevertheless, they have also indicated the need of fostering efficiency through administrative capacity strengthening. Regarding business, it has been proven that construction companies' management must be in continuous compliance with ongoing public procurement procedures in order to ensure existence and competitive performance of a company.

Key words: management, public procurement, works contracts, economic policy, construction

* The complete text is available on CD-ROM / Šandrk Nukić, Marošević

Introduction - cohesion policy as a framework of public procurement system

Cohesion policy of the European Union is a policy that provides a framework for financing a wide range of projects and investments with the aim of encouraging economic growth in EU member states and their regions. As such, it has “the overall goal of promoting economic prosperity and social cohesion throughout the entire territory of the Union.” (http://www.euractiv.com)
The three main objectives of the EU’s cohesion policy are (Crnić Duplančić, 2012):

1. Convergence – decrease of growth and development differences among regions within the EU. Over 80% of the cohesion policy budget is allocated to the regions whose GDP per capita is less than 75% of the EU average. This money is aimed to boost economic growth, including transport and other infrastructure investments. Most of such regions are new member states from Central and Eastern Europe, as well as Greece, Spain, Portugal and southern Italy.
2. Regional competitiveness and employment – strengthening of economic competitiveness and attractiveness of regions by promoting innovation and entrepreneurship, protecting the environment, improving transport links, adapting the workforce and investing in human resources. Around 16% of the money from the cohesion policy budget is available for this purpose.
3. **European Territorial Cooperation**– promoting cooperation among regions in different member states, especially between border regions, by means of joint projects and exchanges of experience. Somewhat more than 2% of the budget remains for this goal.

Beside the goals, there are several significant ideas put forward by the Cohesion policy: programme approach, co-financing and partnership (Crnić Duplančić, 2012).
Programme approach implies linking allocation of funds to the objectives, meaning defining long term operative initiatives through National strategic referent framework (NSRO) as well as stronger monitoring and evaluation in order to move to a more result-oriented approach. This kind of monitoring is based on clear and measurable indicators agreed in advance, used to assess the outcomes of defined operative initiatives.
In order to support assessment of defined initiatives, one of the most significant cohesion policy ideas is co-financing, suggesting the use of public national/regional/municipal assets, possibly together with capital from private sources. This cohesion policy spending is done using three cohesion policy instruments, i.e. the spending is channeled through three funds – These are the European Regional Development Fund (ERDF), the European Social Fund (ESF) (both of them are often called 'Structural Funds') and the Cohesion Fund. All of these funds have a role to promote economic and social cohesion within the EU.
Prof Branko Grčić, Ph.D., Minister of Regional Development and EU said that, during the period from the second half of 2013 till the end of 2020, Croatia can count on approximately 10 billion EUR from Structural funds and the Cohesion fund. Since that kind of money values as a whole, additional national budget, Croatia should prepare a stock of ready made, mature projects which shall provide an optimum benefit for our regions. (http://www.safu.hr)
Finally, the idea of strengthening partnerships aims to increase the involvement of all relevant stakeholders between European Commission and a member state as well as within a member state. Relevant stakeholders being primarily government bodies and civil society organizations involved in the implementation of operational programmes (http://www.euractiv.com).
Current programming period of Cohesion policy head document associating Croatian development priorities with European Cohesion policy goals and consequently defining the strategy of investments arising from Structural and Cohesion funds that will be available to Croatia is called National strategic referent framework (NSRO). In respect of currant programming period of Cohesion policy that comes to an end in 2013, this document defines financing priorities from becoming a full member state in

July 2013 till the end of 2013. These priorities are set as 4 key development categories: regional competitiveness, transport, environmental protection and up-growth of human resources and institutional capacity building (Izazovi i pripreme za kohezijsku politiku, 2012:7).
Since the full membership of Croatia in the EU is expected to begin on 1st of July 2013, being also the date of earning the privilege of application for Cohesion and Structural funds, our concern is in fact the new cycle of operational programmes 2014-2020. Goals of Cohesion policy for that period are as follows:

- "research & innovation"
- information and communication technologies (ICT)
- competitiveness of small and medium-sized enterprises (SMEs)
- shift towards a low-carbon economy
- climate change adaptation & risk prevention and management
- environmental protection & resource efficiency
- sustainable transport & removing bottlenecks in key network infrastructures
- employment & supporting labour mobility
- social inclusion &combating poverty
- education, skills & lifelong learning
- institutional capacity building & efficient public administration" (Izazovi i pripreme za kohezijsku politiku, 2012:9)

It is important to emphasize that experience of other countries that have recently joined the EU shows that Cohesion and Structural funds mean an opportunity, not an achievement themselves. The country needs approved programmes, thousands of projects that match with national/regional/municipal development targets and reach a high standard of quality, and a capacity to process and implement those projects in order to attain the money from funds, spend it efficiently and effectively and achieve results. (Sarmaviciene, 2012:2).
Since the most of the potential users of Cohesion and Structural funds are governmental and civil society institutions (Konzultacije o nacrtu Nacionalnog strateškog referentnog okvira, 2010:11), majority of these funds will be channelled to final users through means of public procurement processes. Public procurement systems becomes a tool for Cohesion policy goals accomplishment. Therefore we find it important to investigate the methods of efficient management of contracts conducted as part of public procurement processes.

1. Public procurement system in Croatia

Public procurement comprises satisfaction of public needs and public consumption, consequently assuming spending of extremely high amounts of money out from the budget or other public resources. As such, it is both sensitive and important issue that needs to be carefully regulated.
The Government of the Republic of Croatia has adopted the Strategy for Development of the Public Procurement System and the Action Plan for its implementation. „Thorough implementation of the Strategy is aimed to ensure":

- Compliance with basic public procurement system's principles defined as: transparency, non-discrimination, market competition, equality of procedures, attainment of the best value for money
- Fulfillment of principal goals, being increased market competitiveness for works, supplies and services acquired by public authorities, including concessions and promotion of private public partnership modeles" (Strategija razvoja sustava javne nabave u Republici Hrvtaskoj, 2008:19).

The competent body for the public procurement system in Croatia is the Ministry of Economy, Directorate for the Public Procurement System. The competencies of the Directorate include analysis of implementation of regulations in the field of public procurement through activities aimed at prevention and instruction and training and professional development in the field of public procurement (http://ceftatradeportal.com)

Other important authorities involved in creating an efficieint and transparent public procurement system in Croatia are the Ministry of Finance, The Agency for Public Private Partnership and The State Comission for supervision of public procurement procedure.
The Ministry of Finance is the competent body for concessions and fiscal charges in public-private partnerships and keeps a Concessions Register as an integrated electronic record of all concessions granted.
The Agency for Public Private Partnership evaluates proposed projects in collaboration with the competent state administration bodies and issues opinions on projects which can be implemented using the public-private partnership model.
The State Commission for Supervision of Public Procurement Procedure is an independent second-instance state body with competence for handling appeals in public procurement procedures (http://ceftatradeportal.com).
Over the years, public procurement directives have been progressively implemented in order to simplify procedures and cut administrative costs, whilst further increasing transparency and competition.
However, legislative and institutional framework through which the EU's public procurement regulatory rules are being adopted varies from country to country. Therefore, „the correct, efficient and effective application of EU public procurement rules across the Union remains a constant challenge“ (Annual public procurement implementation review, 2012:5).
As for Croatia, "As early as in the starting phase of the screening, Croatia expressed its willingness to accept the Community acquis of the EU regarding public procurement. Furthermore, Croatia pointed out that no obstacles are expected in application of that part of the acquis before acquiring the full membership in the EU." (Ljubanović, Britvić-Vetma, 2011:411)
Legal framework for public procurement in Croatia was set and updated by several public procurement acts (Official Gazette 117/2001, 110/2007, 90/2011), i.e. laws on amendments and changes of the public procurement law (Official Gazette 092/2005 and 125/2008). Currently valid Law on public procurement accepts relevant EU Directives and alleges the Common Procurement Vocabulary, both proving conformity of Croatian legal framework with the acquis.
Public procurement in Croatia is regulated also by Concessions (Official Gazette 143/2012), Act on Public Private Partnership (Official Gazette 78/2012), Act on the State Commission for Supervision over Public Procurement Procedure (Official Gazette 21/2010) and subordinate legislation pursuant to those acts.
Now more than ever, the time has come for Croatia to think of public procurement from the aspect of the EU member state. From that aspect, public procurement represents a strategic area of the single market. As such, it has increased cross-border competition and improved prices paid by public authorities. Furthermore, single market ensures the enforcement of public procurement rules through mutual exchange of experience and benchmarking among member states. (The comparative survey on the national public procurement systems across the PPN, 2010:10).
Public procurement makes public authorities significant market players as buyers of goods and services. According to statistics regarding public procurement in Croatia, structure of those authorities is as presented in tab. 1.

Table 1. Number and structure of public authorities involved in public procurement procedures in Croatia in 2011

Type of authority	Number	%
Central Government bodies	152	9,81
Local Government and Municipalities	405	26,13
Legal entities as per Public Procurement Act, article 3, section 1, clause 3	759	48,97
Organizations as per Public Procurement Act, article 3, section 1, clause 4	77	4,97
Subjects as per Public Procurement Act, article 3, section 2	41	2,65
Other	116	7,48

Source: Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu, p.7

The table shows that almost half of total authorities involved in public procurement in Croatia in 2011 are legal entities, being therefore the most important market player in that area. This is confirmed by the fact that legal entities recorded also the highest portion of contracts (52,5%), i.e. their contribution in the total value of contracts is 50,9%. (Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu, 2012:53)
Concerning the type of public procurement procedure, structure is as follows:

Table 2 Number and value of contracts as per procedure type

Procedure	Number	%	Value	%
Open procedure	22955	84,99	21.936.536.728	83,57
Restricted procedure	64	0,24	24.495.399	0,09
Negotiated procedure with prior notice	102	0,38	724.821.750	2,76
Negotiated procedure of urgency	39	0,14	122.318.256	0,47
Negotiated procedure without prior notice	2703	10,01	2.871.696.746	10,94
Bidding procedure	26	0,10	5.130.644.	0,02
Contracts for public services from Annex II.B	1120	4,15	564.108.955	2,15
TOTAL	27.009	100,00	2.249.108.478	100,00

Source: Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu, p.29

As in previous periods, the preferred type of procedure in 2011 was again open procedure, with 84,99% contract notices, which counted for 83,57% of the total contracted value.

2. Work contracts as important segment of total contracted value within the public procurement system

In Croatia, total value of public procurement was 30.982.902.308 HRK in 2011, which meant an increase of 2,49% in comparison to 2010. Furthermore, this value represented a contribution to Croatian GDP of 9,04%, proving its considerable economic significance (Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu). Even higher numbers are to be expected, because „every year around one fifth of EU GDP is spent by different levels of government (central and sub-central) bodies governed by public law and utility service providers to procure goods, works and services" (Annual public procurement implementation review, 2012:7).
Analysis of this value upon the procurement subject shows results presented in tab. 3.

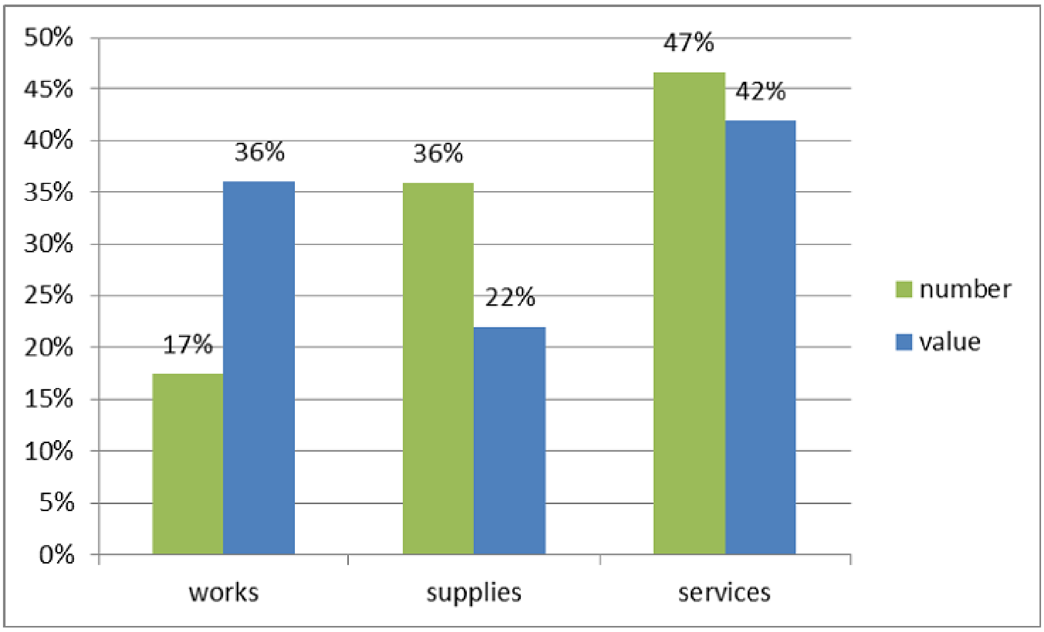
Table 3. Total public procurement structure upon procurement subject

Procurement subject	Number of contracts	%	Contracted value in HRK	%
Works	5708	21,13	9.434.624.047	35,94
Supplies	13525	50,08	7.269.684.432	27,70
Services	7776	28,79	9.544.799.999	36,36
Total	27009	100,00	26.249.108.478	100,00

Source: Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu, p.11

It is interesting that supplies have recorded the highest contribution of contracts quantity, but in the same time, in respect of their average contract value, they have the smallest portion in the total contracted value through the public procurement system in Croatia.
The biggest contribution to the total contracted value in 2011 pertains to services with 36,36%, but work contracts are very close with 35,94%. It is also interesting that value of 9.434.624.047 HRK belonging to work contracts, represents in fact an increase of 97,66% in comparison to 2010! (Statističko izvješće o javnoj nabavi u Republici Hrvatskoj za 2011. godinu, 2012:53)
Similar numbers are being recorded by the EU statistics, as well. „In 2010, approximately 36 % of the value of contract award notices published in the OJ/TED was attributable to works contracts. 42 % was spent on services and 22 % on goods“ (Annual public procurement implementation review, 2012:8). Comparison of number and value of contract award notices published in the OJ/TED in 2010 is shown in fig. 1.

Figure 1. Number and value of contract award notices published in the OJ/TED in 2010, grouped by type of contract [in %]



Source: DG MARKT, based on OJ/TED data

Source: Annual public procurement implementation review, 2012, p.9

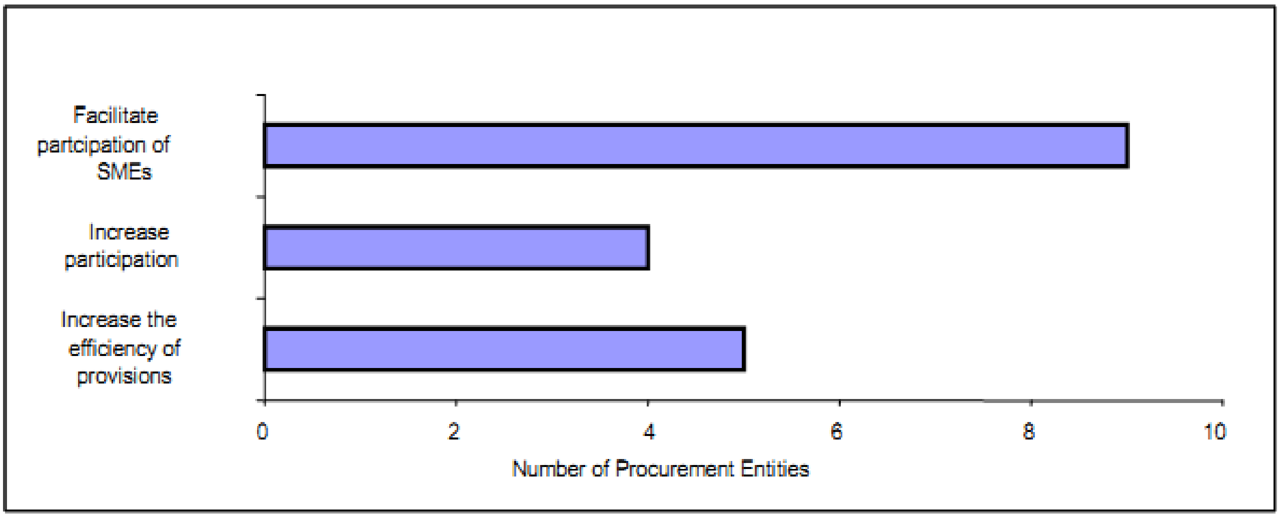
“It is widely agreed that rules governing public procurement should be designed to achieve value for money. However, in the public works sector, '... the good being procured is usually complex and hard to be exactly specified ex ante, ... [and] alterations to the original project might be needed after the contract is awarded. This may result in considerable discrepancies between the lowest winning bid and the actual costs that are incurred by the buyer' (Bajari et al., 2006 in: Guccio, Pignataro, Rizzo, 2012)
Taking into account that specificity of the works segment of public procurement together with previously presented value of that segment, it is obvious that effectiveness and efficiency of the segment are of utmost importance. The efficiency of execution of public works contracts is usually defined in terms of the capacity to complete works within the costs and the time agreed on in the contract. (Guccio, Pignataro, Rizzo, 2012b)
Works contracts resulting from public procurement procedures in recent years in Croatia have come out mostly from roads and high-roads investments. Regarding that type of contracts, there has been an interesting study of European, or to be more specific – Italian experience.

Guccio, Pignataro and Rizzo (2012) have studied execution of public works for roads and highways and have determined that the efficiency of those works was relatively high in Italy in the period from 2000 till 2005, taking jointly into account cost overruns and time delays. The study also showed that the gain in efficiency could bring out significant saving in public money and in time of completion.
After an extensive review of the literature on adaptation costs in public procurement, these Italian authors (Guccio, Pignataro, Rizzo, 2012) have identified several sources of the increase in planned costs of public works:

- Complexity, uncertainty and the inescapability of adaptation
- Optimism bias and political incentives to underestimate of costs
- Opportunistic behavior
- Corruption

These findings are interesting because their applicability goes beyond Italian experience. In order to meet above listed challenges, several methods and instruments are being used in works segment of public procurement, like segmentation of work into lots, introduction of a reserve price, participation requirements and competition fostering.
Regarding work segmentation, the most important reasons to split the works contracts into lots, as examined by Piga and Zanza (2005), are presented in fig. 2.

Figure 2. Reasons to split the work contracts into Lots



Source: Piga, G., Zanza, M.: An exploratory analysis of public procurement practices in Europe, p.10

Another important instrument for efficiency increase is reserve price. "The reserve price is the maximum amount the procurement entity is willing to pay for a certain good or service and reflects the perception of the procurement entity with respect to the expected discount. (…) Usually, the reserve price (or the expected one) is calculated on the basis of average price that prevail in the market at the awarding date (resulting from thorough market analysis) and the previous awarding price (if available)." (Piga, Zanza, 2005:12) Majority of procurement entities decide not to publish the reserve price, but having it enables them to:

" - Request an explanation to the bidders; and
 - Decide to declare the auction unsuccessful and rerun it" (Piga, Zanza, 2005:12)

if the best bid price received is higher than expected.
Participation requirements are another important method. These requirements are seen as a form of guarantee for the execution of the contract as planned, regarding both the technical and financial terms. The most often requirements are: "specific budget revenue, bank warranties, ability to execute contract, quality certificates, financial standing and dealings, no bankruptcy, no tax duties,

technical qualification, legal eligibility. Majority of procurement entities requires at least four of listed requirements". (Piga, Zanza, 2005:13)

The last but not least, for the efficiency of work contracts procedures it is important to foster competition. In order to do so, public entities could introduce disclosure policy which advises the procurement agencies to disclose as much information as they can before the auction. Furthermore, the agencies should introduce mechanisms for detection and avoiding of collusive behavior. The use of the sealed bid auction has been identified as the most important mechanism in avoiding collusion.(Piga, Zanza, 2005)

In respect to Croatian public procurement system, including also procurement in the segment of works contracts, the Review made by the State Commission for Supervision over Public Procurement Procedure declared the system's functionality and transparency satisfactory. Of course, it detects also certain areas for improvement. For example, collision of public procurement legislation with different specific directives from construction, environment protection, telecommunications etc. is still present and should be reconciled. Furthermore, it has been emphasized that the public procurement's image in the public is still closely related to corruption. This issue should be addressed by additional education on public procurement legislation and anti- corruption actions. (Izvješće o radu Državne komisije za kontrolu postupaka javne nabave za 2011. godinu, 2012)

Regarding anti-corruption efforts, existence of the State Commission for Supervision over Public Procurement Procedure is of the utmost importance. Number of complaints submitted to the Commission has increased for 0,10% from the year 2010 till 2011, but if 2011 is to be compared to 2007, number of complaints increased for more than 60%! This is a result of increased number of subjects involved in public procurement, increased number of procedures that allow complaints, but for sure also the result of trust in the Commission and its anti-corruption efforts. (Izvješće o radu Državne komisije za kontrolu postupaka javne nabave za 2011. godinu, 2012:44)

"Upon its very nature, public procurement is extremely significant for the society as a whole (...) End users of each and every procurement object must always be, directly or indirectly, citizens" (Izvješće o radu Državne komisije za kontrolu postupaka javne nabave za 2011. godinu, 2012:52).

Since repercussions of public procurement on citizens comprises not just the objects resulted from public procurement contracts but also wellbeing of companies the citizens work for (providing the citizens both employment and salary, i.e. providing their every day existence), we find it very important to analyse also the microeconomic level reflections of public procurement. As the focus of this paper are especially public works, we have analysed the performance of a randomly selected civil engineering company in Croatia.

3. Performance of a civil engineering company

The link between macroeconomic and microeconomic level is straightforward, meaning that efforts at national level are aimed in fact to improve competitiveness of firms and livelihood of people living in a certain country. A stable context at the macro level improves the opportunity to produce wealth but does not create the wealth by itself. Wealth is created by utilizing at best human, capital and natural resources to produce goods and services, i.e. 'productivity'. But productivity depends on the microeconomic capability of the economy which ultimately resides in the quality and efficiency of the firms. (Schwab, 2010).

In respect of the research question of this paper, we have analyzed influence of public procurement on a company's performance, thus indicating the importance of the efficient work contracts management.

We have randomly selected a middle-size civil engineering company (in further text company X), present in Croatian construction industry from 1993. It has been involved in different civil engineering activities but as in many other construction companies, its capacities and expertise grew especially during the cycle of investments on Zagreb - Split highway.

With such a development strategy, the company was in fact highly dependant on public procurement procedures, because majority of its activities came out of public investments. With a down-turn of national roads and high-roads investments, the company employed its capacities in other markets from the surrounding region. Its results, as shown in tab. 4, culminated by 2009,but after that also the foreign countries public investments diminished significantly, so the company started facing severe lack of contracts, resulting in revenues downfall.

Table 4. Financial results of the company X

	2007	2008	2009	2010	2011
Total revenue (HRK)	117.061.600	163.325.200	166.676.102	64.517.913	80.322.654
Total costs (HRK)	107.392.816	144.870.133	140.945.599	63.046.807	65.079.509
Net earnings (HRK)	9.222.384	16.138.668	20.448.872	1.106.724	12.059.032

Source: www.poslovna.hr

In a situation like that, company X was forced to regulate its costs and find other revenue sources whilst in search for new public procurement contracts it could compete for. As a result of that, it cut its number of employees in half and abalienated 25% of its assets. At the same time, the company investigated which civil engineering investments are being planned for the coming period, and invested in specific education of some of its employees accordingly. The company X took the advantage of flexibility characteristic for medium size companies and become specialized also in water management and other civil engineering activities closer to the environment protection, hoping that efficient management will turn those activities into a successful recovery strategy. As a result of all those activities, as well as the new joint venture agreements the company undersigned with foreign companies that had both know-how and references needed to apply at this new type of public procurement tenders, the company X accomplished its goal.
Because of the serious problems the company X experienced in 2010, it is interesting to analyze also what was happening with public procurement in Croatia at the time.

Table 5. Value of public procurement procedures in Croatia

	2007	2008	2009	2010	2011
Contribution of public procurement procedures to GDP	16,34%	7,29%	12,19%	7,41%	9,04%
Total public procurement procedures (HRK)	44.953.540.556	25.157.704.646	40.597.519.320	24.786.394.308	30.982.902.308
Work contracts (HRK)	18.433.786.642	8.919.329.194	22.218.385.156	5.192.351.926	11.362.681.028
Work contracts in total value of public procurement (%)	41%	36%	55%	21%	37%

Source: Statističko izvješće o javnoj nabavci u RH for 2007, 2008, 2009, 2010 and 2011;

Evidently, 2010 was the worst year regarding works contracts in Croatia in general. Contribution of total public procurement procedures to the national GDP was a bit lower in 2008 than in 2010, but construction investments in 2010 were only 58% of those recorded in 2010. Serious lack of works contracts occurred in 2010. Therefore, it can be concluded that the performance trend in a civil engineering company is very similar to the trend of recorded public procurement procedures' value, especially works contracts' value, suggesting that efficient public procurement system significantly influences efficiency of works contracts' management in a single company, thus determining its performance.
Such an indication, i.e. dependence of a company's performance on public procurement procedures can be seen also out of the statistics of public procurement procedures that the company X has been involved in, shown in tab. 6.

Table 6. Company X's public procurement experience and conducted works contracts

	2010	2011	2012
Number of public procurement procedures the company participated in	66	50	42
Total value of participated public procurement procedures	120.499.351,09	121.259.578,37	104.541.726,17
Number of cancelled PP procedures	11	11	6
Cancelled / total number of PP procedures ratio	17%	22%	14%
Number of works contracts resulted from PP procedures	16	17	10
Contracted / total number of PP procedures ratio	24%	34%	24%
Total value of works contracts resulted from PP procedures	15.743.002.,75	35.668.085,78	26.407.073,09
Works contracts' value / total participated PP procedure value ratio	13%	29%	25%
Total annual revenue	64.517.913,00	80.322.654,00	50.892.000,00
Works contracts' value /total annual revenue ratio	24%	44%	51%

Source: Company X's internal records

Regarding other similar companies at the time, it must be said that positive trends in construction culminated by 2008. After that, severe fall of annual value of works done and number of employees indicated beginning of recession in construction and Croatian economy in general. Total value of construction works done fell in 2011 for 40,4% in comparison to 2008, whilst the number of employees fell down for 22,8%! (Pregled osnovnih statističkih podataka u sektoru graditeljstva RH, 2012:2)
Luckily, effort and efficient management of the company X enabled this company to surmount the worst phase of economic crisis and finally survive, but there is no doubt that ongoings and changes within the public procurement system strongly influence the performance of each and every subject participating in it.

4. Conclusion

Different activities are being carried out in order to introduce the public with preparations that are being undertaken regarding implementation of Cohesion policy and Structural funds, from the aspect of public procurement system in Croatia. For example, last December, a Conference called "Structural funds and public procurement: managing the EU funds requires an efficient public procurement system at both central and local level" was organized by Croatian Chamber of Economy, Ministry of Regional Development and EU Funds, Ministry of Economy and the European Commission. At the conference, Mrs Trnokop Tanta, vice-president of Croatian Chamber of Economy said: "Public procurement system is a mirror for reflection of the whole system's discipline. Opportune notice determines the efficiency of public procurement procedures', and as a bottom line, those procedures determine the performance of national economy in whole." (www.hgk.hr).

In respect of foreseen increase of public procurement's contribution to GDP, it can be said that a significant deal of national economy's recovery relies on public procurement, i.e. efficiency of procedures and value of contracts resulting from them. With the national budget being bonded with different duties, it is obvious that Cohesion and Structural funds indeed represent great expectations. But in order to transform those expectations into activities with results, a lot of effort including efficient management is needed. "Efficiency of public administration is a public interest of the community because it ensures an optimal ratio of inputs and outputs" (Benazić, 2009:1). This efficiency is primarily preventive in its nature, but the need for monitoring the execution efficiency of works contracts, in terms of time and costs, must not be neglected, too.

Furthermore, analysis of Croatian public procurement system has shown its coherence with the acquis and great efforts that are being paid in order to increase its functionality and transparency, especially through different measures of fostering competitiveness and fighting corruption. However, strengthening administrative capacity remains as the challenge for performance increase of public procurement system, national economy as well as individual companies. But, strengthening of administrative capacity should not be understood as its enlargement, rather as its further education and reorganization. "Measured by the contribution of total public expenditures in GDP, public administration in Croatia is large and the trend should be toward its reduction. In the same time, full membership in the EU will result in enhanced and more complex business scope of public entities, therefore organizational changes of public administration are one of the most important prerequisites of effective public procurement system". (Benazić, 2009:2)

The case study of company X and its involvement in public procurement system presented in the end of this paper, confirmed the strength of impact the system has on performance of a single company. Focus of the paper was on a segment of works contracts within the public procurement and it undoubtedly showed the importance of efficient management of such contracts. In fact, in respect of works contracts being an important segment of total public procurement, it underlined the influence of management of contracts resulting from public procurement on economy as a whole.

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ENIVIRONMENTAL MANAGEMENT IN PROJECT ORIENTED COMPANIES*

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Abstract

Construction industry is a typical project-oriented industrial sector. For a contracting company, production has a project character and starts only after the contract between the client and the contracting company has been signed. Construction activities are associated with a range of various adverse environmental impacts, such as noise, raw material consumption, energy consumption, emissions into air, water and ground and fuel consumption of construction machinery. In order to control and mitigate these adverse phenomena, an environmental management system needs to be implemented into a construction company.
The paper will review the main environmental effects of the construction project. A comprehensive conceptual model that extends the concept of quality into the area of sustainability is supplemented with Environmental Impact Assessment for a given construction project. In the last part, the paper provides an overview of the implementation of environmental management systems into construction industry on the basis of a recently conducted survey.

Keywords: construction industry, quality management, environmental management, project based production

* The complete text is available on CD-ROM / Šelih, Srdić, Campos, Trierweiller

Introduction

The awareness of the importance of global sustainable development is increasing ever since a global framework for environmental goals and activities was provided in 1987 by the so-called Brundtland report (Our common future … 1987). It has caused many industrial and service sectors around the world to place more attention to the sustainability issues, and encouraged them to try to strive to achieve these goals. In order to attain them, specific policies and measures targeted to various industrial and service sectors have been established in several countries.

Within contemporary view of the construction sector, the traditional goals related to production (i.e. scope/quality, time and cost) are supplemented first with requirements related to resource efficiency, emission control and preservation of biodiversity, and then extended to the field of ensuring environmental quality while taking into the account social equity and respecting economic effects, as schematically presented in Figure 1.

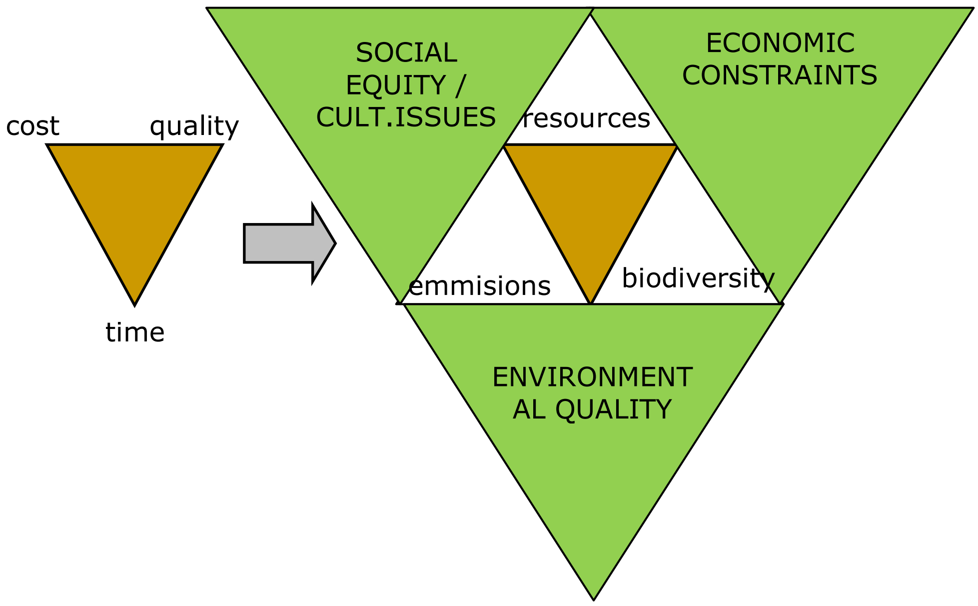

Figure 1. Extending the conventional construction project goals to the sustainability field (Agenda 21 … 1999)

With respect to the built environment, the above listed goals manifest themselves in various sub-goals and subsequent actions. **Environmental goals** are expressed as striving to reduction of environmental effects

- in manufacturing processes where construction materials and products are being made (construction product level)
- during construction (project and organization level)
- for the final product, i.e. the building or engineering works (structure level) (Srdić and Šelih 2011).

In the area of the built environment, the **social equity goal** can be achieved by constructing buildings and facilities that provide the required infrastructure for the local population. The results of this measure are improved public service facilities (e.g. schools, hospitals,…), and consequently general living conditions and available to the whole society, especially to the more vulnerable parts of the population. On project and organization level, social equity goal is manifested as providing appropriate working conditions, offering opportunities to the member of minority groups etc. **Cultural aspect** of sustainability, linked to the built environment, demands respect of the needs of various groups within population and acknowledgement of their cultural differences, thus ensuring that the constructed facilities and buildings respect and cater to the needs of all members of the society. Within this work, we will limit ourselves to the environmental aspect of the sustainable development in the area of construction.

1.1 Research statement

Although sustainability and environmental management are being today often formally promoted within various organisations involved with construction and its accompanying processes, there is still lack of knowledge and concrete guidelines on how to efficiently implement environmental management into a construction project. Further, there is no systematic approach to define the sustainability of the structure. There is also not enough knowledge on the role of organisational culture upon successful implementation of environmental management into construction contracting organizations, nor on the key environmental influences as perceived by the enterprises.

1.2 Research objectives and methodology

The first aim of the paper is to present and justify the proposal how to extend the concept of quality and its comprehensive management in construction to the field of sustainability. The second objective is to examine the existing body of knowledge available through relevant papers published in various scientific journals, and to identify and further elaborate measures to ease the implementation of an environmental management system (EMS) into the construction contracting organisation as well as into a construction project. Emphasis is placed also to the role of organisational culture within the contracting company. Environmental Impact Assessment is to be determined for a selected project as the second goal.
The third goal is to determine the level of EMS implementation within construction industry. A web-questionnaire based survey was carried out on a sample of Slovenian construction industry, with the intention of identify the key environmental influences of the activities carried out within the construction project and their relative importance as perceived by the responding companies.

2. Extending the quality concept to sustainability performance

The model of Srdić and Šelih (2011) proposed a conceptual way to extend the quality model for buildings that needs to be established on the three above-mentioned levels, to the environmental field. On the *construction product* level, the essential requirements have to be met for the structure in order to ensure quality of the structure. According to the recent Construction Product Regulation (2012), the essential requirements include the 7th essential requirement “Sustainable use of natural resources” that *the structure* needs to comply to. Compliance to essential requirements is achieved a) if construction products that are permanently built in the structure comply with the relevant European product standards, and b) if design of the structure, execution of works and maintenance of the structure complies to the relevant standards.
Construction product compliance with relevant standard specifications provides therefore the first assurance of conformity with the essential requirements for the structure. Construction Product Regulation (2012) provides also further rules for the attestation of conformity of construction products, where the selection of the attestation of conformity procedure for a given product or family of products is specified by the European Commission. The selection of the procedure depends upon the importance of the part played by the product with respect to the essential requirements, in particular those relating to health and safety; the nature of the product; the effect of the variability of the product's characteristics on its serviceability; and the susceptibility to defects in the product manufacture (Srdić and Šelih 2011).

Bearing in mind the project orientation of the construction sector, and the fact that several business entities usually take part in a single construction project, *on the process/project level*, the model of Srdić and Šelih (2011) requires establishment of quality and environmental management systems both on project, as well as o organisation level. Preferably, the QMS and EMS should comply to the requirements of the international standards ISO 9001, and 14001, respectively.
A schematic representation of the three levels of the proposed model and associated elements is depicted in Figure 2.

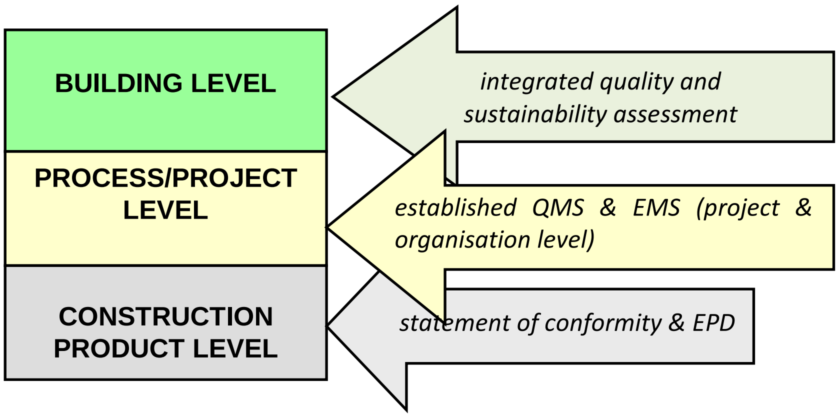

Fig.2 Levels and elements of the proposed conceptual model (adopted from Srdić and Šelih, 2011)

3. Environmental Management Systems and construction industry

This section focuses the attention to the organization and process/project level within construction, where significant environmental impacts may appear.
On the organization/company level, contracting companies establish environmental management systems with the intention of gaining various benefits, such as improved regulatory compliance requirements; reduction of liability and risks; enhanced reliability among customers and peers; reduction of harmful impacts to the environment; prevention of pollution and waste (which can result also in cost reduction); improvements in site and project safety by minimizing injuries related to environmental spills, releases and emissions; improved relationships with stakeholders such as government agencies, community groups, and clients (Christini *et al* 2004; Campos *et al* 2013). In addition, regulatory requirements provided by the European and national legislature demand reporting on all environmental impacts generated by an enterprise, and its separate production units. An established EMS, when designed in an appropriate way, can facilitate collection of the data subjected to obligatory reporting. In addition, many companies realize that reducing environmental impact ensures optimal use of resources and enforces measures that improve the company's competitiveness (Kein *et al*, 1999).
The project oriented production, characteristic for construction, manifests itself as a decentralized project organisation (Gluch and Raisanen 2012). As such, it has a temporary nature by definition, and therefore requires different planning and management techniques than serial production. In addition, several business entities are involved in the construction project:

- the client as the initator of the project;
- AEC companies specifying in details the properties of the facility to be constructed and the processes to be executed;
- general contractor and subcontractor executing the works,
- the Engineer with the task to survey and control the construction works being executed in terms of scope, quality and time; and

- managing companies planning and executing the maintenance and repair of the facility.

The listed stakeholders differ in type of expertise, marketing strategy, number of employees, annual turnover, marketing strategy, organizational culture, the type and magnitude of environmental impacts related to their activities (Šelih 2007). Consequently, they need different approaches to environmental management within their organizations. In addition, typically, there are few business relationships of permanent nature among project participants; this, in practice, hinders efficient implementation of EMSs into the construction project.
Another barrier to successful implementation of project environmental management system within the construction project, as proposed by Srdić and Šelih (2011), is corporate culture, observed in construction enterprises that encourages conservative attitude towards introducing change and innovation into the construction project (Cheung et al 2011).
The longitudinal study of environmental professionals in construction carried out by Gluch (2006) concluded that environmental practices have not yet become embedded in construction project culture and practice, and that environmental and project discourse have yet to be aligned. Presently, there are also no specific guidelines how to achieve recognition of environmental issues within a construction project, and consequently, the need for further research in this field is still present.
Further, environmental management systems are often seen as technical rational management tool for analytical actions that helps to plan, systemize and evaluate the environmental management tasks issues in an organization (Von Maimborg 2002), however this view is often not sufficient. Several authors argue that in order to behave in a sustainable way, the companies will need to implement organizational actions that will need to go beyond technical actions, and that they should be accompanied by the actions aimed at changing the culture of the company (Harris and Crane 2002). Conscious, planned actions aimed at changing the organisational culture towards better understanding of environmental management within the company can be extremely useful, however one should bear in mind that changing the culture is a long term process. Further, in order to achieve successful implementation of an EMS, the companies need also a well developed system for environmental monitoring and information management (Von Maimborg 2002).

4. Environmental impact assessment for construction projects

The increasing global awareness of the environmental impacts of human activities within the last two decades resulted in critical assessment of the environmental impacts resulting from various activities, including those related to construction. The report prepared by UNEP in 2009 (Buildings and climate change, 2009) states that the building sector alone contributes up to 30% of global annual greenhouse emissions and consumes up to 40%. Further, worldwide, it is estimated that approximately 40% of the total energy consumed, 40% of all the waste produced, and 40% of all virgin raw materials consumed are associated with the construction sector. (Jeffrey, 2011; Agenda 21, 1999) Total environmental influence of construction activities is clearly significant, and, in order to be able to manage the overall influence upon the environment, we have to establish environmental impact categories relevant for the built environment.
On the construction project level, two types of projects should be clearly distinguished from the viewpoint of environmental management:
a) construction, and
b) demolition projects.
The main difference is that demolition projects result in large quantities of construction and demolition (C&D) waste, while for construction projects, especially in certain cases of engineering works (e.g. dams), large quantities of construction materials are being consumed / built in the structure. Consequently, substantial depletion of natural resources is associated with such projects. Refurbishment projects can be considered as a combination of construction and demolition projects,

as both listed activities are carried out with the same project, although in significantly smaller quantities.
Further, when a framework for environmental impacts is being defined, one should not forget to take into the account the differences designing and executing buildings, and engineering works. Even when the final use of buildings differs from one to another, there are several common features within the construction process of the buildings. Engineering works, on the other hand, are extremely diverse, ranging from roads and dams to energy supply networks. The accompanying environmental influences are diverse, and consequently, it is more difficult to prepare a generic list of environmental impacts, both for the construction as well as for operation and maintenance stage.
Chen et al (2005) identify the a list of environmental effects of the on-site construction activities, which includes soil and ground contamination, construction and demolition waste, dust, noise and vibration, hazardous emissions and odours, impact on wildlife and natural features, and archaeology impacts. Gangolells at al (2009) compiled an alternative list of adverse effects of the construction activities: soil alteration, waste generation, atmospheric and water emissions, resource consumption and other potential impacts.
A generic list of n environmental impacts, accompanied by the assessment of severity index proposed by Šelih (2006) is presented in Table 1. Severity index, S_i, expresses the relative magnitude of consequences when the environmental impact under consideration, i, occurs. For the purpose of this study, it belongs to the following range:

$S_i \in [1, \ldots, 5] \quad ; \quad i \in [1, \ldots, n]$

where 1 means no influence, and 5 disastrous influence upon the environment. n environmental impacts are identified, and for each of them, i, the value of S_i is estimated by an expert (Table 1).

Table 1. List of generic environmental impacts (n=13)

i	ENVIRONMENTAL IMPACT, i	SEVERITY INDEX, S_i (expert judgement)
1	Noise	4
2	Dust	3
3	C&D waste	3
4	Emission gases	3
5	Electricity consumption	3
6	Hydraulic oil consumption	3
7	Drinking water consumption	2
8	Waste water consumption	2
9	Fossil fuel consumption	2
10	Inert waste	2
11	Transport	2
12	Production waste	2
13	Ozone layer depletion	2

Table 2. Case study: environmental impact assessment

i	ENVIRONMENTAL IMPACT, i	SEVERITY INDEX, S_i (expert judgement)	$C_{env,i}$	CF_i
1	Noise	4	7,5	30,0
2	Dust	3	7,0	21,0
3	C&D waste	3	6,0	18,0
4	Emission gases	3	5,0	15,0
5	Electricity consumption	3	4,5	13,5
6	Hydraulic oil consumption	3	4,0	12,0
7	Drinking water consumption	2	6,0	12,0
8	Waste water consumption	2	5,5	11,0
9	Fossil fuel consumption	2	5,0	10,0
10	Inert waste	2	5,0	10,0
11	Transport	2	4,5	9,0
12	Production waste	2	4,5	9,0
13	Ozone layer depletion	2	3,0	6,0

The value of environmental impact coefficient for the environmental impact i , $C_{env,i}$ is determined by the equation

$$C_{env\,i} = \sum_{j=1}^{m} a_{ij} \quad ; \quad a_{ij} \in [0, 1] \tag{1}$$

where a_{ij} is the value assigned to the criterion j (for the impact i) determined by an expert, and m is the number of relevant environmental aspects.
Final impact assessment coefficient for the impact i, CF_i, is determined by the expression

$$CF_i = S_i \cdot C_{env\,i} \tag{2}$$

Results of an environmental impact assessment for a selected case study are presented in Table 2. An environmental impact is considered to be important if $CF_i > 12$, where consequently surveillance is required during construction project execution.
Even with different proposed structure of categories for environmental impacts as described above, the researchers are in agreement that environmental management is a must for contemporary construction contracting organisation. The companies can gain significantly by combining environmental impact assessment of their activities by establishing a formal environmental management system that complies with one of the existing standards in this field, e.g. ISO 14001(2004), as discussed in the continuation of the paper.

5. Empirical study of EMS implementation in construction industry and environmental influences related to construction projects

In addition to the study of the environmental impacts related to construction activities, we are also interested in gaining an overview of the implementation of the environmental management systems in construction industry. A sample of Slovenian construction companies was surveyed, with the intention of finding out how well the environmental management systems are spread, and to which environmental areas the companies place their attention.

5.1 The method

A survey among Slovenian construction companies (Eloy Maurel, 2013) was carried out in order to determine the perceived importance of the above defined environmental indicators. The names and addresses of the 77 companies, selected for participation in the survey, were obtained from the database of Economic Chamber of Slovenia. A web-based survey was prepared and sent to these construction companies. As special attention was devoted to the identification of the person in charge of environmental management system, a reasonably high overall response rate (63,6%) was achieved.
Literature review on environmental influences related to construction projects was carried out in our previous works (Šelih, 2007) and the following list of environmental management areas was compiled:

- energy use,
- material recycling,
- waste material generation and control,
- noise prevention,
- air pollution, and
- other.

5.2 Results

Only a summary of the survey results, related to environmental management systems, will be presented in this paper. The persons filling out the questionnaire belong either to top management (22%), 32% are project managers, 12 % responsible for environmental management, and 8% of them are public relations officers. The number of employees of the majority of surveyed companies (31 out of 49 respondents, or 63%) is below 250, meaning that they can be classified as micro or small and medium size enterprises (MSMEs).

31 out of 49 (63,3%) respondents that answered question regarding environmental policy claim that they have established an environmental policy, and defined environmental goals and procedures. The companies were then asked to identify environmental management areas to which they focus to. Results presented in Table 3 show that that the area perceived as the most important is waste control; 58 % of the answering companies claim that waste control is the most important area of environmental management, and consequently place their main focus there, and 23 % consider this area as the second most important. 13% of the responding companies place the main focus to recycling of materials, while 48% of the respondents rank this area as the second most important. The third area of perceived importance is energy savings, where 35% and 48% perceive this indicator as the most, and second most important environmental area.

Table 3. Rank of importance of listed environmental areas (energy savings, recycling of materials, waste control, noise prevention, air pollution control, other)

ENV.AREA	**RANK OF IMPORTANCE**							
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**Total**
Energy savings	**11** *(35%)*	**15** *(48%)*		**5** *(16%)*	**-**	**-**	**-**	**31** *(100%)*
Recycling of materials	**4** *(13%)*	**15** *(48%)*	**7** *(23%)*	**5** *(16%)*	**-**	**-**	**-**	**31** (100%)
Waste control	**18** *(58%)*	**7** *(23%)*	**6** *(19%)*	**-**	**-**	**-**	**-**	**31** (100%)
Noise prevention	**7** *(23%)*	**5** (16%)	**-**	**7** *(23%)*	**5** *(16%)*	**5** *(16%)*	**2** (6%)	**31** (100%)
Air pollution control	**5** *(16%)*	**11** *(35%)*	**5** *(16%)*	**5** *(16%)*	**3** *(10%)*	**1** *(3%)*	**1** *(3%)*	**31** (100%)
Other	**4** *(100%)*							**4** (100%)

Analysis of subsequent questions and corresponding answers shows that 64 % of the companies answering the questionnaire have implemented an ISO 14001 compliant environmental management system. 23% have established another type of EMS, and only 10% of the respondents do not have an EMS. 79% of the respondents claim that their EMS is integrated with the existing quality management system (QMS).

6. Conclusions

A comprehensive model for assessing sustainability of the built environment is justified and systematically built in this work. It has been shown that environmental assessment impact, being a part of this model, can be used also on construction site level, thus improving the environmental performance on this level. When supplemented it with the use of relevant Environmental Product Specifications for the construction products being built in the structure, and appropriate process standards, the model can be used for the assessment for the selected structure. The results of the presented study on implementation of environmental management systems in Slovenian construction industry shows that the EMSs are already reasonably spread within this sector, however more systematic effort should be devoted to the their implementation, in particular in the area of organisational culture.

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INNOVATIONS IN THE PROCESS OF BUILDING RECONSTRUCTION*

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Abstract

Progressive tools built on the principle of parametric modelling and building information model /BIM/ to simplify work and increase the quality of construction projects, is being increasingly applied in the design and preparation of new buildings. Their application finds its place also in other sectors, especially in sector of building reconstructions, where time and cost overruns are very common. Calculate volumes and quantities without previous documentation is very difficult. Laser scanning method improves the collection of missing project documentation and provides a basis for creating a building information model. This model can be used for design of building reconstruction. The article deals with integration of progressive tools such as laser to model technology, in the category of building reconstruction. The aim is to show the possibilities and advantages of the information model in the area of building refurbishment.

Keywords: Model, Scan, Documentation.

* The complete text is available on CD-ROM / Šoltes

Introduction

Times have changed; one of the outcomes of the recent global downturn is that clients are now looking to refurbish their existing building stock rather than finding a green field [1]. Building Information modeling has become the main instrument for coordinating the data in the project. Its advantages can be applied also in the process of building renovation. Reconstruction is the specific industry that requires intensive preparation. Consuming preparation is one of the barriers to implement Building Information Modeling in the recovery process. This situation could change by adopting new technologies such as laser scanning that will facilitate data collection. The original construction documentation is often incomplete or completely lost. Survey the building state is the basis for the final project. This is especially true for historic buildings where surveying takes up most of the time. Problems are especially in complicated details of facades and roofs. Documenting the state with laser technology significantly improves quality of work documentation. The documentation is then processed in a virtual environment. This environment facilitates the designer's vision of construction and it can be presented via 3D printers.

2. Reconstruction building survey method – Laser scan

First stage for reconstruction should be collecting data of the existing state. Original documentation often does not correspond to the actual situation. In any case, whether or not there is necessary to be documented the real state of construction. In the past this documentation was created by measurement. Measurements are extensive and require a team of people and a lot of time. Measurement of current state is redrawn to 2D on paper or digitally. The disadvantage of this work is working with minimum building data. More sophisticated tools can work in a 3D environment at the surface models. Lack of data in the process ties the hands at work. Using parametric modeling which would place the map of point cloud from scanner would open the way to the advanced modeling techniques based on building information model.

3D laser scanning used in conjunction with other methods of recordation, including high-resolution photography, and visual inspection of the building's materials. Full sets of 2D plan and elevation drawings are often required and the scan data itself is increasingly provided as part of the client deliverable. High-definition surveys are also used to precisely capture existing geometry for heritage buildings that are to be meticulously taken down and then re-built in another location. Scanning is a great tool for brick-for-brick, panel-for-panel matching of the original building with the re-built building. Scanning is used to help analyze structural damage or even cosmetic damage, such as older buildings that have begun to shift and sag over time. Where there has been a collapse or other serious damage, scanning is used to accurately assess the structural damage so as to enable accurate repairs. A corollary of this application is to use scanning to capture an accurate "before" geometric snapshot of a building prior to any construction being completed on the building. In this way, if a building is or is not damaged during construction, the contractor or building owner will have a record that can be used to quickly resolve disputes such as, "Hey, that exterior crack wasn't there before!" or "I think you altered the shape of my building when you installed the underground garage!" Scanning provides inexpensive dispute resolution insurance. Monitoring deformation and building movement [2].

2.1. Documentation of existing state

Documentation of the actual state as it was mentioned in the introduction implements measurements are time consuming. A progressive scanning method allows generating original state of building very precise and time effective. This method is of particular benefit in the statement of a bill. Square footage can be processed with great precision.

From a given position the object to be digitized, the scanner projects a low-power, non-damaging laser light upon a section of the object's surface. Each point of the surface touched by the laser light is captured by a CCD camera integrated into the scanner, and both the X, Y, Z coordinates and the laser light intensity of each of these points are recorded in the memory of the computer controlling the scanner. This operation is repeated thousands of times each second and generates a file containing a large amount of point data of the scanned surface. This file, displayed on the computer screen, shows the 3D shape of the scanned surface. Thus, the operation of creating sequential overlapping images from multiple points of view on the surface of the object is carried out until the entire surface of the object is covered. Individual 3D digital images thus captured are then aligned together with appropriate software using overlapping sections of the images to create an accurate 3D digital model of the object. The software makes it possible to eliminate redundant points in overlapping sections in order to generate a homogenous density of 3D points throughout the model. Some scanners capture the color directly with laser scanning - in this case, RGB values (Red, Green, Blue) are recorded along with the X, Y, Z coordinates - or indirectly by mapping a color photograph taken while scanning the 3D digital image. In the latter case, lighting conditions will have an effect on color quality. Here, the term ''object'' refers to small, medium and large objects (ranging from a few millimeters to a few meters in length and width) as well as buildings and large sites (ranging from many square meters to a few square kilometers in surface area). According to the object or site to be scanned, the 3D scanning process is carried out by moving the object in front of the scanner or by moving the equipment around the object or inside and around the site [3].

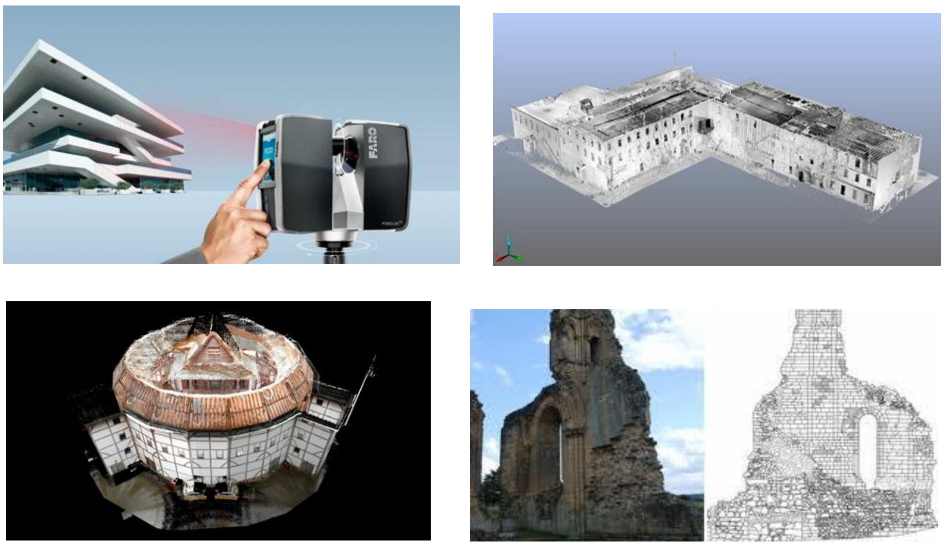

Figure 1: Laser scanner and scanned models [4].

Today, we can find a wide range of 3D scanning systems available on the market. The following main characteristics differentiate these systems:

- *Operating mode;*
- *Capacity to capture a given color;*
- *Accuracy of measurement;*
- *Resolution (planar resolution and depth resolution);*
- *Need to install or not control targets in the scene to be digitized;*
- *Portability; and*
- *Operation range (distance between the scanner and the surface to be scanned).*

While operating methods with a 3D scanner are typically quite similar, we will not use the same 3D scanning system to digitize a small statue, the interior or exterior of a building, or a human body. The choice of the right system is dictated by the needs and specifications of the project itself. Thus, a single system will not be suitable for all types of projects [3].

A 3-D laser scan produces a precise record of a physical space or object. Initially, the operator of the system takes a photo-mosaic image with a camera and then marks the area to be scanned. The laser scanner then rotates robotically, capturing data at a speed of up to 4,000 points per second. The result is a raw image that is loaded into 3-D visualization and modeling software, which produce accurate existing condition drawings. An example of a successful implementation of this technology comes from the historic tower that serves as the headquarters of the Eastman Kodak Company in Rochester, N.Y. Kodak decided to restore the building's facade, particularly the terra-cotta tile section on the upper four floors of the 19-story tower. The team of specialists charged with exterior repair and restoration decided to use the 3-D laser scanning technology. The entire exterior scan was completed in less than two weeks from 32 adjacent rooftop or ground-level positions. Approximately 84,000 square feet of 3-D facade data was collected and entered [5].

2.2. Case of study laser scan of Eastman Kodak Company

Case of study is focused to the possibility of building scanning for its repair and renovation. The subject has become Eastman Kodak Company building in central Rochester, NY. The building dates from 1913 and some additions in 1930. Documentation was used for 3D laser scanning technology.
Using 3-D laser scanning technology, Erdman Anthony took less than two weeks to scan the entire exterior of the building, obtaining approximately 25,600 square meters (surface area) of 3-D façade data. Multiple scans were made of the tower from 32 vantage points around the building. These individual scans were then "registered" together to form one point cloud of the overall tower. Prior to scanning, a network of GPS control points was set up around the tower. By scanning targets, which were set up over these control points, along with the face of the tower, each scan was related to a common coordinate system and elevation datum. In this case, the dates were the New York State Plane Coordinate System North American Datum (NAD) 1983 and the North American Vertical Datum (NAVD) 1988. By tying the scans to these commonly used dates, the tower is now on an easily reproducible spatial reference system [6].

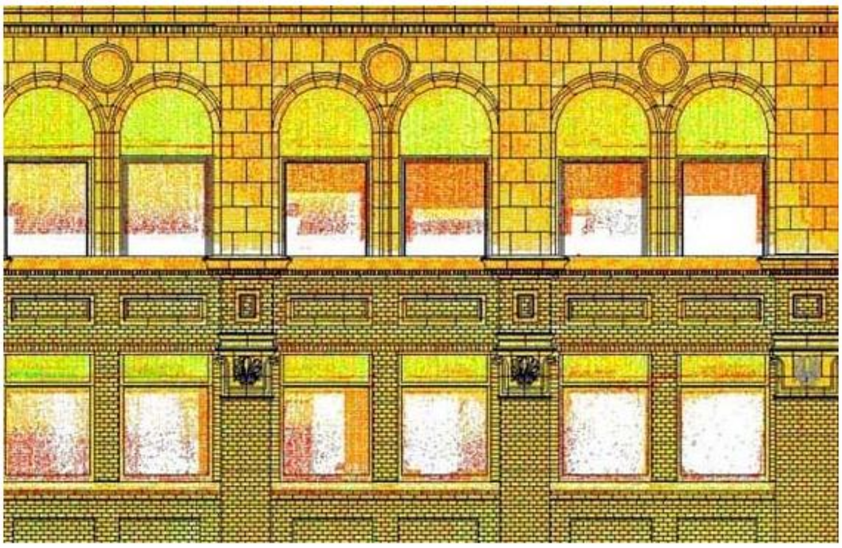

Figure 2: Scanned models facade [6].

Erdman Anthony collected points in each scan on a 1 cm x 1 cm grid. By overlapping adjoining scans, the final point data grid was of an even higher resolution. In all, the final point cloud was made up of over 60 million points. As a quality control check, Erdman Anthony personnel went back to the building to field checks the drawings from safe locations, such as balconies and the upper promenades. This field edit verified that features had been mapped to a level of detail of at least of 0,5cm^2 [6].

Figure 3: Scanned building surface [6].

Utilizing laser-scan-generated drawings, Erdman Anthony enabled the architectural team to spend less time in a dangerous situation, cut the likelihood of error by reducing the amount of manual data collection required, allowed an extraneous consideration-Mariah the peregrine falcon- to remain in the area without disturbance, and brought timeliness and accuracy to the Kodak Office Tower project [6].

3. From laser scan to Building information Model

Building Information Modeling is used as a data repository for the project. BIM improves the quality of building reconstruction preparation. By using this technology it is possible to determine quantities in high precisions. Combine different materials and verify functionality through analysis. For all these processes will need to enter information on the current state. Laser scan method produces clouds of points in CAD as a result of the measurement. Building information model is essentially based on the CAD environment. It is therefore possible to use the laser scan method for survey the old state of building. Laser scanners can be used to capture dense 3D measurements of a facility's as-built condition. It is important to note that the results of the measurements will always be a cloud of points. It is therefore necessary to organize points to functional form which can be used or readable for BIM.

3.1. Data preparing

The actual scanning is the least complicated part of the process— the most challenging is the smooth export to BIM. Infinite views, from any vantage point, are available from the unified point cloud. Once the 3D point cloud data is consolidated and exported to a CAD or BIM platform, traditional A/E deliverables such as 2D plans, elevations, and sections can be readily extracted. While 3D models depict ideal conditions, 3D scans reflect the buildings as they actually are: seldom perfectly straight, level or plumb. 3D modeling is simplified using point cloud data for referencing, but the point cloud itself can serve this purpose, saving many hours of digital model building [7]. Given a point cloud of a facility, the modeling of a BIM involves three tasks: modeling the geometry of the components ("What is the shape of this wall?"), assigning an object category and material properties to a component ("This object is a brick wall."), and establishing relationships between components ("Wall1 is connected to Wall2 at this location."). These tasks do not necessarily take place sequentially, and depending on the workflow, they may be interleaved [4]. The goal of the geometric modeling task is to create simplified representations of building components by fitting geometric primitives to the point cloud data. Geometric primitives can be individual surfaces or volumetric shapes. For example, a simple wall can be modeled as a planar patch, or it can be a rectangular box (cuboid). Surfaces like moldings or decorative carvings may not be well modeled by a simple geometric primitive. In such cases, different modeling techniques can be used. For linear structures (e.g., moldings), a cross-section of the object can be modeled by fitting splines to the data and then sweeping the cross-section along a trajectory to form the object model [8]. More complex structures (e.g., decorative carvings) may be modeled non-parametrically, using triangle meshes, for example, or they can be modeled from a database of known object models [9]. Since BIMs are normally defined using solid shapes, surface-based representations need to be transformed into solid models [4].

The modeled components are labeled with an object category. Standard BIM categories include wall, roof, slab, beam, and column [10]. Additionally, custom object categories can be created based on individual project needs. Objects may be further augmented with other meta-data, such as material properties or links to specifications for custom components [4]. Topological relationships between components, and between components and spaces, are important in a BIM and must be established. Connectivity relationships indicate which objects are connected to one another and where they are connected. For example, adjacent walls will be connected at their boundaries, and walls will be connected to slabs at the bottom. Additionally, containment relationships are used to encode the locations of components that are embedded within one another, such as windows and doors embedded within walls [11] and [12].

3.2. BIM data processing

BIM data import or points cloud export as a most challenging part of the process is done manually or ´´automatically´´. Literature [13] describes manual and automatic process:

Manual process:
Data transfer is divided to two different methods. The first approach is to fit geometric primitives to the 3D data directly. Geometric modeling software typically includes tools for fitting geometric primitives, such as planes, cylinders, spheres, and cones to the data, as well as special-purpose tools for modeling pipes [14]. These tools are semi-automated and require significant user input. For example, to model a planar surface, the user selects a few points or a patch of data, and a plane will be fitted to the selected data. The planar patch may be extended using a region growing algorithm to the extent that contiguous data lie within a tolerance distance of the initial surface estimate [4]. In this way, approximate boundaries of the patch can be identified, but, in practice, these boundaries can be irregular and inaccurate (Fig. 4a).

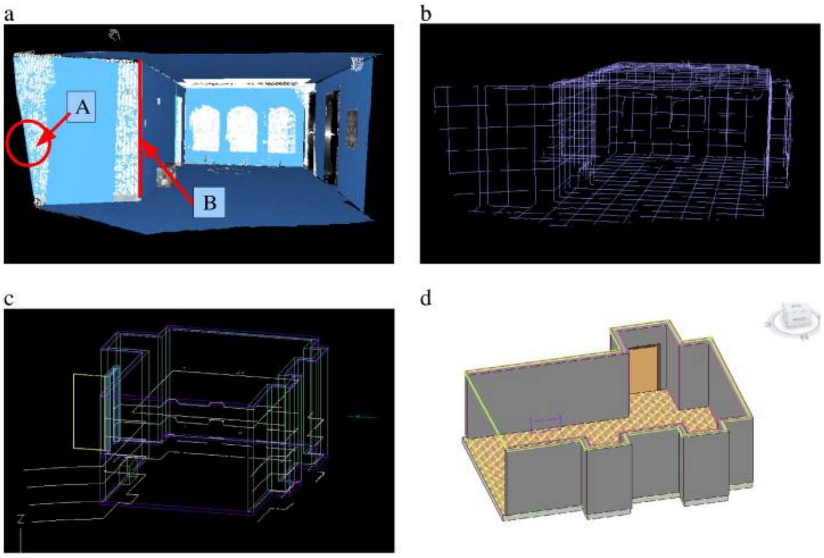

Fig. 4. Examples of methods for reconstructing an as-built BIM from laser scanner data [13].

More regular boundaries can be obtained by intersecting multiple geometric primitives. For example, the intersection of three orthogonal planes representing two walls and the floor forms the corner of a room as well as straight line wall–wall and wall–floor boundaries. Depending on the software, geometric modeling may operate on point clouds or polygonal (usually triangular) surface meshes. At present, BIM design software does not have the capability to convert geometric primitives created with reverse engineering tools into BIM objects directly. Therefore, it is common practice to re-model the geometry within the BIM design environment using the reverse engineered model as a guide. The need to transfer models back and forth between several different software packages gives rise to data interoperability problems as well [13].
The second geometric modeling approach uses cross-sections and surface extrusion (Fig. 4b). First, horizontal and vertical cross-sections are extracted from the data, and lines are fit to the cross-sections to represent walls and slabs in plan views. Then, vertical cross-sections are extracted to determine the heights of walls, and any doors and windows, with respect to the floor and ceiling. Finally, walls are modeled by extruding the horizontal cross-section vertically based on the constraints of the vertical cross-sections. This approach is less computationally intensive than the surface-fitting approach, but it can lead to errors when the components do not follow their idealized geometries, for instance, if a wall is not truly vertical [13].

Automatic process:
Ideally, a system could be developed that would take a point cloud of a facility as input and produce a fully annotated as-built BIM of the facility as output. This is a challenging problem for several reasons. Facilities can be complex environments, often with numerous unrelated objects, such as furniture and wall-hangings, which obscure the view of the components to be modelled. Depending on the information requirements of project participants as well as the context of a project, the

problem of as-built BIM reconstruction can have several variants in terms of available inputs and expected outputs. On the input side, additional information about a facility, beyond the raw point cloud data, may be available. This information may be a previously created as-built or as-designed model. We can distinguish between variants by the dimensionality (2D plans and elevations or full 3D CAD models) and the level of semantics in the a priori data (e.g., geometry, object labels, object relationships). Such prior information can simplify the BIM reconstruction process because the prior model can be aligned with the collected data, and knowledge gleaned from that prior model can serve as guidance [13].

BIM transfer process in practice - Revit 2012:
Revit 2012 sees the use of Autodesks propriety point cloud engine to access large point cloud datasets. The following raw formats .las, .xyb, .pts, .ptg, .fls, .fws. are supported. You are able to insert a Point Cloud file via the Insert > Managed linked tab but due to the nature and size of point cloud files they are referenced into the project rather embedded.img_point cloud linking [1].

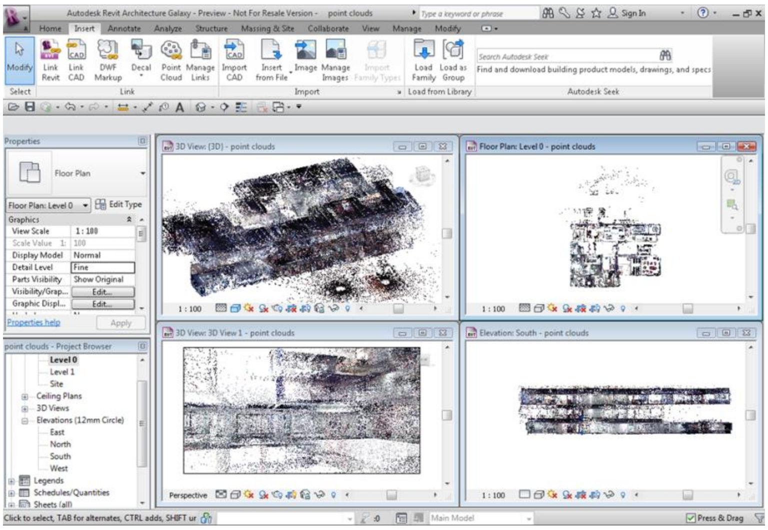

Fig. 5. Cloud of points in Revit 2012 [13].

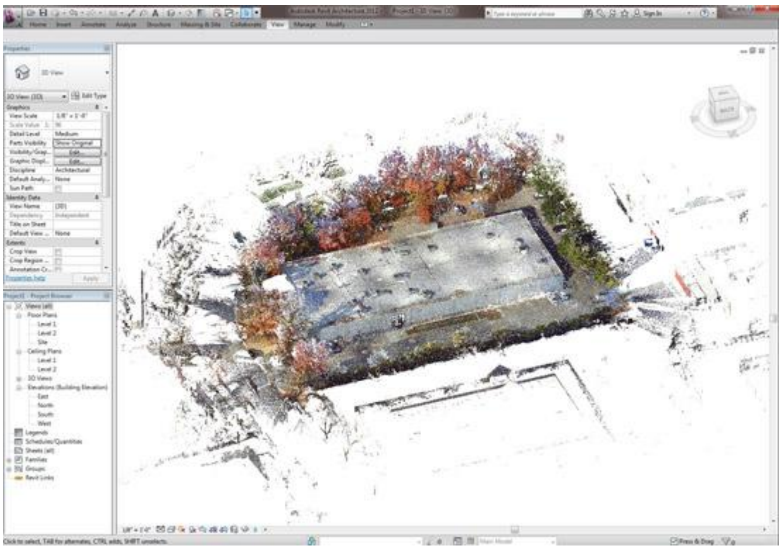
Fig. 6. Revit has the powerful ability to directly import entire 3D point clouds using its .pcg format. Once imported, the point cloud can be treated like any Revit object [7].

Once linked into a project, a point cloud file behaves like any other model element. It will appear in views and can be selected, rotated, copied, deleted and mirrored. You have the capability to link multiply point cloud files and you can obviously control the display of the cloud file via Visibility / Graphics. All the normal Revit rules apply so, plans, section as well as section boxes can cut through the cloud file which is particularly useful if you need to isolate a particular areas of the cloud data [1].

Conclusion

As was mentioned in the introduction trend of buildings renovation and reconstruction increases. Therefore it is very important to deal with the implementation of advanced technology in this field. Adaptation Laser Scanning to BIM provides tools widely used in the process of reconstruction of buildings. The problem remains the automation of this process. Progress could bring allocation information on admission. Cloud of points could recognize materials by resolution or reflectivity. This area requires a more profound discussion. In any case, this technology will bring the quality of the process, speed and accuracy.

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MANAGEMENT OF MEGAPROJECT DURING THE TRANSITION PERIOD: EXAMPLE OF NUCLEAR POWER PLANT MOCHOVCE*

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Abstract

In the paper we are analyzing the process of completion of units 3 and 4 in the nuclear power plant in Mochovce – the largest megaproject ever realized in Slovakia. The growing requirements for safety of the nuclear power plant, the transformation of country to market economy, privatization, the necessary respect for the numerous stakeholder attitudes, had impacted in the important way the project completion.

Megaprojects have distinctive characters when compared with the smaller construction projects. The cost overruns and time delays are quite common. The risk management of such projects is quite complex, and many risks are not quite evident at the beginning. Moreover there are also serious political risks which are quite strong especially in Central and Eastern Europe, with which we deal in detail. In the conclusions we outline the economic impact of the project as well as the possible lessons that were acquired during its realization.

Keywords: megaprojects, transition, stakeholders, NPP Mochovce

* The complete text is available on CD-ROM / Špirkova, Ivanička

Introduction

Megaprojects are large-scale investment projects, which costs are worth more than 0.5 billion EUR. The common denominator of megaprojects is the extreme difficulty of technical, technological, financial, and social sphere as well as their long-term nature. Megaprojects bind most of the government and private spending on infrastructure creation and successful implementation is reflected in the income area of public finances and at the same time they significantly affect the society as a whole.

Management of megaprojects with the specific requirements for their construction and subsequent operation is very difficult. These projects are very risky, even though the participation of the high level specialists in their implementation is the must.

One of the major success factors of large construction projects is their correct localization. It means for example the reconciliation of the investment plan and land use plan of the site, taking into account the tectonic and seismic activity area, extreme meteorological conditions in the area, probability of inundation, a major requirement may also be the presence of water source and other factors that could significantly affect total value of future investments. (Špirková et al., 2012).

The construction of nuclear power plants represents a lengthy process, which is very cost intensive. Non-stable economic and political environment, the technological progress, the complexity of governmental decisions, the activity of stakeholders may be the source of serious uncertainties that can result in considerable delays and overruns of the project costs of construction of the nuclear power plants.

The project of completion of third and fourth nuclear power plant (NPP) in Mochovce, Slovakia is typical large-scale investment megaproject costing more than EUR 3 billion. As other megaprojects in Europe it is extremely complex and it has the long record of late delivery, frequent changes and substantial cost overruns financed in the large part from the public funds.

At the same time the project have significant implications for society in Slovakia and Central Europe. The completion of NPP enables to achieve the higher level of the self-sufficiency of power generation in Slovakia. Successful project delivery will have major implication for new owner ENEL and government finances as well. This completion is one of three nuclear power plant currently being built in EU:

- third unit will be put into operation in 2014 and fourth unit in 2015,
- each unit with performance 440MWe,
- non nuclear part contractor: ENEL Ingenerate e Innovazione,
- contractor of control and management system: Areva-Siemens,
- up to 2/3 of work was carried by Slovak (local) companies,
- communication strategy of the completion is based on transparency and therefore more than 2/3 of Slovak population and more than 87% of the population in the 10km zone around the plant supports the completion.

2. Completion of NPP Mochovce - units 3 and 4

Completion of the third and fourth unit of NPP Mochovce was planned in 2012 and 2013. This would be the largest private investment in the history of the Slovak Republic. Performance of each unit will be a 440 MW. Slovenské elektrárne began with the completion of units 3 and 4 by formal opening of construction works on November the third, 2008. In this process the German, Italian, French, and Russian companies take part. Thus the complex network of relations among stakeholders for completion of the NPP Mochovce was established as shown on Fig 1.

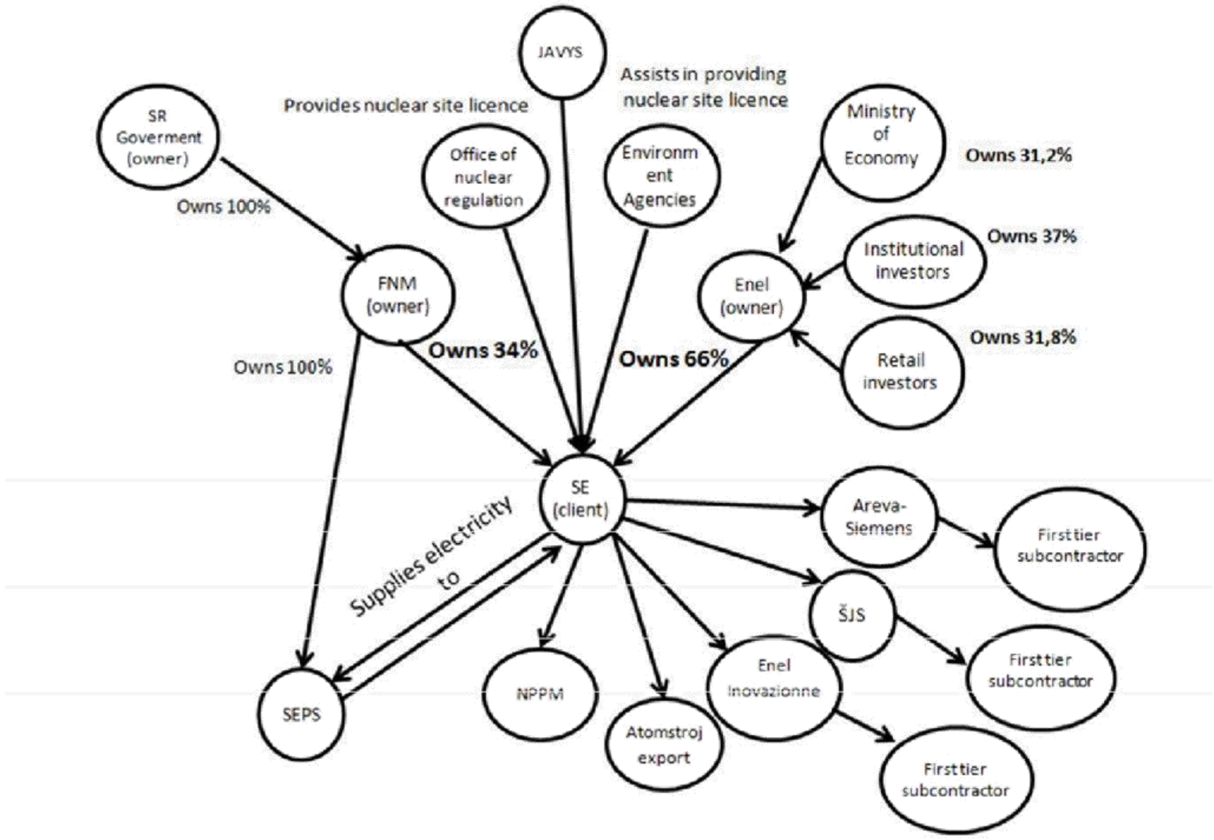


Fig. 1 Stakeholders for NPP Mochovce completion -units 3 a 4

2.1. Cost management processes

The construction of NPP Mochovce was funded by state resources until 1991. By the end of 1991, about 19 billion of Czechoslovak crowns were invested into the project. In the early nineties, lack of resources greatly influenced the construction of NPP Mochovce. The third and fourth units were reported to be only 40% and 30% complete when work was halted on them at the beginning of Nineties. The only way to continue the construction was searching for funds abroad. In September 1995, the government approved a model of financing of units 1 and 2. It was agreed that the completion will be carried out within the range of the original design and the original contractors. Contracts with suppliers and credit institutions were signed in 1996 where the government agreed to take over loan guarantees for the completion of units 1 and 2. The total costs and capital costs of completion of NPP Mochovce are presented in Tab 1 and Tab2.

In October 2004, the Italian national utility ENEL acquired a 66 percent stake in Slovenské elektrárne (SE) and, as part of its bid, proposed to invest nearly €2 billion in new nuclear generating capacity.

Tab. 1 Total costs in construction of the NPP Mochovce

Units	1&2	3&4
Start of construction	1986	1987
Grid connection	1998/1999	2012/2013
Total costs of construction (mil. €)	1.930	2 775

Tab. 2 History of capital costs related to the construction of the NPP Mochovce

	Invested costs (till 2005)	Total costs (2006)	Total costs (2008)
Capital costs (mil. €)	**659** (129)	**2.058** (1.394)	**3.419** (2.755)

In 2007 the feasibility study has been completed. The result was positive but the timescale to complete NPP Mochovce 3 and 4 slipped. By 2007, the expected completion date was 2012 when the contracts for completion were expected to be signed in mid-2008. Obtaining finance became a problem. In 2007, a consortium of nine banks agreed to provide ENEL/SE with a €800m 'revolving credit' facility over seven years. However, in 2008, under pressure from Greenpeace, three banks, ING, Banca Intesa and Erste Bank, refused to allow the credit facility to be used for the completion of Mochovce, and then projected to cost €1.7bn. ENEL/SE was forced to issue a statement that it would finance completion of the plants from internally generated cash. The process was further delayed in September 2008 by a Slovak government decision to require ENEL/SE complete a new Environmental Impact Assessment (EIA). As the consequence of the delays, some of the contractors has augmented their prices The European Commission also became concerned in May 2008 that the designs were not adequately safe. The Commission has expressed the concerns that the facility is not meeting the objectives of the Euratom Treaty," provided the utility "bring(s) the design in line with the existing best practices" including the protection against external attack. Based on such opinion, the new safety measures were implemented. Not long ago CWZ/JAVYS proposed to build another NPP unit at Bohunice site, expected to come on-line in 2020. As a result of that a surplus of base-load power might be available and this could force down the price ENEL/SE would receive for the output of NPP Mochovce 3 and 4. Such situation would mean the reduced profits or even losses for ENEL/SE In Eighties the planned cost of construction of Units 3 and 4 represented EUR 1.3 bn. In 1992 construction works on the completion of Units 3 and 4 were stopped. One reason was the lack of funds. The construction works on Units 3 and 4 were recommenced in 2007, which raised the costs to 3.4 billion euros. At that time it was expected that the completion of Mochovce NPP - units 3 and 4 will be €3 billion, where the equity financing would represent EUR 2.2 bn. And EUR 500 million will come from foreign sources. Since the financial performance of the SE at that time was positive, the equity financing seemed to be a good option. When ENEL took over SE the forecast completion date for the reactors was 2011-12. ENEL was expected to finalize a feasibility study in April 2007 and then to take a final decision whether or not it would invest in the units.

2. Fukushima accident impact on the completion of Mochovce power plant

The challenges which nuclear safety and its governance face were highlighted in the accident at the Fukushima reactors in Japan following the earthquake and the tsunami in March 2011.

NPP Fukushima is the largest NPP in the world (installed capacity is 9096 Mw with number of units 10) (Slugeň et al., 2004). Fukushima accident on March 2011 was a series of equipment failures, nuclear meltdowns and releases of radioactive materials at the Fukushima I Nuclear Power Plant, following the Tōhoku earthquake and tsunami. This event highlighted the challenges which nuclear safety and its governance face. The lessons from the accident have shown that nuclear reactors must be protected even against accidents, which have been assessed as highly improbable. The most important reason Fukushima accident were the faulty design, insufficient backup systems, human error, inadequate contingency plans, and poor communications. The European Union reacted on Fukushima accident by ordering the comprehensive and transparent risk and safety assessment ("stress tests") and to propose by the end of 2011 any improvements that may be necessary Although based on the stress tests, national regulators concluded that there are no technical reasons requiring the shutdown of any NPP in Europe, nevertheless, practically all NPPs are expected to undergo safety improvements, as hundreds of technical upgrade measures have been identified. These measures include additional mobile equipment to prevent or mitigate severe accidents, the installation of hardened fixed equipment, and the improvement of severe accident management, together with appropriate staff training measures. The costs of additional safety improvements were estimated to be in the range of €30 million to €200 million per reactor unit in 2011. Based on the necessity of realizing stress tests, implementing additional safety measures, ENEL has substantially delayed the completion of third and fourth block of NPP, while demanding additional EUR 800 million for the completion.

The ENEL's Slovenské elektrárne requested for additional funding of NPP Mochovce from Slovak budget raised the resentment from the Slovak government. The government declined the request for the second time on May 28 2013 and ENEL threatened to stop the construction works. The missing agreement on raising the budget may endanger the completion of the entire project, in which Czech companies are taking part. The costs of completion of the units 3 and 4 have increased to EUR 3.8 billion from the originally estimated EUR 3 bn. This would endanger jobs in the construction and cause a fall of tax revenues to the state budget, SE said. The investment in the completion of the 3rd and 4th units of Mochovce represents a significant contribution to the growth of the Slovak economy. The government would however like to force Slovenské elektrárne to complete the project, under the threat of sanctions. The construction has already been delayed. Originally, the two units were to be completed in the course of last year and this year. According to available information, they should complete in 2014 and 2015 at the earliest. According to Enel, the delay has been caused partly by additional measures aimed at enhancing the plant's safety, which ensued from stress tests. Owing to the delay of the launch of the two new reactors, the state loses dividends from SE's profits. The third and fourth units could collect per year, according to the planned volume of production at current prices, more than EUR 300 million. Part of this amount would be through dividends could have been received also by the state budget.

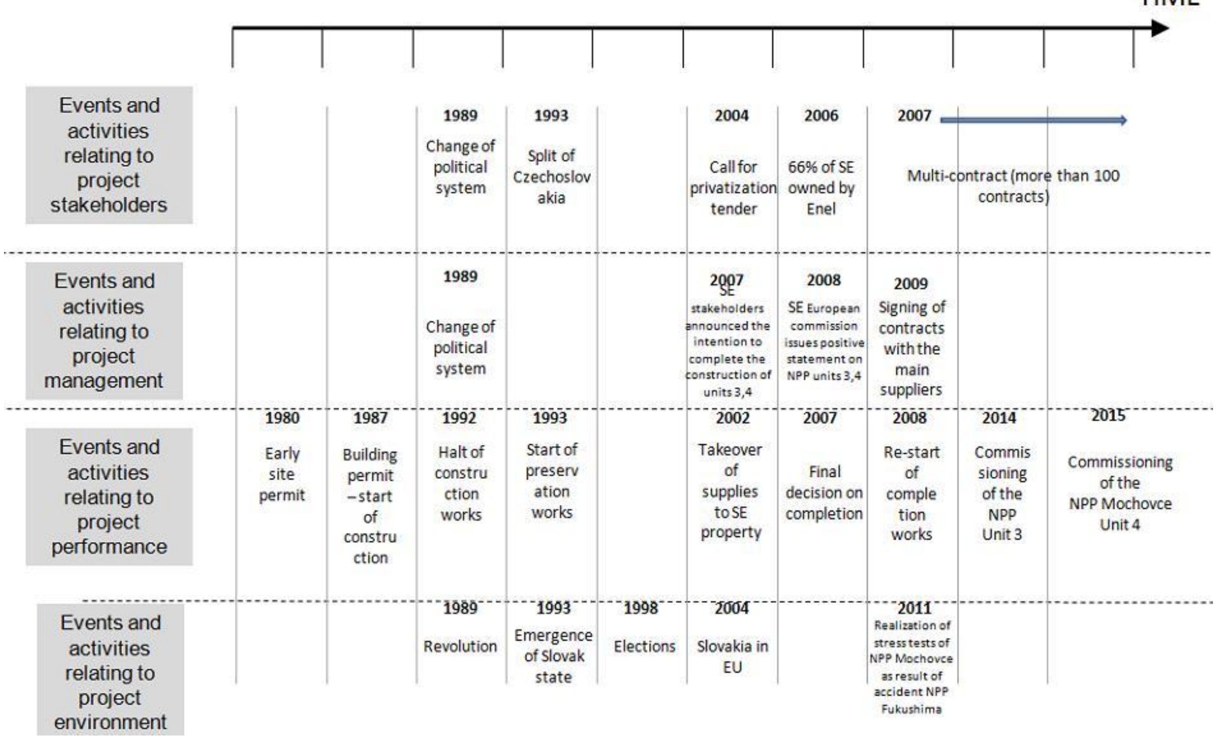
The stress tests in post-Fukushima period and the implementation of the results has caused another delays and cost overruns in the project. The following changes were added to design of NPP:

- severe accident consequence mitigation,
- seismic reinforcement,
- enhancement of plant protection to area events (flooding, fire, etc),
- plant instrumentation and control and human machine interface,
- protection from high energy pipe breaks,
- minimization of radioactive wastes.

The management and verification of the design works are being performed by Slovenské elektrárne through a dedicated Engineering Team which consists of specialists from NPP Mochovce 3-4, NPP Mochovce 1-2, NPP Bohunice and from Enel SpA. For the technical activities, Slovenské elektrárne is assisted by an international engineering consultant. In order to ensure that the revision of basic design is performed by implementing the best applicable safety practices, SE has also set up a Safety

Board, composed by 6 leading national and international experts in nuclear safety, which is aimed at providing guidelines as well advice on all subjects concerning safety.
The most important events that had the impact on the megaproject completion are shown on the following table 3.

Tab. 3 History of the most important events and activities Mochovce NPP completion



The changes schedule as the results of these events is shown on the following table 4, elaborated based on SE, a. s., 2012.

Tab. 4 Construction schedule of the third and fourth unit of NPP Mochovce

1980	**Start of construction**	Site permit
1987		Building permit – start of construction
1992	**Halt of construction works**	Halt of construction works
1993		Start of preservation and protective works
2000		Approval of the NPP Mochovce 3&4 Strategic preservation maintenance and protection plan by the Nuclear Regulatory Authority (NRA)
2002		Takeover of the supplies in the property of Slovenské Elektrárne
2007		Realization of feasibility study
February 2, 2007	**Continuation and planned completion of the project**	Slovenské elektrárne stakeholders announced the intention to complete the construction of units 3&4
July15, 2008		European Commission issues positive statement on NPP Mochovce - units 3&4
August 14, 2008		NRA approved NPP Mochovce 3&4 design modifications and prolonged the building permit by Dec 31,2013
November 3, 2008		Inauguration of the re-start of construction works
2009		EIA process for NPP Mochovce 3&4 operation (public participation)
June 11, 2009		Signing of contracts with the main suppliers
April 30, 2010		

		Ministry of Environment issues its Final Statement on the EIA Report
September 5, 2010		Installation of unit 3 reactor pressure vessel
2011		Realization of stress tests of NPP Mochovce units (that were not planned) as the result of accident NPP Fukushima
March, 2012		Decision on delay of commissioning NPP Mochovce - units 3&4
2013-2014		Commissioning of NPP Mochovce - units 3&4 (the original date 2014 -2015)

3. Political environment

In 1992, all work on the third and fourth unit for lack of money stopped, and experts began to preserve equipment. At that time the third and fourth units were reported to be only 40% and 30% complete. Work started on first and second unit, however, continued albeit with interruptions. In 1995 the Slovak government approved the financial model of financing of the first two units of NPP Mochovce.

The first reactor becomes fully operational in 1998. Two years later, the second unit was put to the operation. The gross output of each unit in 2008 was increased from the original 440 to 470 MW. As a condition of accession into the European Union (2004) Slovakia was forced to deactivate two reactors at the V-1 plant in Jaslovské Bohunice. The first reactor was shut down at the end of 2006, the second on the last day of 2008. A provision in the accession treaty allowed for reactivation in case of emergency.

The Russia-Ukraine gas dispute in January 2009 disrupted natural gas supplies and electricity generation. On January 10, 2009 the Slovak government decided to urgently restart the reactor shut down just days before. Eventually, the reactor was not started. This is one of the most important projects, present and future. Project of the third and fourth unit of Mochovce nuclear power plant is the largest private investment in the Slovak Republic since its creation. Slovak power plants invested in the completion of construction approximately 3
billion EUR over five years. Already about 80% of contracts were signed with the Slovak and Czech companies. In addition to the pulse for economic development at present, the completion of these units will contribute significantly to the energy security of Slovakia in the future. Already the production of one unit covers about 12% of electricity consumption in Slovakia.

Nuclear energy is an important part of the energy package of Slovak Republic. The share of nuclear energy on total energy consumption is around 35 %. Nuclear power plants have significant proportion of producing the electricity. In 2007, 55 % of electricity was generated at nuclear power plants in Slovakia. After 1998 and 2000, when the first two units of the Mochovce were completed (EMO 1, 2), Slovakia has become self-sufficient in electricity production by 2006 and part of the strategic commodities exported. Change occurred after the shutdown of unit V1 nuclear power plant in Jaslovské Bohunice (EBO V1) in 2006 and in 2008 - Slovakia has again become an importer of electricity. Such a situation motivated the Slovak republic to complete and launch units 3 and 4 in Mochovce (EMO 3.4), which should enable Slovakia to become again self-sufficient in electricity production. All Slovak governments since 1989, considered the nuclear energy is the most important part of the energy package and none of them did expect to fully replace nuclear energy with other sources. Document Energy Security Strategy of Slovak Republic (ESS SR) is the current framework document, which was approved by the Government on 15th October 2007 with the perspective to 2030. One of the key information at the beginning of ESS SR refers to the fact that the EU is unable to guarantee the energy security of its members. Therefore in the competence of the EU Member states remain setting energy policy and particularly the determination of the energy mix. The energy mix of EU 27 is composed of 14.4% nuclear energy. Particular attention government pays to the nuclear energy. "Nuclear Illustrative Program" is also part of the Energy Policy for Europe – which together with the European Council and their Action Plan on energy policy became the basis for energy policy in the short - and medium term.

In all post-communist countries of Central Europe there is virtually no political opposition to nuclear energy. If one can speak of political parties with antinuclear orientation in these countries, then those are marginal formations scoring low in elections; in addition, if they gained parliamentary seats, they did so, according to analysts, by articulating other themes. The dominant political parties in these countries are pro-nuclear. The general attitude towards nuclear energy in the countries studied was explored by Eurobarometer in 2009. Eurobarometer asked whether the share of NPPs in the production of electricity should change. Great support for increasing the share or maintaining it at the present level was witnessed in all post-communist countries even after disaster in Fukushima.

Czech Republic, Slovenia, Hungary and Poland are dominantly pro-nuclear, whereas neither in Austria nor in Germany would find today a relevant political actor offering an alternative to the moratorium on NPP construction.

3.1. Relations with Austria

For Austria the nuclear power euphoria was typical for Sixties. They had started construction of nuclear power plant Zwenterdorf, which was expected to be completed in 1976. But during 1975 the protest movement was developed and half of the population was against the operation of nuclear power plants. The referendum in 1977 has forbidden commissioning Zwenterdorf plant. The disaster at Three Miles Island in 1979 and Chernobyl catastrophe further strengthened anti-nuclear power plant opposition in Austria. Moreover the nuclear power plant agenda enabled to join political forces that were against the former premier minister Bruno Kreiski.

Currently support of nuclear power in Austria by the public is the lowest in the whole EU. Antinuclear stance is also typical for Austrian parliament and government, while Parliament is in their views more radical, more approaching to public attitude. (Pavlikova, 2011).

In the section on foreign policy of Austria expressed concern over the "nuclear renaissance". Austria will by all means protest against the presentation of nuclear energy as a safe and sustainable form of energy and will strongly advocate for the proliferation - and the form of a multilateral system of controlling access to nuclear fuel. Austrian politicians and media promote a strict anti-nuclear policy, not only on its territory, but also in relation to other countries, especially neighbors and try to promote anti-nuclear the concept at European Union level. Before 1989, Austria had no real possibility to influence nuclear policy of states that were behind the Iron Curtain, however the situation has changed later and Austria began to oppose very strongly the development and operations of nuclear power plants in Slovakia and the Czech Republic, since these facilities are located not far from the Austrian borders, and in the case of serious disaster it would be impossible to protect the Austrian citizens.

Against the completion of Mochovce Austria stood out as very active at international level – she for instance managed to unit the allocation of credit for completion of the European Bank for Reconstruction and Development (EBRD) in Nineties in 20th century. The Austrian anti-nuclear power activists from Greenpeace and Global 2000 occupied the Slovak Embassy in Vienna in May 1998 and demanded all the technical documentation for NPP Mochovce. (Böck, Drábová, 2005). The pressure from the activists was also focused on banks providing the credit for completion of third and forth unit of EMO Mochovce, and I some cases they succeeded in way that the banks refused to provide the credits for completion. The 2011 crash of Fukushima plant in Japan has caused renewed growth anti-nuclear tendencies.

Austria at the end of March 2012 decided to undertake the action against Czech and Slovak Republic in front of the European Court of Justice (ECJ). It was part of new action plan adopted by Austrian government in the document "International rethinking of nuclear power to renewable energy and energy efficiency", which was approved on March 3, 2011 (Rehfus, 2011). The program aims to promote the closure of nuclear power plants across the European Union, through extensive campaigns and cooperation with other anti-nuclear oriented countries. For many years the European authorities closely monitored the safety of the nuclear reactors in Czech and Slovak Republics, as well as in other new European countries, which was quite fruitful approach leading to many changes that had led to implementation of many safety measures. However European Union has never shared the extreme opinions of Austrian politician to the development of the nuclear power stations. So when Vienna provincial government sued Slovakia for the completion of third and fourth EMO units in 2011, it did not succeed. The Slovak-Austrian controversies regarding the operation of Nuclear power plant in Mochovce are likely to continue in future, even though the safety standards were significantly augmented. Otherwise there are no real problems among both countries, which have otherwise the friendly relations; many Austrian companies operate in Slovakia, and the intensity of mutual advantageous economic relations is growing.

Conclusions

It is expected that the completion of NPP Mochovce would have the significant local and global economic impact:

- stabilizing economy and economic growth,
- new working opportunities, indirect impact on community development,
- increase of tax revenues for municipalities,
- reduction of negative environmental impact, and efficiency increase,
- company SE EMO 3&4 as Independent power producer - IPP can be successfully designed and financed as sole project,
- the preliminary calculation of internal rate of return (IRR) of the project was around 18.61% for the whole life cycle of the project / 40 years.

The new production capacity in NPP Mochovce will become the next great stabilizing element in Slovak energy system and it guarantees stable and secure supply of electricity. Placing third and fourth block of Mochovce into operation in 2014 and 2015 will replace fossil fuel burning in the Central region of Slovakia. It is expected that this would reduce the volatility of electricity prices for households and industry on the Slovak market.

The expected benefits are high enough. The paper shows, however, also the difficulties of completion of the nuclear power megaproject in the Central Europe during the period of technological changes, political shifts, economic transition and economic cycles. Such events as the shifts from public to private financing, the establishment of the sovereign state of Slovakia, development of the Slovak government, European Union accession and frequently changing power relations could hardly be without any consequences on the cost and time schedule on the project completion schedule. Several lessons could be learnt from this:

- such megaprojects during the turbulent times need the very strong and intelligent political support. This is not easy to achieve in the situation when the political and public servants elites are changing frequently;
- the megaproject NPP Mochovce represents certain form of private-public partnership in which the risk should be distributed among the partners by using legal, economic, managerial and other instruments. These instruments are often not very well known in public sector in Central European transition countries. Moreover some of the risks, such as for instance the impact of Fukushima accident, or referendum on construction of nuclear power plants in Italy, on the completion of NPP Mochovce are not easy to predict and these risks can hardly be eliminated without incurring the substantial costs and time overruns. Moreover it is quite difficult to deal with the environmentalists groups, such as Greenpeace or the groups representing anti-nuclear power stance in the adjacent countries. In fact these groups have been able to undermine the credit agreements with

the consortia of foreign banks that would help to accelerate the completion of NPP Mochovce. Also the understanding of the motivation (real and hidden) of the engaged stakeholders is the necessity for the progress of the project;

- Even though the realized feasibility study (in 2007) for the completion of the nuclear power plant in Mochovce revealed the substantial positive economic effect for Slovakia including the self sufficiency of the country in the energy
production, yet the real outcomes will be lower than expected because of occurrence of many unpredicted events;
- project management of megaprojects in future would perhaps require to realize the scenario analysis, which might help to some extent forecast the possible positive as well as negative features in the future that can help to prepare the alternative strategies for the finishing the project. In practice it is difficult to achieve, since there is the tendency to show the positive events that support the acceptance of the project, while negative scenarios may undermine the starting of the project throwing the serious doubt concerning its feasibility. Such exercise might be useful for the preparation of better contracts, it can be helpful in negotiations with stakeholders, and finally in may enable the more efficient sharing of the risks.

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COSTS ASSESSMENT AND BREAK EVEN POINT ANALYSIS OF BUILDING RECONSTRUCTION*

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Abstract

This paper describes the costs assessment of much frequented revitalization of apartment buildings today. Costs assessment of this reconstruction is based on the determining the price of apartment building thermal insulation. The determining price, as well as other products, consists of two main components which are the cost and profit. The paper deals with the economic evaluation of the cost of revitalization apartment building and identifying the Break Point Analysis of a particular contract. Economic evaluation of results is from the setting price of residential building thermal insulation and it compares projected cost with actual incurred cost.

Keywords: Thermal insulation, apartment building, budget, cost, profit, Break-Even-Point

* The complete text is available on CD-ROM / Tažikova, Pokryvkova

Introduction

Currently very frequent revitalization of residential buildings shall have the task of fulfill several follow-up requests from client. The first requirement is to reduce energy consumption for heating. It follows automatically fulfill the second requirement and that is reduction unhealthy emissions of CO_2. At the same time revitalization of residential building will also provide an additional requirement and namely the extension of the life cycle of building (O'Connor, 2012). The said requirements create a predisposition for sustainable development (Fig. 1). In order to meet these requirements is necessary to incur significant costs. Topic is extremely timely, whereas it is still nearly ¾ of the housing stock without insulation, according to expert estimates. Specifically, according to the Association for thermal insulation of buildings is in the segment of family houses insulated 20.2%, in the segment of residential buildings is 31.9% insulated buildings, for the last eighteen years old.

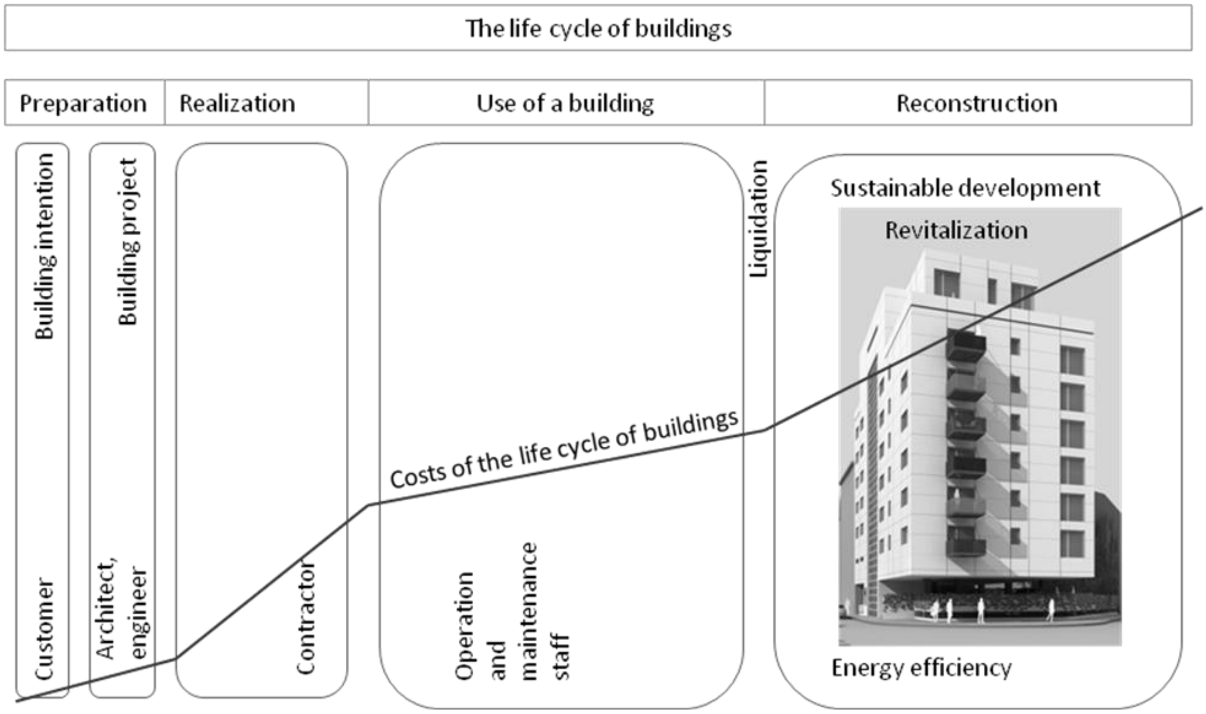

Figure 1: The life cycle of building

The annual heating energy consumption can be up to 75% of total energy consumption (Fig.2) by Slovak Innovation and Energy Agency (SIEA). Revitalization of the house is a way of reducing the energy consumption.

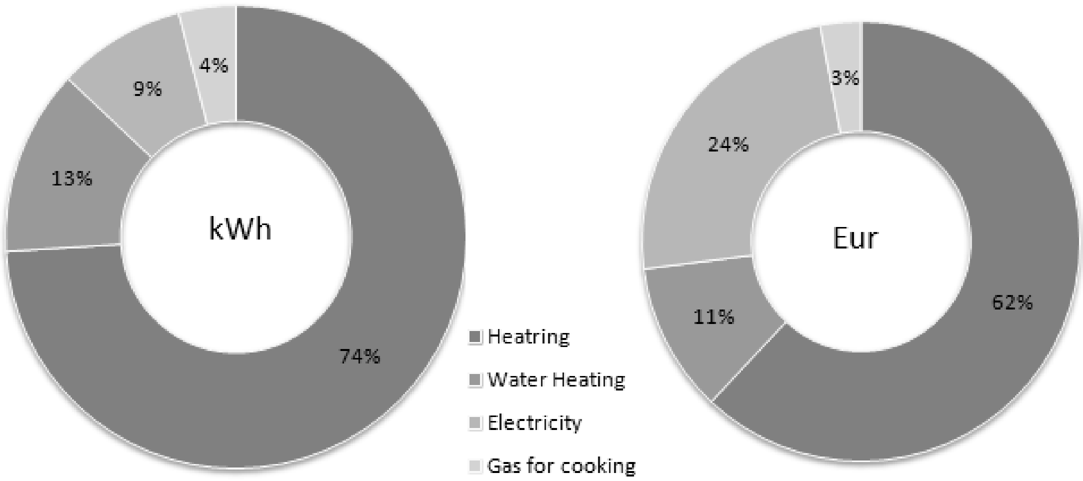

Figure 2: Annual energy consumption in households

Economic evaluation is apparent from the pricing of realization thermal insulation in residential building. Price, as well as for other products, consists of two main components, which are the cost and profit (Mesároš, 2003). Cost of construction may be affected: by environmental risks (Holthe, 2009; Spišáková, 2012), by building projects risk (Kozlovská, 2008; Župová, 2012), by lean production (Struková, 2011), by time structure modelling (Bašková, 2007). In the majority of contributions, we come across with the cost of thermal insulation only as one cumulative item. This item is price in relation to the total return on investment and in relation to a reduction of consumption expenditure on power. Prospective owners often determine what costs the future investment will bring. In most cases, is given the pricing information that the total cost of insulation will be in the range of 30 to 40 euro per square meter. In the second case, contractors tend to differentiate the price per square meter accurately in items on the price of building materials and on the price for the performed work. In fixing these prices are two main ways to determine the cost of the contractor to realization this building insulation. One way is to determine the cost of using indicative prices. The indicative prices are average prices in Slovakia for the current quarter, published by institutions which deal with creating price list of construction works. These prices are updated regularly and generally, this is also the maximum price. Conversely, contractors can minimize these prices otherwise, so that use individual calculation works. The individual calculation of works is already included specific construction conditions. In the budget, prices not constitute already indicative prices but sales prices from specific supplier of building materials. Lowering prices can be obtained, for example quantity discounts and so on. Similarly, every contractor realizes construction work with a certain amount of overhead, which is different for individual contractors. Amount of overhead depends on the size of the contractors firm, the number of employees and the number of contracts. Article talks about how created mentioned a price range of 30-40 euro per square meter of building insulation. Description of contractor calculated cost is given in the specific example reconstruction of residential house, where are analyzed economic relations between proceeds, costs, production volumes and profits, which arising for contractor.

2. Materials and methods

2.1. Creation of sales budget

Sales parameters of building are defined by items budget, which is the result of a final agreement with investor and annexed to the contract for work. In our example, we reported here the simplified budget structure, which provides information on the total amount of the contract price and the structure completed construction process: Insulation of external walls, roofing repair and exchange of stair windows and entrance door (Tab.1).

Table 1: Recapitulation of construction - sales budget

Revitalization of residential houses			
Contract	**Price**	**VAT**	**Price + VAT**
Revitalization of residential houses	**102 627,41**	**19 499,21**	**122 126,62**
Thermal insulation	88 684,08	16 849,98	105 534,06
Repair of coating covering	5 680,90	1 079,37	6 760,27
Entrance door and stair windows	8 262,43	1 569,86	9 832,29
Total	**102 627,41**	**19 499,21**	

2.2. The processing of the tender calculation

When processing and discussion offer was prepared by the contractor the tender calculation to assess the economic benefits of the contract and the estimated amount of profit. Information about total estimated costs provided Tab. 2 broken down by realized processes.

Table 2: Recapitulation of construction – tender calculation

Construction: Revitalization of residential house						
Contract	**Costs total**	**Material**	**Wages and deductions**	**Machinery**	**Subcontracts**	**No calculated items**
Revitalization of residential house	**80 611,18**	**22 412,11**	**30 207,78**	**5 822,48**	**20 726,58**	**1 442,20**
Insulation	69 659,18	22 412,11	30 207,78	5 822,48	11 117,45	99,34
Repair of coating covering	4 462,00	0,00	0,00	0,00	4 462,00	0,00
Entrance door and stair windows	6 490,00	0,00	0,00	0,00	5 147,14	1 342,86

In the table these processes are listed as aggregate. Tender calculation consists of calculated individual items of materials, wages, cost of equipment and subcontracts. Total costs also include not calculated items, which include Construction Site Costs (CSC). Between CSC include outside-site transport, regional influences, operational influences and other arrangement costs. Based on these assumptions proceeds and costs were processed quantification of the expected economic result in stage offer submission, using the Cenkros Plus software. Cenkros Plus software is one of the best known and the most used specialized software programs on the Slovak market, which are used for budgeting and calculated the price of building production.

2.3. The processing of the production calculation

Before the start of construction on site, the offer calculation was reworked to form called realization production calculations (Tab. 3), with a view to realization the specific conditions in terms of prices of materials supplies, deployment of manpower or work organization. At the same time the structure of production calculation aims to track the progress of work performance and simplify the monitoring costs during construction.

Table 3: Production calculation

	Amount						**Total**
Title	**Material**	**Wages**	**Machinery**	**ODC**	**Sub**	**Overhead**	
Main construction							
A - Gable 1 total	2 255	2 930	0	0	0	0	5 185
B – Back facade	7 006	9 102	0	0	0	0	16 108
C - Gable 2 total	2 255	2 930	0	0	0	0	5 185
D – Front facade	8 817	12 448	0	0	0	0	21 265
Subcontracts total	0	0	0	0	19	0	19 621
Price 1. – main construction	20 333	27 410	0	0	19 621		**67 364**
Production							
Management	0	0	0	0	0	3 341	3 341
Energy	0	0	0	0	0	600	600
Spaces, containers	0	0	0	0	0	280	280
Service	0	0	125	0	0	100	225
Equipment	0	0	0	0	0	3 421	3 421
Transport	0	0	2 860	0	0	2 520	5 380
Price 2. – production	0	0	2 985	0	0	10 262	**13 247**
Total price	20 333	27 410	2 985	0	19	10 262	**80 611**

ODC-other direct costs

3. Results and discussion

3.1. Achieved the economic result

Resulting contract based on previous data:

- Net profit was 13 605 EUR, which represents 13.3% of the sales price
- Actual result is better than the assumption (plan) about 3 391 EUR, respectively about 3.3%
- In the budget is the price 48 EUR / m² for 1 m² insulated surface
- Actual cost of 1 m² is 31 EUR / m²

- Savings in material is 3 276 EUR because of the achievement of quantity discounts when buying insulation and adhesives, but we have over consumption of adhesives compared to standard, whereas we have used 10 kg / m^2, and calculated standard was 7 kg / m^2. (The cause is the uneven surface, which should be taken into consideration in costs calculation of the similar projects.)

Structure of economic result contract is displayed by individual works in Tab 4. From the table 4, we can see that positive gross margin (sales minus direct costs), business forms from activities, which were realized by own capacities. Conversely, a negative gross margin was achieved in the work which was made by subcontractors or in calculation of construction site costs.

Table 4: Structure of the profit and margin production

Item	Budget		Costs		Gross margin		Overhead (EUR)	Net margin		Comment
	EUR	%	EUR	%	EUR	%		EUR	%	
1. Own works										
A. Insulation	**76 766**	75%	**49 370**	64	**27 396**	36	**8 828**	**18 568**	24%	**profi**
Material			16 204							
Assembly			30 698							
Machinery			2 468							
B. Other	**2 808**	3%	**2 183**	3%	**625**	22	**323**	**302**	11%	**profi**
Material			853							
Assembly			1 279							
Machinery+ ODC			51							
2. Subcontracts	**18 634**	18%	**19 822**	26	**-1 187**	-6%	**2 143**	**-3 330**	-18%	**loss**
3. Production overhead	**4 419**	4,3%	**5 845**	8%	**-1 426**	-32	**508**	**-1 934**	-44%	**loss**
TOTAL	**102 627**	100 %	**77 220**	100 %	**25 407**	**25 %**	**11 802**	**13 605**	**13%**	**profit**

ODC-other direct costs

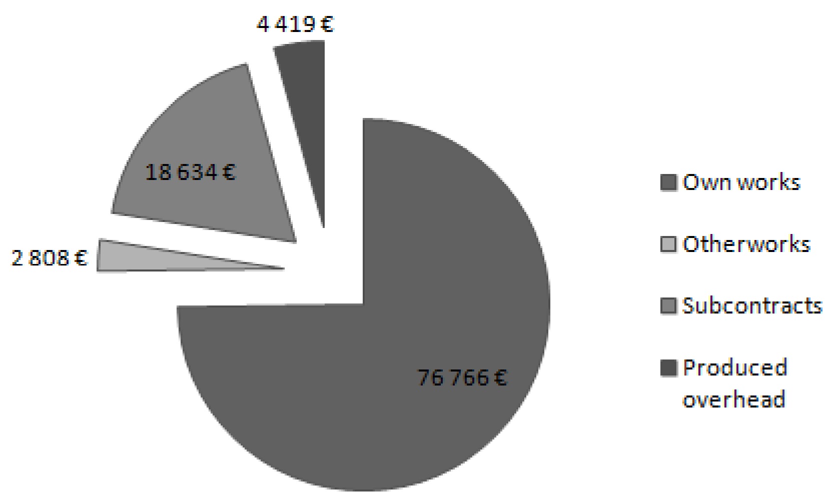

Figure 3: The structure of the calculated costs

A negative margin from the realized works by subcontractors is the noteworthy. However, it is possible that the company had to include this subcontractor's work in your delivery in spite economic disadvantages. Whereas investor could have a condition that the supply will as complete, respectively, in the case of subcontractors could go about nominated suppliers, where the company could not select a lower price subcontracts. Graphics processing of individual units in the calculation formula of the total budget 102 627 EUR is provided in Fig. 3. The image processing of actual costs in the amount of 77 220 EUR is in Fig. 4.

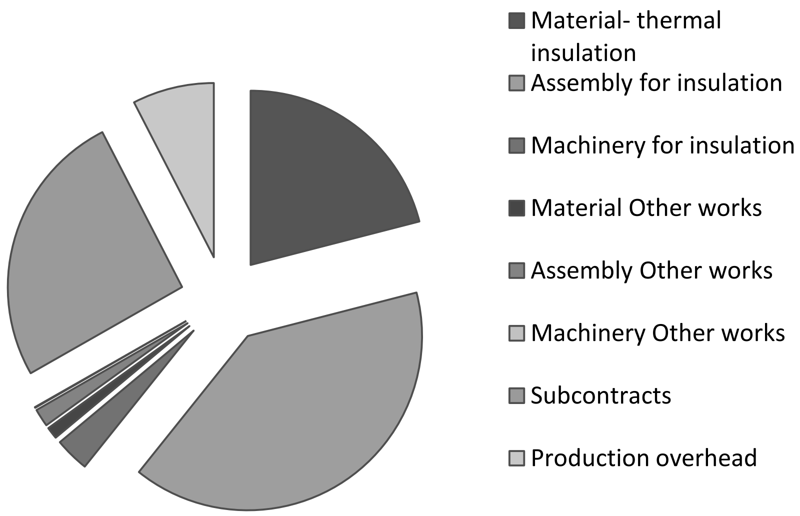

Figure 4: The structure of the actual costs

Uniquely, from the above data it is evident that the profit centers are works realized within the thermal insulation of facades of this contract (see the Tab.4, Fig. 5).

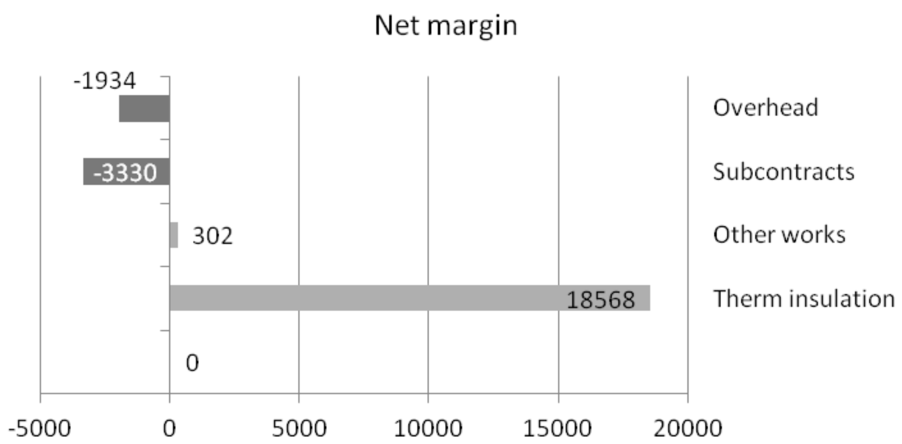

Figure 5: Analysis of generating a profit

The net margin of insulation cover the loss incurred on the realization of the subcontracts respectively not covered loss from construction site costs.

3.2. *Analysis of unit price of thermal insulation*

Based on the information about the total insulated surface can then analyze the creation of profit on production unit of insulation, which is the square meter. If the total area of the insulated area was 1,592 m^2, then unit sales price of insulation is about 48 EUR / m^2. The actual cost of insulation (material, labor, machinery) were quite of 49 370 EUR, so the unit cost is about 31 EUR / m^2. Achieved gross margin is 36%, what on power for unit amounts to 17 EUR / m^2. This margin is then used to cover losses on other types of work, as well as to cover the overhead. The total economic result and net margin is 13 605 EUR, which represents about 8.5 EUR / m^2 (Tab. 5).

Item	**Budget**		**Actual costs**		**Gross margin**			**Margin of other work (EUR)**	**Overhead (EUR)**	**Net margin (EUR)**
	EUR	**EUR/m²**	**EUR**	**EUR/m²**	**EUR**	**%**	**EUR/m²**			
Own works Ther. Insul.	**76 766**	**48**	**49 370**	**31**	**27 396**	**36**	**17**	**-1 988**	**-11 802**	**13 605**
Material			16 204	10						
Assembly			30 698	19						
Machinery			2 468	2						

Table 5: Analysis of unit price of thermal insulation

3.3. *Break-Even Point analysis*

Zero point, otherwise known as break- even point is point, which states such the volume of production, where revenues equal to total costs incurred. *At this point, the profit has zero value and contract does not exhibit the loss. This point can be achieved if the contract price (product) equal to the* average cost, which are incurred for this contract. Break-Even Point analysis (BEP) can find a way to achieve increased profit.
Increase company profit can achieve:

- increasing the volume of realized contracts
- increasing prices of construction works
- reducing variable costs to the contract or
- reducing fixed costs to the contract.

Information about the unit price and unit cost could be used to calculate the zero point of the contract. The zero point is calculated according to the formula (1):

$$Q_0 = FC/(P - AVC) \quad (1)$$

where: P-product price, Q_0- zero point, FC-fixed costs, AVC- average variable costs on one product.
So the value of zero point is (2):

$$Q_0 = 13791/(48-16) = 801 \ m^2 \quad (2)$$

Fig. 6 shows the relationship of revenue, expenses and generation profit in the increasing of insulation area.

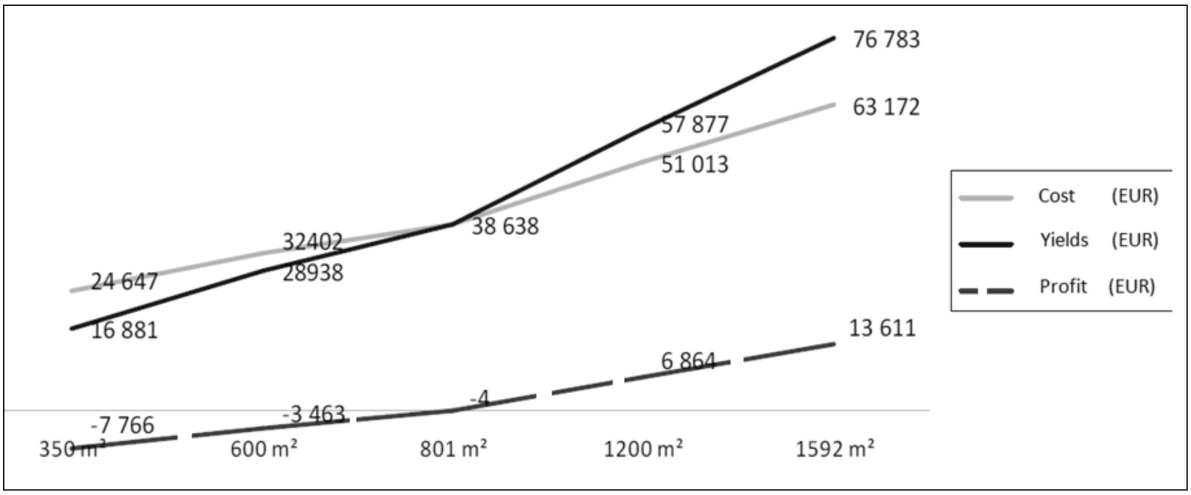

Figure 6: Break-Even Point according area of thermal insulation in m^2

An analysis of the zero point of a particular contract residential building insulation is clear that the zero Economic result company achieved if implemented works with an area of 801 m^2. In reality at construction was realized 1592 m^2. The company thus on this particular contract was not in a loss, but it made a profit about the value of 13 611 EUR. Initially, this profit was an even bigger, but the company achieved within two entries loss in calculation formula, which was transferred to the profit reduction.

Conclusion

The contractor needs to establish the reason for overrun planned cost on subcontracts and on construction site costs. In reality, construction site cost was not sufficient for 4.2 % of the basic costs. Therefore, it is necessary to contractor prepared the individual calculation of construction site costs, so this costing item of next the contract did not create loss. Also, from the content contribution is evident how is created the mentioned price range 30-40 EUR per square meter and what this price range includes.

Acknowledgements

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ESTIMATING OPTIMUM OF FLOW-SHOP SCHEDULES*

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Abstract

At Flow-Shop Problems the job is to schedule work of *n* machines on *m* workpieces for to achieve a pre-set optimum – say, the shortest overall execution time. Analogy of it can be recognized at managing Industrialized Construction. Main challenge of Flow-Shop Schedules is that the mathematical problem is Non-Polynomial, and – except of some special cases – the correct solution can be gained by some kind of enumeration. For testing and demonstrating effect of sequences on overall execution time of a Master Schedule embracing execution of numerous sub-projects a special software had been developed at BUTE DCT&M. After testing numerous principal ways of achieving optimal solutions our researches lead us to the experiences:

1. Neither the simple nor the more sophisticated search algorithms for finding optimal solutions proved to be more effective than the most primitive way of random sampling;
2. Solutions later prove to be optimal or very close to optimum (pseudo-optimal solutions) may get in view in a relatively short time, but proving their optimality takes significantly longer.

The paper focuses on later lesson and introduces some ways of estimating optimum of $F||C^{max}$ problem via elaborating lower bounds by help of which we can guess how far the found or constructed solutions are from the optimum and/or how much efforts to find even better ones are likely necessiated.

Keywords: Scheduling, Flow-Shop, Industrialized Construction

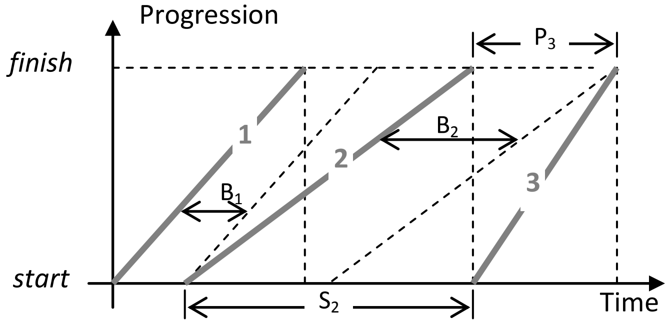
* The complete text is available on CD-ROM / Vattai

PREFACE

For graphical representation of ideas to be discussed on following pages instead of using one-dimensional schedules (known as Bar Charts or Gantt Charts) usually applied at discussing scheduling (*sequencing*) problems, we illustrate our thoughts by two-dimensional *time-route diagrams* known as *progression curves*, *cyclograms* or as *linear schedules*, as seen below. Horizontal axis of these 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) being scheduled.

Figure 1

Two-dimensional representation of timing processes (1,2,3) of a project (here: *workpiece*)



Processes are represented by individual lines (See: line „1”, „2” and „3” above) slopes of which can be read as *intensity* of progression, while durations of processes (P_1, P_2, P_3) and timing of them (e.g. succession times between them either at start: S_1, S_2 or at finish: F_1, F_2) can be read as horizontal (time) views of their linear representations.

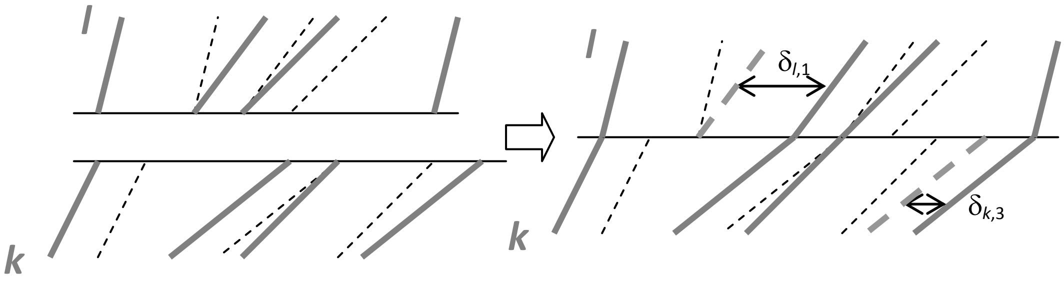
For succeeding processes with or without overlapping in time, minimum succession times (*technological breaks* or *critical approaches* succeeding the given processes represented by *B* values) are used to set minimum of their non-overlapping period.

Ranges/values of critical approaches can be defined/selected tipically by considering technical-technological constraints, such as time of hardening, cooling, drying, consolidating, etc. as constant values or can be set as functions of progression due to needed manipulation area or safety zones or on-site storage capacities and so on. Guiding relative timing of processes this way any relative time position, *lead* or *lag* time can be set.

The schedule of a workpiece in which all the succession times between succeeding processes are at their minimum (set by *B* values) we do refer as *own-schedule* or *most compact schedule* of it (as if it was processed in its own). These most compact own-schedules of workpieces will be released (succession times between neighbouring processes can and will be increased) as requires when combining or linking them up in a *Master Schedule*.

Thus the problem of forming a Master Schedule and finding on optimal sequence of workpieces for to achieve the shortest overall completion time can be derived back to the problem of matching pairs of succesion vectors (succession times „F_k” at finish on preceeding workpiece and succession times „S_l” at start on succeeding workpiece). (See: Figure 2.)

Figure 2 Releasing *own-schedules* of projects/workpieces (*k* and *l*) when linking them up in a Master Schedule with expectation of breakless performance of processes/machines. (Detail of the *Master Schedule* is to the right.)



INTRODUCTION

Though thinking it over in short it can be seen clearly, it is less widely known that sequence of buildings to be erected may have significant effect on completion time of the buildings themselves and on overall completion time of all when having the same resources assigned to them (see Figure 3).

The phenomenon is well-known in manufacturing industry and much effort have been made to help scheduling workpieces to achieve a pre-set optimal characteristic of the whole *production program*, thus calling into existence a special branch of applied mathematics (*Operations Research*) referred as *Scheduling*.

In 1973 researchers had suggested a reference system to identify scheduling problems by classification, indicating availability of resources and further restrictions completed by identification of actual target function [4]. Using their coding system *Scheduling Problem* discussed can be identified as $F|overlap, no\text{-}wait|C^{max}$ to be read as:

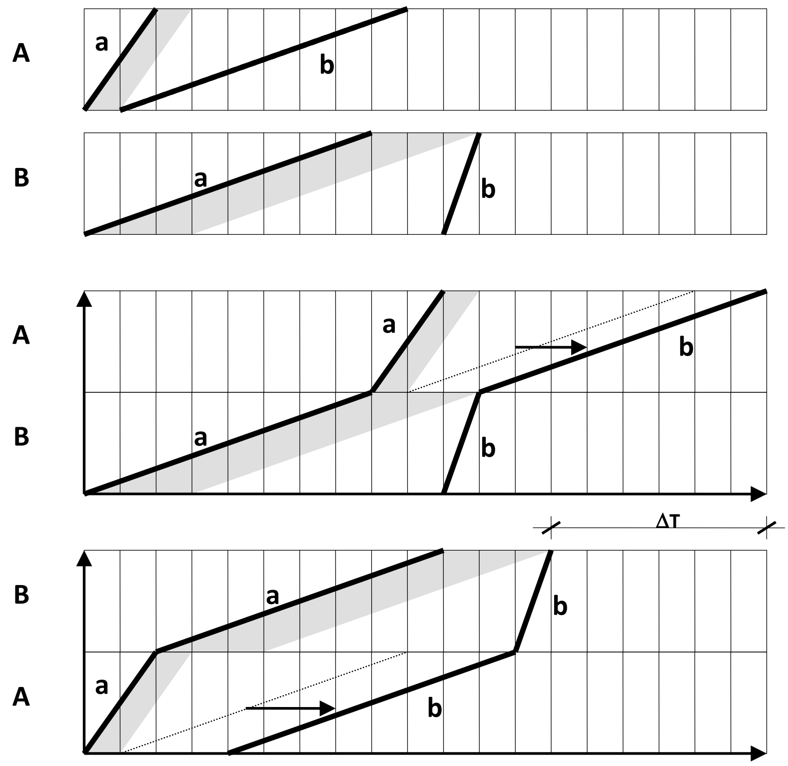
> The job is a so called *Flow-Shop* scheduling with no limit on number of machines (‘*F*’), where overlapping in time is allowed when processing a workpiece by succeeding machines, machines should not wait when shifting from a workpiece to an other (‘*overlap, no-wait*’), and the aim is to minimize the overall execution time identified by *completion time* of the last workpiece (‘C^{max}’).

Flow-Shop as a basic class of scheduling problems embraces a set of conditions on production environment:

- There are ‘*m*’ workpieces to be scheduled on ‘*n*’ machines (each workpiece must be processed by each machine);
- Order of machines at processing workpieces is given and is the same for each workpiece (technological order of machines is fixed and known);
- Order of workpieces must be the same on each machines;
- Machines are performing their only job (special machines for each process);
- Each process is performed by one machine (one machine is available for each kind of processes).

To demonstrate variety of scheduling problems and their coding we can mention *Job-Shop* scheduling (*J*), where technological orders of machines are given in advance but may differ by workpiece; *P* refers to situation when *parallel machines* are used and each machine can perform any job; *pre-emption* indicates when processing of a workpiece can be broken at machines; *idle* refers to allowed workless periods of machines between succeeding workpieces, while *no-wait* warns us when it is unacceptable; *res1,res2* identifies limited availability of resources; target function can be minimum of sum of *completion times* (ΣC_i), minimum of sum of *delays*-, *lateness*- or *tardiness* (ΣD_i, ΣL_i, ΣT_i) too; and so on – to mention the most frequent ones only.

Figure 3 Demonstrating effect of sequence of workpieces ('A' and 'B') to be processed by two machines ('a' and 'b'). At top we see the most compact individual own-schedules of workpieces with technological breaks indicated (grey stripes, indicating minimum succession times between succeeding jobs). Below we see Master Schedules constructed off them sequencing the two wokpieces in order of B→A and another variant of it sequencing the workpieces in order of A→B. Both variants of the Master Schedule are the most compressed ones! Minimum overall completion time is (can be) strongly effected by the sequence of workpieces. (See ΔT)



Difficulty is that for to solve most of the Flow-Shop Problems there is no any existing close formula. For to find optimum some type of *enumerative algorithm* [7, 8] is needed, which may/would take enormous run-time. Computations of these kinds are referred as *NP-hard* in technical literature, which means that time (steps) needed to find solution is *non-polinomial*, it can not be defined as $n \bullet x$, or n^2, n^3, etc., where *n* represents the number of workpieces to be scheduled.

To demonstrate difficulties of these calculations let assume a computer calculating one million Master Schedules (permutations) of the same 20 projects in a second. Well, to examine all possible permutations that computer should work for more than 77 thousand years ($20! = 2.43 \cdot 10^{18}$; $2.43 \cdot 10^{12}$ sec > 77,000 years). So long machine time – for to solve a single problem – usually we do not have. ...

$F2||C^{max}$ (Scheduling *m* workpieces on *2* machines) is one of a few delighting problems for which there exists a polynomial solution – first published by S. M. Johnson in 1954 [1]. Having more than two machines the problem seems to be stubbornly *NP-hard*.

It is not by chance that much effort were made to derive $F||C^{max}$ scheduling problem back to *$F2||C^{max}$*. Szwarc published an *elimination method* in 1971 [2] later improved to an *optimal elimination method* published by him in 1973 [3]. Also Szwarc published *dominance conditions* for *$F3||C^{max}$* problem in 1978 [5].

Z.A.Vattai proved *optimality* of Johnson's (1954) heuristic algorithm and generalized the solution for *overlapped* situations (*$F2|overlap|C^{max}$*) while introducing term of *o-shaped* (master) schedules (where succession times between the processes both at start and at finish are at their minimum and all necessary releases have been made mainly in inner sections of the Master Schedule) in 1993 [9].

Time by time comprehensive overviews are published reporting latest results of searching faster and faster methods to find solutions for Flow-Shop Scheduling problems. *Theoretical approaches* were comprehended in Proceedings of the NATO Advanced Study and Research Institute in 1981 [6]. Results are adopted in up to date *management techniques* [7] and resource pool of *finite mathematics* [8] is enriched permanently by more and more sophisticated methods of supporting *decision making*.

Recognizing difficulties of providing a sure optimum and also recognizing sensibility of optimal schedules (meaning: a slight modification of data can significantly effect final result) the empasis had turned to *pseudo-optimal* and practically acceptable solutions and to *probabilistic* and/or *combined* methods.

Amy D. Wilson et al tried to estimate the optimum on *statistical* basis and published their results in 2004 [10]. R. Ruiz and C. Maroto gave a comprehensive review on *heuristic methods* applied for Flow-Shop Scheduling problems in 2005 [11]. The latest endeavours are focusing on *generic algorithms* and on development of some kind of *hybrid heuristics* for the problem, some results of which were published by M. G. Ravetti at al. in 2006 [12].

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 had been developed by the author at Department of Construction Technology and Management of Budapest University of Technology and Economics. Lessons of test runs had been published in 2008 [13].

Primary aim was to bring attention of our students (future managers) on extended considerations of construction management in case of executing large-scaled complex development works. After modelling and testing potential effects of sequences on total execution time 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 set of optimal matches of individual schedules – with the hope of deriving the problem back to a kind of *Assignment Problem* that can be solved by *Linear Programming* (*Arranged Branch & Bound*);
3. Finding partially optimal solutions for simpler cases and extending/combining them for more complex situations (*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 of resolving some contradictions in Construction Industry and to get *real* 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 a more promising challenge. Having it, we could judge optimality of any sequence found or produced, and we could estimate likely return of our efforts to find an even better solution if the one produced did not seem to be optimal. ...

Establishing a lower bound

Before discussing data and algorithm some general recognition are worth to be highlighted. (For better understanding see Figure 4.)

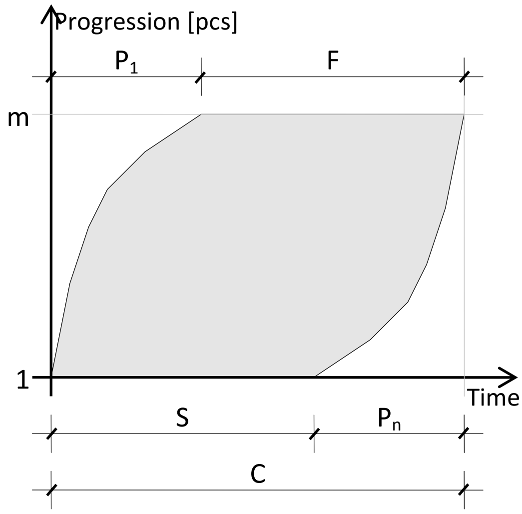
- Overall execution time of any Master Schedule can be divided in two segments:
  1. Overall processing time on the first machine (P_1), which is a constant value, not varying by the sequence of workpieces.
  2. Time span between finishing the first and finishing the last process on the last workpiece (F) 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 (P_n) and time span between starting the first and starting the last process on the first workpiece (S).

- In an optimal Master Schedule F and S values are at their minimum so these are the quantities the examinations should focuse on. Thus calculations should concentrate on *succession times*, while processing times have less or indirect importance.

Figure 4

Constant (P_1; P_n) and variable (F; S) parts of overall completion time (C) in a Master Schedule



$C = P_1 + F$

Studying Figure 3 and Figure 4 it is easier to understand *o-shaped* characteristic [9] of an optimal Master Schedule: 'succession times between the processes both at start and at finish are at their minimum while all necessary releases have been made mainly in inner sections of the Master Schedule'. …

Denotions

For faster discussion we do introduce some mnemonic denotions:
(For better understanding recall Figure 1.)

Denotions for own-schedules of workpieces

p_{ij} = **p**rocessing time of machine j on workpiece i

$b_{i,j}$ = minimum succession time (technological **b**reak) between processes j and j+1 on workpiece i

$s_{i,j}$ = minimum succession time between **s**tarting processes j and j+1 on workpiece i

$f_{i,j}$ = minimum succession time between **f**inishing processes j and j+1 on workpiece i

s_i = minimum succession time between **s**tarting the first and the last process on workpiece i

f_i = minimum succession time between **f**inishing the first and the last process on workpiece i

c_i = minimum **c**ompletion time of workpiece i

Denotions for a fictive „optimal" Master Schedule

P_j = (overall) **p**rocessing time on machine j in the fictive Master Schedule

B_j = minimum succession time (technological **b**reak) between processes j and j+1 in fictive the Master Sschedule

S_j = minimum succession time between **s**tarting processes j and j+1 in the fictive Master Schedule

F_j = minimum succession time between **f**inishing processes j and j+1 in the fictive Master Schedule

S = minimum succession time between **s**tarting the first and the last process in the fictive Master Schedule

F = minimum succession time between **f**inishing the first and the last process in the fictive Master Schedule

C = minimum **c**ompletion time of the fictive Master Schedule

Denotions for estimating completion time of the optimal Master Schedule

E_1, E_2, E_3, E = partial and overall **e**stimates

At interpreting and reading the scheduling problem and the abbreviations above analogy between manufacturing and construction can be highlighted by changing some key words, such as:

- *workpiece* in manufacturing = *building* or *project* in construction;
- *machine* in manufacturing = *machine* or *team* or *subcontractor* in construction

Calculating own-schedules of workpieces

Overlapping processes in time when erecting a building is typical in Construction for to shorten overall completion time. In Manufacturing, when workpieces are moving from machine to machine this solution can not be applied. Before going on with processing a given workpiece on the succeeding machine, the preceeding machine must finish its job. Expectation of non-overlapping in time can be considered as a special case of overlapping, with succession time equal to minimum of durations of processes linked to each-other. (See processes „**2**" and „**3**" in Figure 1 – and B_2 value between them. $B_2=\min\{P_2, P_3\}$)

$b_{i,j} = \min\{p_{i,j}; p_{i,j+1}\}$ i = 1,2,…,m; j = 1,2,…,n-1 R 1.1

Assuming constant intensity of processing at each process, progressions can be represented as straight lines in linear schedules. Thus, minimum succession times (critical approaches, b_{ij} values) will appear between starts or between finishes (or both) of succeeding processes. Thus, succession times between starts and between finishes of processes in the most compressed individual schedules (*own-schedules*) of workpieces can be calculated:

$s_{i,j} = \max\{b_{i,j}; b_{i,j}+p_{i,j}-p_{i,j+1}\}$ i = 1,2,…,m; j = 1,2,…,n-1 R 1.2

$f_{i,j} = \max\{b_{i,j}; b_{i,j}-p_{i,j}+p_{i,j+1}\}$ i = 1,2,…,m; j = 1,2,…,n-1 R 1.3

Minimum of variable part of completion times of individual workpieces can be calculated (See analogy on Figure 4):

$$s_i = \sum_{j=1}^{n-1} s_{i,j} \qquad i = 1,2....,m \qquad \text{R 1.4}$$

$$f_i = \sum_{j=1}^{n-1} f_{i,j} \qquad i = 1,2....,m \qquad \text{R 1.5}$$

As explained at Figure 3, having the constant part and having the variable part at minimum, minimum completion times and most compact (*own*-) schedules for each individual workipeces can be calculated.

$$c_i = p_{i,1}+f_i = s_i+p_{i,n} \qquad i = 1,2....,m \qquad \text{R 1.6}$$

These schedules can/will/must be released (by increasing succession times between succeeding processes) when combining them into one single Master Schedule.

Calculating a fictive „optimal" Master Schedule

As most compact schedules were calculated for individual workpieces, the same way a *fictive* most compact Master Schedule can be caculated for the whole series for to estimate the theoretically achievable minimum (as lower bound). With the assumption that minimal succession times will appear between starts and/or between finishes of succeeding processes, similar logic and similar relations can be used for calculation.

The only difference is that when considering individual processing times we have to consider overall processing times on the individual machines, and when considering minimum succession times (technological breaks) we have to consider the minimum of techonolgical breaks between processing on succeeding machines.

$$P_j = \sum_{i=1}^{m} p_{i,j} \qquad j = 1,2....,n \qquad \text{R 2.0}$$

$$B_j = \min_i\{b_{i,j}\} \qquad j = 1,2....,n-1 \qquad \text{R 2.1}$$

$$S_j = \max\{B_j;\ B_j+P_j-P_{j+1}\} \qquad j = 1,2....,n-1 \qquad \text{R 2.2}$$

$$F_j = \max\{B_j;\ B_j-P_j+P_{j+1}\} \qquad j = 1,2....,n-1 \qquad \text{R 2.3}$$

$$S = \sum_{j=1}^{n-1} S_j \qquad \text{R 2.4}$$

$$F = \sum_{j=1}^{n-1} F_j \qquad \text{R 2.5}$$

$$C = P_1+F = S+P_n \qquad \text{R 2.6}$$

Estimating the optimum

Having the individual own-schedules of workpieces and having the fictive Master Schedule we can establish at least three estimates as lower bounds on the shortest overall completion time:

1.) Assuming that unreleased own-schedule of the workpiece with the shortes succession time between finishing the first and the last process on it can be the last in the optimal Master Schedule, overall completion time can not be shorter than E_1 value calculated below:

$E_1 = P_1+\min\{f_i\}$ R 3.1

2.) As it was mentioned earlier, building up a Mater Schedule is a symmetrical problem, so we can follow similar logic when constructing it from direction of start or of finish. Also, assuming that unreleased own-schedule of the workpiece with the shortes succession time between starting the first and the last process on it can be the first in the optimal Master Schedule, overall completion time can not be shorter than E_2 value calculated below:

$E_2 = \min\{s_i\}+P_n$ R 3.2

The two estimates (E_1 and E_2) can not substitute each other. We need both.

3.) We also can conclude that overall completion time of the optimal Master Schedule can not be shorter than completion time of the fictive Master Schedule where – by assumption – no inner conflict within the schedule necessitate releasing minimum succession times between succeeding processes.

$E_3 = C$ R 3.3

By our experiences none of the estimates above can be harder lower bound on the theoretically achievable minimum than the others. Accuracy of them is defined by the actual set of data.

$E = \max\{E_1; E_2; E_3\}$ R 3.4

Though the three estimates are hard lower bounds they may more or less fail the real optimum. There can be situations when the most compact own-schedule is an outstanding one and it can not be at the beginning and at the end of the Master Schedule in the same time – that is: overall processing times on individual machines override own-schedules of individual workpieces. Also, there can be situations when technological breaks are over-dominating extents of processing times, thus individual own-schedules are overriding overall processing times on the individual machines. And we can imagine any mixture of them.

For practical use a kind of combination of the three estimates had been integrated in the software mentioned above. That is, after calculating individual own-schedules, all workpieces are tested to be the first, while others to be the last one in the Master Schedule, and the rest of workpieces are substituted by a single fictive (inner, partial master) schedule with processing times equal to overall processing times on machines less processing times on the selected two workpieces and with zero minimum succession times between them. Thus $m \bullet (m\text{-}1)$ tests are performed to establish a lower bound to estimate theoretical minimum of overall completion time.

CONCLUSION

Due to standard technologies and to specialization of resources typical in Construction Industry problem of harmonizing preferences of Clients and those of Contractors can be demonstrated by the challenge of *Flow-Shop Problems*. Expectation of completing workpieces (buildings) as individual deliveries in the shortest times (Clients' interest) is not necessarily coinciding endeavour of firms contributing in completing the series of workpieces – also in the shortest overall execution time (Contractors' interest).

The question we faced was if computerized *tools of sequencing* could help us at resolving some contradictions of interest of clients and that of contractors in a way of finding proper arrangements/sequences of contracts, according to which each building could be delivered in an acceptably short period and performance of contractors could be managed in an effective *industrialized* way. …

For testing and demonstrating effect of sequence on minimum overall execution time of a Master Schedule a small computer appilcation had been developed at Department of Construction Technology and Management of Budapest University of Technology and Economics. Together with modelling and testing potential effects of the sequences more principal ways of building/finding optimal solutions had been tested.

Experiences show that none of the advanced techniques and/or approaches proved to be either deliberately or more outstandingly better or effective than the most primitive way of *Random Trials*. The same time it was found that elaborating a proper estimate on likely optimum is a more promising challenge. Having it, we can judge optimality of any sequence found or produced, and we can estimate likely return of our efforts to find an even better solution if the one produced did not seem to be optimal.

In this paper we introduced a way of estimating optimum of $F|overlap, no\text{-}wait|C^{max}$ problem.

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COMPARISON OF PROJECT'S PROCESS MANAGEMENT USING PROJECT MANAGEMENT SOFTWARES

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Abstract

This paper elaborates different project management softwares that are in use in the construction and compares three types of softwares present in Southeast Europe: Primavera, MS Project and GALA. The survey that included construction management professionals in Southeast Europe, helped to identify a listing of most frequent project management softwares in the industry, the reasons for their use (as well as differences among management perspectives) and satisfaction of the respondents with current project management software. The aim of the survey was to define the differences between the Southeast Europe and the world practices in selecting the project management systems in construction. Survey results show that Southeast Europe construction companies still use basic software (like Excel) as a prevalent choice for project management and that programs like MS Project, GALA and Primavera are not frequently in use. These results differ from the world findings, since Primavera and MS Project were the first two choices in America and the Middle East. At the end, paper presents a project management system selection road-map which companies can use when selecting the most suitable tool for their projects.

Keywords: project management software, construction, management perspectives, Southeast Europe, survey, information systems

Introduction

Present organizations need to become adaptive, fast, collaborative, flat, flexible and use IT systems if they want to compete on today turbulent market (Bechor, Neumann, Zviran, & Chanan, 2009). It is especially obvious in construction industry where delivering projects within boundaries of the iron triangle, i.e. time, cost and quality, is more than just signing the contract and waiting for objectives to be delivered by themselves (Eccles, 1991; Egan, 1998). For a successful project management (PM) there has to be an efficient supporting infrastructure – an efficient IS system, as well (Ismail, Rashid, & Hilo, 2009; Liberatore, Pollack-Johnson, & Smith, 2001; Nitithamyong & Skibniewski, 2004). Over the years, critical path method (CPM) scheduling has become a standard project control and has unfortunately become a synonym for PM. Therefore, construction companies manage projects only trough schedule and thus use only scheduling applications for PM (Al-Jibouri, 2003; Freeman & Beale, 1992).

This paper elaborates different PMS that are in use in the construction and gives a comparison of three types of PMS, present in SSE: Primavera, MS Project and GALA. The survey, sent out to construction management professionals in SSE, helped us to identify a listing of most frequent PMS in the industry, why they were used for (as well as differences among management perspectives) and satisfaction of the respondents with current PMS. The survey has also enabled us to obtain timely technical and managerial information about the expectations of different management perspectives with PMS. This is especially important since in construction project, where activities are typically divided into functional areas, i.e. investor, contractors and consultants (architect, engineers etc.), and where every functional perspective has been improving its processes without understanding its effects on the performance of the project with which they are involved (Love & Irani, 2003). Our research can be compared with similar works in the U.S (Galloway, 2005, 2006b) and in the Middle East (Ismail, et al., 2009), but it also differs in a way where wanted to focus on the search for a holistic PMS solution, that is aligned with business culture of SSE construction. At the end, we present a PMS selection road-map which companies can use when selecting the most suitable tool for their projects.

2. Literature review

The construction's inability to deliver the expected level of performance (C21; Egan, 1998) has put a poor image on the industry (Beatham, Anumba, Thorpe, & Hedges, 2005; Dulaimi, Ling, & Ofori, 2004; Xiao & Proverbs, 2003). Only in 1999, in UK, the industry spent more than £1 billion on rework (Nicholson, 1999) and in 2003, more than £1.5 billion on performance measurement applications (Edwards & Thomas, 2005). Nevertheless, only 34% of constructions projects, today, meet the iron triangle criteria (http://www.standishgroup.com). During literature review we had found Primavera and MS Project as the most frequent PMS in construction industry, today (Galloway, 2005). In America, over 64 percent of construction companies indicated that they had used Primavera as their specified software, with only just over 20 percent requiring MS Project. Other software mentioned included: OPLAN, MS Excel, Government Proprietary software, CBCM and CA Super Project (Galloway, 2005). It is interesting to note that 14 percent of construction companies still require arrow diagramming scheduling. This then correlates to a corresponding percentage of MS Project's needs as Primavera does not support arrow diagramming. In the Middle East the distribution was similar, where Primavera had gotten 58% and MS Project 23% (Ismail, et al., 2009). Construction companies state that the primary reasons for CPM scheduling are (starting in ascending order) (Galloway, 2005): periodic control of work after start of construction, developing look-ahead schedules, coordination of subcontractors, detailed planning of work prior to construction, schedule impact, claims analysis, tracking of changes, coordination of own trades, estimating and bidding, tracking shop drawings and submittals, calculating payment requests for work performed, design development, operation and maintenance of projects, tracking costs and materials planning.

2.1. PMS in SSE construction: GALA, Primavera and MS Project

SSE construction industry has a low performance, as well (39% of projects makes it on time and cost (Radujkovic, 1999)). Moreover, competitive, economic and politic pressures are forcing the industry to change everyday activities and processes. Izetbegović et al. (2003) listed purposes for IS use in the SSE construction; 98% for accounting and book-keeping, 89.8% for personnel management, 79.6% for spreadsheets, 73.5% for cost prediction, bidding and BoQ, 53.1% for CAD and only 28.6% for scheduling. These results indicate that the sector is still trying to cope with traditional management procedures trough accounting. The author also concluded that SSE is still in the early stages of computing, i.e. on technical and operational level, which was similar with other emerging markets (He, Khalifa, Kusy, & Zhao, 1998). In the following sections we will briefly present three types of PMS that are in use in SSE construction.

2.1.1.Primavera P6 Professional Project Management, Oracle

Primavera Systems has been developing their PMS package for construction from 1983. Starting from January 2009, Oracle Corporation has acquired Primavera. Today, it has more than 450000 users in more than 60000 companies worldwide and thus the tool has become a leading provider of Project Portfolio Management (PPM) solutions (Galloway, 2006b). One of Primavera's star products is Primavera P6 Professional Project Management. The application has been tailored for project oriented companies and thus it helps companies in managing portfolios, programs and projects. Primavera can be used within a single project or in a multi project environment. Besides scheduling, it can be used to organize projects up to 100,000 activities and provide unlimited resources and an unlimited number of target plans. It can be also used for: synchronizing projects; managing organizational structures; allocating resources; selecting the right strategic mix of projects; corporate governance, project team collaboration etc. Primavera was once mostly used to handle very large, multifaceted and complex projects, especially in the engineering and construction business. Today in the US, many projects under $100,000 use Primavera, as well (Harris, 1999). Besides the construction, Primavera has now started to focus on other industries, e.g.: public sector, aerospace and defense, utilities, oil and gas, manufacturing and high tech, and IT and services. Because it covers such a large span of industries, the tool is not only specialized for the construction processes nor with construction business culture in SSE. We also agree with Galloway's (Galloway, 2006a, 2006b) arguments that Primavera's is complex system that cannot successfully work without external consultants.

2.1.2.MS Project Professional 2007

The first version of Microsoft Project was released for DOS platform, in the long gone 1984, by a company working for Microsoft. Today's version of MS Project is owned by Microsoft and its called MS Project Professional 2007. The application has been design primarily as a tool which is easy to use. It can assist project managers in: developing plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads. The application creates budgets based on assignment work and resource rates. The application supports multiple plans where multiple resources can be assigned to each task. MS project also schedules task work, based on the resource availability. Unfortunately, the application presumes that additional raw materials are always available without limit. Therefore it cannot determine how many finished products can be produced. This makes MS Project unsuitable for solving problems of available materials in a constrained production. Since its birth, MS Project has always been a popular tool among project managers (Galloway, 2005; Ismail, et al., 2009), but has never become the number one tool in PM. The reason can be found in its simplistic approach to highly complex systems, such as projects are. This fact is even more evident in construction, where special processes and procedures are needed in order to manage projects. Still, MS Project is the second most frequently used PM in the construction, today (Galloway, 2005; Ismail, et al., 2009). This can be explained with construction low perception of PM processes, which can be also perceived in the low performance of the industry (Beatham, et al., 2005; Latham, 1994; Radujkovic, 1999).

2.1.3.GALA 2009

Gala was firstly developed as an internal tool for one Croatian Construction company. Owning to extremely positive reactions, it was placed on the market in 2003. The application has been designed for managing projects in respect to business conduct of SSE construction. The application uses normative (9750 work and over 25,000 material items) and standards in civil engineering, combines them with empirical and project data and thus generates: bills of quantities (BoQ), cost estimates, analysis of cost, invoices, project schedules, histograms, S-curves, project trends etc. Every BoQ item can be drafted from a large database of normative or can be calculated separately. One of the greatest strengths of Gala over the other two PMS is the link between BoQ and the time schedule. Thus, all materials, works and machines, implicit in the BoQ can be transferred into the schedule. Hereafter, activity duration is calculated upon normative of the work and machines. Gala also supports on-site management where users can issue receipts, various requests, requisition slips, internal delivery notes, delivery orders etc. Gala enables warehouse management and monitors expenditure of the materials. Gala also enables partnership management and controls completion of on-site documentation (which is required by the SSE regulations). In that way, the application supports ISO 9001 quality assurance initiative. Gala is a PMS which covers all phases in a construction project and is aligned with SSE business culture in construction. It has been designed mainly for contractor organization, because of the on-site management abilities. Still, in a multi-project environment, its application is still limited.

3. Research methodology

The literature review identified that only few studies covered the topic of PMS in construction (Galloway, 2005, 2006a, 2006b; Ismail, et al., 2009). Since the industry is project oriented, there is a high level of dispersion and a high level of causal links among different management perspectives. Thus, all three management perspectives; investors (sponsors), consultants (designers, architects, consulting engineers, quantity surveyors etc) and contractors were examined to provide an overview of PMS practice. The aims of this study were to find out what are the most frequent used PMS in Croatian construction industry, second and for what purpose they are used. We used data obtained from a semi-structured survey. After general information about the respondents (management perspective, turnover, number of employees etc), survey listed current PMS, i.e. Primavera and MS Project (in regard to the World findings) and added 5 more PMS that we had found in use in SSE, namely: Excel, GALA, Adria KOD, Carpio and Maris. Respondents could also add some other PMS, as well.

Since we wanted to find out why managers were using PMS, as well, we offered them a listing of PM process in construction e.g.: periodic control of work after start of construction, developing look-ahead schedules, coordination of subcontractors etc. The listing of processes came out from previous similar studies of PMS in construction (Galloway, 2005, 2006b; Ismail, et al., 2009) and specificities of the SSE construction.

In the survey we targeted members of Civil engineering and Construction management associations and chartered civil engineers. In total, the survey was sent out to a group of 3000 construction professionals in SSE (Izetbegovic, Oreskovic, & Bandic, 2004). The survey was managed through a web application called SurveyMonkey.com. In total, 401 valid responses were received, 267 respondents bounced back, because of the wrong email addresses, and 2439 did not respond. As the pilot questionnaire required no change they were added to the sample, as well, leading to a total consolidated response rate of 16.4%. We found this result to be acceptable and in accordance with similar research practice (Bechor, et al., 2009; Fellows & Liu, 2003).

4. Findings

SSE construction takes Excel as the most frequent PMS with 56.2% (figure 1). Afterwards follow: MS Project, GALA and Primavera, with 26.5%, 7.0% and 4.6%, respectively. The rest belongs to the other PMS, i.e. Maris, Adria KOD and Carpio. These results differ from the world findings since Primavera and MS Project were the first two choices in America and the Middle East. In SSE, Primavera's rating was pretty low, which could be explained with its high complexity and its misfit with SSE business culture. MS Projects' results corresponded with the World findings which, probably due to its simplicity. It was very interesting to find a domestic PMS, like GALA, to overtake Primavera, which has been the top PMS in the World. This was probably because of GALA's alignment with SSE procedures in construction.

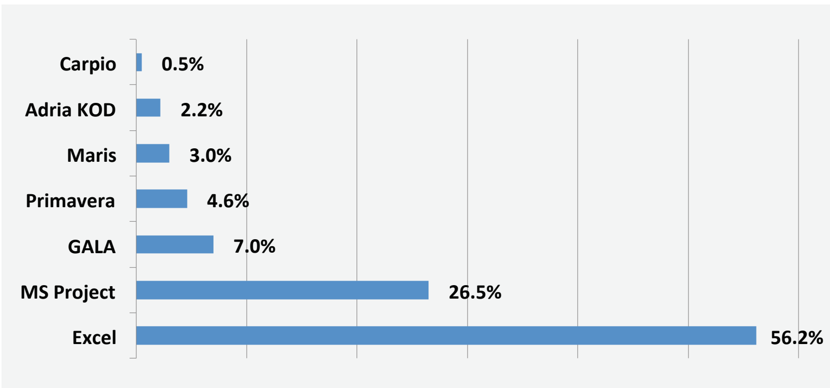

Figure 1 Frequency of use of the PMS in SSE construction

Table 2 shows the most frequent PM processes that were implemented by using a certain PMS. The results show that the top three were: tracking costs and materials planning; periodic control of work after start of construction and investment assessment. These results show certain differences from the world findings. Thus, while the SSE construction puts cost control as the top PM process, the companies in America put control after start of construction. Also some PM processes, which were popular in America, e.g. developing look-ahead schedules, coordination of subcontractors, detailed planning of work prior to construction and tracking of changes were not as much popular in SSE. This shows that SSE construction is still oriented on financial indicators and accounting based project management (top three PM processes were financial oriented), while the world practice has started to implement the other processes, as well.

Table 2 PM processes implemented using PMS

Answer Options	Response Percent	Response Count
tracking costs and materials planning	60.0%	222
periodic control of work after start of construction	49.2%	182
investment assessment	47.6%	176
estimating and bidding	45.7%	169
detailed planning of work prior to construction	42.4%	157
book and bill of quantities	40.3%	149
tracking of changes	35.4%	131
resource planning	30.8%	114
developing look-ahead schedules	30.0%	111
coordination of subcontractors	27.6%	102
document management	27.3%	101
work orders	23.2%	86
standardization and norm calculations	21.6%	80
control of indirect costs	18.1%	67
communication in team	17.6%	65
warehouse management	11.9%	44

We also looked if there were differences in PM processes, in regard to the different perspective and different PMS (table 3). The processes did not significantly differ in regard to different management perspective, but there were significant differences in regard to the processes that a certain PMS was used for. Thus, Primavera significantly differed from GALA and MS Project with p=0.001, while MS Project differed from GALA with p= 0.003.

Table 3 Frequency of use of different management processes in regard to different PMS

Answer Options	Primavera	MS Project	GALA
periodic control of work after start of construction	12	39	9
developing look-ahead schedules	13	43	6
coordination of subcontractors	7	40	5
detailed planning of work prior to construction	14	71	11
investment assessment	7	36	9
estimating and bidding	5	35	13
tracking of changes	13	50	9
tracking costs and materials planning	15	48	21
resource planning	11	42	11
control of indirect costs	6	16	4
work orders	3	17	12
document management	7	21	13
book and bill of quantities	8	16	22
warehouse management	1	8	12
communication in team	4	25	4
Standardization and norm calculations	2	19	17

Table 3 also shows that Primavera was primarily used for: tracking costs and materials planning, detailed planning of work prior to construction and developing look-ahead schedules. MS Project was primarily used for tracking of changes, tracking costs and materials planning and developing look-ahead schedules. GALA was generally used for: tracking costs and materials planning, book and bill of quantities and standardization and norm calculations. Therefore Primavera was mostly used for detail planning, MS for tracking changes, while Gala for on-site activities.

5. Discussion

All the three PMS have been well accepted in the practice. MS Project showed the same results in SSE as it did in the World. We have found that one quarter of respondents had been using the application (there was no significant difference among project perspectives in its use). The application represents a simple PMS, but in the following period, if MS Projects wants to excel in construction, it has to support portfolio and on-site management, as well. Gala was the only PMS that was aligned with ISO 9001 standard and thus supported quality assurance in project management in construction. Furthermore, GALA was the only PMS that had integrated PM with on-site management, which was probably the reason of its high popularity (7% of market in five years), especially among contractors. Still, the software needs some improvement, particularly in portfolio management. Primavera has gotten the lowest rate of 4.6%, which mostly differs from the world findings. The application was mainly used by the investors and the consultants. This was probably because of its project portfolio management orientation, where companies could monitor and control various projects across their portfolio. Thus, Primavera has still not managed to cope with complex construction environment and the business culture of SSE (which explains such a low rate). If Primavera wants expand its market share in SSE, to the tool should align its procedures with on-site processes and the business culture of the region. Table 4 shows advantages and disadvantages of the three PMS. To simplify the road-map: if a construction company wants to implement a PMS for PM and on-site management, that is aligned with SSE business conduct, it should use Gala; if it wants to implement a detailed enterprise portfolio project management (EPPM) it should use Primavera and if it wants to use a simple multi-purpose tool it should use MS Project.

Table 4 Road-map for selecting the most appropriate PMS for SSE construction

Features / PMS	**GALA**	**MS Project**	**Primavera**
Server mode (one database for all projects)	Yes	Limited	Yes
Enterprise project portfolio management	**Limited**	**Limited**	Yes
Organizational breakdown structure	**No**	**Limited**	Yes
Procurement management	Yes	**No**	Yes
Contract management	Yes	**No**	Yes
Partnership management	**Limited**	**No**	**No**
Multi project scheduling	**Limited**	**Limited**	Yes
Gantt chart	Yes	Yes	Yes
Arrow diagramming	Yes	**No**	**No**
Critical path analysis	Yes	Yes	Yes
Work breakdown structure	Yes	Yes	Yes
Resource scheduling	Yes	Yes	Yes
Manpower loading	Yes	Yes	Yes
Machine loading	Yes	**No**	**No**
Material loading	Yes	Yes	Yes
Calculation of activity duration	Yes	**No**	**No**

Database of normative in construction	Yes	**No**	**No**
Time/cost trade off	Yes	Yes	Yes
Indirect costs management	Yes	**No**	**No**
Income vs. Expenditure analysis	Yes	**No**	**No**
Histograms	Yes	Yes	Yes
S-curves	Yes	Yes	Yes
Forecasts of resources needed	Yes	**Limited**	Yes
User defined reports	Yes	Yes	Yes
Earned value	**No**	**Limited**	Yes
Probability analysis	**No**	**Limited**	**Limited**
Bill of costs	Yes	**No**	**No**
Log books	Yes	**No**	**No**
Situations	Yes	**No**	**No**
Book of quantities	Yes	**No**	**No**
Warehouse management	Yes	**No**	**No**
Aligned with Croatian business conduct	Yes	**No**	**No**
Construction site documentation	Yes	**No**	**No**
ISO supportive	Yes	**No**	**No**
For micro and small enterprises	Yes	Yes	**No**
For medium enterprises	Yes	**Limited**	Yes
For large enterprises	**No**	**No**	Yes

Note: "Limited" means that the application has implemented the feature, but not with its full capabilities.

Nevertheless, none of the PMSs, provide all of the PM processes, stated in the road-map. Authors of the PMS can also find this road-map useful as the guidelines when further developing their PM applications. Finally, only fully project oriented and mature companies should try to implement Primavera but with caution to Primavera's complexity and the cost of consultants for the implementation support. However, it is important to stress that the contractors which will try to implement Primavera will also need GALA for on-site management. Even though Primavera has been presented in the literature as the world leading project management software, GALA still stands as more used and aligned tools with the SSE construction environment.

6. Conclusion and recommendations

This article has analyzed various PMS applied in construction industry. Since up to date, only a limited research has been conducted in this area, construction organizations should perceive these findings very interesting and useful when selecting a PMS. Furthermore, since significant cost savings in organizations can be made when using IT (Latham, 1994), companies should rigorously approach to PMS evaluation and try to use the road-map. Even though Primavera stands as the first PMS choice for the construction, the tool has yet not been able to manage with the specificities of the SSE construction market, which some domestic tools, e.g. GALA, have. This is an important finding which brings a new light on PMS for construction. For SSE construction companies, Primavera's complexity still represents a large burden, especially since it increases project cost because of the inevitable presence of Primavera's consultants in the projects [10]. We have also found MS Project as a quite popular in SSE, but with limited applicability to complex construction projects. While construction industry in America is using PMS for a wide range of PM processes, SSE construction sector is still managing projects just through financial procedures. Nevertheless, companies are becoming more satisfied and aware of the benefits arising from modern PMS, which can be perceived in relatively level of satisfaction. In order to implement all of the benefits that modern PMS provide, we recommend that construction companies should:

- define the PM processes which they lack in their projects (try to use international PM standards e.g. IPMA or PMI)
- conduct a market analysis of PMS and try to come up with cost-benefit analysis
- find the best PMS for their needs (use the road-map)
- try to implement all of the PM processes, that certain PMS enables;
- determine if the selected tool is supportive for the needs.

At the end, project management IS, i.e. PMS, is definitely one of the pillars that the construction excellence stands upon. In future, construction industry ought to start using these modern tools or otherwise the industry will limp behind the others.

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BUSINESS INFORMATION MANAGEMENT PRACTICE IDENTIFICATION METHODOLOGY IN CONSTRUCTION INDUSTRY*

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Abstract

The management of business information is of great importance in construction at the levels of process, company and the industry. This paper presents the methodology for investigating the practice of business information management. The particular module of methodology has been created in order to investigate the formal position and the real contribution of institutions and public bodies in management of information relevant to the construction industry. The methodology has so far been applied on the sample of more than one hundred Croatian construction and construction engineering companies as well as in four important public institutions. The results of this research will be shown in the paper, same as the proposal for widening the sample to international level. The cooperation with research teams in different countries could be of great interest and could bring the possibility for identification and application of best practice.

Keywords: business information, management, construction

* The complete text is available on CD-ROM / Zavrski, Novak, Mihic, Sertic

Introduction

Importance of information for the success of any human activity has been known for centuries (Dedijer, 1999) and has been the matter of scientific research for decades (Wiener, 1948). Continuous efforts for improvements in management of information can also be noticed in the field of construction. We can identify the topics of interest that have been changed during time. The era of information technology and its consequences brought a necessity to update a strategic management system in construction (Betts, 1999). The development of information technologies is required to shed a new light on the process management (Cooper et.al., 2005) which leads to the possibility for integration of business process in construction (Ghassan, Arayici, 2010). Some research simply tries to identify the practice of using different kind of hardware or software and related experience (Izetbegović et.al. 2003).

However, the essence of information needed in construction business to maintain the market position and competitiveness of the company has not been in a particular theoretical focus. Type and content of information, time of procurement, techniques of collecting and its management are attributes of interest to business intelligence (Moss, Atre, 2003), the discipline dealing with business information management, highly needed also in construction industry. The aim of this research is to create a theoretical base for analysing the practice of business information management in construction. There are two important levels of interest. The first one is related to individual construction company and the second one to the institutions, public bodies and associations expected to act as a support to the industry, mostly at the national level. Both aspects are important and interdependent.

2. Methodology for identification business information management practice

The methodology created in this research is qualitative one, based on two questionnaires that enable the observation of the phenomenon in its natural context (Eisenhardt, 1989)(Yin, 2003). The first questionnaire is to be applied on the sample of construction and construction engineering companies and the second one on the sample of institutions, public bodies and associations operating as a support to the industry.

The questionnaire dedicated to construction and construction engineering companies is structured in five groups of questions, whose content is shown in Table 1. It consists of 42 questions all together, which for that reason are not presented in detail in the paper, but partly shown in chapter 3.

Table 1: Content of the questionnaire - construction and construction engineering companies

General information on company	Market position Structure of employees General organisation
Information management practice	Information collection and management system description Procedures Staff Hardware, software
Character of information	Content Sources Purpose
Information security	Maturity of information security system
Vision of future development	Critique of existing system Vision of future development

The questionnaire created for research of business information management practice in institutions is also structured in five groups of questions shown in Table 2. It consists of 14 questions all together. The questions are not presented in details, but contextualised in chapter 3.

Table 2: Content of the questionnaire - institutions

General information on institution	Mission and Vision Ownership General organisation
Information management practice	Information collection and management system description Information dissemination system description Procedures Staff Hardware, software
Character of information	Content Sources Purpose
Information security	Maturity of information security system
Vision of future development	Critique of existing system Vision of future development

3. Methodology application and results

The methodology was applied on a sample of construction and construction engineering companies in Croatia. The sample was designed with aim to cover all categories of companies spread across the country. By their scope of activities 30 of companies were construction companies, and 9 were construction engineering companies. Ten companies participate in category of big enterprises, employing more than 500 people and creating gross income per year of more than 50 mil €. Seven companies are from category of small enterprises, employing less than 50 people and creating gross income per year of less than 2 mil €. All other companies can be categorised as medium. The total number of responders was 39 of 110 that were asked for cooperation. All the questionnaires were filled out by hand and signed by responder.

The results shown in this paper are based on the answers to the questions in the questionnaire relating to the business information management in general and to the security of the companies' own business information.

As can be seen in figure 1. 25 out of 39 respondents (64,1%) claimed that they regularly gather, analyse and store business information. 14 (35,9%) respondents say that they do it occasionally, while none of the respondents claim that they do not gather business information at all.

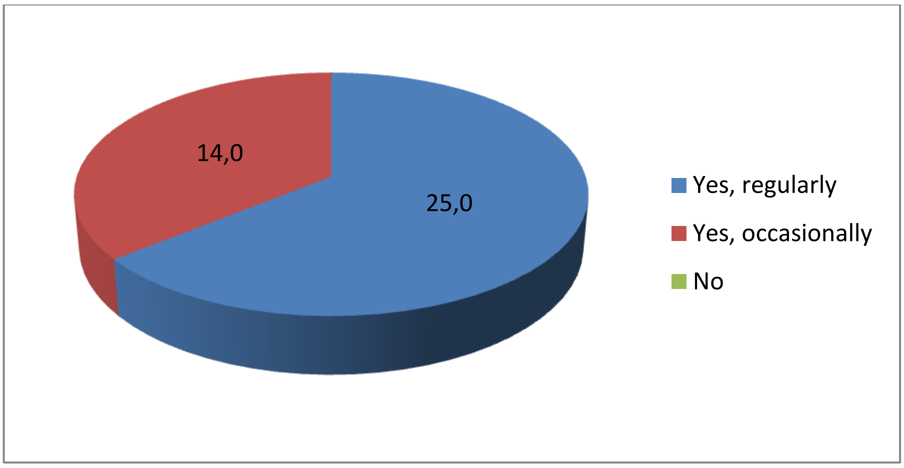

Fig. 1. The practice of gathering, analysis and storing of business information

Somewhat contradictory to the previous statements of all of the respondents that they, at least occasionally, collect business intelligence is their answer to the question whether they have a formal procedure for data gathering. 7 respondents (17,9%) do not have a formal procedure for data gathering so some further research may be required into which business information is gathered, how is it gathered and what is done with it afterwards. The majority of the respondents, however, confirmed the existence of formal procedures, whether they are regularly or only sometimes applied. Detailed results are shown in Figure 2.

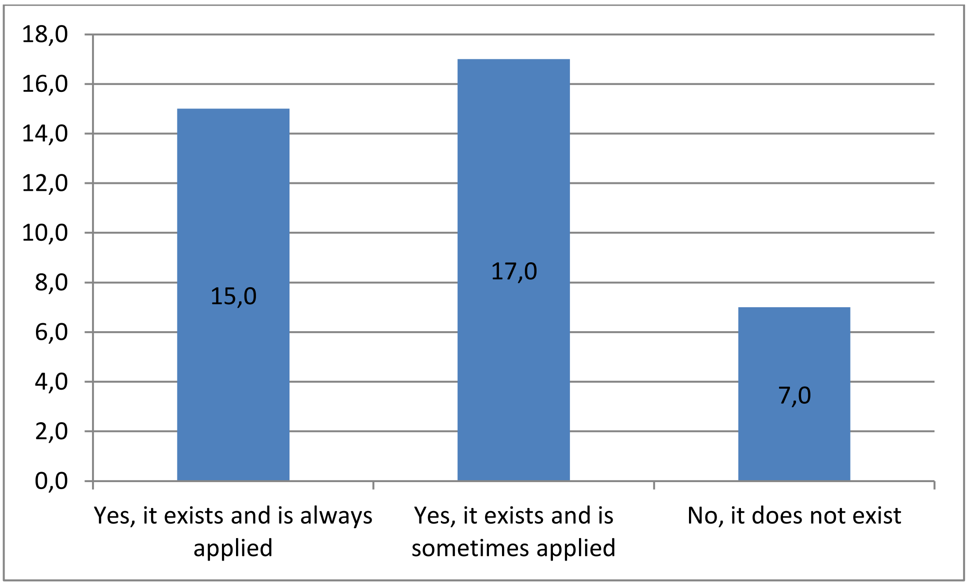

Fig. 2. Existence of formal procedure for data gathering

Figure 3. shows whether there is a separate business function charged with business information management. The results are almost equal, with 19 respondents (48,7%) saying that they have a separate function and 20 respondents (51,3%) saying that they do not have a separate function charged with business information management. The presented results tell us that at least some of the questioned enterprises have recognised the importance of business information management. Other enterprises may also regularly gather business information, even without a separate function for it, but they can certainly only do it at a lower capacity.

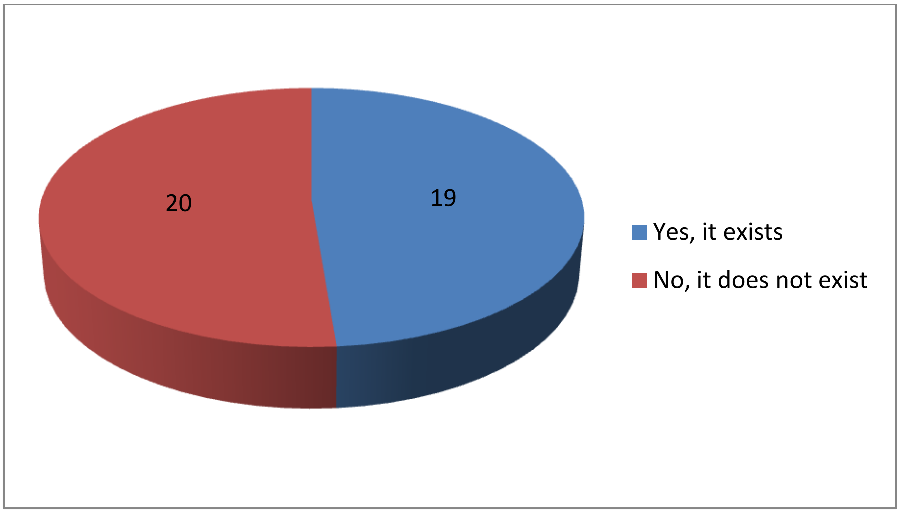

Fig. 3. Existence of business function charged with business information management

The security of business information is another aspect of information management covered in this paper. A very high majority of the respondents 30 out of 39 (76,9%), seen in Figure 4., consider the security of business information extremely important, 7 respondents consider it not so important and only one considers the security of business information not important at all.

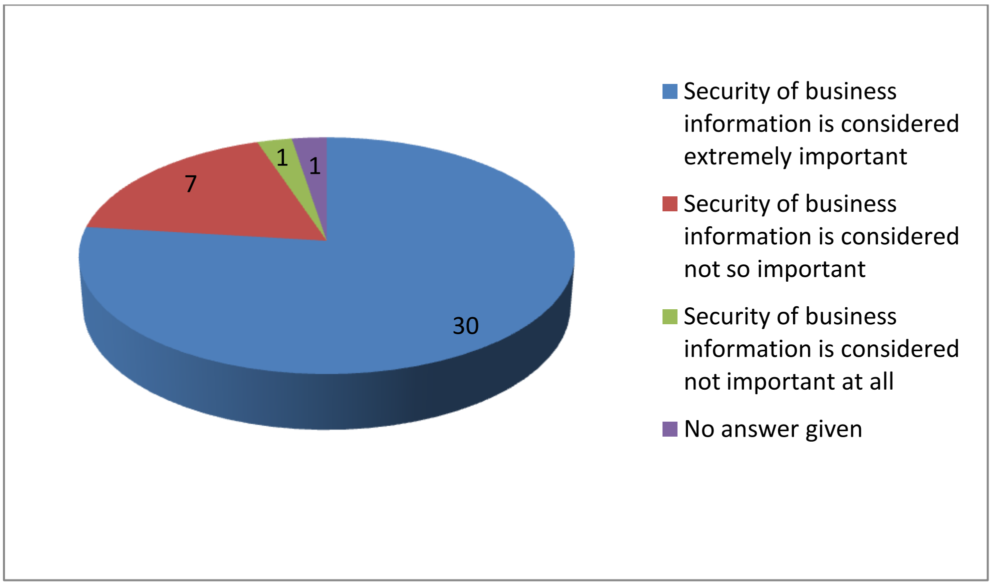

Fig. 4. Approach to the security of business information

Considering the answers to the previous question we would expect that a lot of the enterprises take steps in ensuring the safety of their business information. However, as is seen in figures 5. and 6. a very large percentage of respondents do not have a formal procedure for leak detection and a separate business information security department. This large discrepancy in their answers on the importance of business information security and the implementation of security measures is most probably due to the limited funds that do not allow for implementation of needed security measures.

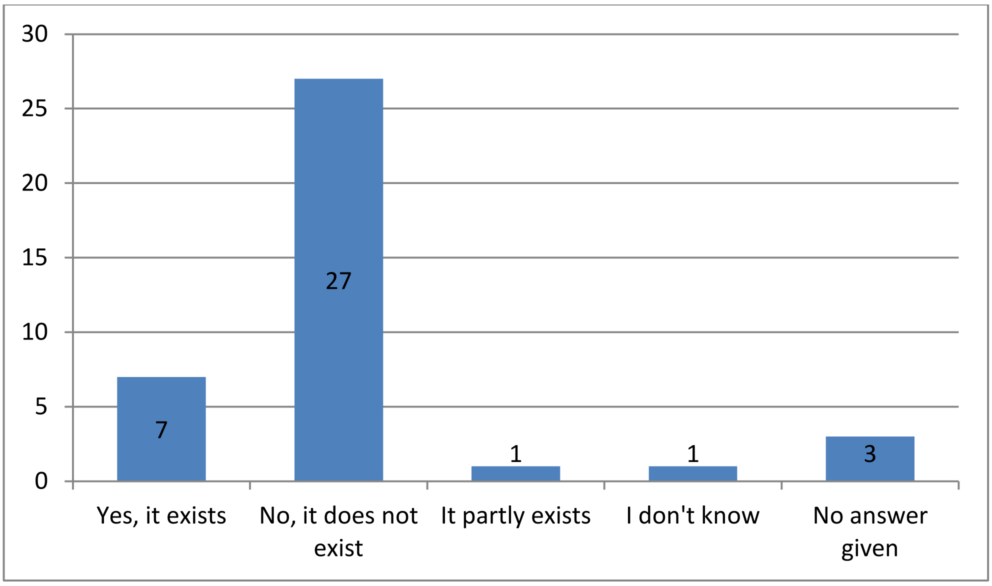

Fig. 5. Existence of a formal procedure for information leak detection

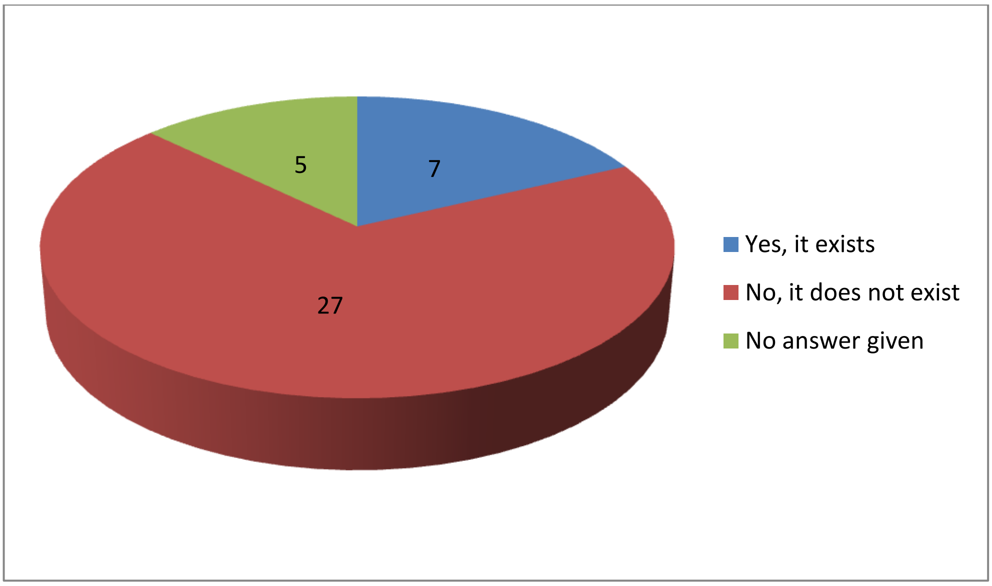

Fig. 6. Existence of business information security department

The same methodology that was applied on the construction companies was also applied on the sample of four important governmental and public institutions. Expected work scope of the studied institutions is to support the activities of construction industry and industry in general in Croatia.

From their answers, the following summary can be made:

- Information is occasionally or systemically gathered with the purpose of passing new regulations and as a service to the economic subjects;
- In most cases a separate function for business information gathering does not exist, however "everybody gathers information in their own area of operation";
- The institutions do not use professional services from outside their system;
- Dissemination of information occurs through seminars and lectures, is available on demand and through the web pages;
- Some institutions gather information from abroad and broadcast them in Croatia;

- A centralised analysis centre does not exist;
- Opinions on the assessed usefulness of information from the construction sector are mixed;
- Most consider that the system needs to be dramatically improved and are only partly satisfied with the current system.

4. Benchmarking and best practice

Although the information management system as one of the most critical for any company and national economy is usually the subject of confidentiality, it is still possible to benchmark it. The benchmarking activities can be established among the partners within the same or different position on the market, within the same or different business, inside of national boundaries or internationally (McCabe, 2001). The important prerequisite for benchmarking is the unique methodology of studying the organisation and collecting related data. Therefore it is important to establish the standardised research procedure. That process can hopefully lead to establishing the best practice for the benefit of all participants.

It is the intention of authors that methodology presented in this paper be a base for benchmarking and international benchmarking of business information management in construction. To reach this goal it is necessary to undertake a lot of next steps, which will be prepared based on next research activities.

5. Conclusions

This paper has dealt with business information management in construction industry. It identified the methodology suitable for monitoring and analysis of business information management practice in construction and construction engineering companies, same as in public institutions acting as support to construction industry. The methodology applied on the sample of 39 companies and 4 institutions in Croatia has brought the initial data on their organisational practice related with information management. The dataset from the sample is relevant and enables the comparison. However the full success of the methodology would be reached with enlargement of sample. This would be particularly important for institutions. For that reason, the next research should be focused on comparison of data, and defining the procedure of international benchmarking.

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SPECIFICS IMPLEMENTATION OF INVESTMENT-CONSTRUCTION PROJECTS IN CONNECTED AND SEPARATE FUNCTIONS: INVESTOR – CONTRACTOR*

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Abstract

According to one definition, the term project, implicates a set of activities that need to be done in a certain time with a known aim, within the available resources, with specific criteria assessment of the validity of its realization. In the circumstances of economic crisis in transitional societies such as Montenegro, project management has its own specific and different conditions, trends and consequences for consumers and society, if the function investors and concentrated in one or two separate entities. All analyzes and conducted research for the period of the last ten years[1)] presented in this paper prefer variant in which the functions of investors and performers are unified, especially if they rate criteria: quality of the project, meet expectations and customer satisfaction and future exploitation treatment facility and its enviroment. Proposed measures that have to be taken immediately, that the current negative trends neeed to be stopped does not imply mere compliance with European regulations, but a balanced approach that takes into account all the legacy and decades created errors and omissions in the development, and based on accurate assessment decision acceptable and the applicable legal framework.

Keywords: quality of the proect, the contractual price, terms of realization, the craftsmanship of overcoming conflict situations

* The complete text is available on CD-ROM / Žarković

INTRODUCTION - DEFINING THE PROBLEM

Intensive construction investment in Montenegro, in the last decade, in addition to raise the level of urbanization and partial infrastructure development, is followed by a host of failures, which is urgently needed to be identified, professionally and objectively evaluated and based on these parameters, take a full set of system measures, to those as soon neutralized and eliminated in the future.

These failures are many and are present in all stages, from determining the spatial planning documents through poor construction to exploitation of objects.

In the planning stage is often that space is unjustifiably overloaded, which later leaves irreparable consequences on overall ambience of our cities and villages.

Also further in the implementation and use of these planning documents, from detailed to regional plans usually occur numerous negative deviations in the direction of exceeding the permitted and / or the maximum allowable coefficient of busyness[2)] and index builtness[3)] , which increases the negative implications for the nature and course by comfort of life exponentially. For example, the planned abolition of the traffic ports or as one green, for the benefit of the living quarters, implying multiple problems in the implementation of the entire plan coverage area. Those variations used to be illegally legalized and sometimes everything would be erected without, the essential approval: people move in, and technically the facility never received, and institutes in the cadastre as illegal. By some estimates which are immigrated these facilities Montenegro has over 120,000.

The devastation of the natural environment and natural resources, with the creation of non-urban environment are the essence of the problem. This devastation has direct negative effects on the conditions of living and residence in these city quarters or settlements.

Then irresponsible, intentional and negative human influences, for total urban environment, occur due to non-application of technical regulations and standards in the design and construction phases. Because of this fact constructed buildings do not meet the technical standards, which is another reason to be never technically accepted, namely can not get the permission for use. Despite this terrible fact people in them live and work.

In this paper I dealt with the problems of the latter stages of the life cycle of the investment projects. There are few reasons for the selection of research in the field of construction, I accentuating the three main: The first one is of practical nature. In my twenty-year professional work most experience and knowledge I gained in the design and construction stages, both at home and abroad, the implementation of the construction of various types of facilities. Due to this fact this section is very close and familiar to me. This fact has helped me to approach the treatment of this issue objectively, as its practical participant, looking at each stage from the perspective of the immediate stakeholders and participant in the roles of contractor and investor, in their joint and / or separate functions.

The second reason is related to the fact that this is technical - engineering field, which is generated by us engineers from different vocations, either as designers or contractors. As experts - practitioners, we are often far away from various political, and forum structures, which we often recognize as the causes of many deviations from established plans and enforcement practices that are not in compliance with regulations and all for the benefit of personal and general public interests. It is also clear that against such tendencies is difficult to fight because they are characteristic of all eras and periods, especially expressed in the present and very current transitional times.

[2)] allowed the coefficient of availability of building plots is the ratio of gross floor area of buildings and surface plots

[3)] Permitted construction index is the ratio of gross developed area and surface plots

The third reason is contained in the fact that the construction investment is relatively new experience in Montenegro and therefore this area neither legally nor technically is sufficiently regulated, so possibilities, of different abuses are large and even expected. It is clear that in this sphere intertwine different, often diametrically opposite interests of subjects which realize investment projects.

2. SUBJECTS WHICH REALIZE INVESTMENT PROJECTS AND THEIR RELATIONSHIPS

Subjects - stockholders,[4)] which realize the investment-construction project are:
- Investor
- Projector
- Reviewer
- Contractor
- The Supervisory Authority (Chief Engineer and Executive Engineer)
- Surveyor
- Professional Team (society-consortium) who performs technical control
- The municipal or state institutions and public companies, which issue:
    * Building Permit
    * Use Permit
    * Perform registration of special parts of the object (registers)
- Banks that participate in the financing-crediting of certain investment projects

All subjects engaged in the execution of the investment project, passing through various contractual obligations. Harmonize them and bring in economic balance is, one of the basic tasks so that the goals of so called ''Sustainable development'' would be fully filled and to achieve synergistic effects of all subjects, in order to obtain a high quality project, which is the highest - the general requirement of any society.
Defining intercourses of all subjects, in terms of their conflicting interests, goals and tasks, leading to their frequent disputes and conflicts.
Apart from being a legal framework at the state level, mutual coordination, synchronization process and the confidence of all subjects that are engaged in the execution of the investment project, are decisive factors for the success and quality of its completion. It is important to match the aspirations and interests of all these subjects, so resultant of their aspirations and efforts would led in the direction of raising the quality of the project and its successful completion. When defining relationships between subjects subordinate to investor, almost exclusively focused on the price and terms of the execution of the project. All subjects, from investors to the supervisory authority, set achievement of sustainable deadline of construction, as one of the most important, and also the most challenging tasks in the field of management of investment projects. Because of these aspirations and interests, the question of the overall quality of the project is consequently unduly neglected. Starting with the decision to accept the investment, the investor according to their abilities real plan on the value To accept the investment, the investor according to their abilities makes plan about the value and duration of the investment, usually by empirical evidence. These plans, as well as previous and approximate, are based on incomplete data and worked often without deeper and more exact, expert analysis**[10]**. Despite their imprecision, are

[4)] stakeholders (Pocket Mentor, Harvard business-management projects), **[14],** the natural and legal persons who are directly involved in the preparation or implementation of a project, or its use. Stakeholders are always entities realize the project. Often stakeholder can be a person who is not a formal subject in the project.

often the basis for negotiation. During the realization the performer reveals all the "approximation" and "incompletes." Once the cause of all the rush of investors and lack of awareness that is good preparation guarantee for, successful completion of the project. However, once this is done with intent. Because of the imperative desire to achieve the best possible economic results, investors do all that those funds be as small as possible, realizing that shorter deadlines, and the quality is, by definition, with these factors directly inversely proportional.

The latest developments in the past three years, in Montenegro, with last year's floods and last snow, have shown that it is not a quality level of a significant number of our facilities. Blown and collapsed roofs, awnings, facades, damaged terraces, bridges and roads, discovered all the irresponsibility and incompetence of individual and total, all subjects that are realized by them. Besides the state, the biggest culprits for this are investors, contractors and its inspections! What will happen during the next earthquake, it is terrible to predict!

All conducted studies and research on the most damaged buildings show the following:

- Conceivably prevail objects which are implemented by investors and contractors in separate functions
- Performers were mostly new society, without significant reference, some had no license to perform, but they are "covered" with a major contractor licenses, which fully performing confided such societies through subcontracts.
- In most cases, the function of the construction supervision has low quality and was irregular, in the sense that the control was not permanently present on the sites. In some cases, several companies conducted by the construction supervision, and between leaving and entering the first new recorded the time intervals of a few months to more than half a year.

Clearly outlined liberal of the state institutions in Montenegro and passing bad legislation allowed such behavior and practices, which produced low quality construction.

According to statements by the majority of reference, quality is the main feature of each project

All present wish and desire to maximize the shortness of duration of the project, with insufficiently defined and vague domestic legal framework, with the help of protectionist-tendentious help and "participation" bureaucratic apparatus, contributing to the final biggest loser on most projects is fine.

If the contractor - the company which exclusively performs works for the client, his situation can be very difficult when both coincide in this circumstance.

Evident and identified gap, intentions and interests of investors, customers and the community resulting in unsatisfactory quality of construction and the unsatisfactory quality of architecture and urbanization of our space**[7]**. The desire and need for technical and aesthetic quality on the one hand, collides with the desire and intention of the lower cost of construction, design and comfort, on the other hand. Also, the desire and the need for greater economic development and standard conflicts with the wishes and needs of the nature preserve and not to damage **[6].** During these struggles, different interests and contradictions, a place reserved for users and society as a whole in the stages of planning, design and construction remain empty. Therefore, it seems to me that essentially important that decision-makers understand that they must create the environment that the interests of investors on the one hand and agree to bring balance to the legal users and society as a whole, on the other hand. It is necessary to create an environment that the interests of all parties are jointly and that all the subjects of interests referred to in the same direction. Address of this direction should be the quality of each project and the total of all projects as a harmonious complex, which create our streets, towns, quarters, cities ...

For the beginning , you need to create a new law on physical planning and construction of buildings. Creating a new its necessary to raise general awareness of shared goals and responsibilities. It is necessary to have a realistic, detailed and applicable law with a strict code of ethics and regulations. Situation and the importance of this area are such that our citizens, professionals, trade associations and non-governmental sector must be involved in solving them. The biggest problem is and will represent a corrupt political and entrepreneurial interests related clans, who create our ambience according to their wishes and needs, not the needs society altogether. If the society manage to fight for the elimination of their influence, the faster we will feel the order and progress, not only in this area.

2.1. DEADLINE-CONSTRUCTION, CAUSES OF QUALITY IN REALIZATION OF INVESTMENT PROJECTS

It is difficult to classify the most important and align all the phases of the project life cycle. If we would choose which phase of life cycle[5)] has the most variety, most diversity, most key stakeholders engaged, most of the material and financial resources and the direct perpetrators, it is unrivaled execution phase of the project task, popularly called the construction of the facility. Execution of the project task is also difficult to standardize, each location, each project is like a living being with its specific characteristics and predispositions. Each must be approached individually, taken with a special treat, planned and calculated after. Missed time and allowed inaccuracies and errors in one stage, very often it is impossible to fix in one of the next phases of the project life cycle.

At this stage of the life cycle of every construction project, execution time is one of the main tasks required to meet the project team.

The achievement of schedule crucially affects the main contractor and subcontractors second course. So their choice is very demanding and responsible decisions, often opting fate of not only the date but also the quality finished project. Due to this fact and avoiding the evident risk, many investors - construction companies deciding to independently carry out a construction project implementation. In these societies the roles of employer and contractor are combined. Many companies like those existed for many years and have been specializing in this business. However, most investment projects in Montenegro Investors realize who, for implementation of a specific project , on the basis of the Agreement on the application realize project, with one or more companies that have a group of construction workers. In this case it is particularly A significant problem of monitoring the dynamics of previously established works, for which very often caused conflict situations and problems for contractors in terms of financial sustainability of the contract works.

A significant problem of monitoring the dynamics of previously established works , for which very often causes conflict situations and problems for contractors in terms of financial sustainability of the contract works.

However, mostly performers place themselves in a situation that they have to work and act in an extremely short period of time. Why?

In this time of crisis, finding it in the gap: the lack of jobs and high competition, they consciously accept these unrealistic conditions for contracting. Investors too optimistic set

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[5)] In the literature, different authors define the different stages through which to realize investment projects. I prefer the division into four investment stages of their implementation:

- project idea and previous analysis of eligibility
- planning of investment project: making investment and technical documentation
- construction project of
- checking and completion of the project, I.E. the creation legal and technical requirements for the submission of final products to future customers

Each of these phases has more sub-phases and subprojects. The realization of these phases has its own characteristics, if it realizes one entity, I.E. a construction company, which is an investor and a direct-actualizing performer given project.

deadlines of completion of their projects, with strict contractual sanctions for their punching, wishing thus reach earnings. Contractors without any objection and thoughtless, in fear that as contractors could be refused to accept the proposed, adverse conditions in the contract documents. If this problem adding the inevitable unforeseen factors, then their problem multiplies **[12]**.

Mostly, problems arise because the same reveal late, barely at stage of performance, and these are usually: inconsistency and being left the project documentation, modifications of design solutions by orders of investors, failure to provide all the conditions for a safe and smooth construction, irregular funding, etc. The event is unforeseen circumstances due to the influence of politics and its holder (the public and facilities owned by the state), changing local conditions, unresolved property rights, also sudden problems with financing, climatic conditions, poor organization, changes in design conditions for a variety of reasons, shortages of certain materials, equipment and etc. **[12]**.

In all the previously stated reasons, the most common is that performer, as a service provider, the subject of all, has the most damage. For contractor in each of the previous reasons costs are increased, it is inevitable punching set deadlines, along with all the other chain disruptions and costs.

The contractor is forced to try to make up for lost time with no extra final period end, of course, if the contract is not secured to the consequences of these unforeseen circumstances, so that it has the right to postpone the deadline. In all other cases, the contractor comes in a situation in a given

contractual term, perform the contracted work, and also the ones left over from the previous period. This can be achieved by shortening the deadlines for future work (those who remained unfinished).

The motives of investors to require tight deadlines are different: they may be politically motivated, that on the occasion of an important historical date or planned election results, pre-fix date of completion (when the state or local communities are investors). It can also be economically motivated, the shortening of deadlines to reduce construction costs, and return on investment is faster (when investors are private individuals). Motives are often of psychological - ongoing marketing nature**[14]**.

On the other hand, the performers in similar problems, although these problems are different in character. The aim is to complete the building in time or with as little additional costs because of the inevitable breakthrough period. Short deadlines require the introduction of shift work, further recruitment of new workers or Subcontracting. All this increases costs, doesn't conduce increasing of productivity, as often increasing number of employees complicates the execution of many processes and phases of work, as proportional and linear, does not contribute to the shortening of deadlines in relation to costs.

Certainly the question of the agreed price and contractual sanctions are in direct function of choice for solutions that the contractor will decide , in order to solve the problem of short term. If the price does not give much room for taking quality measures (increase in number of employees, shift work, the introduction of additional subcontractors), for performers are problematic situation, in which by the rule the quality hurts of the execution of the contract works. This further, multiply the problems of communication between the control and the investor on one side and the contractor, with its sub-contractors, on the other hand.

The best possible option that the contractor can choose a contractor in these situations is to increase the organizational and production functions in order to raise the level of productivity at the highest possible level. Occasionally, this measures is necessary to combine with the replacement of project materials, equipment and structures, on the other that will take less time in preparation, installation, assembly, and achieving projected or binding strength, thus enabling faster start next position papers and etc. Of course, for this require the consent of the investor and / or his supervisory authority, and if the changes are drastic and relevant

municipal or state institutions also. All additional costs of designing and agreeing, by the rule, are the contractor's problem . Certainly he's the one who needs to assess whether it is worth it, if everything is rational to achieve the previously accepted limit?
The final and least popular, and dare I say the worst option is that the contractor gets into overdraft, thus causes contractual sanctions, and that this amount compensates the greatest possible reduction in construction costs. This approach inevitably influences on reducing the level of quality, which is necessary to have in mind. However, often in practice contractors opting for this option. The most common amount of criminal sanctions for exceeding limits in practice amounts to 2-3 per thousand for each day of delay, and usually is limited to 5%, sometimes reaching up to 10% of the total value of the contract works.
Management contractor makes the final decision on how to proceed and which option to give a priority in each case. Once economic and technological reasons are not decisive. Often the contractor submits his decision to the expectations of investors, despite financial indicators. Often make different decisions for the same cases and situations, on different projects. And this proves that every project is a case for iteself and each must be individually accessed. All the relevant factors of the project and the consequences of missing deadlines, the management contractor compare, analyze and select the option that likes all the time suits. It is difficult to unify and advance to prescribe optimal and universal method or the method of choice of such decisions. Of course, there is no decision which is selected without any risk. Analysis of the World Bank from 2010. show contractor literally undetectable to lose about 12% of the total value of contracted works on behalf of small and costly consequences of individual failures and losses. **[13], [21],**
Taking into account this fact, it is clear what the artist means an additional loss of 5 or 10 per cent due to the delay. Profit is the long-lost, the battle for the lowest possible loss is started! Taking into account the additional load, which according to the regulations and instructions FIDIC [8] or PRAG apply, then the full weight positions the Contractor, in the business environment such as the Montenegrin:
1. The Contractor shall publish a bank guarantee to the investor advance payment in the amount of 1% to 2% of the total value of the contract;
2. Guarantee of good performance is 10% of the contract value. This guarantee Contractor must submit before starting work or his investor takes the first advance payment. Refunds Contractor expected (if the investor estimates that the well finished all the works) 45 days after his Investor certifies that it has accepted all the work;
3. Guarantee for works within the agreed period is whole 10%. The funds on the basis of these guarantees in the amount of 50% Contractor returning after obtaining a certificate of completed works, the other 50%, only 45 days after the expiration of the warranty period;
The application of these rules in terms of the absence of other legal and technical regulations, the efficiency of the institutions and the state court, and the entire legal system, it is very risky and disadvantageous for contractors in Montenegro. Also, the level of contract prices, where earning from the start is negligible, leads contractor in extremely difficult situation. If we add, no education of the most representatives of investors and supervisory authorities which apply these rules often do not consider professional, in principle, even ethical, then the position of the Contractor, in such contracts is reduced to extremely dependent and subaltern.
Also, to contracting company to operate successfully it is essential that the dynamics of the cost is in line with the dynamics of charge of construction. Otherwise, coming to a halt, reducing the effects of workers and unnecessary additional costs. Respect the deadlines in the implementation of projects for the society is extremely important, because in addition to avoid the agreed sanctions (faster construction within), the society on that way, provides secure and fast payment. Still the most important is that it contributes to good references to society that respects the contractual deadlines.

It is clear that all is not dependent on the quality of the Contractor, as irresponsible and / or insolvent investor can bring in a good Contractor bad position.
The question is, how it looks if the contractor is at the same time investor?
Responsibility for the quality of work, deadlines, necessary, contingent and other extraordinary expenses due to these and other reasons occur, fall in this case, the burden of FIC-Contractor. This fact complicates on the one hand position of FIC-contractor, while the other gives him a greater chance of creating the building, discretion and a real impact on all streams and executing plans.
Investor-contractor also has the advantage of being completely governing all situations and details of the project, has all the relevant information and have direct contact with all known future users ie customers. Certainly this is a positive position, but it also inflict full responsibility and obligation for all the failures, mistakes and shortcomings to all other subjects of the project.
In situations when incorporates FIC and the Contractor, the investor must have a good organization of the company and its necessary professional qualifications. These are societies that have been formed to deal with its long-term profession, not those formed an "ad hoc" to complete a project, and further, "we will see what and how." For this reason, they have developed and streamlined ways of working: good business relations with relevant institutions, banks, suppliers of materials, equipment, subcontractors specialized for specific tasks, etc. Due to these facts, the projects that they implement as a rule have a higher quality than those built Performers on orders Investor.
Also in such situations Investor-contractor has fewer options for calculations, avoiding the transfer of responsibility to the contractor, and that his situation requires greater control and increases the responsibility and obligation to fulfill and respect all norms and rules of execution of investment projects.
On the other hand, all of the research and analysis of the financial effects of the business, current crisis years have shown that to the investor is not economical to build by himself, but to include contractors. In such situations, as a rule, the deadlines are smaller, responsibility to other entities incomparably smaller, the risks are also lower. Such a situation also affects the increased competition and a significant drop in prices for services contractor, which caused a general economic insolvency as a result of the Great Depression.
The biggest winners of the merged role Investor-contractor the quality of the project, users and ultimately society as a whole.
Because of this state institutions to the creation of a legislative framework had to constantly contribute to and stimulate the investment mainly engaged in the construction of such a society. The Montenegrin society, unfortunately these positive intentions, the reference group of companies, is still not financially valorized. The crisis has further encouraged a tendency to a crucial role for the election to the Contractor, and real estate prices are, not their quality!
Unfortunately, this research has confirmed, that the EU institutions, which in many ways funded projects in Montenegro, as the primary, use criteria of lowest price when choosing the contractor.

3. SYNCHRONIZATION PROBLEMS OF MANUFACTURING PROCESSES MORE SUBCONTRACTORS

What is practical the main problem of successful completion of each project, especially investment and construction, when the dynamics and quality are concerned, is the synchronization of production processes more entities (subcontractors).
This also applies to cases of separate and connected functions investors and contractors.
Due to the aforementioned facts projects are often not implemented on schedule. The main

reasons for this are as follows:
- Lack of preparation and efficiency of subcontractors to comply with their contractual obligations
- Delays in delivery of materials and equipment in relation to the planned and agreed frequency of work performed by subcontractors
- Weak effects, mostly due to a lack of supervision of specific offender - Subcontractors
- Internal problems of financing subcontractors (pay its suppliers of materials, payment of wages, etc.), due to lack of working capital, especially when the developer investor and / or the main contractor, currently pays mostly by compensation performed works, instead of money, real estate construction, often on the same project, or object that does not yet exist.

This last factor is the most important, in terms of impact and possibilities of positive investors action or main contractor and his team, from the moment of identification of problem to opportunities and ways to overcome them. What is very well known in the literature and these studies also proved to be a major and insurmountable problem: It is impossible to affect the negative trends of the perpetrators when the main weapon (payment) out of hand the Chief Project Manager.

Conclusion: The only imposed situations (when there are not available circled funding for implementation of the project), are to accept compensation arrangements with subcontractors [20], [21].

Besides deadlines, due to the inability of real influence in these contracts (which is a way of paying compensatory payment), usually falling quality of the works.

4. REPERCUSSIONS OF ECONOMIC CRISIS ON THE COMPANY'S BUSINESS IN ROLE OF THE INVESTOR-CONTRACTOR

The research results show another anomaly when it comes to comparisons investor-contractor in the merged or separate roles.

Because of the economic crisis, and the drastic fall in real estate transactions, all investors-contractors have experienced greater impact than investors who are contractually hired contractors. Slowness in adapting to new conditions and organization of the investor-contractor now became for them a new problem and the additional burden.

Any investor who is not performing construction, generally has a lower structure of employees in the company. He did not have the technical resources, construction machinery and equipment and halting further investments didn’t have many problems as Investors-contractors had . Investors-contractors had to take care of their employees, which were material and moral burden in terms of idleness. Construction operations, machinery, equipment required the storage, preservation and storage to a new use. If the case of funds purchased through leasing, or through other credit sources, their preservation and disposal is a further burden to society: Investor-Contractor, who had to regularly pay its financial obligations to creditors, and the income from those funds had no longer. There wasn’t any work for the operators but the funds and equipment need to be maintained. All this requires additional, necessary expenses.

In this way, the investor-contractor spent on maintaining a healthy capital costs of employees in the company and costs for maintenance of equipment and other resources. All that couldn’t employ their capacity in any way, and were move inert in making unpopular decisions: redundancy of employees and reducing their costs are exhausting for their material and financial reserves and thus weakened. Of course it is not easy to suddenly turn off some or all of its technical and craft personnel that has been getting used to certain terms and conditions for many years.

These are the most difficult decisions for each of the executive directors of the company, in this case, general manager of the company, which is engaged in construction.

It is very difficult to create a capable and good working team, it is easy to lose and the most difficult to regain again.

The crisis has had a less favorable parameters and greater intensity, than anyone had been announcing. Obtaining performing jobs is more difficult. Day by day the competition is growing, performing prices getting lower, and enter the new investment was and still is extremely risky. Because of these circumstances, relationships and interests of subjects that realize an investment project to further intensify, get new forms and are often opposed. Also, relationships and interests of subjects projects and the community as a whole, and especially the future users of the new property, acquire new dimensions. This adds to the fact that the crisis has encouraged operators for savings, reducing costs and achieving shorter deadlines for implementation. These situations cause disputes, conflicts and different dissatisfaction, which, due to lack of organization in any legislation seeks justice and his sense of rationality.

5. CONFLICTING INTERESTS AND EXPECTATIONS IN RELATION: INVESTOR - USER AND INVESTOR - SOCIETY

Economic challenges that have always faced the construction sector include growing global competition, the need to raise standards of performance and in the reduction of costs **[1], [4],** shortening deadlines and the like. Currently on stage is global free market, that with standardization of products and technical technological progress promotes the interests of large companies, which largely does not suit the interests of ordinary people.

The investor has the priority aims: the realization of investments in the expected timeframe, cost and quality arising from the budget formula, which are at function of the minimum cost and maximum profit potential. Therefore, the interests of the investors targeted towards the realization of these goals at all stages of the life cycle of the project and significantly different from those of future users. They are often they directly threatened!

To over costly, risky and often sluggish process of realization of a particular investment project were protected interests of the investor and future users, and the overall society, there must be good quality, of the legal framework, in which all phases of the project will be under the control of the waking, some or more subjects . Montenegro's legal framework is far from quality. Lack clear and stricter sanctions for all entities that violate its powers and jurisdiction. Even those that are prescribed by existing laws, the practice does not apply. With us, all written conduct is not an easy waken up task to carry out if you take into account our stable and traditional habit in Montenegro, that provides its not necessarily to apply the rule. System of subordination and quality control has not yet been precisely established yet. The key is to strike a balance between private interests of investors and their responsibility to consumers and society. Harmonized, transparent and unbalanced regulations can only benefit one or several subjects. According to the present state of at least protected and disadvantaged in terms of fulfilling the rights and interests of are users, ie customers and society as a whole. As I have already said the current "Law on Spatial Development and Construction of Structures" Official Gazette of Montenegro, br.51/08 of 22 08th 2008th years, with amendments, the February 2010th year **[9],** there are many ambiguities, contradictions and shortcomings. Generally it does not direct the regulation of construction to total quality, but mostly by the quality of the individual parts. When we look at the interests of the subjects, the law suits to banks and investors.

It is clear that the protection of investors and the protection of customers and users require different, often opposite measures. The best protection of to achieve are clearly and thoroughly defined levels of competence and responsibility.

In this sense, it is necessary to do and adopt a new law in the spirit of the development strategy of Montenegro as an ecological and tourist destinations of the country **[19], [22]**. Negative experiences and problems which are recorded in the previous practice must be

eliminated. Risk of customers from irresponsible actions of investors, contractors and supervision, or who do not complete the facilities as a whole or complete in accordance with project documentation and the regulations in the field of law and civil engineering, must be avoided or secure.
Supervision must be supervision in the full sense of the word. He must answer for arbitrary changes to the construction by the regulations, policies and technologies. Supervision must be on the property permanently, and not sometimes to just "certify" records.

6. IMBALANCES OF RELATIONSHIP BANKING SECTOR TO THE INVESTMENT CONSTRUCTION IN MONTENEGRO

One of the main factors that has generated the strongest expansion of construction in Montenegro, from 2003rd by 2009. he was the banking sector. The same sector was the same expansion struck hardest hit early and 2009th year, their diametrically opposed relationship.
Liberal and extremely simplified way to credit, dramatically fueled investment cycles, which at the beginning of the economic crisis abruptly halted.
Ethically and practically, foreign bankers are directly to blame for the huge proliferation of all kinds of buildings, quarters, towns, and for their incompletion, canning. Bankers are without valid criteria, easily approved funds, driven by profit greed, that unilateral blockades many investors condemned to decay.
Thanks to banks construction and building industry represents the most significant driver of economic development of Montenegro, in the first eight years of this century. According to published data **[11]**, the participation of construction in GDP, depending on the overall level of economic development varies from 5% to 10%. But much more important is the fact that 1% increase generated by the construction and building industry, could result in GDP growth from 1.4 to 1.6%, depending on the level of economic development of the specific country.
According to “Monstat” (Montenegro Statistics Institute): The value of construction work performed in the 2005th year was 84 million, which was a jump of 40% compared to the previous year, to 2008th year reached a value of 285 million. This represented a record, almost 10% of the gross domestic product of Montenegro.
Probably, we will wait long to repeat and achieve these records. In most, bankers jumped unjustifiably blocking operations of the construction sector, of whom up to this time of crisis would collect large funds on the basis of interest, traffic and so on.
Table of macroeconomic indicators of Montenegro in the period since 2000. to 2010th year **[3]**, vividly demonstrates the effects of the economic crisis that has virtually paralyzed investments in Montenegro. Those indicators were largely the consequence of irresponsible banking sector, which were cheap rates from 12 to 16 percent, plus “Euribor” rates from 1.3 to 4.5 percent. And such conditions would be for many investors and builders were more salutary of bankruptcy, but no such conditions bankers did not approve of most applicants.
Of course, our government is guilty as its neo-liberal concept of permitting that with our economy and construction agents by commercial banks, in this way they play.
From mid-2008. the commercial banks in Montenegro are introducing new rules of business. For investment projects term project financing, except for five "pilot" projects of the Austrian Erste Bank, was never implemented in Montenegro!
Until the end of 2008. year, we could get from our banks funds with mortgage guarantees worth 1.5 to 2 times higher valuations [6)] of the amount of those funds. Since 2009. The bank introduced builders, in a literal sense embargo on approving new ASSET RATIO.
Later, in order of their advertising campaigns formally published downloading embargo but all seem to not approve anything to anybody. Draconian administrative measures are discourages for applicants, by raising interest rates, increasing bureaucratic procedures to

ridiculous extreme demands that have to provide cash collateral in the amount requested amount.
Who could ask for money as a loan with high interest rates if you already have somewhere as a deposit?
The most common basic package of documents, from bank to bank between is from 25 to 32 different required documents, budgets, programs, studies, assessments.

Each bank leaves itself the right to require further and requested additional evidence and calculations, so that the number of these documents comes in some cases up to 40 digits! [7)]

6.1. OVERVIEW OF REQUIRED DOCUMENTATION HEEDED FOR FINANCIAL ANALYSIS AND EVALUATION QUOTE APPLICANT FOR THE APPLICATION OF COMMERCIAL BANKS IN MONTENEGRO FOR APPROVAL OF FUNDS:

1. ¬ Status documentation:
1.1. The decision on registration of CRPS;
1.2. Excerpt from the statistics;
1.3. OP form;

[6)] Estimates are doing authorized Bank's experts. Non-market values of mortgage real estate grew from year to year, and after the example 2009. year, again not market were downed from 2.5 to 4 times as compared to 2007. year. This is also proof that the banks because of goals artificially dosed economic parameters and finally led to the crisis.

[7)] For the purposes of this study, I have been analyzing the credit rules and norms of the largest banks operating in Montenegro, as follows:
- NLB Montenegro Bank
- Commercial Bank Budva
- Erste Bank
- Hypo Alpe Bank
- CKB

1.4. Specimen signatures;
1.5. Statute of the company;
1.6. The decision of the Public Revenue RCG Tax identification number (TIN)

2.¬ Application for approval guarantees that contains the following documents and information:

2.1. Basic data of the applicant (name, address, legal status, bank account, registration number, activity code, contact information);
2.2. Description of the activity in which the client is engaged;
2.3. The amount and type of required guarantees;
2.4. A brief history of the clients with the described activities.

3.¬ Management decisions on borrowing under the Statute of companies

4.¬ Financial indicators:

4.1. The final bill for the three previous years and the section on the day of submission of request (Balance Sheet, Income Statement, Statement of cash

flows);
4.2. Analysis of buyers and suppliers on the date of application
4.3. The stock on the date of application
4.4. Table maturity (attached)

5.¬ Statement legally related persons companies and founders
(Given in the appendix)

5.1. Questionnaire on client business
5.2. Information about the legal entity
5.3. Data on fixed assets
5.4. Details of the company
5.5. Data on the market and competition
5.6. Data on customers and suppliers
5.7. Data on banks and leasing companies
5.8. Explanations movement position in the final account
5.9. Information about investments
5.10. Information on Frozen accounts and litigation

6.¬ List of real estate without the burden and constraints, in order to establish fiduciary or lien as Provision of guarantees

7.¬ Estimate of real estate by the Directorate for real estate appraisers certified

8.¬ Investment program (Business Plan)

9.¬ Questionnaire on the business customer (given in the appendix)

10.¬ Confirmation of realized payments from other banks
(If available)

Each bank writes the following notes: If necessary, the bank will ask for other documents from which will determine the facts relevant to the approval of the guarantee.
Despite this voluminous administrative legal and technical procedures and vast business and investment, which the applicant must conduct, that would even have to apply for approval of funds, banks have the largest number of applicants in the construction sector responded negatively. I am not able to obtain data from commercial banks operating in Montenegro, the number and value of (un) authorized funds. Justifying with a trade secret, they all told me that there are approved very little or no such requests. As they say about the order of their exchanges that currently gives up on the construction sector in Montenegro **[23].**
I wonder what they thought of the same exchange when their branch in Montenegro literally raced builders to borrow from in 2002. by 2009. year?
Also, I wonder why our Central Bank of Montenegro and the relevant government ministries are not able to predict or announce such consequences and why any measures have not affected the mitigation?

7. CONCLUSIONS

Frequent changes in the legislative frame[8)], changes in market and socio-economic conditions, with all the negative consequences of the Great Depression: failure to fully its law duties and responsibilities of the state and municipal administrations are general and external problems faced by operators of investment construction.

And with this work, through carried out research is confirmed in the literature known fact, as far as the implementation of investment-construction projects is demanding, important and complex activity. Its proper and good legal and normative arrangement are both for the individual and society as a whole **[2], [5].**

We all know how important it is to live in makeshift dwellings, ride and walk through the comfortable and safe roads have organized European cities and towns. Much detail, factors and techniques that determine the quality of all segments of the field. Montenegro nowadays has a lot of quality personnel in the field of civil engineering, legal and other ancillary professions, which is necessary to urgently mobilize in accordance with previously adopted strategy development, through all the authorities and institutions, on the basis of past experiences do new legislation and legal framework in order better way. Increasing the number of employees in the relevant inspection services, that must provide a complete, public insight into the application of legal norms, is also a priority. The participation of NGOs, citizens and all trade associations in the negative forms of devastation of our space, our greatest resource, it must be significantly higher.

Montenegrin society has not yet found the optimal solution for the investment activity. The key is that there is no effective government or their own institutions and devising mechanisms that are necessary in this area, because it is unequivocally clear that the current does not fully correspond to their tasks. What evidently missing are:

- State Development Bank, that financial flows would channel into the development of infrastructure and promote healthy and stable development of companies.
- Efficient and equitable justice system, which introduced job security and fairness.
- System control and monitoring for consistent implementation of all obligations of each subject to realize each investment project.

In this sense, the debate on the achievements of the construction sector and the construction industry in the coming crisis or post-crisis years would be focused on qualitative, rather than quantitative indicators.

The quality in Montenegro is unfortunately what is not mentioned enough!

Neither our profession talks about it enough!

Our space is very limited. Especially the space is limited that is of interest to investors. If the society allows its "concrete" and still devastation, so-called.

[8)] In Montenegro, often amended the Law on Spatial Planning and construction of facilities:
- The existing law (Official Gazette of Montenegro br.51/08), adopted 2008 years ...
- Two times were made amendments to that law in 2010 and 2011 years
- Engineering Association of Montenegro prepares new draft Law on Amendments invaluable importance **[2], [5]**.

"Budvanization," the consequences will indeed be difficult or impossible to predict and even harder to fix.
With poor infrastructure, lack of elaborate planning documents and a lot of problems in the implementation of existing ones, the protectionist policies of local administration rights of market competition, the quality is not there and is not possible.

In such a chaotic environment functions of public and general interest is often beyond the influence of any subject **[1], [3],** which would be about to take care and adequately protect it.
All these negative trends, in the final have multiple negative effects on the design of our space and life in it, and all the most obvious and most transparent observed from the perspective of the subject, which also performs the role of investors and contractors.

Investors in Montenegro realize their projects, not only without odds which are used in the world of so-called. project finance, but in this time of crisis, they have no access by objective conditions of bank loans in the literal sense!

Interrelationships and often conflicting interests of subjects that realize one investment project in Montenegro can harmonize, reconcile and bring in economic balance, which will encourage them to genuine cooperation the new Law on Spatial Planning and construction of buildings.
We do not need too much research, taste or earlier inherent innovation with new legal solutions. Should be used in practice, tried and tested Western European practice, and also experience similar conditions, which has, for example Croatia, which is like Montenegro a tourist destination, which has managed to rebuild infrastructure, not allowing the devastation of their area, what happened to us **[15], [16], [17], [24]**. Certainly based on similar experiences and conditions to look for rational solutions. I have already said previously to eliminate the influence of tycoon-political clans, otherwise, we will get something already seen: the new solution will be worse than the previous incumbent. Montenegro has gone through this absurd situation, that at the time the largest investment wave, the state instead of increasing control and raises the criteria, doing the opposite. It made them weakened.

What did we get by applying such a law? **[9], [18]**.

We got a situation where the profession and knowledge, are not did not dominate. Dominant is money. Dominant influence on the state and municipal competent institutions. In the final, everyone in Montenegro know that investment by building at least deal with professionals: builders, architects, engineers, managers. It is clear that this was done because of personal interests and motives of their own individual interests and, to this
sometimes, profitable business, the easier it approached those who want to profit, while in the other European countries would have no rights. Certainly not in such a way **[7].**

It is absurd that according to the Law on Spatial Planning and construction of facilities, such as main control can perform the function of the main contractor.
So: Contractor control himself?

It’s not familiar to me that any other country of the former Yugoslavia, has this bad law. Its effects are already being felt, and as evidence and eternal monument of bad law and bad relations between the state towards its citizens and future generations, as our settlements along the coast, in Žabljak, around Podgorica, etc.. Budva is the most striking evidence that the users as one of the subjects of investment construction, were absolutely neglected and forgotten. It's not that short. Not even a year or two. Decades long chaos, in which many foreigners warn us, but we do not have the strength or will to fight for the rule of law which is dominated by the quality of life, not the individual, and the current profit, which does not leave any crumbs to future generations!

Due to this situation the development and definition of the relevant topics of our society must devote much more space, importance and attention.
It is necessary to set a general goal that future development is a function of the quality of life, rather than operational profit. The role and responsibilities of existing and new - future investor-contractor, must be highlighted and emphasized, as this research has confirmed that these companies promote quality. On the basis of such quality are increasing urban, social and psychological factors of individuals and society as a whole.

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HEALTH AND SAFETY CLIMATE PERCEPTIONS AMONG EMPLOYEES IN CONSTRUCTION INDUSTRY IN REPUBLIC OF MACEDONIA*

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Abstract

The aim of this paper was to explore health and safety climate perceptions among employees in different work positions in the construction industry in Republic of Macedonia. Three aspects of this construct were in the study focus: perceived management commitment to health and safety in the workplace, perceived health and safety inspections rate and accidents frequency, perceived site workers commitment to work health and safety.
It was hypothesized that skilled workers perceived management staff as less committed to work health and safety, noted health and safety inspection as rare and accidents as frequent and perceived co-workers as more committed to work health and safety compared to civil engineers and clerical employees.
Sample consisted of 156 employees in construction sector. Health and safety climate was measured with 12 items assessed on a 5-point Likert scale. Results showed that perceived priority of work health and safety depends on employees work position.

Key words: Health and safety climate, construction industry, Republic of Macedonia.

* The complete text is available on CD-ROM / Žileska-Pančovska, Blaževska-Stoilkovska, Mijoski

Introduction

Health and safety climate refers to employees' perceptions of the priority of health and safety in the workplace. Precisely, safety climate denotes the degree to which employees believe that true priority is given to safety performance (Cooper and Phillips, 2004). Safety climate is also noted as perceived procedures, polices and practices related to safety in the workplace (Neal and Griffin, 2006).

There is an evidence that positive safety climate is strongly associated to involvement into safety behavior - safety compliance and safety performance (Griffin and Nail, 2000), that is related to higher work satisfaction (Gyekye, 2005), perceived organizational support (Gyekye and Salminen, 2007) and organizational commitment (Tao et al., 1998, as cited in Mearns et al, 2010). It was reported that long tenured workers had more positive safety climate perception than short tenured workers (Gyekye, 2006). Also, there is an evidence that positive safety climate is connected to lower rate of accidents and injures in the workplace (Cooper and Phillips, 2004; Griffin and Neal, 2000; McCaughey et al., 2013, McConagle and Kath, 2010; Neal and Griffin, 2006), as well as to lower risk perception (Rasmussen and Tharaldsen, 2012).

This construct, as stressed by Cooper and Phillips (2004), could be "early warning" of potential failure of safety system.

From a total of 12 deaths at work in 2011 in Macedonia, 11 occurred in the construction sector. They were caused by falls, contusion of construction vehicles and lack of safe work procedures. According to the State labor inspectorate (State labor inspectorate report for year 2011), responsible for this situation are mainly the supervisors and less frequently the workers. The data from the inspectorate indicates that 85 accidents have occurred at the workplace. As the most common cause for them are identified the inconsistent application of regulations, rules and principles of safety at work, unsafe physical working conditions, insufficient training of staff and unfulfilled medical examinations.

Taking into consideration what was mentioned above, it could be concluded that examination of health and safety climate in construction as industry with high rate of injures and fatal accidents will have important scientific and practical implications.

Accordingly, the aim of this paper was to explore health and safety climate perceptions among employees at different work positions in the construction industry in Macedonia.

More precisely, three aspects of health and safety climate were in the study focus:

- perceived management commitment to health and safety in the workplace,
- perceived health and safety inspections rate and accidents frequency and
- perceived site workers commitment to work health and safety.

There are different models with different number of dimensions of safety climate construct (for e.g. Zohar, 1980, as cited in Griffin and Neal, 2000; Dedobbeleer and Beland, 1991; Hayes et al., 1994; Neal and Griffin, 2006). The ones mentioned above are identified in some models, but they are considered to be most usefull for the Macedonian kind of research.

It was expected that employees in construction sector in Macedonia will differ in their perceptions of safety and health at the work site.

Following hypotheses were defined:

- Skilled workers perceived management staff as less committed to work health and safety compared to civil engineers and clerical employees;
- Skilled workers contrary to civil engineers and clerical employees perceived health and safety inspection as rare and accidents as frequent;
- Skilled workers perceived co-workers as more committed to work safety and health compared to civil engineers and clerical employees.

2. Method

2.1. Sample and procedure

The research was performed on a sample of 156 persons, employed in the construction sector in Macedonia, 80.8% were men and 19.2% were women. 91 participants were skilled workers, 34 were civil engineers and 31 were at clerical work position.
The data was collected in December, 2012 during work breaks. It was explained that participation is voluntary, that responses would stay confidential and be only used in research purposes. The questionnaire was filled for 10 to 15 minutes.

2.2. Measure

Twelve items measure developed by the authors of the study was administered to assess health and safety climate dimensions. They were organized into three separate subscales:

- *Management commitment to health and safety subscale* consisted of five items (e.g. *Management provides all necessary safety equipment for employees*). This scale denotes the extent to which management was perceived to be committed to working safely. Cronbach alpha reliability was α=.87.
- *Perceived accident rate and health and safety inspection subscale* has five statements and was used to assess the extent to which employees perceived work conditions in construction sector safety, as well as the perceived level of application of mechanisms by organizations and relevant state institutions (e.g. *Inspections of safety and health conditions in the workplace are conducted frequently*). The reliability coefficient of this subscale was α=.77.
- *Co-workers commitment to safety and health subscale* with two items (e.g. *Some workers do not use safety equipment even if they take risk actions during their work),* measures perception of co-workers' engagement into unsafe behavior during work tasks completion. Its reliability coefficient was α=.78.

Answers were given on a 5-point Likert scale ranging from 1-not at all agrees to 5-completely agree. Higher score on each subscale indicated a more positive perception of safety climate dimensions.

2.3. Statistical analysis

To examine differences in three dimensions of safety climate among participants at distinct work positions Kruskal Wallis test was used. The data was processed with statistical package SPSS v.17.

3. Results

The preliminary analysis showed that the error variance is not equal among the three groups of participants (skilled workers, civil engineers and clerical employees) when it comes to the variable - *perceived management commitment to health and safety in the workplace* ($F(2, 154)=6.82$, $p< .001$) (tab. 1). Shapiro-Wilk test of normality showed that the variable - *perceived management commitment to health and safety in the workplace* is not normally shown in the group skilled workers (stat.= .94, df=91, $p< .001$) and among clerical employees (stat.= .93, df=31, $p< .05$). This test suggest that the distribution of the variable *perceived site workers commitment to work safety* in the category skilled workers is not normal (stat. = .92, df=91, $p< .001$).
Therefore, for data analysis the Kruskal-Wallis test was applied.

Table 1.
Ranks of study variables

Safety climate dimensions	Work position	N	Mean Rank
Management commitment to safety in the workplace	Skilled workers	91	70.60
	Civil engineers	34	93.31
	Clerical employees	31	85.45
Safety inspections rate and accidents frequency	Skilled workers	91	70.45
	Civil engineers	34	82.66
	Clerical employees	31	97.58
Site workers commitment to work safety	Skilled workers	91	87.10
	Civil engineers	34	69.29
	Clerical employees	31	63.35

Results showed that participants significantly differ in the perception of health and safety climate.
Skilled workers compared to civil engineers, reported that they perceived management staff as less committed to work health and safety, $H(2)= 7.2$, $p< .05$.
Contrary to clerical employees, skilled workers perceived that there are not enough health and safety inspection and that accidents are relatively frequent, $H(2)= 8.76$, $p< .05$. They, also, perceived their co-workers as highly committed to work health and safety compared to clerical employees, $H(2)= 8.33$, $p< .05$.
Post hoc tests (Mann-Whitney) were performed for further analysis. It was demonstrated that there were not additional differences among pairs of investigated groups of employees in respect to health and safety climate dimensions. Accordingly, hypothesis 1, hypothesis 2 and hypothesis 3 were partially confirmed.

4. Discussion

The aim of this paper was to explore health and safety climate perceptions among employees at different work positions (skilled workers, civil engineers and clerical employees) in the construction industry in Macedonia. Namely, three aspects of safety climate were in the study focus:

- perceived management commitment to health and safety in the workplace,
- perceived health and safety inspections rate and accidents frequency and
- perceived site workers commitment to work safety and health.

According to the report from the State labor inspectorate, it is concluded that safety and health, while working in the construction site, do not reach the satisfactory level. The report states that the management in this sector does not fully obey the procedures for safety at work and in some cases the same is established for the workers.
It often happens for workers to not wear the protective helmets and gloves because they might be less efficient or when in the working environment dominates the opinion that men who wear protective equipment are cowards (Riggio, 2003).
According to the findings, the civil engineers and the clerks judge the workers as less attached to the rules and procedures for safety and health at work. On the other hand, their most direct associates judge them more positively in this dimension of the health and safety

climate, actually their opinion is that they do not take risky actions and that they wear the necessary equipment all the time. But, the Kruskal-Wallis test has shown that statistically there is a big difference in the civil engineers opinion and it has shown that they statistically differ only from the sluzbenicite in the way they perceive the behaviour of their colleagues in the domain of safety at work. Therefore the first hypothesis is partially confirmed.
When it comes to the dimension management commitment to health and safety at work, the results are different – the civil engineers judge the management commitement to the safety rules and procedures positively, while the workers claim that the managers don't make enough efford for the working conditions and that they don't provide training and enough equipment for safety and health. The way the engineers understand this aspect of the health and safety climate does not match the conditions in the State labor inspectorate. But, if taken into consideration that a big part of this group are executives, then it is most likely that they show the situations in the best way possible. It is possible that their grades are based on a minimal level of realized safety standars, which are not enough. But, signal for failure, as it is called Cooper and Phillips (2004) this construct, it is obvious that it shouldn't be neglected.
When it comes to the accidents and the injuries at work sites, clerks state that their number is relatively small and that the controls of the safety are regular. The workers statistics significantly differ from them, about the rate of accidents at the work sites, and the organizational supervision in the implementation of the procedures of safety and health in the workplace. Notably the workers grade this aspect of the health and safety climate more negatively than the clerks.
Generally, the results of the way the employes in the construction sector grade the priority given to the safety and health at work sites, could be due to the different views of the work. Workers at higher job ranks are more satisfied (Furnham, 2011) which maybe further on would lead to more positive perceptions to the health and safety climate. Another explanation could be the degree the employees are famillier with the procedures for safety and health at work sites and the degree of awareness fot the activities the management does in that domain.
Probably, the identification with the group to which the surveyed people consider belonging, the support from the executives and the type of communication that exists in the superior – subordinate relationship should be all considered.

5. Conclusion

The reported findings indicate that employees with different job positions in the construction sector have a different mental model for safety and health at worksites. For more detailed understanding of the given differences it is necessary to examine the role of other factors as well. In that way more secure explanations would be given for the differences in the perception of the health and safety climate.
Furthermore, it would be useful to verify or modify the safety procedures and practices (e.g. Zohar, 2002), all employees should be introduced with them and they should be implemented in the working environment.
Open communication and support among management, supervisors and workers is needed, too. It is expected that, that is the way of overcoming the wrong perceptions/misperceptions connected to the roles of each of these sides in the safety and health at worksites.
Finally, that will contribute to health and safety behavior and physical and mental health among employees. Working in safe and health environment in turn, will lead to higher work performance and lower financial costs from accidents, injures, medical treatments and absenteeism.

Further investigations of safety climate from broader perspective (eg. Kines et. al., 2011) together with other psychological aspect of work environment in construction industry (eg. Boschman et al. in press) is needed.

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MULTI CRITERIA ASSESSMENT OF RESIDENTIAL UNITS*

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Abstract

The last two decades have been a turbulent time for the SE Europe. Socioeconomic conditions strongly affected the real estate conditions in an adverse manner. In addition, the economic trends over the last 5 years resulted in explicit demand of the potential buyers to have an objective assessment tool at their disposal. Several criteria have to be taken into the account if such tool is to be perceived by the stakeholders on the real estate market as useful.
The paper presents foundations for the development of the multi-criteria model. Relevant criteria and sub-criteria are identified and justified: location, technical quality, architecture and living comfort, and their relative importance is judged from Bosnian point of view.
Further, as green building and building certification play an important role in raising awareness and promoting the construction quality, they are used as one of the starting points of the model.
The research results conducted in the city of Mostar (Bosnia and Herzegovina) are presented. Data were collected from five agents employed in the real estate agencies. Each agent has given details for 8 potential buyers, which includes a total of 40 residential units. Data were collected by surveying and interviewing, and by using of existing databases.

Keywords: multi criteria assessment, residential buildings, real estate market, quality, customer

* The complete text is available on CD-ROM / Žujo, Ćećez, Šelih, Kušar

Introduction

Bosnia and Herzegovina, as a republic of the former Yugoslavia, had an identical housing purchase system during the socialist period as well as the other republics of former Yugoslavia, until 1992. A variety of local companies were Investors that have funded the building construction for their employees. Dwellings were awarded primarily based on the social criteria ranking list. The quality of construction was not in the first place. This is understandable, because the occupants received their dwellings on a "gift". There were very few real estate agencies at that time.

Residential real estate market has experienced many changes since 1995. Trading has rapidly increased, conditioned by the populations' demographic changes in the former common state. We are witnessing a massive construction, reconstruction and repairs of all types of dwellings. Due to the construction speed and lack of funds, buildings of poor quality were built. Additional burden on the construction quality is the lack of free construction land in the centers of larger cities. At such locations there is a much greater housing demand than supply in the market. Such a condition can be misused by the contractors, who want with less money invested to get more profit on sales.

For the majority of people, regardless of their age, purchase of residential units is the biggest investment in their lives and one of the most important personal events. In the process of decision making the customer usually behaves intuitively, which is certainly not the best way to solve his housing problems.

A particular problem when purchasing a residential unit is the buyers' lack of information and technical features knowledge from the civil engineering point of view.

This paper analyzes the criteria that will be the main input for determining multicriteria mathematical model for the assessment of residential units, which will be the aim of future research.

2. Previous researches

Real estate assessment methods are challenge for both practice and academia. Any method of residential units' evaluation is a complex work and involves contradictory aspects. Nearly all methods are based on local regulations and standards, in accordance with local economic, social, cultural, environmental and other aspects. However, there are several examples of global methods. Various tools of sustainability assessment are available on the construction market, and they are widely used in the declarations of Environmental Protection (for example, BREEAM in the UK and LEED in the U.S.). There are also Life-cycle assessment (LCA), based on the available tools that have been developed specifically to address the building as whole, e.g., Eco-Quantum (Netherlands), EcoEffect (Sweden), ENVEST (U.K.), BEES (U.S.), ATHENA (Canada) and LCA House (Finland). Tools for evaluation are in constant development in order to resolve their constraints on the local environment. The main goal is to develop and implement a systematic methodology that supports the design process of a building (Bragança et al., 2010).

Solving problems using multicriteria methods can be applied in many fields, starting from a global, such as economics, construction, mathematics to individual processes, such as road design, property management, environment control, contractors' ranking etc. Numerous examples show that the multicriteria analysis in construction is necessary. Selection of the best solution should not be based on single criteria (Kracka et al., 2010).

In Germany, the German Sustainable Building Council ("Deutsche Gesellschaft für Nachhaltiges Bauen", DGNB) was formed in 2007, and by 2010 has more than 820 members. The DGNB has claimed for their German Certification for Sustainable Construction to developed “first system of the second generation” asking for performance oriented indicators and considering the entire life cycle of a building. Based on approx. 50 criteria the overall buildings sustainability is evaluated and color (gold / silver / bronze) as well as grade is awarded to the building. Each criteria reflects one aspect that is important to sustainability (Wittstock et al., 2010).

SBTool method gives a new methodology based on the lifelong cycle (preparation phase, construction phase, use phase and end of life phase) and by calculating potential impact reductions for object that will be built in relation to a reference building. This method is based on the principle that the rating system has to adjust to local conditions at the very beginning. The method is completely objective, which avoids the subjectivity in the assessment. This method can be successfully used for the buildings certification, with carefully 'weighed' impacts (Macias and Larsson, 2010).

Damaging impacts of buildings on the environment are diverse. The key for environmental impact reduction and strengthening of green building lies in the adoption of an integrated approach to design and life cycle of the building.

GRIHA (National Rating System for green buildings in India) deals with various issues of green building through the design, construction and use of buildings, to ensure minimal environmental impact. This rating system has the ability of ranking the air-conditioned and non-air-conditioned buildings, based on the actual energy efficiency (Vij, 2010).

The assessment should take in consideration all the characteristics of residential units that potential buyers claim (Pšunder, 2009).

In order to assess the environmental impact of the Swedish building and property (real estate) management sector, a new top-down life cycle assessment (LCA) method was used which was based on input–output analysis using national statistical data. Key implications will be on the selection of building materials, the construction process and the extension of building longevity (Toller et al., 2013).

Commercial methods of real estate evaluation represent a mechanism which can enable the environmental and social aspects to be more included into the economic question. The perception of the real estate is changed if the structure characteristics are taken as main evaluation factors. (Lützkendorf and Lorenza, 2005).

Some countries have introduced the so called mass appraisal for taxation purpose. The evaluation appraisal relates to real estate groups, not to a particular real estate. Mass appraisal system management is both a challenge and an opportunity. To resolve the task, the mass appraisal assessors use modern technology in form of a computer assisted mass appraisal – CAMA. These systems enable the possibility of increasing the efficiency and technical competence of state bodies and creation of a more accurate and fairer evaluation (McCluskey and Anand, 1999; McCluskey et al., 1997).

3. Research in Bosnia and Herzegovina

3.1. Literature data

In Bosnia and Herzegovina, the residential units’ construction was 8.0% higher in the 2012 in relation to the 2011. In the first part of 2013 an increase of 83.40% compared to the same period 2012 was registered (Agency for Statistics of Bosnia and Herzegovina, 2013). As the population gravitates to cities, the number of residents in urban areas increases, and greater demand for quality residential units can be expected.

Real estate prices are determined mainly arbitrarily, without adequate evaluation of the residential unit quality. As a consequence unrealistically high prices are frequently encountered.

In Bosnia and Herzegovina agency for building certification on the basis of the construction quality assessment does not exist. This means that potential buyers of dwellings can not get valid information about the construction quality of the dwelling which they want to buy. The only guarantee for customers is the Use permit which is the result of technical acceptance performed by the service ministry after the completion of the construction. During the buildings' technical acceptance, the Investor is required to submit to the Commission, certification for all installed building materials (Construction Act, 2002). Experience shows that this practice should be improved, because certificates are not always legitimate and members of the Commission do not always know to interpret the certificate in the right way. This suggests the need to establish an institution that will solely deal with buildings certification. It should be emphasized that the building certification has an important role in raising awareness and promoting higher quality of building construction.

According to „Energy Performance of Building Directive“ in Bosnia and Herzegovina there are no relevant energy policies and legislation for energy efficiency and energy saving, also, there are no application of environmental pollution Directive, neither the buildings certification model (www.training.eebd.org).

Nowadays, real estate appraisal in Bosnia and Herzegovina is performed by court experts of the civil engineering profession who have been appointed by the Ministry of Justice on public invitation. The experts are all of the civil engineering profession and are expected to show a high level of professionalism. However, in reality, they have no formal education from the real estate appraisal field or any standards or methodology to follow when performing their job.

In 2012 the Bosnian and Herzegovinian Property Association (BHPA) was founded in Sarajevo whose aim is to be the only organization in Bosnia and Herzegovina for certifying experts of the real estate field (www.bhpa.org.). BHPA is dedicated to creating and maintaining a strong base for future experts of the real estate field through knowledge and professionalism perfection of its members. BHPA certifies four professions: real estate market evaluation, real estate management, real estate development and real estate agent. BHPA will ensure integrity, credibility and ethical standards of the profession to be compatible to the global standards determined by the RICS (Royal Institution of Chartered Surveyors) in London (www.rics.org).

At the University of Sarajevo, for the first time in the region, the School of Economics and Business proudly presents Master of Property – Advanced Finance in cooperation with the University of Melbourne. The program aims at achieving specialist knowledge and professional standing in the field of property – applied finance. The Master of Property – Applied Finances focuses on activities encompassing the full property cycle. This professional course is intended for graduates keen to acquire an indebt understanding of the structure and operations of the property sector. It is rather popular because it encompasses a diverse range of skills. It enables students to develop/enhance expertise in professional fields such as property funding, valuation, management and development. The ethos of the course is to offer teaching which introduces underpinning theories and then through case study analysis underpin its practical orientation. The course has a strong commercial focus and a practical orientation and provides the student with the essential knowledge and necessary skills (http://www.efsa.unsa.ba/ef/ba/property-applied-finances).

The University of Sarajevo, School of Economics and Business’s partner for this master study is the School of Economics of University of Split.

4. Field data

The results obtained in this study will be the input parameters for the determination of multicriteria model for a comprehensive assessment of residential units. This model should serve to potential buyers of residential units for an optimal choice decision. The optimal choice of residential units is one that has the most favorable ratio of price and features. In addition, real estate agents, managers, engineers, architects, as well as various construction companies would have benefit from this model. What is important for such a model is simple usage and that with construction plans and related auxiliary means one can realistically assess the residential unit.

In the period March/April 2013 field research was performed. Data were collected from a total of five agents employed in the Real Estate Trading Agency in the city of Mostar, which is the center of Herzegovina. Each agent has given information for 8 potential buyers, which includes a total of 40 residential units. Data were collected by surveying and interviewing, and by using existing databases. The interview was required in cases where the questionnaires were incomplete or the answers were not precise enough. Survey/interview was conducted in a way that each agent was asked two questions:

1. "What criteria potential buyer prefers when buying a dwelling?"
2. "To what level are potential clients interested in green building?"

The answers collected can be placed in four groups: location, technical quality, architecture and living comfort. The research has resulted in the following values:

- Location - 35%
- Technical quality - 25%
- Architecture - 20%
- Living comfort - 20%

Each of these parameters is summarized through the sub-criteria.

Location:

- Micro location (city center, other urban areas, suburban areas) – 70%;
- The position of the building within the micro location (traffic jam, traffic noise) – 5%;
- Insolation (per individual rooms) – 5%;
- Utilities – 5%;
- Public areas – 5%;
- Neighborhood (proximity of adjacent buildings, storeys of adjacent buildings) – 10%.

Technical quality:

- Construction type (monolithic, semi-prefabricated, prefabricated) – 50%;
- Building materials (natural, artificial) – 10%;
- Building equipment (lift, antenna system, multimedia networks, computer networks, video surveillance, alarm system, blinds) – 15%;
- Building elements (roof, facades, windows and doors, flooring) – 15%;
- Heating, cooling, ventilation – 10%.

Architecture

- Rooms in the apartment (number of rooms, layout, size of the rooms, insolation) – 30%;
- Geographic location (population density, green areas) – 5%;
- Number of storeys (number of floors in the building, the location of the apartment in the building, number of floors in the apartment) – 35%;
- Parking space (uncovered, covered, closed) – 30%.

Living comfort:

- Sound insulation (sound in the air, the sound in object) – 35%;
- Thermal insulation[*] – 55%;
- Natural light (per individual rooms) – 10%.

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[*] Bearing in mind that the city of Mostar has very high summer temperatures (average 31°C)

For the second survey question, data shows that potential buyers of residential units do not mention green building and it appears that their total disinterest stems from the lack of information on the principles, the importance and benefits of green building.

5. Conclusion

Residential unit purchase for the majority of people, regardless of their age, is the biggest investment in their lives and one of the most important personal events. In the process of decision making the customer behaves intuitive, which certainly is not the best way to solve his housing problem.

Research on a sample of 40 residential units in the city of Mostar in Bosnia and Herzegovina has shown that customers are not informed about the principles, importance and benefits of green building in Bosnia and Herzegovina and in the world. Also, research has shown that potential buyers prefer the most location - 35% (microlocation, ie downtown area) and then technical quality - 25% (the most important is the type of construction, ie whether the object is a monolithic), architecture - 20% (number of storeys and location of the dwelling in a building) and living comfort - 20% (primarily thermal insulation).

In Bosnia and Herzegovina there is no relevant energy policies and legislation for energy efficiency and energy savings, there are no application of environmental pollution Directive. There is no agency for building certification on the basis of the construction quality assessment. It should be emphasized that building certification plays an important role in raising awareness and promoting the construction quality.

The results obtained in this study will be the input parameters for the determination of multicriteria model for a comprehensive assessment of residential units. This model should serve to potential buyers of residential units for an optimal choice decision. The optimal choice of residential unit is one that has the most favorable ratio of price and features.

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CROATIAN SESSION

ORGANIZACIJA ODRŽAVANJA DRŽAVNIH, ŽUPANIJSKIH I LOKALNIH CESTA VARAŽDINSKE ŽUPANIJE U ZIMSKIM UVJETIMA*

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Sažetak

Tema ovog rada je analiza stanja organizacije održavanja državnih, županijskih i lokalnih cesta u zimskim uvjetima, na području Varaždinske županije, s prijedlozima poboljšanja. Rad sadrži objašnjenja što su i gdje se nalaze stalna mjesta pripravnosti te stupnjevi pripravnosti, kao i detalje o vrstama prioriteta cesta koje se održavaju u zimskom periodu. Objašnjeni su načini i sredstva kojima se i kada ceste posipavaju kako bi se spriječila poledica, te način i vrste komunikacije i obavješćivanje unutar organizacije zimske službe i prema javnosti. Smjernice koje su navedene u ovom radu vode prema poboljšanju izvedbe samog zimskog održavanja u smislu jednostavnijeg i bržeg reagiranja i rada prilikom vremenskih neprilika, a radi povećanja sigurnosti prometa uz minimalno povećavanje troškova zimske službe.

Ključne riječi: Zimska služba, stupnjevi pripravnosti, županijske ceste, državne ceste, lokalne ceste, sigurnost prometa.

* The complete text is available on CD-ROM / Amadori, Cesar-Kelemen, Varga

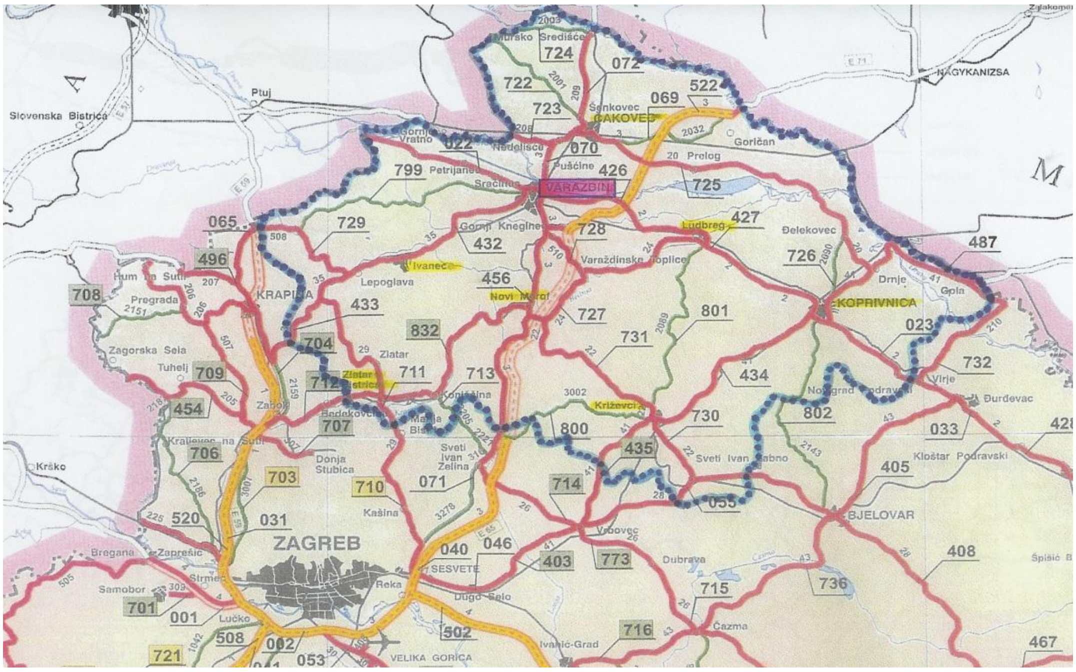
UVOD

Održavanje državnih, županijskih i lokalnih cesta u zimskom periodu moguće je kvalitetno obavljati samo uz dobru organizaciju i stalnu informiranost o stanju na cestama u svakom trenutku, kao i pravodobno i ispravno donošenje odluka o aktivnostima koje je potrebno provesti. Poduzeće PZC Varaždin d.d. (u daljnjem tekstu: PZC) temeljem Okvirnih sporazuma, godišnjih ugovora s naručiteljima i Operativnih programa zimskog održavanja Hrvatskih cesta Ispostave Varaždin i Ispostave Zagreb, Županijske uprave za ceste Varaždinske županije, Županijske uprave za ceste Koprivničko – Križevačke županije u zimskom razdoblju koje je utvrđeno od 15.11. tekuće godine do 15.03. (odnosno u Varaždinskoj županiji do 23.03.) slijedeće godine, održava 570,09 km državnih cesta i 1925,37 km županijskih, lokalnih i nerazvrstanih cesta na području Varaždinske, Međimurske, Krapinsko – Zagorske i Koprivničko – Križevačke županije, što ukupno iznosi 2.495,45 km cesta, a prikazano je u tablici 1

Tablica 1. Ukupne dužine cesta koje održava PZC Varaždin d.d.

ŽUPANIJA	DUŽINA DC	DUŽINA ŽC	DUŽINA LC	DUŽINA NERAZVRSTANIH CESTA	UKUPNO
KRAPINSKO-ZAGORSKA	57,99				57,99
VARAŽDINSKA	206,01	364,52	504,48	159,01	1.234,02
KOPRIVNIČKO-KRIŽEVAČKA	216,58	437,28	460,08		1.113,94
MEĐIMURSKA	89,50				89,50
UKUPNO:	570,09	801,80	964,56	159,01	2.495,45

Na slici 1. prikazano je na karti područje koje pokriva svojim održavanjem tvrtka PZC Varaždin d.d.



Slika 1. Prikaz područja koje održava PZC Varaždin d.d.

2. ZAKONSKE ODREDBE

Sukladno Zakonu o cestama[*], Pravilniku o održavanju i zaštiti javnih cesta[†], kao i Zakonu o sigurnosti prometa na cestama[‡], Hrvatske ceste d.o.o. i Županijske uprave za ceste, upravljaju državnim, županijskim i lokalnim cestama u Republici Hrvatskoj (u daljnjem tekstu "upravljači").
U ovom radu obuhvatit će se organizacija redovitog održavanja u zimskim uvjetima na državnim, županijskim i lokalnim cestama u Varaždinskoj županiji koje održava poduzeće PZC Varaždin d.d., a izostavit će se ceste na području gradova i općina (nerazvrstane ceste) zbog velikog obima djelatnosti.

Održavanje cesta dijelimo na dvije kategorije:

- redovito održavanje,
- izvanredno održavanje.

Redovito održavanje cesta[§] čini skup mjera i radnji koje se obavljaju tijekom većeg dijela godine ili cijele godine na cestama, uključujući i sve objekte i instalacije, sa svrhom održavanja prohodnosti i tehničke ispravnosti cesta i sigurnosti prometa na njima.
Redovito održavanje cesta dijeli se na ljetno i zimsko održavanje.

Održavanje **cesta** u zimskim uvjetima[**] (u daljnjem tekstu: zimska služba), podrazumijeva radove neophodne za održavanje prohodnosti cesta i sigurnog odvijanja prometa, za režim prometa u zimskim uvjetima koji je određen posebnim propisima.

Održavanje **javnih cesta** u zimskim uvjetima[††] (zimska služba), podrazumijeva radovE neophodne za održavanje "prohodnosti" javnih cesta i sigurnog odvijanja prometa za utvrđeni režim u zimskim uvjetima. Cesta se u smislu navedenog Pravilnika o održavanju i zaštiti javnih cesta smatra prohodnom kada je radovima na uklanjanju snijega omogućeno prometovanje vozila uz upotrebu zimske opreme u skladu s posebnim propisom prometovanja vozila u zimskim uvjetima.

Pod neophodnim radovima održavanja javnih cesta u zimskim uvjetima podrazumijevaju se[‡‡]:

- pripremni radovi prije nastupanja zimskih uvjeta;
- organiziranje mjesta pripravnosti za održavanje javnih cesta i njihovo označavanje;
- zaštitne mjere protiv stvaranja snježnih nanosa, zapuha ili lavina;
- čišćenje snijega s kolnika i prometne signalizacije;
- obilježavanje rubova kolnika crveno-žutim štapovima gdje je moguće zametanje traga ceste;
- zaštita cesta od poledice (sprečavanje klizavosti kolnika uslijed smrzavanja vode);
- stalno i povremeno obavještavanje o stanju i prohodnosti cesta kao i upozoravanje korisnika cesta odgovarajućom prometnom signalizacijom;
- uklanjanje vozila ostavljenih na kolniku ceste ukoliko onemogućava normalno odvijanje radova na čišćenju snijega na cesti;

[*] Zakon o cestama, Narodne novine 84/11
[†] Pravilnik o održavanju i zaštiti javnih cesta, Narodne novine 25/98
[‡] Zakonu o sigurnosti prometa na cestama, Narodne novine 67/08
[§] Zakon o cestama, Narodne novine 84/11
[**] Pravilnik o održavanju i zaštiti javnih cesta, Narodne novine 25/98
[††] Pravilnik o održavanju i zaštiti javnih cesta, Narodne novine 25/98
[‡‡] Ibid.

- osiguranje odvodnje kolnika za vrijeme otapanja snijega na cesti;
- postava posebne dodatne prometne signalizacije u slučaju zatvaranja ceste ili posebnog režima vožnje.

Hrvatske ceste d.o.o. i Županijske uprave za ceste , organiziraju i provode zimsku službu. U cilju ispunjenja prethodnih uvjeta i radi provedbe zimske službe Hrvatske ceste d.o.o. i Županijske uprave za ceste izrađuju Operativne programe radova održavanja cesta u zimskom razdoblju (u daljnjem tekstu: Operativni program).

Operativni program iz članka 66. Pravilnika o održavanju i zaštiti javnih cesta sadrži:

- mjesta pripravnosti zimske službe,
- stupnjeve pripravnosti,
- potreban broj ljudstva, mehanizacije i materijala za posipavanje i njihov razmještaj po mjestima pripravnosti,
- redoslijed izvođenja radova, uzimajući u obzir planom utvrđene razine prednosti,
- dinamiku provođenja pojedinih aktivnosti,
- nadzor i kontrolu provođenja zimske službe,
- uvjete kada se zbog sigurnosti prometa isti ograničava ili zabranjuje za pojedine vrste vozila.
- sistem veza,
- procjenu troškova zimske službe,
- obavješćivanje javnosti o stanju i prohodnosti cesta.

3. RAD ZIMSKE SLUŽBE

Da bi rad zimske službe bio efikasan, na temelju višegodišnjih podataka, konfiguracije terena, mikroklimatskih uvjeta i drugih iskustvenih elemenata koji utječu na rad zimske službe, organizira se određeni broj stalnih mjesta pripravnosti.

3.1. MJESTA PRIPRAVNOSTI

Na području koje održava PZC Varaždin d.d. predviđena su 8 (osam) stalnih mjesta pripravnosti (Varaždin, Ludbreg, Ivanec i Novi Marof, Čakovec, Koprivnica, Križevci i Đurđevac) koji ispunjavaju uvjete za boravak ljudi kao i obavljanje poslova za zimsko održavanje cesta, uskladištenje materijala, smještaj vozila i potrebne opreme. U ovom radu dalje se promatra samo izvođenje zimske službe na području Varaždinske županije.
U stalnim mjestima pripravnosti, te u stožeru zimske službe organizira se dežurstvo koje traje 24 sata. Ovisno o vremenskim prilikama, dežurstvo se odlukom stožera može uvesti i u drugim mjestima, koje se tada nazivaju povremena mjesta pripravnosti.

Dežurstvo kroz 24 sata odvija se na sljedeći način:

- u stalnim mjestima pripravnosti dežura kroz 24 sata stalna ekipa (veličina ovisi o stupnju pripravnosti) i odgovorna tehnička osoba (voditelj cestarije, poslovođa cestarije, grupovođa...);
- u povremenim mjestima pripravnosti organizira se dežurna služba na načelima I stupnja pripravnosti;
- u stožeru zimske službe uvijek je kraj telefona i UKV veze dežuran djelatnik raspoređen po rješenju na radno mjesto dežurnog, dok u mjestima pripravnosti to dežurstvo obavljaju svi djelatnici (cestar, vozač, strojar...) raspoređeni u pojedini stupanj pripravnosti ovisno o trenutnom zaduženju;

- na području Varaždinske županije u pravilu zimska služba počinje 15. studenoga tekuće godine i traje do 25. ožujka naredne godine pa se u tome periodu i organiziraju dežurstva. U slučaju vremenskih nepogoda prije ili kasnije od ovih načelnih datuma zimska se služba prilagođava dežurstvom ili radovima;
- plan i raspored dežurstva te odgovornih tehničkih osoba radi se prije početka zimske službe i daje se na upotrebu stalno dežurnim djelatnicima u mjestu stalnog dežurstva, tj. stožeru zimske službe te odgovornim osobama;
- dežurne odgovorne osobe po završetku dežurstva predaju dužnost sljedećoj odgovornoj osobi, a o obavljenom radu i događajima za vrijeme trajanja dežurstva vode evidenciju aktivnosti koje se upisuju u knjigu dežurstva.

3.2. STUPNJEVI PRIPRAVNOSTI ZIMSKE SLUŽBE

Ovisno od prognoze vremena, meteoroloških uvjeta i vremenskih prilika, u skladu s Pravilnikom o održavanju i zaštiti javnih cesta*, utvrđuju se 4 (četiri) stupnja pripravnosti zimske službe. Prognoza vremena dnevno se dobiva tri puta iz državnog hidrometeorološkog zavoda.

Novina u zimskom održavanju cesta uvodi se početkom rada i na kraju zimske službe, a također može se uvesti kada su vremenske prilike povoljne i kada nema izgleda za nastupanje zimskih uvjeta (npr. temperatura zraka oko i više od 5˚C bez mogućnosti za padaline). U **nultom stupnju pripravnosti** organiziraju se stalna dežurstva sa kombi vozilima do 2t i radnicima – cestarima. Za vrijeme trajanja nultog stupnja pripravnosti obilazak se organizira povremeno prema potrebi i procjeni, prateći vremensku prognozu i vremenske uvjete.

Prvi stupanj pripravnosti se uvodi nastupanjem zimskih uvjeta. Prvi stupanj pripravnosti (dežurstvo) je stupanj pripravnosti u kojem se organizira stalna dežurna služba u mjestima pripravnosti, opremljena mobilnim telefonskim uređajima i UKV stanicama koje su montirane u mjestima pripravnosti (stalne), u vozilima (pokretne) i centralnom mjestu dežurstva u Varaždinu (Mihovila Pavleka Miškine 67), te se osigurava odgovarajući potreban broj ljudstva i mehanizacije radi intervencije u slučaju potrebe. Ta se mjesta još nazivaju i stalna mjesta pripravnosti.

Drugi stupanj pripravnosti se uvodi kada je temperatura zraka oko 0˚C s predvidivom mogućnošću slabih oborina (kiše, susnježice, snijega), te se s obzirom na stupanj pothlađenosti kolnika (stanje kolnika koji ima vrlo nisku temperaturu zbog višednevnih izuzetno niskih temperatura) može pojaviti poledica. Po određenom redoslijedu izvode se radovi na sprečavanju poledice i čišćenju snijega na potencijalno opasnim mjestima, a obavezno:

- na dionicama s uzdužnim nagibom većim od 4% i horizontalnim zavojima polumjera manjeg od 300 m;
- na kolnicima mostova, nadvožnjaka i propusta;
- na raskrižjima željezničko – cestovnih prijelaza u istoj razini i prilazima benzinskih postaja;
- na drugim dionicama cesta prema operativnom planu rada zimske službe.

* Pravilnik o održavanju i zaštiti javnih cesta, Narodne novine 25/98

Treći stupanj pripravnosti se uvodi kada se praćenjem vremenske prognoze očekuju dugotrajnije i jače padaline snijega ili kiše koja se smrzava na tlu zbog pothlađenog kolnika, te se u ovom stupnju aktivira sva planirana mehanizacija i ljudstvo (radnici).

Četvrti stupanj pripravnosti, uvodi se kada snježne oborine uz jak vjetar poprimaju karakter elementarne nepogode i svi planirani kapaciteti strojeva i ljudstva iz trećeg stupnja pripravnosti nisu dovoljni za uklanjanje snijega i osnovne zadaće prohodnosti cesta. U tom slučaju cesta se zatvara za sav promet radi sigurnosti sudionika u prometu, a u čišćenje snijega uključuju se postrojbe civilne zaštite te privredni subjekti s toga područja koji raspolažu s opremom i ljudstvom.

3.3. POTREBNI RESURSI ZIMSKE SLUŽBE

Kako bi uspješno djelovali na stvaranju što kvalitetnijih uvjeta na cestama odnosno da bi omogućili nesmetano odvijanje prometa na javnim cestama u zimskom periodu, ovisno o vremenskim prilikama, svako mjesto pripravnosti treba biti dobro organizirano i opremljeno s dovoljnim kapacitetima ljudstva i mehanizacije koji po potrebi djeluju na uklanjanju smetnji izazvanih tim vremenskim neprilikama.

Tablica 2. Ukupan broj radne snage, mehanizacije i materijala (primjer Hrvatske ceste d.o.o.)

Radna snaga, mehanizacija i materijali	Prvi stupanj pripravnosti	Drugi stupanj pripravnosti	Treći stupanj pripravnosti
Radna snaga	40	80	92
Kamion s plugom i posipačem	8	21	27
Specijalno vozilo (Unimog)	0	0	0
Odbacivač snijega	0	2	2
Utovarno sredstvo	8	8	8
Samohodna snježna freza	0	0	0
Postrojenje za pripremu otopine $CaCl_2$-a	0	1	0
Ostala mehanizacija	0	4	4
Natrijev klorid (t)	3.520,00		
Kalcijev klorid (t)	0,00		
Kamena sitnež (m^3)	1.175,00		

Tablica 2. je podijeljena na tri stupnja pripravnosti koje koriste Hrvatske ceste d.o.o. Zagreb, gdje je vidljiv potreban broj djelatnika, mehanizacije te planirane količine posipala (sol i kam. posipalo), a koje se izračunava prema višegodišnjim podacima o padalinama na području gdje se primjenjuje.

3.4. IZVOĐENJE RADOVA PREMA UTVRĐENIM PREDNOSTI

Kod Državnih cesta postoje samo dvije razine prednosti prva (I.) i druga (II.), a to je zbog većeg broja vozila koja se kreću tim cestama. Kod Županijskih i lokalnih cesta postoji i treća (III.) razina.

Na cestama, koje su Operativnim programom zimske službe svrstane u I. razine prednosti, radovi na osiguranju prohodnosti odnosno sve intervencije na čišćenju i osposobljavanju kolnika za nesmetan prolaz vozila moraju biti izvršene u roku od 5 sati u nizinskom, odnosno 8 sati u brdskom području, računajući od prestanka padanja snijega.

Na ostalim državnim, županijskim i lokalnim cestama prohodnost se mora osigurati najkasnije u roku dvadeset četiri sata od trenutka prestanka padalina, a sve sukladno odredbama Pravilnika o održavanju i zaštiti javnih cesta.

3.5. NAČINI POSIPAVANJA

Ovaj ključni segment unutar zimskog održavanja cesta je jedan od najinteresantnijih, najopasnijih ali i najtajanstvenijih. Zašto? Nevjerojatan je podatak da o količini posipavanja ne postoji baš ni jedan službeni dokument s osnovnim uputama o količini posipala za ceste koje bi izvođač mogao i trebao slijediti. Sve znanje koje se primjenjuje prilikom količine posipavanja je čisto iskustvo. Kad se već govori o načinu posipavanja princip je sljedeći: državne ceste se u pravilu posipavaju čistom solju (NaCl – natrij klorid). Eventualna alternativa kod izuzetnih hladnoća (naime sol – NaCl djeluje zadovoljavajuće do -6˚C, dalje se svojstvo otapanja smanjuje) vrši se posipavanjem mješavinom drobljenog kamenog agregata (4 – 8 mm) i soli u omjeru 2:1 ili 3:1 u korist soli. Ta metoda koristi se zbog dobrog prianjanja guma od vozila na kolnik koji je prekriven snijegom.

Kod županijskih i lokalnih cesta posipavanje se vrši :
- cestovni pravci I. prioriteta – čista sol i mješavina soli i posipala (agregata) u omjeru 1:2;
- cestovni pravci II. prioriteta – mješavinom soli i posipala u omjeru 1:4;
- cestovni pravci III. prioriteta – mješavinom soli i posipala u omjeru 1:6.

Prioriteti održavanja prometnica postavljeni su načelno i podložni su promjenama Stožera zimske službe i operativnom rukovodstvu investitora.

3.6. SREDSTVA I MATERIJALI ZA POSIPAVANJE CESTA

Osnovni materijal koji se koristi za posipavanje cesta u zimskim uvjetima je sol. Sol kao sredstvo za otapanje u zimskim uvjetima koristi se već duži niz godina. Zbog svojih dobrih osobina otapanja probila se ispred svojih konkurenata, kao što su: drobljeni kamen, pijesak, alkohol, glikol ili urea. Tipovi soli koji se koriste su:

- Morska sol - prilikom koncentracije morske soli ne dolazi do istovremene kristalizacije svih minerala soli, već se to odvija određenim redoslijedom. Ta osobitost se koristi za selektivno dobivanje soli, kada se ona postupno taloži u bazenima. Najprije se kristaliziraju teško topivi sastojci (kalcit i gips), zatim natrijev klorid, a posljednje napokon kalijeve i magnezijeve soli.

- Kamena sol - dobiva se u pravilu u podzemnim rudnicima. Sirovina se nakon postupka mehaničkog usitnjavanja postupkom sortiranja dalje obrađuje kako bi se komponente kamene soli očistile od popratnog kamenja. Zbog djelomičnog srastanja soli s drugim mineralima soli, postavljena je granica za sortiranje gustoće soli, što ponovo dovodi do različitih kakvoća soli koje ovise o nalazištima.

- Kuhana sol - dobiva se iz podzemnih naslaga nekadašnjih mora, te se otapanjem u vodi izvlači sustavom cijevi i ponovnim sušenjem dobiva kruta tvar, ali koja je u primjeni dosta rijetko iako je najkvalitetnija zbog svojih karakteristika. Jedna od vrlo dobrih karakteristika kuhane soli je i mali udio netopivih tvari 0,02% (kamena sol koja se i najčešće koristi ima udio od 1,20%), a te tvari su ono što na cesti ostane nakon njezina sušenja kao prašina. Također jako velika razlika između tih vrsti soli je i u agresivnosti na betonske elemente u cestovnom profilu koja je osjetno manja pri primjeni kuhane soli. Posljednja ali ne i manje važna prednost kuhane soli je njezina djelotvornost na otapanje koja je bitno veća u odnosu na ostale vrste soli.

Znači, ukoliko se želi zaštititi cestu i njezine elemente (odvodnju, betonske objekte i sl.) koji su vrlo osjetljivi na količinu i karakteristike soli koja se primjenjuje za posipavanje na cestama (npr. u Austriji je zabranjena primjena kamene i morske soli za posipavanje cesta zbog posljedica na betone koji se koriste kod izrade cesta), kvalitetan pomak u budućnosti morala bi biti nabava i korištenje kuhane soli umjesto kamene soli, koja se koristi 98% na našim cestama, a koju pribavljaju Hrvatske ceste d.o.o. za sebe i Županijske uprave za ceste u Hrvatskoj, zbog oko 20% manje cijene.
Naravno da je cijena jako važan čimbenik kod planiranja troškova, jer ukoliko se utroše sredstva na zimskom održavanju u pravilu umanjuju se sredstva za ljetno održavanje.

Planiranjem drugih vrsta posipala (kuhana sol, magnezijeve i kalijeve soli sa smanjenom agresivnošću na betone - sumporna kiselina) sigurno bi se smanjila potreba za održavanjem betonskih elemenata ljeti, jer bi drugačijim odabirom soli bili znatno manje oštećeni i ne bi ih trebalo zamijeniti ili popraviti, ali naravno takve bi se posljedice mogle izmjeriti tek nakon nekoliko godina.

4. DINAMIKA PROVOĐENJA POJEDINIH AKTIVNOSTI

Pripremni radovi kod izrade plana, a prije nastupanja zimskih uvjeta izgledaju ovako:

- Utvrđivanje dužina cestovne mreže državnih, županijskih i lokalnih cesta po mjestima pripravnosti, vrsti kolnika, razini prioriteta, obzirom da zbog izgradnje novih dionica cesta, te prekategorizacije cesta (kada cesta iz državne prelazi pod nadležnost županijske ceste ili obrnuto), dolazi do promjena u dužini cesta. Zbog proračuna potrebnih količina posipala, mehanizacije i radne snage, prije izrade plana zimske službe moraju se utvrditi stvarne dužine cestovne mreže, te utvrditi kapaciteti i utrošak vremena potrebnog za osiguranje prohodnosti cesta;

- Procjena stanja zaliha i plana potrebnih količina soli, kamenog posipala, signalnog kolja, dopunskih prometnih znakova te hladne asfaltne mješavine – grambita (grambit je hladna asfaltna mješavina koja se nabavlja početkom nastanka zimskih uvjeta - jer može stajati, a koristi se za privremeno krpanje udarnih rupa koje nastaju zimi;

- Pregled mjesta pripravnosti i deponija za prihvat materijala za posipavanje cesta (nadstrešnice za sol i silosi). Pregledom svih planiranih potreba, kapaciteta spremišta te zaliha soli, dolazi se do zaključka da li postoji dovoljno kapaciteta za primanje planiranih količina soli i posipala za zimsko održavanje prometnica

- Suradnja sa Policijskim upravama, lokalnom upravom i ostalim javnim djelatnostima.
- Pregled i kontrola spremnosti

5. NADZOR I KONTROLA PROVOĐENJA ZIMSKE SLUŽBE

Kada je izvoditelj radova na održavanju cesta u zimskim uvjetima izabran,organizaciju rada i kontrolu izvođenja radova tijekom rada zimske službe potrebno je promatrati na sljedeći način:

- osiguranje kapaciteta, organizaciju i kontrolu ispravnosti kapaciteta provodi Stožer zimske službe, koji je organiziran u centralnom mjestu pripravnosti u sklopu trgovačkog društva kojem je povjereno održavanje cesta u zimskim uvjetima;

- kontrolu stanja cesta u određenom stupnju pripravnosti u cilju poduzimanja mjera za otklanjanje nedostataka, provode zaduženi dežurni djelatnici u mjestima pripravnosti, uključujući i zadužene tehničke osobe iz trgovačkog društva koje je ugovorilo radove na održavanju cesta u zimskim uvjetima;

- kod operativnog djelovanja kapaciteta u određenom stupnju pripravnosti kontrolu kretanja po utvrđenim dionicama, preusmjeravanje i određivanje potreba, vrše zaduženi djelatnici trgovačkog društva koje je ugovorilo radove na zimskom održavanju cesta;

- kontrolu pripremnih radova, operativnog djelovanja, kontrolu stanja cesta te kontrolu prometa na cestama provodi Služba inspekcije cesta zadužena pri Ministarstvu pomorstva, prometa i infrastrukture, Upravi prometne inspekcije.

Sve aktivnosti u obavljanju održavanja cesta u zimskoj službi unose se u dnevnike zimske službe. Dnevnik zimske službe vodi svakodnevno ovlaštena osoba ugovornog izvoditelja u mjestima pripravnosti. Dnevnik zimske službe osnovni je dokument za registriranje svih događaja, obavijesti, naloga, izvršenih radova, vremenskih prilika, vremena i kretanja vozila i strojeva, ali i drugih važnih sadržaja za rad zimske službe, pa ga treba precizno i ažurno ispunjavati.
Potrebno je osobito registrirati:

- vremenske prognoze kao i mjerenja temperature svakih dva sata u kritično nastupajućim promjenama;
- izvršavanje redoslijeda prioriteta cesta, upisivati vrijeme izlaska, kao i vrijeme povratka svih vozila i ljudstva kada su pristupili ili izvršili zadatak čišćenja i posipavanja cesta;
- utrošak soli i sipine (kam.agregata) za izvršeno posipavanje toga dana;
- predane izvještaje o stanju na cestama, izvanrednim događajima;
- zatvaranje ceste, privremenu regulaciju prometa, režim prometa, postavljanje prometne signalizacije i izvršitelje;
- štetu na cesti ili objektima koji nastanu po učesnicima u prometu.

Pripremne radove, te nadzor i kontrolu izvođenja pojedinih aktivnosti poduzeća zaduženog za izvođenje radova na održavanju cesta u zimskim uvjetima, provode zaposlenici Županijske uprave za ceste Varaždin - za županijske i lokalne ceste i djelatnici Hrvatskih cesta d.o.o. Zagreb Ispostava Varaždin - za državne ceste.

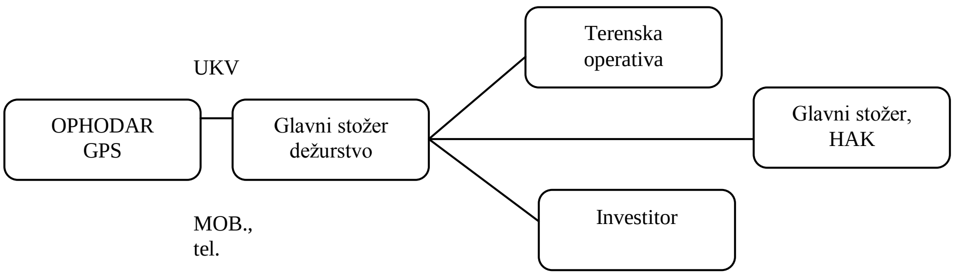
Kontrolu pripremnih radova, operativno djelovanje, kontrolu stanja cesta, te kontrolu prometa na cestama provodi inspekcijska služba Ministarstva pomorstva, prometa i infrastrukture a preko inspektora cestovnog prometa i cesta zaduženih za određena područja.

6. SUSTAV VEZA

Za uspješnu djelatnost i postavljanje organizacije zimske službe, sistem veza ima vrlo važnu funkciju. Prikupljanje podataka od mjesta pripravnosti tj. cestarija vrši se u pravilu telefonom ili UKV vezom i to na način da u propisno vrijeme dežurno osoblje iz mjesta pripravnosti dojavljuje podatke dežurnom u stožeru zimske službe, na način utvrđen u sistemu dojave. Sve cestarije i mjesta pripravnosti, republička hidrometeorološka služba, radiona za popravak vozila i terenska operativa moraju biti međusobno povezani UKV vezom. Sve UKV stanice u repetitorskom sustavu ostvaruju povezanost kao nadopunu telefonskim vezama.

Dojava podataka s terena znači funkcionira preko UKV mreže, a u novije vrijeme preko mobilnih telefona (Prikazano na slici 11.)
Prosljeđivanje sistematiziranih podataka prikupljenih iz mjesta pripravnosti dojavljuje se za državne ceste još i **Glavnom stožeru zimske službe, Zagreb** fax. porukom u određenom vremenu, koji sistematizira prikupljene podatke iz cijele Republike Hrvatske i zatim ih prosljeđuje zainteresiranim stranama.

Veza između izvoditelja radova, nadzorne službe Hrvatskih cesta d.o.o., Županijske uprave za ceste te inspekcijske službe Ministarstva pomorstva, prometa i infrastrukture zasniva se na statičnoj telefonskoj ili mobilnoj vezi.
Kao poboljšanje u sustavu veza i praćenja aktivnosti, sukladno odredbama ugovora, na vozilima koja služe za ophodnju i na teretnim vozilima ugrađeni su GPS lokator, na osnovi kojih je moguće pratiti kretanje i aktivnosti tih vozila na pojedinim dionicama državnih cesta.
Radi efikasnosti rada zimske službe spomenuti sustav detektiranja (GPS) potrebno je sukladno ugovoru uvesti u sva vozila koja rade u zimskoj službi i to naročito na vozila koja nisu opremljena tahografom.



Slika 11. Shema sustava veza

7. ZAKLJUČAK

Na području Varaždinske županije ima **207,33 km državnih cesta, 437,28 km županijskih cesta i 460,08 lokalnih cesta, ili sveukupno 1.104,69 km javnih cesta** u zimskom održavanju. Zimska služba je organizirana kroz četiri stalna mjesta pripravnosti gdje su smješteni potrebni kapaciteti radne snage i mehanizacije, a opremljena su silosima i nadstrešnicama za smještaj soli i posipala potrebnih za zimsko održavanje cesta. U svim mjestima pripravnosti osigurano je i dežurstvo **24 sata** kako bi se moglo intervenirati u svakome trenutku.

Održavanje cesta u zimskim uvjetima vrši se prema određenim stupnjevima pripravnosti, a same dionice cesta održavaju se prema unaprijed određenim prioritetima. Hrvatske ceste d.o.o. vrše u svoje ime i u ime Županijske uprave za ceste nabavu soli prema Planu zimske službe, a potrebne količine posipala (drobljenog kamenog agregata 4-8mm) pribavlja izvoditelj sam i taj sistem je dobar, jer izvoditelj nije financijski opterećen oko nabave soli.

Svi kapaciteti – vozila koja obavljaju posao u zimskom održavanju (vozila s roto - posipačima i ralicama, ophodarska vozila, interventna kombi vozila) moraju biti opremljeni UKV uređajima te GPS uređajima za praćenje, kako bi investitor mogao uvijek znati njihov status. Način komunikacije i obavješćivanja javnosti je dobro razrađen i jako dobro funkcionira.

Kada samo jedan detalj u cijeloj zimskoj službi ne bi bio organiziran u detalje, sigurnost na cestama u zimskom periodu bila bi upitna.

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POLIURETANSKE PRIJELAZNE NAPRAVE*

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Sažetak

Cilj ovoga rada je prikazati karakteristike polimernih prijelaznih naprava (PPN), osobito novih fleksibilnih poliuretanskih prijelaznih naprava (FPPN) u odnosu na standardne prijelazne naprave (SPN). FPPN omogućavaju manje stvaranje buke pri prijelazu vozila, vodonepropusnost, veću mehaničku otpornost i dulji vijek eksploatacije uz mogućnost ugradnje u etapama i na nižim temperaturama. Ove nove prijazne naprave ugrađuju se u Velikoj Britaniji, Austriji i Italiji, u zadnje dvije godine i do sada nisu zabilježena oštećenja. Prikazan je postupak ugradnje FPPN na mostu Krapina.

Ključne riječi: fleksibilne prijelazne naprave, poliuretan, polimeri

* The complete text is available on CD-ROM / Bajić, Adem, Gukov

1. Uvod

Prijelazne naprave na mostovima premošćuju otvore promjenjivih dimenzija u rasponskoj konstrukciji. Dizajnirane su za prihvaćanje pomaka nosive konstrukcije uz osiguranje mirnog prometa. Osnovni uvjeti koje moraju zadovoljavati prijazne naprave:

- Vodonepropusnost ili kontrolirana odvodnja
- Provjetravanje prostora za slobodno pomicanje ispod dilatacije i dijelova konstrukcije u području dilatacije
- Sposobnost prilagođavanja i preuzimanja očekivanih pomaka u vertikalnom i horizontalnom smjeru
- Otpornost na utjecaje očekivanih opterećenja
- Buka treba biti što manja pri prijelazu vozila
- Duži vijek upotrebe i očekivanu trajnost najmanje kao asfaltni kolovoz uz dilataciju
- Otpornost na utjecaj korozije i abrazije
- Jednostavnost kontrole, održavanja, popravljanja i zamjene oštećenih dijelova naprave.

Prijelazne naprave dijele se prema mogućnostima veličine pomaka na: prijazne naprave za minimalne pomake (do 20 mm), za male pomake 50-70 mm, za srednje pomake do 150 mm i za velike pomake iznad 300 mm.
Na izbor prijelaznih naprava mogu utjecati i posebni uvjeti kao što je cestovni promet s gustim prometom gdje treba biti zadovoljen prometni kriterij jednostavne i brze zamjene bez obzira na veću cijenu prijelazne naprave (Fu, Zhang, 2011).

Na željezničkim mostovima kod ugradnje prijelaznih naprava potrebno je razmotriti dva elementa: dilataciju mosta i dilataciju tračnica. Danas se daje prednost izvedbi zavarenog dugog tračničkog traka. Zato mnogi moderni mostovi nemaju dilatacionih uređaja za tračnice. Europska norma Eurokod 1, dio 2 (RN1991-2) daje pravila za maksimalnu duljinu neprekinutih tračnica. Udaljenost između središta temperaturnih pomaka i kraja sklopa ne smije prijeći 60 m čelične konstrukcije, odnosno 90 m za betonske ili spregnute mostove s kolosiječnim zastorom na mostu. Ukoliko duljina dilatacije prelazi ove vrijednosti, potrebno je koristiti dilatacione naprave. Dilataciona naprava za tračnice nije smještena izravno nad rasponom mosta, već se treba nalaziti na nasipu, u blizini mosta (npr. iza upornjaka) (Radić, 2005).

2. Bitumenske prijelazne naprave

U građevinarstvu se koriste bitumenske prijelazne naprave koje su sačinjene od bitumenske mješavine, a sastoje se od agregata i elastomerno-modificiranih veziva. Zbog navedenog kemijskog sastava i svojstava bitumenske mase, a u svrhu postizanja što bolje povezanosti agregata i veziva nužna je ugradnja ovih naprava na visokim temperaturama. Poznato je da su sve asfaltne mješavine na višim temperaturama osjetljive na plastične deformacije. Zbog toga se javlja kolotrag. On može na niskim temperaturama uzrokovati znatne udarne sile (Radić, 2002). Prijelazne bitumenske naprave u praksi su pokazale neke nedostatke:

- Ove naprave su termolabilne
- Materijal od kojeg je načinjena naprava je vrlo tvrd pri niskim temperaturama, stoga može procuriti, osobito na dijelovima koji nisu izloženi prometu
- Materijal ima sklonost plastičnim, ireverzibilnim deformacijama pri visokim temperaturama
- Ove naprave stvaraju udarne sile

- Ne mogu se ugrađivati na autocestama i prometnicama gdje su potrebna česta ubrzanja ili kočenja (u blizini autobusnih stajališta ili semafora)
- Vijek trajanja je kratak, najviše kao i okolni asfaltni objekt ceste, a to je najviše do 5 godina, osobito pri velikim prometnim opterećenjima

Prednosti:

- Mogu se ugrađivati kod željezničkih mostova kod kojih je kolosijek izveden zastorom od tucaničkog materijala
- Ove naprave su jeftinije od polimernih prijelaznih naprava (Radić, 2005).

3. Polimerne prijelazne naprave

3.1. Općenito o polimerima

Polimeri se mogu podijeliti na prirodne i sintetske. Zbog svojih dobrih svojstava: relativno niske gustoće, lagane prerade, niske električne provodljivosti, dobre zvučne i korozijske zaštite danas se oni sve više koriste u proizvodnji prijelaznih naprava. Prirodni polimerni materijali biljnog porijekla su : kaučuk i jantar, a sintetski su elastomeri i poliuretani, koji se koriste u građevinarstvu za izradu dilatacionih prijelaznih naprava. Jednokomponentni polimeri ne koriste se u građevinarstvu. Zbog bolje prilagodbe zahtjevima u građevinarstvu, zatim zbog poboljšanja svojstava, produljenja trajnosti materijala i smanjenja cijene, polimerima se raznim industrijskim postupcima dodaju komponente koje njihova svojstva poboljšavaju. Miješanjem polimernog materijala ili spajanjem više vrsta materijala, dobiva se kompozit koji ima poboljšana svojstva, odnosno specifična svojstva za primjenu u određenim uvjetima.

Dobra svojstva polimera su:

- Mala gustoća
- Lako oblikovanje
- Otpornost prema kemikalijama i atmosferilijama
- Otpornost prema koroziji
- Dobra izolacija topline i elektriciteta
- Sposobnost prigušivanja zvuka
- Vodonepropusnost

Loša svojstva polimera su:

- Mala čvrstoća
- Dimenzionalna nestabilnost
- Mala toplinska otpornost, laka zapaljivost
- Sklonost starenju i razgradnji

Navedena loša svojstva polimera današnjim postupcima proizvodnje kompozitnog polimernog materijala pokušavaju se što više smanjiti, kako bi se postigao što bolji polimerni materijal od kojega se danas izrađuju dilatacione prijelazne naprave (Šimunić, 2007). Prema ponašanju pri zagrijavanju i elastičnim svojstvima razlikuju se slijedeći polimeri:

- Plastomeri (pri porastu temperature omekšavaju, a pri opadanju temperature se skraćuju)
- Duromeri (pri porastu temperature ne omekšavaju)
- Elastomeri (imaju izražena elastična svojstva)

- Elastoplastomeri (imaju elastična svojstva kao elastomeri, a pri rastu/opadanju temperature se omekšavaju/skraćuju kao plastomeri

Duromeri i plastomeri nazivaju se plastičnim masama za razliku od elastomera i elastoplastomera koji se smatraju gumama zbog svoje velike elastičnosti. Najčešće korišteni polimeri u građevinarstvu su elastomeri i poliuretan.
Elastomeri su materijali koji na temperaturi 20°C pod vlačnim opterećenjem mogu dvostruko povećati dužinu, bez zaostalih deformacija po prestanku vlačnog opterećenja. Elastomeri imaju mali modul elastičnosti (1-10 MPa), a veliku elastičnost. Jedan od postupaka u izradi polimernih prijelaznih naprava je i postupak ekstrudacije, kojim se rastali polimerni granulat, a zatim u tekućem stanju ulazi u pužnicu u kojoj se rastaljeni materijal hladi, skrućava i u polutekućem stanju ulazi u kalup u kojem se oblikuje prijelazna naprava (Čulin, 2004).

3.2. Jednoprofilne i višeprofilne prijelazne naprave

Jednoprofilna ili višeprofilna prijelazna naprava poznata je pod nazivom lamelarna ili modularna prijelazna naprava. Ove prijelazne naprave sačinjene su od jedne ili nekoliko čeličnih lamela ili centralnih greda koje zatvaraju jedno ili nekoliko pojedinačnih praznina koje su zapečaćene elastomernim profilima protiv prodora vode. Lamele su oslonjene na poprečne grede. Karakteristike ovih prijelaznih naprava su: vodonepropusnost, ne stvaraju buku pri prijelazu vozila, dugotrajnost, jednostavna izmjena oštećenih dijelova naprave. Kod ovih prijelaznih naprava mogući su pomaci od 100-1200 mm. Osim lamelarnih višeprofilnih prijelaznih naprava postoji varijanta valovitih sinusoidnih čeličnih ploča koje su sačinjene od građevinskog nehrđajućeg čelika s elastomernim omotačem. Ovakve prijelazne naprave omogućuju pomake i do 1500 mm.

3.3. Neoprenske prijelazne naprave

Ove modularne spojnice napravljene su od elastomera, najčešće dužine do 2 m, koje mogu prihvatiti horizontalno, vertikalno i poprečno pomicanje zbog mogućnosti smičuće deformacije (kao kod elastomernih ležajeva). Naime, umjetna guma (elastomer) omogućava posmične pomake, a čelični ulošci napravi daju potrebnu čvrstoću.

Neoprenske prijelazne naprave armirane su čelikom i namijenjene su za pomake do 330 mm. Mogu biti postavljene primjenom ankera otpornih na zamor, izravno u beton, nakon obrade površine ili na čeličnu podkonstrukciju. Neoprenske spojnice imaju zupčaste spojnice na krajevima i postavljaju se ispod kolovoznog zastora ili pješačke staze. Na taj način izbjegnuta su mehanička oštećenja. Brtveni ulošci (elastomere) koji se umeću između spojnica (letvi) mogu se nakon oštećenja lagano izvaditi i zamijeniti novima.

Prednosti ovih naprava su:
- Lagano postavljanje zbog ravne konstrukcije
- Pogodni su za popravke
- Mogućnost rezanja na mjestu postavljanja
- Mogućnost postavljanja preko postojećih prijelaznih naprava
- Čvrsta konstrukcija naprave
- Dugotrajnost
- Vodonepropusnost
- Mogućnost primjene u cestovnim i željezničkim konstrukcijama

3.4. T-mat neoprenske prijelazne naprave

Ove naprave su jedna varijanta neoprenske prijelazne naprave koje se često koriste kao zatvorena prijelazna neoprenska naprava na željezničkim mostovima, tj. ispod tucanika. Napravljene su od estrudiranog elastomernog profila koji je očuvan pomoću čeličnog uklliještenog profila i vijcima pričvršćen za masivnu čeličnu podkonstrukciju. Ove naprave se također koriste za cestovne mostove u gradskim područjima zbog udobnosti koju pružaju tijekom vožnje i zbog manje emisije buke. T-mat neoprenska naprava može se koristiti za pomake do 160 mm.

3.5. Beton polimerna prijelazna naprava

Ovu napravu čine dva metalna rubna profila između kojih je smještena prijelazna naprava s gumenim brtvenim profilom. Rubni profili izliveni su u brzo stvrdnjavajućoj elastomernoj smoli tkz. polimerskom betonu. Profil načinjen od konstrukcijskog čelika izveden je u nekoliko elastičnih profila za pomake 50-150 mm (Raymond,1992).

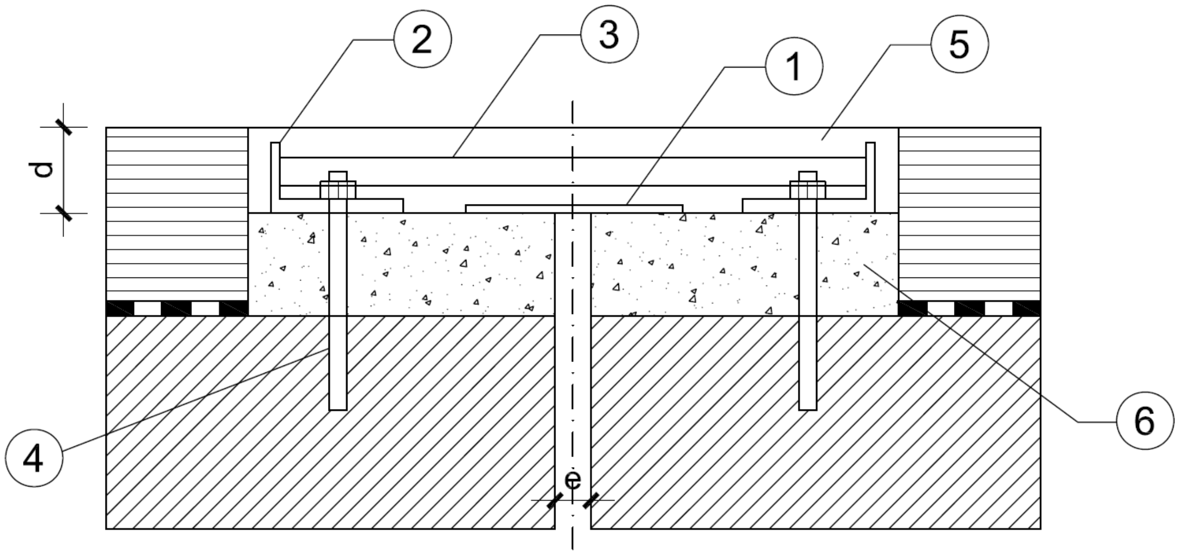
3.6. Fleksibilne poliuretanske prijelazne naprave (FPPN)

Ova naprava sačinjena je od kompozitnog materijala koji se sastoji od dvije komponente poliuretana u tiksotropnim (polukrutim) uvjetima i zaštićena je od rastvarača. Komponente se miješaju bez zagrijavanja hladnim postupkom i tako su spremne za ugradnju na temperaturama iznad 5°C. Poliuretan je polimer sastavljen od lanca organskih jedinica spojenih karbamat (uretan) vezama. Većina poliuretana su termootporni polimeri koji se ne rastapaju pri zagrijavanju. Poliuretanski polimeri nastaju reakcijom izocijanata s poliolom. Izocijanat i poliol služe kako bi poliuretan sadržavao u prosjeku dvije ili više funkcionalne skupine po molekuli (Gallai, 2012).

Tablica 1. Prikaz fizikalnih karakteristika poliuretanske mješavine

Odnos komponenti u mješavini	1:10
Gustoća	1,05 g/cm^3
Tvrdoća	~65 Sh
Zatezna čvrstoća	14 N/mm^2
Izduživanje	650%
Čvrstoća trganja	20 N/mm
Vrijeme obrade na 10°C	40 min
Vrijeme obrade na 20°C	30 min
Vrijeme obrade na 30°C	20 min
Vrijeme ponovne obrade na 10°C	9 h (minimalno)
Vrijeme ponovne obrade na 20°C	6 h (minimalno)
Mogućnost otvaranja prometa na 10°C	48 h (maksimalno)
Mogućnost otvaranja prometa na 20°C	24 h (maksimalno)
Potpuna ugradnja na 10°C	5 dana
Potpuna ugradnja na 20°°C	4 dana
Temperatura zraka i konstrukcije	5-35°C
Dopuštena vlažnost	90 % (maksimalno)

Ukoliko se naprava ugrađuje na temperaturi od 20°C, promet može započeti već nakon 24 sata, a ukoliko se naprava ugrađuje na 10°C, promet može započeti 48 sati nakon ugradnje prijelazne naprave. Fleksibilna poliuretanska prijelazna naprava sastoji se od: podloge sačinjene od polimernog betona ili betona na kojoj se s gornje strane iznad dilatacione pukotine nalazi ploča i klizni element. Podloga je učvršćena čeličnim kutnicima i vijcima za betonsku konstrukciju koja se nalazi ispod polimernog betona. Čelični kutni profili, vijci i pokrovna ploča izrađeni su od uobičajenog konstrukcijskog pocinčanog čelika. Klizni element koji dopušta veće pomake (iznad 100 mm) nalazi se ispod poliuretanske folije. Izbušeni čelični kutnici oslobađaju bokove od opterećenja i održavaju vezu s okolnim zastorom, a njihove perforacije osiguravaju bolju ugradnju i povezivanje s ispunom. Takvi elementi za stabilizaciju održavaju ravnomjernost u svakom položaju i nužni su samo za najveće pomake (Gallai, 2012).



Slika 1. Poprečni presjek FPPN

Na slici 1 prikazan je karakterističan poprečni presjek fleksibilne poliuretanske prijelazne naprave: 1-ploča i klizni element, 2-čelični kutnik, 3-elementi za stabilizaciju, 4-vijci za pričvršćivanje kutnika, 5-poliuretanska ispuna FPPN, 6- podloga od polimernog betona ili betona.

Fleksibilne poliuretanske prijelazne naprave za razliku od standardnih prijelaznih naprava uspijevaju postići sasvim nove standarde u pogledu kvalitete i dužine vremena eksploatacije. Njihove prednosti u odnosu na standardne prijelazne naprave ili neke druge polimerne prijelazne naprave mogu se podijeliti u dvije grupe: prednosti s obzirom na dobre karakteristike poliuretanskog materijala i same konstrukcije naprave i na prednosti zbog šireg područja primjene, načina ugradnje i održavanja naprave u okolni zastor (Gallai, 2012).

Prednosti fleksibilnih poliuretanskih prijelaznih naprava s obzirom na dobre karakteristike materijala i konstrukcije naprave:

- Smanjena emisija buke
- Visoka elastična svojstva, nema plastične deformacije naprave
- Vodonepropusnost
- Dugotrajnost
- Otpornost na mehaničko habanje
- Otpornost na koroziju
- Otpornost na zamor
- Dobra mehanička otpornost
- Dobra mogućnost prilagođavanja promjenama širine dilatacione reške u svim uvjetima
- Poboljšana ravnost ispred i iza naprave (manja od 5 mm)

- Povećana otpornost površine na klizanje

Fleksibilne prijelazne naprave imaju čitav niz prednosti u odnosu na standardne i neke druge polimerne prijelazne naprave prema području primjene, zatim načinu ugradnje i održavanja pojedinih oštećenih elemenata naprave.
Karakteristike područja primjene, načina ugradnje i održavanja fleksibilnih poliuretanskih prijelaznih naprava su:

- Mogućnost izvođenja na križanjima kolnika
- Mogućnost ugradnje na vertikalnim dilatacijama
- Mogućnost ugradnje na cestovnim i željezničkim objektima
- Mogućnost izvedbe i kod većih pomaka konstrukcije (većih od 100 mm)
- Mogućnost primjene kod rekonstrukcije postojećih prijelaznih naprava
- Moguća je izvedba svakog detalja rubnjaka i staze za pješake
- Hladna ugradnja
- Mogućnost ugradnje u širokom rasponu temperature (od 5°C do 35°C)
- Površinski slojevi (asfalt ili beton) mogu se postavljati kontinuirano prije ugradnje prijelazne naprave
- Jednostavno održavanje (kontinuirano čišćenje kao kod čeličnih profila nije potrebno)
- Mogućnost jednostavne sanacije reaktivacijom poliuretanskog materijala (npr. ogrebotine od ralica za čišćenje snijega)
- Brza i jednostavna ugradnja uz minimalnu regulaciju prometa (Gallai, 2012)

Nedostaci fleksibilnih prijelaznih naprava (FPN) :

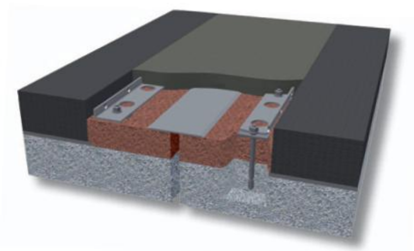
- Zapaljivost poliuretana
- Skuplja cijena od standardnih prijelaznih naprava (SPN)
- Kratko iskustvo u dosadašnjoj primjeni

3.7. Vrste fleksibilnih poliuretanskih prijelaznih naprava (FPPN)

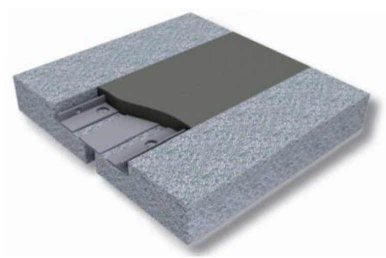
One se mogu podijeliti prema namjeni naprave na:

- FPPN za velika opterećenja i moguće fleksibilne pomake veće od 100 mm (mostovi na cestovnim objektima)
- FPPN za manja opterećenja (željeznički i manji cestovni objekti)
- FPPN za ugradnju na mjestima križanja cestovnih objekata pod bilo kojim kutem i u bilo kojem smjeru (X i T križanja)
- FPPN se može ugraditi i za vertikalne dilatacije bez ograničenja u širini i nagibu

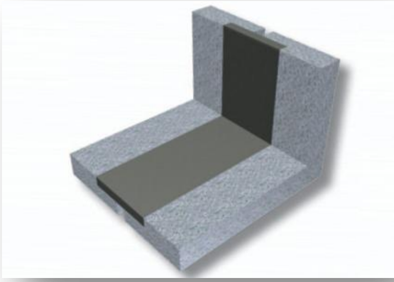
Na slikama 3-6. Prikazane su vrste poliuretanskih prijelaznih naprava s obzirom na potrebe ugradnje (manja i veća opterećenja, T i X križanja cesta ili kod vertikalnih dilatacija)



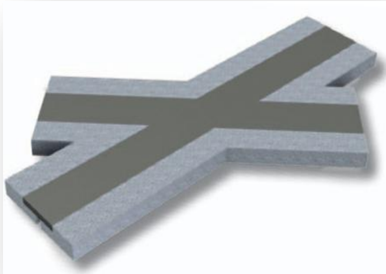
Slika 3. FPN za velika opterećenja



Slika 4. FPN za manja opterećenja



Slika 5. FPN za vertikalne dilatacije



Slika 6. FPN za T i X raskrižja

3.8. Testiranja fleksibilne poliuretanske prijelazne naprave

U testnom pogonu Tehničkog sveučilišta u Münchenu izvršena su ispitivanja mehaničke otpornosti i otpornosti na zamor materijala prema ETAG 032-3, Anex 3M na dva testna primjerka fleksibilne prijelazne naprave.
Testovi su uključivali:

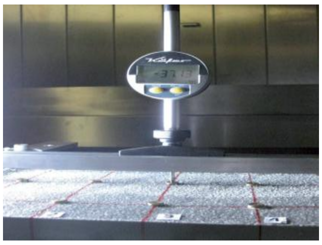
1. Ispitivanje otpornosti FPPN na vertikalno statičko opterećenje i oporavak nakon prestanka djelovanja opterećenja (ispitivanje mehaničke otpornosti naprave)
2. Ispitivanje otpornosti FPPN na ponavljajuće vertikalno dinamičko opterećenje (ispitivanje zamora materijala)

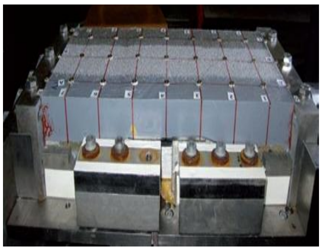
Provedeno je testiranje FPPN na izrađenom uzorku od 1 m (1:1), koji je bio izložen vertikalnoj sili od 150 kN preko kotača vozila (pneumatika) koji se nalazio u položaju najvećeg dilatacionog otvora. Ispitivanje je učinjeno na sobnoj temperaturi od 23 ± 2°C uz kontaktni tlak od 0,94 MPa. Ispitivanje je bilo provedeno u skladu s RVS-om i smjernicama definiranim u ETAG 032 (dio 3, anex 3M metoda). Nakon navedenog tlačnog opterećenja naprave u trajanju od 5 minuta, mjerene su deformacije nakon prestanka opterećenja i analizirana je krivulja oporavka nakon opterećenja FPPN. Ispitivanjem je utvrđeno da su maksimalne deformacije odmah nakon rasterećenja naprave iznosile do 0,5 mm. Sat vremena nakon rasterećenja bio je zabilježen potpuni elastični povratak testirane površine u prvobitno stanje. Vizualno nisu uočena oštećenja niti druge promjene.
Testiran je drugi uzorak sustava FPPN, također u omjeru 1:1. Ispitivanje je učinjeno na Tehničkom sveučilištu u Münchenu, prema smjernicama ETG-a. testiranje je obavljeno ponavljanim kotrljanjem preko uzorka naprave na povišenoj temperaturi od 45°C. Kontaktni pritisak kotača vozila iznosio je 1,0 MPa. Broj ponavljanih prijelaza (kotrljanja) na testnoj napravi iznosio je 3030, gdje je 30 prijelaza (kotrljanja) izvedeno s dodatnim povećanjem horizontalne sile od 10 % kako bi se simuliralo kočenje. Nakon obavljenog testiranja naprave, nisu zabilježeni pritisci niti odvajanja, odnosno odljepljivanja. Prema iskustvima sličnih testiranja asfaltnih prijelaznih naprava, testiranje koje je obavljeno na FPPN s velikim brojem kotrljanja, procjenjuje se da bi očekivani vijek trajanja pod takvim opterećenjima omogućio vijek trajanja FPPN oko 15 godina. Dodatnim testiranjem ispitivano je stvaranje kolotraka na 60°C na SPN i FPPN. Poliuretanska prijelazna naprava se nakon 30 000 kotrljanja pokazala znatno izdržljivija od asfaltne prijelazne naprave nakon samo 100 ciklusa kotrljanja.
Na slikama je vidljiva značajna razlika u testiranju na zamor bitumenske prijelazne naprave nakon 100 ciklusa kotrljanja na 60°C i na zamor fleksibilne poliuretanske prijelazne naprave nakon 30 000 ciklusa pri temperaturi od 60°C.

a) b)

Slika 7. Prikaz ispitivanja otpornosti na zamor a) materijala kod bitumenske naprave b) materijala kod FPPN

Provedena su testiranja karakteristika pomicanja prijelazne naprave (FPPN). Testiranje je provedeno na testnom uzorku naprave (1:1) na Njemačkom federalnom institutu za istraživanja i testiranja materijala u Berlinu (Bundesanstalt für Materialforschung und prüfung-BAM). Provedena su testiranja karakteristika pomicanja prema smjernicama ETAG 032-3, Anex 3N na testnom primjerku fleksibilne poliuretanske prijelazne naprave. Učinjeno je testiranje čitavog deklariranog pomaka (FPPN) između maksimalnog izduživanja i skupljanja u uvjetima velikih temperaturnih razlika (-40°C do +60°C). Tijekom testiranja zabilježene su vrijednosti reaktivnih sila i deformacija. Testiranjem je obuhvaćeno 7 500 000 sinusoidnih ciklusa s amplitudom od 1 mm, u uvjetima ambijentalne temperature pri frekvenciji od 5 Hz. Također je izvršeno testiranje dinamičkih mogućnosti pomicanja naprave na temperaturi od -40° C. Dinamičko ponašanje FPPN pokazalo se izvanrednim, a uzorak nije pokazao nikakve neregularnosti ili zamor nakon ispitivanja.





Slika 8. Prikaz ispitivanja mogućnosti pomicanja testne fleksibilne naprave nakon izlaganja velikim temperaturnim razlikama (-40 C do +60 C)

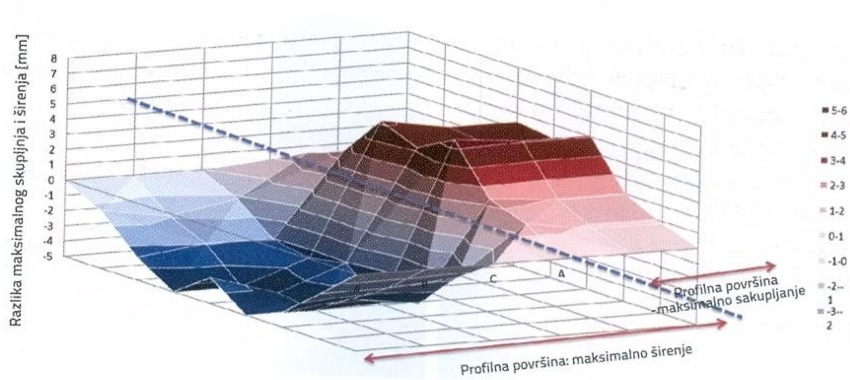
Testiranje vodonepropusnosti

Ovim testiranjem naprava se izložila u maksimalno otvorenom položaju djelovanju vode u trajanju od 8 sati s visinom vodenog stupca od 50 mm iznad najviše točke naprave. Nakon provedenog testiranja nije primijećeno procurivanje ili bilo kakva vlaga ispod uzorka. Navedeno testiranje potvrdilo je vodonepropusnost naprave.

Slika 9. Prikaz testiranja vodonepropusnosti FPPN

Testiranje ravnosti na kolničkoj površini ispred i iza prijelazne naprave

Ovim testiranjem provjereno je jesu li razlike ravnosti kolničke površine ispred i iza FPPN od idealne linije povezanosti između dvije susjedne površine zastora u pravcu odvijanja prometa, bez ikakvih izazvanih horizontalnih deformacija i postoji li razlika u razinama na mjestu neopterećenja veća od 5 mm, što je u skladu s RVS-om i prijedlogom smjernica ETAG-a. Nakon opterećenja, razlike u razinama ne smiju biti veće od 10 mm. Testiranja su pokazala da su razlike u razinama nakon testiranja naprave unutar dozvoljenih i očekivanih vrijednosti, a prikazane su na slici 10.



Slika 10. Prikaz rezultata testiranja odstupanja od ravnine u najviše otvorenom i najviše zbijenom položaju

Novi poliuretanski materijal ima dug vijek trajanja, otporan je na utjecaje okoline, kemikalije i na habanje. Stoga bi očekivano vrijeme eksploatacije s obzirom na dobre karakteristike poliuretana trebalo biti značajno duže od standardnih prijelaznih naprava. Originalni poliuretanski materijal ima dugu tradiciju kao hidroizolacija na krovovima i kontinuirano je unapređivan tijekom vremena (Gallai, 2012).

3.9. Primjena Fleksibilne poliuretanske prijelazne naprave u Hrvatskoj

Na mostu Krapina ugrađena je do sada jedina FPPN u Hrvatskoj. Na slikama 11 i 12 prikazane su važnije faze izvedbe ove nove polimerne naprave.

a) b) c)

Slika 11. Prikaz faza postavljanja FPPN (a-e)
a) postavljanje metalnih profila b) postavljanje gumenog profila c) nanošenje poliuretanske mase

Preko tankog metalnog profila postavlja se gumeni profil kako bi se spriječilo procurivanje poliuretanske smjese prijelazne naprave. Nakon toga nanosi se prednamaz za bolju hvatljivost dvokomponentne zaljevne mase prijelazne naprave i postojeće betonske podloge. Prednamaz se nanosi samo na betonski dio, bez dodirivanja gumenog profila te se suši 2-3 sata, ovisno o temperaturi. Miješavina poliuretanske prijelazne naprave sastoji se od dvije kompopnentne koje dolaze u već pripremljenim omjerima, a neposredno prije primjene miješaju se ručnim mikserom.

d) e)

Slika 11. d) posipavanje kvarcnim pijeskom e) ugrađena FPPN na jednom traku ceste

4. ZAKLJUČAK

Prijazne naprave su „slabe točke“ u kolničkoj konstrukciji i zato su česta mjesta oštećenja mostovnih konstrukcija, gdje se najčešće ugrađuju. Unatoč razvoju novih polimernih prijelaznih naprava, njihova trajnost je još uvijek manja od trajnosti konstrukcije mosta. Stoga je važno odabrati najprimjereniju prijelaznu napravu koja će imati karakteristike koje će odgovarati zahtjevima mjesta ugradnje, atmosferskim uvjetima na mjestu ugradnje, namjeni naprave, potrebama širine dilatacione reške, vrsti konstrukcije koja se spaja s upornjakom, zahtjevima maksimalnog opterećenja, jednostavnom načinu ugradnje na svim temperaturama, jednostavnoj izmjeni istrošenih dijelova naprave i cijeni naprave.

U radu su prikazane standardne prijelazne naprave za male pomake koje su međusobno uspoređene sa svojim prednostima i nedostacima. Standardne prijelazne naprave (osobito bitumenska) svojim karakteristikama ne zadovoljavaju potrebama prijelaznih naprava za njihovom vodonepropusnošću, manjom emisijom buke, trajnošću, mogučnošću elastičnog pomicanja bez plastične deformacije, otpornošću na temperaturne razlike i atmosferilije. Stoga su se tijekom proteklog desetljeća razvijale polimerne prijelazne naprave, kojima su se navedeni nedostaci SPN željeli umanjiti ili potpuno izbjeći.

Polimeri u građevinarstvu zbog svojih karakterističnih svojstava kao što su relativno niska gustoća, lagana prerada, niska električna vodljivost, zatim dobra zvučna i korozijska zaštita, sve više se koriste u građevinarstvu. Oni se za izradu prijelaznih naprava najčešće koriste u kombinaciji s pocinčanim čelikom, koji daje napravi potrebnu čvrstoću, a polimeri daju mogućnost elastičnog rastezanja i vodoneprousnost, tako da su danas nezaobilazni materijali kod elemenata građevinskih konstrukcija kao što su prijelazne naprave. Ekonomična primjena elastomernih materijala zahtjeva poznavanje njihova kemijskoga sastava, molekularne strukture, načina prerade i fizikalnih svojstava. Elastomerne prijelazne naprave smatraju se neispravnima kada izgube svoju elastičnost i fleksibilnost koja je nužna za dobro funkcioniranje prijelazne naprave. Trajnost polimernih prijelaznih naprava u velikoj mjeri ovisi i o karakteristikama elastomernih slojeva koji zaštićuju čelične dijelove naprave od štetnog utjecaja atmosferilija. Danas se dobri rezultati na trajnost naprave postižu primjenom sintetskoga polikloroprenskog kaučuka. Prognoze vijeka trajanja takvog polimernog materijala temelje se uglavnom na podacima ispitivanja umjetnog starenja, jer za sada još nije prošlo dovoljno vremena od početka njihove primjene temeljem kojeg bi se moglo utvrditi stvarno stanje starenja polimernog materijala (Šimunić, 2007).

Danas se u građevinarstvu koriste kompozitni polimeri koji se najčešće sastoje od dvije komponente poliuretana. Polimerima se raznim industrijskim postupcima dodaju komponente koje njihova svojstva poboljšavaju. Miješanjem polimernog materijala ili spajanjem više vrsta materijala, dobiva se kompozit koji ima poboljšana svojstva, odnosno specifična svojstva za primjenu u određenim uvjetima. Komponente se miješaju bez zagrijavanja hladnim postupkom i tako postaju spremne za ugradnju na temperaturama iznad 5°C. Kompozitni polimeri danas se sve više koriste zbog bolje prilagodbe zahtjevima u građevinarstvu i poboljšanja svojstava prijelazne naprave, produljenja trajnosti materijala i smanjenja cijene (Raymond, 1992).

Fleksibilne poliuretanske prijelazne naprave imaju čitav niz prednosti u odnosu na standardne, posebice bitumenske i neke druge polimerne prijelazne naprave prema području primjene, načinu ugradnje i održavanja pojedinih oštećenih elemenata naprave. Poliuretan je polimer sastavljen od lanca organskih jedinica spojenih karbamat (uretan) vezama. Većina poliuretana su termootporni polimeri koji se ne rastapaju pri zagrijavanju. Poliuretanski polimeri nastaju reakcijom izocijanata s poliolom. Izocijanat i poliol služe kako bi poliuretan sadržavao u prosjeku dvije ili više funkcionalne skupine po molekuli.
U radu su prikazana testiranja FPPN na mehaničko opterećenje, opterećenje na zamor, testiranje vodonepropusnosti, testiranje karakteristika pomicanja i testiranja ravnosti na kolničkoj površini ispred i iza prijelazne naprave. Rezultati testiranja za FPPN su pokazali vrlo dobre karakteristike naprave, ali još u praksi nemamo ih dovoljno u eksploataciji da bismo mogli sa sigurnošću donositi definitivan zaključak o novim napravama koje imaju besprijekorno dobre karakteristike u laboratorijskim uvjetima (Gallai, 2012).
Kod nas je prvi puta ova naprava ugrađena na mostu Krapina. Ono što je svakako kod ove naprave evidentno jest činjenica o jednostavnosti postavljanja naprave na svim temperaturama i mogućnost ponovnog odvijanja prometa u kratkom vremenu nakon

postavljanja. Kod temperature postavljanja 20° C, promet se ponovno može uspostaviti nakon 24 sata, odnosno kod temperature od 10° C nakon 48 sati od postavljanja naprave. S obzirom na ugrađenu prvu FPPN u Hrvatskoj pratit ćemo u slijedećih 5-10 godina kako će se ova naprava ponašati u eksploataciji s obzirom na trajnost, vodonepropusnost, moguća oštećenja, mogućnost zamjene oštećenih dijelova i njihovu cijenu. Tek nakon određenog broja godina eksploatacije, moći ćemo potvrditi ili u nekim karakteristikama demantirati, očekivane dobre karakteristike naprave do kojih se došlo testiranjima u laboratorijskim uvjetima. Ove naprave (FPPN) u eksploataciji su oko 2 godine u Velikoj Britaniji, Italiji i Austriji.

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INTEGRACIJA PROJEKTNIH ČIMBENIKA REDOVNOG ODRŽAVANJA CESTA POMOĆU INFORMACIJSKO-KOMUNIKACIJSKE TEHNOLOGIJE*

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Sažetak

Važnost redovnog održavanja cesta i potrebe integracije svih dionika (projektnih čimbenika) koji sudjeluju na projektima održavanja prometnica osnova je ovog rada. U radu se prikazuje da se odgovarajućim dizajnom i implementacijom informacijsko-komunikacijskih tehnologija ostvaruje povećanje učinkovitosti projekta redovnog održavanja cesta.
Osnovni ciljevi rada su definiranje projekta redovnog održavanja državnih, županijskih i lokalnih cesta u Republici Hrvatskoj, analiziranje pojma organizacije i projektnog menadžmenta, te sagledavanje temeljnih načina na koje se provode i kako su organizirani projekti redovnog održavanja u praksi. Predloženi konceptualni deskriptivni model projektnog menadžmenta redovnog održavanja cesta osigurava ilustraciju integriranja svih subjekata koji čine sustav redovnog održavanja cesta u svrhu povećanja učinkovitosti projekta redovnog održavanja cesta.

Ključne riječi : Redovno održavanje cesta, organizacija, projektni menadžment, informacijsko – komunikacijska tehnologija.

* The complete text is available on CD-ROM / Cesar-Kelemen

UVOD

U suvremenim uvjetima poslovanja načelno se može reći da je porasla dinamičnost poslovanja, tako da je puno teže voditi poslovanje posebno kod građevinskih poduzeća koje se bave redovnim održavanjem cesta. Redovno održavanje cesta kao skup mjera i radnji koje se obavljaju tijekom većeg dijela godine ili cijele godine na cestama, uključujući i sve objekte i instalacije, sa svrhom održavanja prohodnosti i tehničke ispravnosti cesta i sigurnosti prometa na njima,[*] jedna je od najvažnijih aktivnosti unutar sustava upravljanja infrastrukturom cestovnog prometa, zbog čega je vrlo važno da se ulaganje u održavanje cesta provodi ekonomično, kako bi se postigle veće koristi od uloženih financijskih sredstava.
Djelatnost redovnog održavanja cesta nije samo rad na terenu nego se sastoji od prikupljanja informacija, obradi, prijenosu i korištenju podataka i informacija, odnosno primjena informacijsko komunikacijske tehnologije, bez koje bi u današnje vrijeme bio teško zamisliv daljnji razvitak cestovnih mreža, a možebitno i onemogućen. Uzimajući u obzir činjenicu da se uvjeti u kojima se odvija projekt redovnog održavanja cesta konstantno mijenjaju, upravljanje u tom slučaju ljudskim resursima, vremenom i ostalim ključnim resursima, te upravljanju odnosima s vanjskim čimbenicima, ne može se definirati kroz kruto postavljene veze. Potrebno je razviti takav sustav koji će pomoću informacijske tehnologije omogućiti brze reorganizacije kao i brzo i optimalno planiranje i alokaciju resursa temeljem dobivenih informacija.
U tom smislu značajnu ulogu može imati razvoj modela projekta redovnog održavanja cesta, koji će se temeljiti na informaciji kao strateškom resursu i učinkovitoj primjeni informacijsko-komunikacijskih tehnologija, a time će sustav biti poboljšan, učinkovitiji i transparentniji. Taj sustav treba povezati sve subjekte koji se sastoji od: cestovnih prometnica, cestovnog prometa, pravnih subjekata koji upravljaju cestovnom mrežom, poduzeća koja se bave djelatnošću održavanja i zaštite cesta, te svih ostalih izravnih i neizravnih subjekata uključenih u redovno održavanje cesta, a sve sa svrhom održavanja prohodnosti i tehničke ispravnosti cesta i sigurnosti prometa na njima.
Dosad tema kao takva nije znanstveno sustavno istraživana. U domaćoj i stranoj literaturi utvrđeno je da na području informacijsko komunikacijske tehnologije, organizacije i projektnog menadžmenta postoje brojna znanstvena istraživanja koja djelomično istražuju međusobne veze i odnose informacijsko komunikacijskih tehnologija, projektnog menadžmenta i organizacije sa drugim djelatnostima ili glede drugih aspekata.
U ovom radu želi se istražiti i dati osnove za daljnja istraživanja na području integracije projektnih čimbenika redovnog održavanja cesta uz pomoć informacijsko komunikacijske tehnologije.

2. VAŽNOST REDOVNOG ODRŽAVANJA CESTA

Nakon ulaganja velikih financijskih sredstava u izgradnju cesta, čime je povećana ekonomska vrijednost cesta, te time i nacionalno bogatstvo, potrebno se usredotočiti na održavanje cestovne infrastrukture kako bi se postigla najveća korist za sve korisnike i društvo u cjelini.[†] Time se osigurava osnovna svrha održavanja, a koja se očituje u osiguranju prohodnosti i tehničke ispravnosti cesta i sigurnosti prometa na njima. Održavanjem infrastrukture cestovnog prometa potrebno je upravljati prema tržišnim principima koji se primjenjuju i u svim drugim komercijalnim djelatnostima. Temelj za upravljanje održavanjem infrastrukture cestovnih prometnica je interdisciplinarni pristup[‡] koji povezuje građevinsko inženjerstvo,

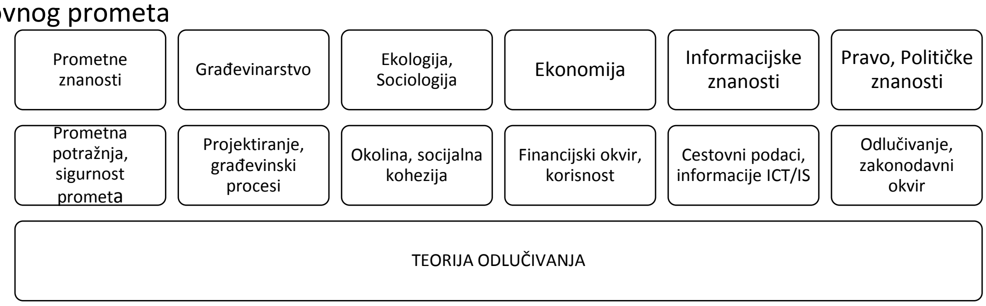
[*] ***Narodne novine (1998), *Pravilnik o održavanju i zaštiti javnih cesta*, Narodne novine d.d., 25, 162

[†] Keller, M. (2001), *Koncept preventivnog održavanja: djelotvoran način očuvanja cestovnih kolnika*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 47, str. 43-55

[‡] Miljković, G., Bratković, G., Krleža J. (2008), *Gospodarenje javnim cestama u Republici Hrvatskoj*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 2, str 40

prometno inženjerstvo, ekonomiju i pravo kroz primjenu najbolje prakse u donošenju djelotvornih poslovnih odluka i strategija održavanja infrastrukture cestovnih prometnica. Djelotvorne poslovne odluke za upravljanje održavanjem infrastrukture cestovnih prometnica, u tom smislu, donose se temeljem interdisciplinarnog pristupa, odnosno povezivanja više znanstvenih disciplina kao što je prikazano na slici 1.[*]

Slika 2. Interdisciplinarni pristup odlučivanju u projektnom menadžmentu infrastrukture cestovnog prometa



Izvor: Prilagođeno prema Miljković, G., Bratković, G., Krleža J. (2008), *Gospodarenje javnim cestama u Republici Hrvatskoj*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 56, str. 40

2.1. DEFINICIJA REDOVNOG ODRŽAVANJA

Cestovne prometnice su jedne od osnovnih poluga gospodarskog života svake zemlje i predstavljaju za mnoge od njih najvažniji način kopnenog prijevoza dobara. Iz tog razloga sve zemlje razgranale su jaku cestovnu mrežu cesta različite važnosti.[†] Međutim, danas kada su cestovne mreže u većini zemalja, a tako i u Hrvatskoj više-manje izgrađene, a postojeće ceste su sve starije, težište rada se premješta s građenja k održavanju.[‡] Razvoj cestovne mreže uglavnom prate sve veći zahtjevi korisnika po pitanju sigurnosti, udobnosti i razini pružanja usluga. Kao posljedica odvajaju se određena sredstva za održavanje cesta, a sve to rezultira kvalitetom održavanja kao i razvojem novih sredstava, tehnologija, te načina i metoda održavanja.[§] Time aktivnosti održavanja postaju svojevrsna stručna i znanstvena disciplina, kao i tema brojnih istraživanja, jer se zahvaljujući njima ostvaruju svi ciljevi suvremenog upravljanja najvećim državnim bogatstvom koje cestovne prometnice predstavljaju.

Održavanje smanjuje stupanj propadanja ceste, ono također smanjuje troškove prijevoza vozila na cesti putem osiguranja ravne vozne površine i ono omogućuje da cesta bude stalno otvorena za promet štiteći je da ne postane neprohodna.[**]

Čak i uz valjano održavanje, ceste s vremenom propadaju. Stupanj propadanja ovisit će o klimi, vrsti i čvrstoći kolnika, čvrstoći tla u posteljici, volumenu prometa koji se koristi cestom i osovinskim opterećenjima komercijalnih vozila. Sve ceste s vremenom dosegnu kraj svog projektnog vijeka trajanja, a tada im je potrebno pojačanje ili poboljšanje. Pojačanje, rehabilitiranje i rekonstruiranje jesu aktivnosti visokih troškova, pa ih je važno odgoditi koliko je moguće dulje putem izvođenja djelotvornog i pravovremenog održavanja. Odlaganje radova održavanja rezultira bržim povećanjem izdataka za ceste.[††]

Prema tome organiziranje pravovremenog izvođenja odgovarajućih radova održavanja predstavlja znatnu ekonomsku korist.

[*] Ibid. str. 40

[†] Lamer, M. (1989), *Tehnologija i organizacija redovnog (ljetnog i zimskog) održavanja cesta*, Zbornik referata seminara o građenju i održavanju cesta, Društvo građevinskih inženjera i tehničara – Zagreb, Društvo za ceste – Zagreb, Zagreb, str. 220

[‡] Keller, M. (2006), *Održavanje cesta – trajan i zahtjevan proces u sjeni građenja*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 52., str. 12-32

[§] Keller, M. (2006), op.cit. pod 2, str. 43-55

[**] Sršen, M. (1989), *Sistemi za gospodarenje cestama u svijetu i u nas*, Zbornik referata seminara o građenju i održavanju cesta, Društvo građevinskih inženjera i tehničara – Zagreb, Društvo za ceste – Zagreb, Zagreb, str. 167

[††] Sršen, M. (1989), *Sistemi za gospodarenje cestama u svijetu i u nas*, Zbornik referata seminara o građenju i održavanju cesta, Društvo građevinskih inženjera i tehničara – Zagreb, Društvo za ceste – Zagreb, Zagreb, str. 167-168

Održavanje cestovnih prometnica treba biti definirano glavnim zahtjevima koji se pred njega postavljaju, odnosno održavanje cestovnih prometnica je skup aktivnosti kojima se bitnije ne popravlja stanje ceste, nego se postiže barem minimalna sigurnost korisnika ceste i donekle štite pojedini elementi ceste od prebrzog propadanja.[*]

Djelatnost održavanja cestovnih prometnica može se podijeliti na četiri međuzavisne kategorije održavanja o kojima će biti više riječi u slijedećim poglavljima:[†]

- Redovno održavanje cestovnih prometnica;
- Izvanredno održavanje cestovnih prometnica;
- Investicijsko održavanje cestovnih prometnica;
- Preventivno održavanje cestovnih prometnica.

Sve aktivnosti održavanja i zaštite cesta provode se uz poštivanje tehnološkog jedinstva cijelog sustava gospodarenja i upravljanja cestama i objektima te temeljene na strategiji razvitka i programu građenja i održavanja cesta. Osnovni preduvjeti za obavljanje poslova održavanja cestovnih prometnica su:[‡]

- referentni sustav označavanja cesta,
- baza cestovnih podataka,
- praćenje stanja cesta i objekata,
- modeli odlučivanja.

Opći postupak održavanja cestovnih prometnica može se prikazati na slijedeći način. Proces započinje potrebom korisnika cestovnih prometnica za sigurnim i neometanim prometom, a završava intervencijama radova redovnog održavanja cesta. Nakon prikupljanja informacija, analiziranja i istraživanja prognozira se cilj, koji će putem modela gospodarenja, modela financiranja i modela održavanja (ne) udovoljiti postupku održavanja. Nakon toga izabire se organizacija za održavanje, te se izvršava program radova. Sam kraj procesa očituje se odlukom o izvršenju programa.

Glavnim čimbenicima u izvršenju procesa održavanja cestovnih prometnica smatraju se slijedeći elementi:[§]

- podaci o cestovnoj imovini odnosno inventaru,
- stanje cestovnih prometnica,
- prometno opterećenje,
- podaci o oštećenjima,
- troškovi održavanja i koristi,
- resursi odnosno sredstva rada,
- financijski proračun,
- standard i politike održavanja,
- informacije za upravljanje održavanjem.

Informacije za upravljanje održavanjem daju mogućnost da se poslovne odluke donose efikasno, te da se planiranje strategija održavanja cestovnih prometnica donose ispravno.[**] Provođenje kontrola i nadzora ovisi o kvaliteti i pravovremenošću raspoloživih informacija.

[*] Keller, M. (2006), op.cit. pod 6, str. 16

[†] Prilagođeno prema ***Narodne novine (1998), *Pravilnik o održavanju i zaštiti javnih cesta*, Narodne novine d.d., 25 i **162**

[‡] ***Narodne novine (1998), *Pravilnik o održavanju i zaštiti javnih cesta*, Narodne novine d.d., 25 i **162**

[§] Tillotson, H.T., Kerali, H.R. and Snaith, M.S. (1996), *Proceedings ot the International Symposium of Infrastructure of the Future*, pp. 220-227, New Age International (P) Ltd, Bangalore, str. 220-227

[**] Tillotson, H.T., Kerali, H.R. and Snaith, M.S., (1996), *Proceedings ot the International Symposium of Infrastructure of the Future*, pp. 220-227, New Age International (P) Ltd, Bangalore, str. 220-227

3. PROJEKTNI MENADŽMENT

Institucije i poduzeća koja se bave menadžmentom i održavanjem cestovnih prometnica odgovorne su za gospodarenje njima kao javnom imovinom.
Aktivnosti menadžmenta održavanja cestovnih prometnica koje se sastoje od radova definiranja aktivnosti, planiranja, održavanja, izvođenja novih cestovnih konstrukcija, poboljšanja i sličnih zahvata na način da se cestovnim prometnicama gospodari primjenom pristupa poslovnosti uključuju slijedeće zadatke:[*]

- definiranje aktivnosti;
- planiranje;
- raspodjelu raspoloživih resursa;
- organizaciju i motivaciju ljudskih resursa;
- kontroliranje i nadziranje izvođenja radova;
- kontrolu, nadzor i verifikaciju cestovne mreže;
- primjenu saznanja i dobivenih rezultata u daljnjim poboljšanjima stanja cestovne mreže.

U širem okviru, projektni menadžment cestovnih prometnica ima slijedeće ciljeve:

- sustavni pristup u unaprijed definiranom okviru;
- procjenu potrebnih financijskih sredstava i raspoloživih resursa;
- prihvaćanje utvrđenih standarda održavanja i projektiranje radova održavanja;
- efikasno raspoređivanje resursa;
- sustavno i kontinuirano revidiranje politike održavanja, standarda i učinkovitosti primijenjenih programa održavanja cestovnih prometnica.

Projektni menadžment održavanja cestovnih prometnica se temelji na četiri osnovne funkcije:[†]

- planiranje,
- programiranje,
- pripremu,
- izvođenje.

Planiranje[‡] uključuje analizu kompletne cestovne mreže uz pripremu višegodišnjih ili strateških analiza razvoja i očuvanja cestovne mreže uz različite ekonomske i gospodarske scenarije. Cestovna mreža se u postupku planiranja definira dužinom cestovnih prometnica ili udjelima cestovne mreže ovisno o različitim kategorijama prema definiranim parametrima, kao što su kategorija cestovnih prometnica, prometni tok, vrste kolničkih konstrukcija i tehničko stanje istih.

Programiranje[§] podrazumijeva razradu, prema raspoloživim financijskim sredstvima višegodišnjih programa i ulaganja u cestovne prometnice kojima se definiraju i odabiru pojedinačne dionice cestovne mreže koje zahtijevaju različite programe obnove. Programiranje je u svojoj osnovi taktički zadatak menadžmenta poduzeća i institucije koje upravljaju cestovnim sustavom. Za određivanje ekonomske i gospodarske opravdanosti svake grupe radova u okviru funkcije programiranja potrebno je provesti ekonomsku analizu troškova i koristi. U samom postupku programiranja cestovna mreža se raspodjeljuje i promatra prema prethodno definiranim linkovima, pri čemu svaki link treba biti karakteriziran

[*] Keller, M., (2000), *Koncept gospodarenja održavanjem cesta*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 46, str. 9-10
[†] Keller, M., (2009), *Gospodarenje cestovnim kolnicima*, Zbornik radova, Četvrto hrvatsko savjetovanje o održavanju cesta, Šibenik, str.42
[‡] Ibid. str. 42
[§] Ibid. str. 42

dionicama ceste i geometrijskim obilježjima, od kojih je svaki link definiran svojim fizičkim posebnostima. Provođenje aktivnosti programiranja omogućuje izradu procjena troškova raspoređene u vremenskom razdoblju, za različite vrste radova i zahvata za svaku cestovnu dionicu. Obzirom da su predviđena financijska sredstva gotovo uvijek ograničena, osnovni zadatak programiranja je utvrđivanje prioriteta radova u okvirima definiranih financijskih sredstava prema ekonomskom kriteriju omogućavanja maksimalne vrijednosti za uložena sredstva. Karakteristična primjena programiranja je izrada financijskog proračuna za godišnji ili četverogodišnji program radova održavanja za cestovnu mrežu u cjelini.

Na razini funkcijske pripreme pripremaju se planovi i projekti za samu implementaciju. U fazi **pripreme**[*] detaljnije se razrađuju projekti, obavlja se priprema troškovnika i procjena mogućih troškova, definiraju se ugovori i izrađuju se upute za rad. Ekonomske analize troškova i koristi ponovno se revidiraju s ciljem potvrđivanja opravdanosti samog projekta. Tipične aktivnosti u fazi pripreme su: iscrpno dimenzioniranje potrebnih zahvata na kolniku, pripremanje dokumentacije za provođenje postupka javnog nadmetanja, provođenje javnog nadmetanja, te izvršavanje ugovaranja radova.

Izvođenje uključuje operativne aktivnosti poduzeća i institucija koje upravljaju održavanjem cestovne mreže. Odluke se donose na dnevnoj ili tjednoj bazi, podrazumijevajući planiranje izvođenja radova koje se treba provesti, te nadziranje i ocjenjivanje izvršenih radova i korištenje dobivenih povratnih informacija za daljnje praćenje i kontrolu. Aktivnosti izvođenja su određene prema pojedinim dionicama ili poddionicama cestovnih prometnica[†].
Informacija je temelj ciklusa menadžmenta održavanja cestovnih prometnica, a koristi se za pomoć kod donošenja ispravnih poslovnih odluka u svim koracima cjelokupnog procesa. Osim toga, ciklus je ponavljajući proces koji se za većinu funkcija menadžmenta održavanja cestovnih prometnica provodi jednom za svako razdoblje, tako da će se za funkciju programiranja ciklus najčešće biti proveden jednom godišnje, dok će se za funkciju izvođenja provoditi na tjednoj ili čak dnevnoj bazi.

Slika 3. Ciklus menadžmenta održavanjem cestovnih prometnica

Izvor: *Guidelines for the design and operation of road management systems*, (1998), Department for International Developement, Transpert Reserch Laboratory, Berkshire, London [http://www.transport-links.org/transport_links/filearea/publications/1_712_orn15%20aug%2001.pdf] (09/2012), str. 6

[*] Keller, M. (2009), op.cit. pod 16, str. 42
[†] Ibid. str. 42

3.1. KLJUČNI ELEMENTI UČINKOSVITOSTI PROJEKTNOG MENADŽMENTA REDOVNOG ODRŽAVANJA DRŽAVNIH, ŽUPANIJSKIH I LOKALNIH CESTA

Mogućnost postizanja očekivane učinkovitosti projekta redovnog održavanja državnih, županijskih i lokalnih cesta ovisi o pravilnoj organizaciji rada, odnosno dobroj koordinaciji ukupnog zaposlenog osoblja od cestara, ophodara, nadcestara do menadžmenta. Učinkovitost projekta redovnog održavanja cesta se temelji na dva osnovna čimbenika:[*]

- racionalnom razvoju potreba i prioriteta održavanja,
- sustavu iskorištenja ugovorenih financijskih resursa i kontrole ostvarenja zadanih zahtjeva održavanja, ovisno o mogućnostima i raspoloživim sredstvima.

Za učinkovitu organizaciju redovnog održavanja državnih, županijskih i lokalnih cesta potrebno je zadovoljiti slijedeće uvjete:[†]

- izgraditi određen broj najnižih organizacijskih jedinica (nadcestarija, cestarija, asfaltnih baza) koje mogu optimalno obuhvatiti cjelokupnu mrežu cesta. Takve organizacijske jedinice moraju imati potrebit broj zaposlenog stručnog osoblja, strojeva, vozila i ostale opreme, optimalno za radove koje sami izvode;
- prethodno odrediti aktivnosti i radove održavanja koje izvode oni koji upravljaju cestama;
- omogućiti pod svim uvjetima kontinuiranost intervencija radova na cijeloj cestovnoj mreži;
- definirati međusobna prava i obaveze na raznim razinama, a posebno radnog osoblja;
- kontinuirano prikupljati relevantne cestovne podatke potrebne za donošenje pravilnih i racionalnih odluka;
- izraditi precizan katastar cesta uključujući objekte, kolničku konstrukciju i prometnu signalizaciju i opremu ceste te za njegovo ažuriranje uspostaviti stalnu stručnu kontrolu;
- uspostaviti bazu cestovnih podataka vezanih uz održavanje cesta i sigurnost prometa;
- utvrditi potrebe održavanja u funkciji dogovorenih normativa, ovisno o razini ceste i zahtjevima prometa;
- dijagnosticirati probleme i specificirati i procijeniti troškove radova održavanja;
- izabrati prioritete, vodeći račun o raspoloživim financijskim sredstvima i izradi programa radova za određeni vremenski period, te postići optimalni odnos između raspoloživih financijskih sredstava i izvršenih radova pomoću stručnih cestarskih radnika, uprave održavanja ili preko trećih lica;
- organizirati ukupnu kontrolu troškova radova pomoću sustava nadzora na svim razinama, kako bi se osiguralo kvalitetno izvođenje radova i dobro funkcioniranje menadžmenta održavanja cesta;
- pratiti utvrđene norme i mijenjati ih ukoliko je potrebno;
- neprekidno prilagođavati organizaciju i sredstva rada tehnološkom razvoju i novim spoznajama;
- omogućiti neprekidno stalno obrazovanje i napredovanje zaposlenika (inženjera, tehničara, računovodstvenih i administrativnih radnika i ostalih), kako bi se menadžment održavanja cesta redovno unapređivao i pratio tehnološki napredak;
- omogućiti bolju suradnju kroz integraciju svih sudionika koji čine sustav održavanja cestovnih prometnica osobiti iz razloga razvoja djelotvorne zajedničke koordinacije s aspekta sigurnosti prometa.

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[*] Lamer, M. (1999), *Uspostava sustava gospodarenja i upravljanja kolnicima i mostovima u Hrvatskoj*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 45, str. 227-230

[†] Ibid., str. 227-230

4. INFORMACIJSKO KOMUNIKACIJSKA TEHNOLOGIJA

Razvoj informacijsko komunikacijske tehnologije u poslovanju poduzeća ima za cilj objedinjavanje svih informacija koje su rezultat svakodnevnih poslovnih promjena unutar poslovnih procesa u jedinstvenu bazu podataka te osiguranje točnog, brzog, jednostavnog, svakodnevnog i trenutnog pristupa do svake pojedinačne informacije ili rezultata obrada postojećih informacija. Da bi se prije navedeni cilj ostvario potrebno je da svaki izvor informacija bude uključen u jedinstven informacijski sustav. Na taj način poslovne promjene u trenutku nastanka ulaze u informacijski sustav i postaju njegov sastavni dio, što znači da svi sudionici u informacijskom sustavu mogu u tom trenutku vidjeti i koristiti novu informaciju u svojim poslovnim zadaćama. Da bi se informatizacija uspješno provela potrebno je osigurati sljedeće:

- informacijsku i komunikacijsku opremu,
- programsku podršku,
- organizaciju protoka informacija i u skladu s tim organizaciju tijeka poslovnih procesa i ljudi koji ih izvršavaju.

Kod redovnog održavanja cestovnih prometnica ciljevi informatizacije se mogu odrediti kao:*

- identificiranje informacijske potrebe projektnog menadžmenta održavanja cesta koji na racionalan način ostvaruje usklađivanje strategije razvoja poslovnog sustava i strategije razvoja informacijsko-komunikacijske tehnologije,
- definiranje funkcije informacijskog sustava održavanja cestovnih prometnica koje podržavaju trenutno promjenjive potrebe radnih procesa koje moraju u svakom trenutku biti sposobne odgovoriti na žurne zahtjeve,
- definiranje politike upravljanja, održavanja i dostupnosti svim raspoloživim informacijskim resursima unutar organizacije za održavanje cestovnih prometnica,
- ključne funkcije informatizacije organizacije za održavanje cestovnih prometnica integrirati unutar organizacijske strukture poduzeća, sa predstavnikom u najvišoj razini menadžmenta,
- dizajnirati učinkovitu i ostvarivu organizacijsku strukturu organizacije za održavanje cestovnih prometnica koja će pratiti i podržavati razvojne potrebe informacijsko komunikacijske tehnologije,
- utvrditi na kojim to organizacijskim razinama razvoj informacijsko-komunikacijske tehnologije najviše doprinosi učinkovitosti funkcioniranja organizacije za održavanje cestovnih prometnica kako bi se na taj način odredili prioriteti budućeg investiranja,
- definirati sve organizacijske prednosti koje se mogu postići učinkovitom upotrebom informacijsko-komunikacijske tehnologije u projektnom menadžmentu održavanja cestovnih prometnica,
- izgraditi financijski prihvatljivu i fleksibilnu informacijsko-komunikacijsku infrastrukturu u projektnom menadžmentu održavanja cesta prilagodljivu za buduće nadogradnje,
- razviti optimalne resurse i sposobnosti za učinkovitu implementaciju informacijsko-komunikacijske tehnologije u projektni menadžment održavanja cesta.

Učinkovita informatizacija projektnog menadžmenta održavanja cesta temelji se na povećanju dinamike i kvalitete poslovnog odlučivanja na svim razinama menadžmenta održavanja cesta, kako na operativnoj tako i na taktičkoj i strateškoj razini. Podsustav za upravljanje unutar organizacijskog održavanja cestovnih prometnica je podijeljen te se sastoji od organizacijskih jedinica za održavanje, mreže dislociranih organizacijskih jedinica (ispostava i nadcestarija)

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* Husnjak, D. (2011), *Utjecaj informacijsko komunikacijske tehnologije na razvoj organizacijskog sustava održavanja cestovnih prometnica*, Magistarski rad, Sveučilište u Zagrebu, Fakultet organizacije i informatike, Varaždin, str. 72

koje operativno provode aktivnosti održavanja cestovne mreže na svom području nadležnosti. Te dislocirane organizacijske jedinice su ujedno i glavni izvor svih informacija neophodnih za donošenje odluka za planiranje, obavljanje radova i utroška potrebnih resursa u djelatnosti održavanja cesta.[*,†]

Informatizacijom projektnog menadžmenta održavanja cestovne mreže očekuje se:[‡]

- kroz jedinstveni sustav svi će korisnici jednostavno moći koristiti dostupne podatke,
- brzo i jednostavan uvid u podatke s punom sigurnošću u njihovu vjerodostojnost i ažurnost,
- omogućit će se argumentirano odlučivanje o vrsti, lokaciji, opsegu, cijeni i vremenu izvođenja radova potrebnih za održavanje cesta,
- poboljšat će se sigurnost i regulacija prometa na javnim cestama zbog olakšanog provođenja aktivnosti održavanja prohodnosti cesta,
- mogućnost kvalitetnijeg donošenja odluka,
- unapređenje aktivnosti vezanih uz održavanje.

Ključni zahtjevi i pretpostavke sa organizacijskog i tehničko-tehnološkog aspekta projektnog menadžmenta održavanja cestovnom mrežom koji se stavljaju pred sam informacijski sustav mogu se navesti kao:[§]

- ažurno prikupljanje podataka o radovima na cestovnoj mreži, prometnoj signalizaciji, brojanju prometa, stanju cestovne mreže i ostalog, prema unaprijed utvrđenoj metodologiji na svim upravljačkim razinama,
- kontinuirano unošenje cestovnih podataka u informacijski sustav ovisno o trenutno nastalim promjenama i dnevno obavljenim radovima na terenu,
- cjelovita obrada podataka i njihovo svakodnevno korištenje za potrebe odlučivanja i obavljanja aktivnosti upravljanja, zaštite i održavanja cesta,
- priprema informacija za potrebe menadžmenta,
- kompatibilnost, integralnost i modularnost implementiranih programskih rješenja.

Sva poduzeća, koja se na bilo koji način bave održavanjem cesta, bilo da su investitori ili izvođači, se prilikom razvoja i primjene sustava projektnog menadžmenta održavanja cestovne mreže suočavaju s brojnim ključnim elementima ili pitanjima.

5. INTEGRIRANI SUSTAV PROJEKTA REDOVNOG ODRŽAVANJA CESTA

Integrirani sustav projekta redovnog održavanja definiran je kao niz procesa koji koriste organizacijske resurse, podatke i informacije iz okruženja uz podršku ICT-a, sa ciljem ispunjenja zahtjeva svih sudionika u prometu, odnosno korisnika cesta i društva u cjelini za sigurno i neometano odvijanje prometa na cestovnoj mreži. Kao što je već ranije navedeno projektni menadžment redovnog održavanja cesta podržan ICT-om sastoji se od 5 osnovnih procesa koji se mogu navesti kao:

- Prikupljanje cestovnih podataka;
- Analiza prikupljenih podataka;
- Utvrđivanje strategija održavanja;
- Izrada plana i programa održavanja cesta;

[*] Debak, R. Golenić, V., Jurić, M. (1999), *Informatička tehnologija kao podrška sustavima gospodarenja i upravljanja cestama u Hrvatskoj*, 2. Hrvatski kongres o cestama, Hrvatsko društvo za ceste Via-Vita, Cavtat, str. 167-173

[†] Debak, R., Lamer, M., Sršen, M. (1995), *ISOC – informacijski sustav u oblasti cesta u funkciji gospodarenja cestovnom mrežom Republike Hrvatske*, Ceste i mostovi, Hrvatsko društvo za ceste Via-Vita, Zagreb, br. 41, str. 303-306

[‡] Brzović, T. (1999), *Unapređenje djelatnosti održavanja cesta oživotvorenjem referentnog sustava i kompjutoriziranih baza podataka o cestama*, Ceste i mostovi, Hrvatsko društvo za ceste, Via-Vita, Zagreb, br. 45, str. 181-184

[§] Brzović, T. (1999), ibid., str. 181-184

- Izvedba radova održavanja cesta.

Sustav redovnog održavanja cesta je dinamički sustav, što znači da kod njega tijekom vremena dolazi do promjena čiji su uzroci procesi koji se odvijaju u dijelovima sustava, a njihovo se djelovanje prenosi internom strukturom sustava putem informacijsko komunikacijske tehnologije.

Za svaki od navedenih procesa ulazni podaci su određene informacije (podaci spremljeni u skladište podataka) koje se putem informacijsko komunikacijske tehnologije unose u projekt redovnog održavanja cesta.

Projekt Redovno održavanje cesta započinje procesom **„Prikupljanje cestovnih podataka“**. Cestovni podaci prikupljaju se putem informacijsko komunikacijske tehnologije poštivajući smjernice za prikupljanje cestovnih podataka, administrativne i tehničke zahtjeve i ograničenja te eventualno dostupnu projektnu dokumentaciju. Prikupljene cestovne podatke predviđeno je (kao integracija svih podataka) pohraniti u skladište podataka. To nisu samo podaci koje prikupljaju izvođači koji održavaju cestu kao ni podaci koji se prikupljaju u Hrvatskim cestama ili Županijskim upravama za ceste (podaci o geometrijskim karakteristikama ceste, podaci o prometnom opterećenju, podaci o karakteristikama kolničke konstrukcije, podaci o postojećoj nosivosti kolničke konstrukcije, podaci o stanju cestovnih objekata, podaci o stanju odvodnje ceste, podaci o stanju prometne signalizacije i opreme, povijesni podaci o stanju cestovne mreže, podaci o povijesti radova održavanja, podaci o broju prometnih nezgoda, podaci o kontroli prometa podaci o imovini). Tu su uključeni i mnogi podaci iz okruženja (MUP, HAK, DHMZ, inspekcija cestovnog prometa, građevinska inspekcija, osiguravajuća društva, zahtjevi korisnika, resursi). Svi podaci prikupljaju se putem informacijsko komunikacijske tehnologije te spremaju u skladište podataka. Uz poštivanje zakonskih ograničenja, administrativnih i tehničkih zahtjeva i ograničenja te eventualno dostupne projektne dokumentacije verificiraju se cestovni podaci, a kao izlaz iz procesa prikupljanje podataka dobivaju se izvještaji o tehničkom stanju ceste, informacije o prohodnosti ceste te podaci iz ophodarskog dnevnika. Ovaj dio procesa izvode radni timovi, inženjeri, tehničari, nadcestari i ophodari.

Slijedi proces **„Analiza prikupljenih podataka“** u kojem se kao ulazni podaci razmatraju verificirani cestovni podaci, odnosno objektivna ocjena postojećeg stanja, rezultati tehničkih ispitivanja i mjerenja, te rezultati probnih mjerenja. Svi se podaci analiziraju putem ICT-a, a posao analize izvodi srednja razina menadžmenta, inženjeri i tehničari. Analiza se radi uz ograničenja kao što su zakonski propisi, pravilnici, upute, standardi i norme, te referentni sustav cestovne mreže i projektna dokumentacija. Kao izlaz iz procesa Analize, dobivaju se podaci o troškovima tijekom životnog vijeka ceste i analizirani rizici. Temeljem izrađene analize postavljaju se zahtjevi za održavanjem na cestovnoj mreži.

Proces **„Utvrđivanje strategije održavanja“** uzima u obzir projekcije buduće prometne potražnje i podatke o razvoju i dostupnosti nove tehnologije, da bi se kao rezultat mogli dobiti ukupne koristi i troškovi, razine intervencija i alternativne strategija. U ovom procesu postoji niz ograničenja uz zakonske propise, standarde, pravilnike, upute i norme, tu se još pojavljuju i ograničenja vezana na raspoložive resurse, institucionalna „društveno-politička ograničenja i/ili prioriteti, ograničenja vezana na modele ugovaranja, modele upravljanja, modele financiranja te modele održavanja.

Ulazni podaci za proces **„Izrada plana i programa održavanja cestovnih prometnica“** su prognoze budućeg stanja cestovne mreže i projektna dokumentacija koja je putem ICT-a dostupna srednjoj razini menadžmenta, inženjerima i nadcestarima. Kao izlazi očekuju se četverogodišnji/godišnji plan održavanja, mjesečni operativni programi radova održavanja, operativni plan i program zimskog održavanja, te radni nalozi, izrađeni uz pomoć ICT-a.Kao ograničenja osim zakonskog okvira, pravilnika, uputa, standarda i normi, tu se pojavljuju ograničenja zbog proračunskog okvira i jediničnih cijena, ograničenja zbog racionalizacije resursa, smanjenja rizika te ograničenja zbog vremenskog okvira.

Posljednji proces je **„Izvedba radova održavanja cesta“** u kojem su ulazni parametri ugovor, standard održavanja te eventualno dostupna projektna dokumentacija. Ograničenja se osim zakonskog okvira, pravilnika, uputa, standarda i normi, tu javljaju ugovor/projektna dokumentacija, plan/proračun, vremenski okvir, upravljanje kvalitetom, upravljanje zaštitom okoliša, kontroling odnosno nadzor izvedbe. Izlazni parametri se očituju u dnevniku rada, građevinskoj knjizi, dnevniku zimske službe, mjesečnoj situaciji, te izvještaju o stanju cesta. Poslove u procesu Izvedbe radova izvršavaju nadzorni inženjeri, tehničari, nadcestari i radna operativa.

Kao konačan rezultat projektnog menadžmenta redovnog održavanja cesta, odnosno niza procesa od kojih se isti sastoji uspostavlja se siguran i neometan promet na cestama.
Opisani konceptualni model projektnog menadžmenta redovnog održavanja cesta podržan ICT-om, odnosno temeljen na učinkovitoj podršci ICT-a zamišljen je na način da uspostavlja takav niz procesa. Integracijom svih navedenih ulaznih podataka povećava se učinkovitost ukupnog projekta redovnog održavanja cesta, jer su svi potrebni podaci dostupni određenim stručnim timovima.

6. ZAKLJUČAK

Osnovni cilj projektnog menadžmenta redovnog održavanja cesta je siguran i neometan promet. Strukturu modela projektnog menadžmenta redovnog održavanja cesta čine procesi sa njegovim međusobnim vezama kroz korištenje informacijsko komunikacijske tehnologije. Projektni menadžment redovnog održavanja cesta sastoji se od pet osnovnih procesa, a to su: prikupljanje cestovnih podataka, analiza prikupljenih podataka, utvrđivanje strategija održavanja, izrada plana i programa održavanja cesta i izvedba radova održavanja cesta.

Kako bi projektni menadžment kao takav mogao zaživjeti potrebno je osigurati:
- informacijsku i komunikacijsku opremu,
- programsku podršku,
- organizaciju protoka informacija i u skladu s tim organizaciju tijeka poslovnih procesa i ljudi koji ih izvršavaju.

Primjenom ovog deskriptivnog modela u praksi očekuje se povećana učinkovitost projekta redovnog održavanja cesta koja se očituje u:
- povezivanju projekta sa strategijom održavanja,
- povećanju iskoristivosti raspoloživih kapaciteta,
- maksimalnom povećanju radnog učinka,
- prihvaćanju novih tehnologija,
- fleksibilnoj prilagodbi promjenama gospodarskih uvjeta,
- povećanju vlastitih potencijala,
- smanjenju poslovnih rizika,
- povećanju stabilnosti organizacijskog sustava održavanja cesta.

Ovaj deskriptivni model projekta redovnog održavanja cesta koji se temelji na informaciji, apliciran uz pomoć informacijsko komunikacijske tehnologije doprinosi teorijskom i praktičnom razmatranju mogućnosti budućih znanstvenih istraživanja projektnog menadžmenta redovnog održavanja cesta.

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PROMJENA TLAČNE ČVRSTOĆE BETONA U VREMENU DO 28 DANA*

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Sažetak

U sklopu završnog rada na Tehničkom veleučilištu u Zagrebu napravljeno je ispitivanje fizikalno mehaničkih svojstava očvrsnulog betona. Istraživanje je provedeno na uzorcima kocke izrađenim od različitih mješavina betona, pri čemu su korištene tri vrste cementa i dva superplastifikatora. Tlačna čvrstoća betona ispitana je na ukupno 126 uzorka, različitih starosti, do 28 dana. Na osnovu rezultata istraživanja određena je funkcionalna ovisnost tlačne čvrstoće betona u vremenu. Dobiveni izraz uspoređen je s izrazima prema EC i ACI 209.

Ključne riječi: Beton, tlačna čvrstoća, v/c omjer, superplastifikator.

* The complete text is available on CD-ROM / Juričić, Gukov, Bajić

Uvod

Napravljeno je ispitivanje fizikalno mehaničkih svojstava očvrslog betona na uzorcima kocke izrađenim od različitih mješavina betona. Korištene su tri vrste cementa i dvije vrste superplastifikatora. Uslijed različitog doziranja dodataka uzorci imaju različite vodocementne omjere. Smanjenjem vodocementnog omjera dolazi do smanjenja poroznosti betona čime se povećava tlačna čvrstoća betona.

2. Opis istraživanja

Tlačna čvrstoća betona ispitivana je na uzorcima oblika kocke brida 150 mm. Uzorci su bili različite starosti do 28 dana.

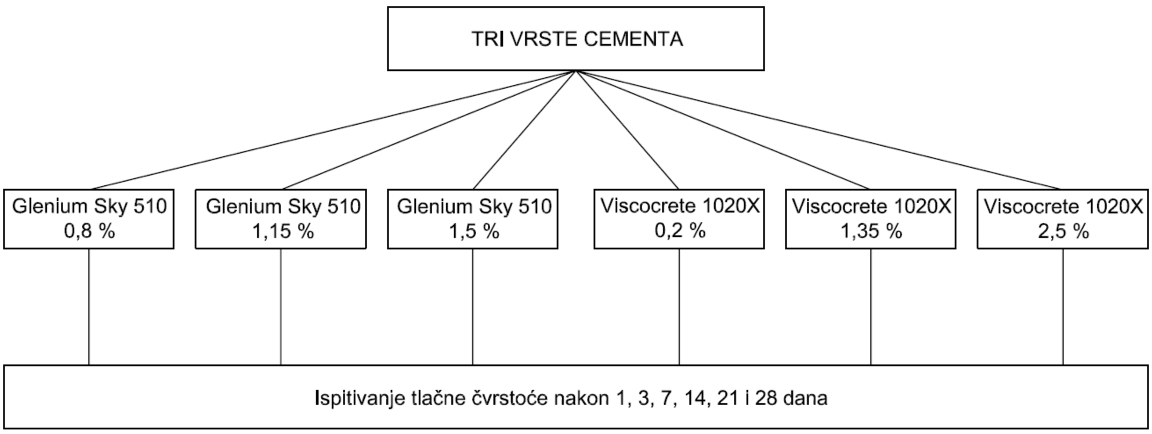
Za potrebe ispitivanja korišteni su slijedeći materijali:

Cement: - Dalmacijacement CEM II/B-M (S-L) 42,5N
- Našicecement (NEXE) CEM II/A-M (S-V) 42,5N
- Holcim expert CEM II/B-M (S-V) 42,5 N

Agregat: - prirodni separirani 0/4, 4/8, 8/16 mm
- drobljeni 0/4 mm

Aditivi: - Glenium Sky 510 (BASF) – doziranje 0,8-1,5% na masu cementa
- Viscocrete 1020X (SIKA) – doziranje 0,2-2,5% na masu cementa

Voda: - gradski vodovod Zagreb



Slika 1. Probna tijela su izrađena od različitih mješavina betona

Za svaku vrstu cementa napravljena su 42 probna tijela. Kako su ispitivane tri vrste cementa ukupno je ispitano 126 betonskih kocki.
Prije izrade sastava betona provedena su prethodna ispitivanja agregata: granulometrijska analiza i vlažnost agregata. Rezultati su prikazani u tablicama 1 i 2.

Tablica 1. Numerički granulometrijski sastav agregata

frakcija (mm)	sito (mm)								
	0,12	0,25	0,5	1	2	4	8	16	31,5
0–4p	3,2	22,4	58,9	69,1	78,7	96,5	100,0	100,0	100,0
0–4d	6,6	20,0	31,7	46,5	68,9	97,8	100,0	100,0	100,0
4–8					0,0	8,0	96,4	100,0	100,0
8-16					0,0	1,1	9,5	97,50	100,0

Tablica 2. Kumulativni granulometrijski sastav agregata

frakcija (mm)	udio (%)	0,12	0,25	0,5	1	2	4	8	16
0-4p	29	0,928	6,496	17,081	20,039	22,823	27,985	29,000	29,000
0-4d	13	0,858	2,600	4,121	6,045	8,957	12,714	13,000	13,000
4-8	20						1,600	19,280	19,818
8-16	38						0,418	3,610	37,050
	kumul.	1,786	9,096	21,202	26,084	31,780	42,717	64,89	98,868

Radi usporedbe s drugim rezultatima ispitivanja u tablicama 3, 4 i 5 dani su podaci o sastavu mješavine betona.

Tablica 3. Radni sastav betona za 1,0 m^3

materijal	masa za $1m^3$	gustoća kg/dm^3	volumen (l) za $1m^3$
CEMENT	365	3,0	121,7
VODA	189	1,0	189,0
v/c	0,518	-	-
glenium %	0	1,06	0,0
viscocret %	0	1,08	0,0
	0	0	0,0
ZRAK %	1	-	10,0
AGREGAT	1807	2,66	679,3
UKUPNO			1000,0

Tablica 4. Korekcija vlažnosti agregata

agregat			apsorpcija		vlažnost		korekcija
frakcija	%	kg	%	kg	%	kg	
0-4p	29	524,0	1,3	6,8	4,30	22,5	539,7
0-4d	13	234,9	1,3	3,1	1,75	4,1	236,0
4-8	20	361,4	1,7	6,1	1,97	7,1	362,4
8-16	38	686,7	1,5	10,3	1,03	7,0	683,4
voda	189,0			26,3		40,8	174,5

Tablica 5. Korigirani radni sastav za 1,0 m3

materijal	**masa za 1m^3**
CEMENT (kg)	365
VODA (l)	174,5
v/c	0,518
0-4p mm (29 %)	539,7
0-4d mm (13 %)	236,0
4-8 mm (20 %)	362,4
8-16 mm (38 %)	683,4
AGREGAT UKUPNO (kg)	1807

Povećanjem količine aditiva dolazi do povećanja konzistencije svježeg betona pri istom vodocementnom faktoru, odnosno superplastifikatori omogućuju smanjenje vodocementnog faktora za istu konzistenciju. U tablici 6 prikazane su količine vode u odnosu na količinu i vrstu aditiva i pripadni v/c omjeri upotrebljeni u ovom istraživanju.

Tablica 6. Količina vode i v/c omjer u ovisnosti o količini aditiva

Aditiv	Količina aditiva (%)	Količina vode za 1,0m^3 (l)	v/c omjer
-	-	189	0,52
Glenium Sky 510	0,80	174	0,48
Glenium Sky 510	1,15	152	0,42
Glenium Sky 510	1,50	138	0,38
Viscocrete 1020X	0,80	169	0,46
Viscocrete 1020X	1,75	148	0,41
Viscocrete 1020X	2,50	136	0,37

Slika 2. Mješavina betona prije i nakon dodavanja aditiva

3. Rezultati ispitivanja

U tablicama 7, 8 i 9 prikazane su tlačne čvrstoće betona (MPa) za različite uzorke cementa i starosti betona.

Tablica 7. Tlačne čvrstoće betona (MPa) izrađenih sa cementom 1

Dodatak	Starost uzorka (dani)					
	1	3	7	14	21	28
bez aditiva	4,9	14,1	21,1	25,1	27,9	29,3
Glenium Sky 510 0,2%	2,2	16,6	26,1	31,1	32,6	32,9
Glenium Sky 510 1,15%	4,1	20,2	31,3	36,3	38,7	40,6
Glenium Sky 510 1,5%	6,0	28,0	37,3	41,6	44,0	45,4
Viscocrete 1020X 0,2%	6,3	19,2	29,3	32,9	35,0	36,0
Viscocrete 1020X 1,35%	3,6	22,4	33,0	39,1	42,4	44,2
Viscocrete 1020X 2,5%	5,6	24,3	34,7	40,1	44,2	48,3

Tablica 8. Tlačne čvrstoće betona (MPa) izrađenih sa cementom 2

Dodatak	Starost uzorka (dani)					
	1	3	7	14	21	28
bez aditiva	6,8	17,6	25,1	29,9	32,5	34,2
Glenium Sky 510 0,2%	6,6	23,0	31,6	35,9	38,9	40,2
Glenium Sky 510 1,15%	5,6	27,3	37,1	42,0	46,1	48,7
Glenium Sky 510 1,5%	7,5	32,7	45,4	49,8	53,0	55,9
Viscocrete 1020X 0,2 %	7,7	22,0	31,9	37,4	40,3	41,0
Viscocrete 1020X 1,35 %	4,6	26,9	38,8	44,7	47,9	49,2
Viscocrete 1020X 2,5 %	6,9	27,0	40,0	48,0	52,0	55,0

Tablica 9. Tlačne čvrstoće betona (MPa) izrađenih sa cementom 3

Dodatak	Starost uzorka (dani)					
	1	3	7	14	21	28
bez aditiva	16,4	22,3	27,2	31,0	33,7	34,6
Glenium Sky 510 (0,2%)	23,1	30,0	34,5	37,3	39,6	41,5
Glenium Sky 510 (1,15%)	26,5	36,5	40,9	44,1	46,9	49,3
Glenium Sky 510 (1,5%)	30,0	42,2	47,2	51,0	54,0	56,7
Viscocrete 1020X (0,2%)	24,8	30,3	35,0	38,6	41,7	43,8
Viscocrete 1020X (1,35%)	30,1	37,7	41,9	45,8	48,6	51,1
Viscocrete 1020X (2,5%)	30,3	39,2	45,3	49,7	53,2	57,1

4. Promjena tlačne čvrstoće betona u vremenu

Na osnovu svih prikazanih rezultata različitih mješavina, napravljena je srednja vrijednost promjene tlačne čvrstoće betona u vremenu, tablica 11.

Tablica 10. Promjena tlačne čvrstoće betona u vremenu

dani	$f_{c,t}/f_{c,28}$
1	0,27
3	0,59
7	0,78
14	0,89
21	0,96
28	1,00

Dobivene vrijednosti interpolirane su većim brojem različitih funkcija među kojima su najbolje rezultate dale slijedeće funkcije:

- Modificiran Hoerlov model (koeficijent korelacije: 0,99991887)
- Vapor pressure model (koeficijent korelacije: 0,99991887)
- Weibullov model (koeficijent korelacije: 0,99978165)

4.1. Modificiran Hoerlov model

$$f_{cm}(t) = f_{cm}\left(a \cdot b^{1/t} \cdot t^{c}\right) \tag{1}$$

Gdje su koeficijenti:
a =0,73171607
b =0,37016168
c =0,10397179
Standardna greška: 0,00455186
Koeficijent korelacije: 0,99991887

4.2. Vapor pressure model

$$f_{cm}(t) = f_{cm}\left(e^{a+\frac{b}{t}+c\ln t}\right) \tag{2}$$

Gdje su koeficijenti:
a =-0,3123624

b =-0,99381529
c =0,10397175
Standardna greška: 0,00455186
Koeficijent korelacije: 0,99991887

4.3. Weibullov model

$$f_{cm}(t) = f_{cm}\left(a - be^{-ct^d}\right) \tag{3}$$

Gdje su koeficijenti:
a =1,1751652
b =6,0891464
c =1,908252
d =0,18378739
Standardna greška: 0,00914524
Koeficijent korelacije: 0,99978165

Poznato je nekoliko jednadžbi kojima se može opisati povećanje tlačne čvrstoće betona u vremenu pri njegovanju na konstantnoj temperaturi. U nastavku su prikazane dvije najpoznatije, prema EC i ACI propisu.

4.3. Prema EC propisu

Prema EC propisu HRN EN 12390, (2012), odnosno CEB-FIP Models Code (1990), promjena tlačne čvrstoće betona u vremenu, za uzorke njegovane na 20°C, može se procijeniti prema izrazu:

$$f_{cm}(t) = f_{cm} \cdot \beta_{cc}(t) \tag{4}$$

Gdje je koeficijent β_{cc} u funkciji vremena:

$$\beta_{cc}(t) = e^{s \cdot \left[1 - \left(\frac{28}{t}\right)^{0.5}\right]} \tag{5}$$

$f_{cm}(t)$ je srednja vrijednost tlačne čvrstoće betona u nekom trenutku vremena
f_{cm} je srednja vrijednost tlačne čvrstoće betona nakon 28 dana
$\beta_{cc}(t)$ je koeficijent ovisan o starosti betona
t je starost betona u danima
s je koeficijent ovisan o vrsti cementa:
- s= 0,20 za cement klase (R) (CEM 42,5R, CEM 52,5)
- s= 0,25 za cement klase (N) (CEM 32,5R, CEM 42,5)
- s= 0,38 za cement klase (S) (CEM 32,5)

4.3. Prema ACI propisu

Prema ACI Odboru 209 promjena tlačne čvrstoće u vremenu opisuje se prema izrazu:

$$f_c(t) = f_{c,28} \cdot \frac{t}{\alpha + \beta \cdot t} \tag{6}$$

Koeficijenti α i β ovise o vrsti cementa. Za beton njegovan u vlazi spravljen s normalnim portland cementom (ASTM Tip I):

$$f_c(t) = f_{c,28} \cdot \frac{t}{4 + 0.85 \cdot t} \tag{7}$$

Za portland cement (ASTM Tip III):

$$f_c(t) = f_{c,28} \cdot \frac{t}{2.3 + 0.92 \cdot t} \tag{8}$$

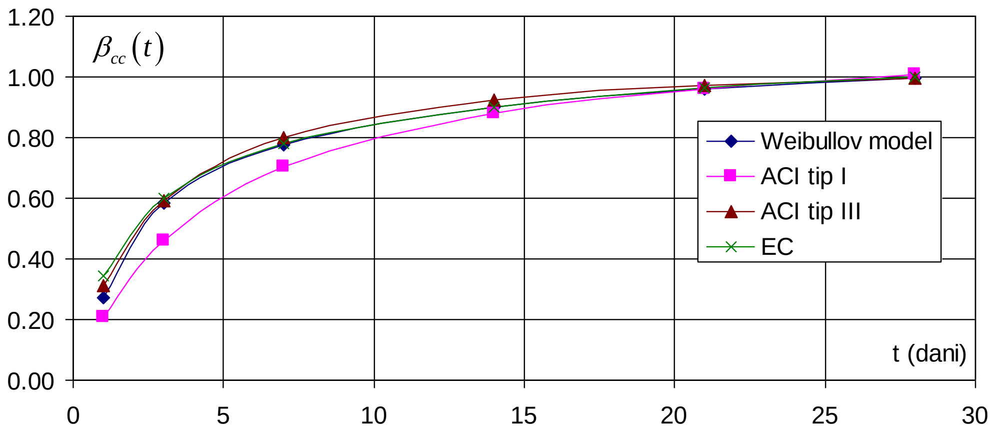
4.3. Usporedba promjene tlačne čvrstoće betona

U tablici 11 prikazana je usporedba koeficijenta $\beta_{cc}(t)$ koji opisuje vremensku promjenu tlačne čvrstoće betona. Zbog usporedbe prikazane se vrijednosti prikazanih izraza do 50 godina. Postoji veće odstupanje u konačnim vrijednostima. EC pokazuje 27% veću čvrstoću nakon 50 godina u odnosu na 28 dana, dok kod ACI izraza to iznosi 18%.

Tablica 11. Koeficijent ovisan o starosti betona, $\beta_{cc}(t)$

Vrijeme (t) dani	Izmjereno	Weibullov model $\left(a - be^{-ct^d}\right)$	EC $e^{0.25\cdot\left[1-\left(\frac{28}{t}\right)^{0.5}\right]}$	ACI Tip I $\frac{t}{4+0.85\cdot t}$	ACI Tip III $\frac{t}{2.3+0.92\cdot t}$
1	0.27	0.27	0.34	0.21	0.31
3	0.59	0.59	0.60	0.46	0.59
7	0.78	0.78	0.78	0.70	0.80
14	0.89	0.90	0.90	0.88	0.92
21	0.96	0.96	0.96	0.96	0.97
28	1.00	1.00	1.00	1.01	1.00
365		1.15	1.20	1.16	1.08
730		1.17	1.22	1.17	1.08
1095		1.17	1.23	1.17	1.08
18250		1.18	1.27	1.18	1.09

Kao što je vidljivo na slici 3, razlike su zanemarive u izrazima prema EC i ACI tip III u odnosu na izmjerene vrijednosti. Isto tako postoji veće odstupanje krivulje ACI tip I koja bi trebala biti mjerodavna za ovu vrstu cementa.



Slika 3. Vremenska promjena tlačne čvrstoće betona

Zaključak

Procjena razvoja tlačne čvrstoće betona kao i procjena konačne čvrstoće betona na osnovu ranih rezultata ispitivanja važna je u mostovima, prednapetom betonu, visokim građevinama i

drugim konstrukcijama koje iskorištavaju materijale do granica njihovih dopustivih vrijednosti. U radu je dan izvorni izraz za vremensku promjenu tlačne čvrstoće betona do 28 dana. Prikazana su tri izraza od kojih je odabran Weibullov model zbog boljih ekstrapolacijskih vrijednosti. Ispitivani su uzorci napravljeni od različitih mješavina i što je bitno, upotrebljeni su najzastupljeniji cementi u Hrvatskoj. Korišteni su i superplastifikatori i različiti v/c omjeri. Kod različitih vrsta cementa primijećena su veća odstupanja u čvrstoćama kako ranim već nakon jednog dana, tako i nakon 28 dana.
Upotrebom superplastifikatora dobivene su 60% veće tlačne čvrstoće betona u odnosu na betone bez dodataka. Oba upotrebljena dodatka dala su približno jednake rezultate, ali je doziranje u različitim omjerima na količinu cementa (Glenium Sky 510 0,8-1,5% i Viscocrete 1020X 0,2-2,5%).

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NOVA LAKIRNICA U MEĐIMURSKOJ ŽUPANIJI – OSVRT SUDIONIKA NA PROJEKT*

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Sažetak

U Međimurskoj županiji je krajem 2011. godine izgrađena zahtjevna građevina lakirnice metalnih zavarenih konstrukcija. Investitor je bilo trgovačko društvo EKO MEĐIMURJE d.d. Šenkovec, koje je angažiralo glavnog projektanta Bojana Perhoča, dipl.ing.arh. iz projektantskog ureda URBIA d.o.o. Čakovec, glavnog izvođača TEAM d.d. Čakovec te ovlaštene inženjere iz trgovačkog društva MEĐIMURJE-INVESTA d.o.o. Čakovec za poslove stručnog nadzora tijekom realizacije ovog vrlo složenog projekta. U radu se analizira osvrt na projekt od strane sudionika u izgradnji s prikazom promjene sustava zaštite od požara tijekom izgradnje radi postizanja racionalnijeg rješenja glede velikih financijskih ušteda.

Ključne riječi: lakirnica, investitor, projektant, stručni nadzor, izvođač, sustav zaštite od požara

* The complete text is available on CD-ROM / Matotek

Uvod

Investitor projekta lakirnice metalnih zavarenih konstrukcija je EKO Međimurje d.d. Šenkovec. Poduzeće je nastalo nastavljajući stoljetnu tradiciju opekarstva u Međimurju. U početku je opekarska proizvodnja bila organizirana na tri lokacije: Šenkovec, Belica i Mihovljan, a intenzivan razvoj počinje još 1945. godine. Od 1963. godine opekarska je proizvodnja bila organizirana u sastavu GK Međimurja, nakon čega su slijedile godine kontinuiranog rasta, razvoja, modernizacije i širenja tržišta. Osnivanjem RJ Oprema 1988. godine, proširena je djelatnost u strojogradnju i plinsku tehniku, a sve uz snažno širenje na inozemno tržište. Nastankom dioničkog društva 1992. godine, stvoreni su temelji suvremene kompanije s jasno postavljenom vizijom i strategijom razvoja, koja se i danas dosljedno primjenjuje. Danas EKO Međimurje d.d. ostvaruje svoju viziju da postane jedna od vodećih europskih poduzeća čiju vrhunsku kvalitetu, pouzdanost i profesionalnost prepoznaju kupci, poslovni partneri, zaposleni i dioničari. Tako je investitor ovog projekta za potrebe poboljšanje usluge lakiranja metalnih zavarenih konstrukcija pristupio nabavi i primjeni suvremene opreme te izgradnji ove građevine. Lokacija nove lakirnice je u postojećoj gospodarskoj zoni unutar građevinskog područja naselja u Šenkovcu, nedaleko Čakovca u Međimurskoj županiji, odnosno unutar poslovno proizvodnog kompleksa investitora.

2. Tehnički opis

2.1. *Opis projekta*

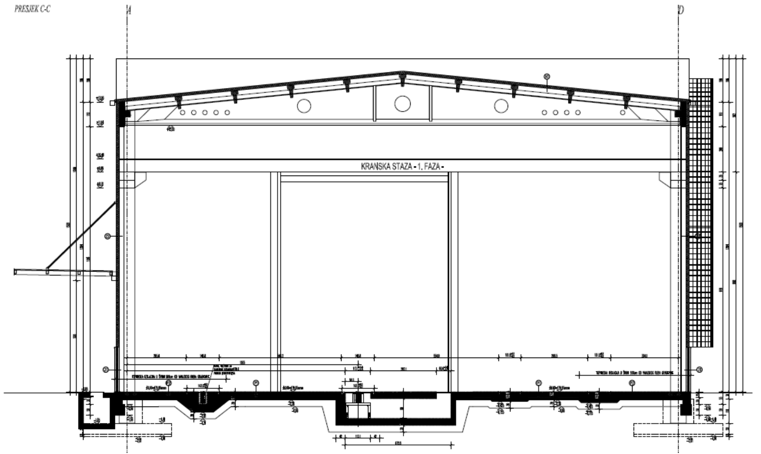
Predmetna lakirnica je izvedena u dvije faze. U prvoj fazi su izvedeni svi građevinsko obrtnički radovi (osim otvora u krovu druge linije za lakiranje), svi instalaterski radovi (osim odzračnih ventilacijskih kanala druge linije za lakiranje), kompletno vanjsko uređenje te montirana oprema prve linije za lakiranje. Isto tako je u prvoj fazi izvedena i čelična nadstrešnica za tipske kontejnere kao spremište boja koje se upotrebljavaju u lakirnici. U slijedećoj fazi je montirana oprema druge linije za lakiranje koja se priključuje na instalacije izvedene u prethodnoj fazi. Isto tako su u drugoj fazi izvedeni krovni proboji i odzračni kanali za opremu druge linije za lakiranje.

2.2. *Smještaj lakirnice*

Prilaz lakirnici je s postojeće asfaltirane prometnice unutar građevinske čestice s izvedenom obodnom prometnicom koja prolazi istočnom, južnom i zapadnom stranom građevine i spaja se na gospodarsko dvorište.

2.3. *Namjena i veličina građevine*

Namjena predmetne građevine je lakirnica metalnih zavarenih konstrukcija, dok nadstrešnica služi za zaštitu kontejnera za boje od atmosferilija. Građevina je upisana u pravokutnik tlocrtnih dimenzija 77,10 x 30,30 m, dok je nadstrešnica dimenzija 5,50 x 14,00 m. Visina atike lakirnice na zapadnoj i istočnoj strani iznosi 15 m od kote gotovog poda prizemlja, dok je visina vijenca (gornja kota ab konstrukcije) sa sjeverne i južne strane 13,05 m od kote gotovog poda prizemlja. Visina nadstrešnice iznosi 4,40 m. Projektirana neuobičajena visina lakirnice je iz razloga tehnoloških zahtjeva proizvodnje, koji definiraju svijetlu visinu prostora od 12 m te potrebne konstruktivne visine krovišta oko 2,50 m, a što konačno iznosi 14,50 m visine sljemena građevine i 15 m visine atike. Lakirnica je organizirana u etažama prizemlja i djelomično kata. Pristupi lakirnici su sa sjeverne i zapadne strane dok su sa južne i istočne strane građevine predviđeni servisni i evakuacijski ulazi, odnosno izlazi. Ukupna neto korisna površina iznosi 2.078,67 m^2, bruto površina 2.493,95 m^2 a volumen 26.508,37 m^3. U većem dijelu prostora građevine smještena je oprema lakirnice, dok se manji dio odnosi na pomoćne i radne prostorije.



Slika 1. Izvod iz projektne dokumentacije Urbia d.o.o. – presjek lakirnice

2.4. Oblikovanje, konstrukcija i obrada

Građevina lakirnice je projektirana suvremenim arhitektonskim izrazom s provjerenim i kvalitetnim materijalima. Konstrukcija je izvedena od montažnih armiranobetonskih elemenata (stupovi, glavni krovni ''A'' nosači i sekundarni krovni nosači). Nadstrešnica je izvedena od čeličnih elemenata. Odabrani konstruktivni sistem omogućio je potpunu funkcionalnost građevine, izražajnost oblika i ekonomičnost u izgradnji. S vanjske strane je zatvorena kombinacijom ab toplinski izoliranih panela debljine 20 cm ili čeličnih limenih termo panela debljine 12 cm. Stropna konstrukcija je ujedno i krovna konstrukcija, odnosno montažna ab konstrukcija s toplinski izoliranim krovnim panelima kao pokrovom. Završne obrade podova razlikuju se prema namjeni prostorija, karakteristikama za otpornost i lako održavanje, kao i prema nivou željene obrade (keramičke pločice ili industrijski pod). Vanjski otvori su izvedeni od aluminijskih profila s prekinutim toplinskim mostom. Ostakljenje je izo staklom ili polikarbonatnim pločama. Unutarnje stavke su izvedene od aluminija bez prekinutog toplinskog mosta. Zaštita od sunca je izvedena fiksnim brisolejima ili refleksivnim premazima u izo staklu. U svim prostorima je osigurano dovoljno osvjetljenje bilo prirodno i umjetno ili samo umjetno. Osigurana je prirodna ili prisilna ventilacija radi osiguranja uklanjanja neugodnih mirisa, uklanjanja suvišne topline i uklanjanja razrijeđene prašine. Dodatna prisilna ventilacija pomoćnih prostorija osigurana je ventilatorima i ugrađenim ventilacijskim rešetkama na fasadnim zidovima.

2.5. Instalacije

2.5.1. Hidroinstalacije

Građevina je priključena na postojeću vodovodnu mrežu kompleksa za sanitarne i protupožarne potrebe. U građevini su izvedeni zidni hidranti, a oko građevine vanjski nadzemni i podzemni hidranti. Sanitarno fekalne vode ispuštaju se u septičku taložnicu zatvorenog tipa, a krovne vode odvode se bez pročišćavanja ispuštaju u postojeću oborinsku odvodnju koja je spojena u otvoreni kanal uz parcelu. Oborinske vode s uređenih površina odvode se nakon pročišćavanja preko slivnika s taložnikom te separatora ulja i masti u postojeću oborinsku odvodnju koja je spojena u otvoreni kanal uz parcelu. Tehnološke vode iz prostora pročišćavanja voda, laboratorija i praonice ispuštaju se u sabirne jame tehnoloških voda do izgradnje sanitarno-fekalne kanalizacije i izrade kanalizacijskog priključka cijelog kompleksa na uličnu kanalizaciju naselja Šenkovec.

2.5.2. Elektroinstalacije

Priključak struje je izveden iz postojeće trafostanice koja se nalazi u krugu postojećeg kompleksa. Za predmetnu građevinu je predviđena maksimalna (angažirana) snaga od 400 kW. Nivo osvijetljenosti prostorija izveden je u skladu sa zahtjevom investitora za razinom osvijetljenosti, a u skladu sa važećim normama (350 lux). Postrojenje lakirnice kao i putovi evakuacije koji vode iz građevine imaju izvedenu panik rasvjetu. U građevini je izveden adresabilni sustav dojave požara s analogno-adresabilnim automatskim javljačima, adresabilnim ručnim javljačima, ulazno/izlaznim modulima, zener barijerom i automatskim termičkim javljačem protueksplozijske izvedbe za nadzor kotlovnice, alarmnim sirenama, izolatorima kvara petlje te mikroprocesorskom modularnom centralom dojave požara smještenom u prostoriji poslovođe, koja je zasebni požarni sektor. Centrala dojave požara priključena je putem telefonske dojave na mjesto stalnog dežurstva, koje obavlja stalni nadzor nad sustavom za dojavu požara.

2.5.3. Strojarske instalacije

Od strojarskih instalacija su izvedeni plinska instalacija, grijanje, ventilacija, lokalni odsisi prašine i komprimiranog zraka. Energent za pogon plinskih uređaja za grijanje je prirodni plin. Instalacija grijanja je dimenzionirana kod vanjskih zimskih projektnih temperatura za Čakovec (Klimatska zona III). Temperature grijanog prostora odabrane su u skladu s namjenom prostora, prema navedenim propisima. Investitor je kupac plina od operatera plinskog transportnog sustava odnosno nije priključen na distributivnu mrežu plinske instalacije Međimurja koja je pod nadzorom lokalnog distributera plina. Plinska instalacija za predmetnu građevinu spojena je na postojeću plinsku instalaciju ispred plinske redukcijske stanice na postojećoj građevini sa sjeverne strane predmetne građevine. U kotlovnici je ugrađen 1 plinski plamenik, namješten na snagu kotla od 300 kW i 1 plinski zidni grijač sanitarne vode snage 28 kW. Ukupno instalirana snaga plinskih trošila iznosi 2.261 kW. Plinska kotlovnica je nazivnog toplinskog kapaciteta 328 kW. Smještena je na katu građevine. Grijanje pogona lakirnice je izvedeno stropnim zračećim panelima, koji odaju toplinu u prostor putem zračenja (radijacija) i vođenja (konvekcije). Zračeći paneli montirani su na visini od 12 m od poda lakirnice. S bočnih strana su opremljeni limovima za usmjeravanje toplinskih zraka prema dolje, a s gornje strane toplinskom izolacijom od mineralne vune debljine 50 mm radi sprječavanja emisije topline prema gore. Razvod medija od kotlovnice do zračećih panela izveden je 2-cijevnim Tichelmann sistemom, u kojem je pad tlaka za svako grijače tijelo jednak, kao i protok medija i raspodjela topline, a čime se postiže dobra izbalansiranost sistema odnosno cijevne mreže. Grijanje pomoćnih prostorija lakirnice (poslovođa, laboratorij, sanitarije, garderoba i stubište) izvedeno je čeličnim pločastim radijatorima s termostatskim radijatorskim ventilima. Grijanje kontejnera za skladištenje boja izvedeno je također čeličnim pločastim radijatorima.

Komore za lakiranje su zatvorenog tipa i nema izlaza otpadnog zraka iz komora u pogon lakirnice, odnosno nema posebnog zagađenja zraka u pogonu lakirnice. Stoga je predviđena opća ventilacija pogona lakirnice kao proizvodne hale. Za odsis otpadnog zraka iz lakirnice na krovu građevine ugrađeno je 9 krovnih odsisnih ventilatora takvog kapaciteta da ostvaruju minimalno 1,5 izmjena zraka na sat (opća ventilacija). Za ulaz svježeg zraka u lakirnicu u vanjski zid na visini od oko 150 cm od poda, ugrađeno je 13 kombiniranih žaluzina (pretlačna sisna + fiksna žaluzina). Količina svježeg zraka za ventilaciju garderobe, sanitarija i tuševa na katu određena je na osnovu minimalnog broja izmjena zraka u toku jednog sata. Ventilacija prostorija izvedena je pomoću rekuperatorske jedinice, sustava dobavnih i odsisnih kanala, dobavnih i odsisnih rešetki i zračnih ventila. Ventilacija praonice izvedena je prisilno. Za odsis otpadnog zraka iz praonice ugrađen je centrifugalni odsisni ventilator, dimenzioniran tako da ostvaruje minimalno 10 izmjena zraka na sat, a kod proračunate količine zraka od 1.750 m³/h savladava otpor od 350 Pa. Kučište, lopatice i ostali dijelovi ventilatora osim motora su izrađeni od vinilestera, odnosno materijala koji je otporan na agresivne medije. Odsisni kanali izvedeni su iz polipropilena otpornog na agresivne medije. Ventilacija komore za pripremu boje je izvedena prisilno pomoću cijevnog odsisnog ventilatora u protueksplozijskoj izvedbi tako da ostvaruje minimalno 25 izmjena zraka na sat.

Na radnim mjestima na kojima se kao nusprodukt javlja prašina od brušenja kita izveden je sustav vakuumskog odsisa prašine direktno sa alata kojim se brusi (brusilica).

Mreža komprimiranog zraka je izvedena od čeličnih bešavnih cijevi ispod stropa pogona lakirnice, a do svakog priključnog mjesta na uređaj ili opremu su spuštene vertikale. Mreža komprimiranog zraka je spojena na postojeću mrežu u susjednoj građevini.

2.6. Opis tehnološkog postupka lakirnice

Tehnološki postupak površinske zaštite obuhvaća sljedeće tehnološke operacije:

1. Odmašćivanje i tankoslojno fosfatiranje predmeta obrada
2. Priprema površine prije nanošenja kitanjem, brušenjem i maskiranjem
3. Nanošenje premaznih sredstava s temeljnim i pokrivnim lakiranjem te sušenjem laka
4. Pomoćne tehnološke operacije, koje obuhvaćaju skladištenje i pripremu boje, te transportiranje predmeta kroz linije.

Transport predmeta obrade kroz tehnološke uređaje linije I je na bremenskim kolicima, koja se kreću pomoću podnog lančanog transportera, a na liniji II se predmeti na početku linije vješaju na viseći kružni transporter i prema tehnološkim zahtjevima transportiraju kroz tehnološke uređaje.

Ukupan prostor namijenjen za montiranu tehnološku opremu je tlocrtnih dimenzija oko 72 x 24 m i površine oko 1.728 m^2. Kompletni prostor je namijenjen isključivo za instaliranje tehnološke opreme za površinsku zaštitu. U tom prostoru se predmeti obrade ne skladište. Po dužini hale od 72 m su usporedno instalirane dvije nezavisne tehnološke linije za površinsku zaštitu. Linija I se sastoji od komore za odmašćivanje i fosfatiranje, sa stanicom za pročišćavanjem otpadnih voda, komore za nanošenje premaznih sredstava, sušionika boje i podnog lančanog transportera. Linija II se sastoji od komore za nanošenje temeljne boje, tunela za odparivanje i dvopozicijske sušare. Dio hale gdje ulaze predmeti obrade je pokriven mosnim kranom, koji služi za utovar predmeta na prijevozna kolica na liniji I i za vješanje predmeta na viseći kružni transporter. Isto tako je polje hale na kraju tehnoloških linija pokriveno drugim mosnim kranom, koji služi za istovar gotovih predmeta, koji se transportiraju dalje u skladište gotovih proizvoda ili na konačnu montažu.

2.6.1. Kemijska priprema površina

Priprema površina se izvodi u komori za odmašćivanje i fosfatiranje. Izvodi se visokotlačnim pranjem temperature medija za pranje od 55°C. Pranje se izvodi ručno primjenom stabilnog visokotlačnog perača s fleksibilnim cijevnim razvodom te ručnom prskalicom i kombiniranim sredstvom za odmašćivanje i tankoslojno Fe-fosfatiranje.

2.6.2. Priprema površina prije nanošenja boje

Poslije kemijske pripreme površina u komori za odmašćivanje obavlja se još priprema površina prije nanošenja boje, koja obuhvaća zaštitu odnosno maskiranje strojno obrađenih površina samoljepivim ličilačkim trakama, kao i specijalnim pastama.

2.6.3. *Nanošenje premaznih sredstava*

Nanošenje premaznih sredstava izvodi se u lakirnim komorama. Ventilacija stvara potrebne radne uvjete za radnike, koji se nalaze u komorama u fazi lakiranja. Boje koje se upotrebljavaju su 2K akril, 2K epoxi, 2K PUR, klasični i HS odnosno MS. Predviđena je i upotreba 2K vodenih boja. Prosječne debljine suhih nanosa iznose za temelj 80 μm a pokrivni 60 μm. Najveće dopuštene unosne količine topila, odnosno premaznih sredstava u lakirnu komoru su određene projektnim izračunom, odnosno projektnim kapacitetom uređaja. Dopuštene unosne količine se iz sigurnosnih protueksplozijskih razloga ne smiju premašivati. Veći intenzitet nanašanja zbog osiguranja odgovarajućega vremena isparivanja i sprečavanja ispusta u zrak nije dopušten.

2.6.4. *Pomoćne tehnološke operacije*

U prostoru za pripremu premaznih sredstava, koji je smješten pri komori, obavlja se sva odgovarajuća priprema premaznih sredstava za nanašanje.

Slika 2. Komora za lakiranje

2.7. *Stabilni sustav gašenja požara plinom Novec*

Radi protupožarnih zahtjeva u komorama lakirnice ugrađen je stabilan sustav gašenja požara plinom komercijalnog naziva Novec 1230, kemijske formule CF3CF2C(O)CF(CF3)2. Navedeni plin gasi požar tako što inhibira kemijsku reakciju između gorivog materijala i kisika i hlađenjem izvora požara. Kao sigurno i efikasno sredstvo upotrebljava se kod gašenja požara klase A (krutih materijala), klase B (zapaljive tekućine) i klase E (električnih instalacija). Sustav protupožarne zaštite pomoću ovog plina naročito je podoban radi sljedećeg:

- najniža potrebna količina plina za gašenje požara od svih zamjenskih plinova za halon 1301
- atmosfera plina u projektiranim koncentracijama ne predstavlja opasnost za ljude
- velika efikasnost gašenja požara
- velika brzina djelovanja
- minimalno smanjenje vidljivosti prilikom gašenja
- maksimalna disperzija plina unutar štićene prostorije
- dobro mješanje plina sa zrakom bez rizika za raslojavanje
- plin nije korozivan, ne provodi struju i ne izaziva hladne šokove na elektronici
- najekološkiji zamjenski plin za halon:
  - ✓ ne oštećuje ozonski omotač ODP=0,
  - ✓ vrijeme raspada u atmosferi je vrlo nisko (5 dana),
  - ✓ vrlo nizak koeficijent GWP=1 (Global Warming Ponent).

Navedeni sustav se sastoji od cjevovoda sa mlaznicom, spremnikom sa pripadajućim ventilom i upravljačkog elektro dijela sustava. Plin Novec 1230 je pohranjen u tekućem stanju u spremnicima natlačen dušikom na 25 bara kod 21°C. Svaki spremnik na izlazu ima pripadajući ventil koji je opremljen s manometrom, sigurnosnom membranom, presostatom (koji je namijenjen nadzoru tlaka u spremniku), ručnim aktuatorom i elektromagnetskim aktivatorom. Kod pojave požara vatrodojavni dio sustava signalizira požar i aktivira elektromagnetski aktivator koji otvara ventil na spremniku s plinom Novec 1230. Prilikom aktiviranja sustava plin Novec 1230 isparava na mlaznicama i gasi požar u plinovitom stanju.

Sustavi za gašenje požara plinom Novec 1230 su razvijeni sa ciljem da detektiraju i gase požar u samom začetku, iznimnom brzinom (<10 sekundi) i s minimalnom štetom na ugrađenoj opremi. Značajna karakteristika navedenih sustava je da koriste plin koji nije štetan po zdravlje ljudi, pa je omogućena sigurna ugradnja sustava u prostorima u kojima stalno borave ljudi. Zbog svih navedenih karakteristika sustavi za gašenje požara plinom Novec 1230 se koriste za zaštitu slijedećih prostora:

- IT prostori
- server prostorije
- telekomunikacijski prostori
- elektro prostori
- industrijski prostori s vrijednom opremom
- knjižnice
- muzeji
- galerije
- skladišta zapaljivih tekućina.

3. Sudionici u izgradnji

3.1. Investitor

Investitor ovog projekta je poduzeće EKO Međimurje d.d. Šenkovec, koji je za potrebe poboljšanje usluge lakiranja metalnih zavarenih konstrukcija pristupio nabavi suvremene opreme i izgradnji nove lakirnice. Više o investitoru je opisano u uvodnom dijelu ovog rada.

3.2. Projektant

Izrada projektne dokumentacije je povjerena glavnom projektantu Bojanu Perhoču, dipl.ing.arh. iz poduzeća Urbia d.o.o. Čakovec, koji je između ostaloga bio glavni projektant većeg broja proizvodnih građevina u Međimurju a i šire. Osim izrade projektne dokumentacije, odrađen je i projektantski nadzor radi složenosti građevine. Pristup projektiranju je bio takav da se prvo definirao tehnološki projekt temeljem kojeg je definirana oprema lakirnice, zatim je oprema smještena u građevinu opisanih dimenzija i sadržaja u ranijim točkama ovog rada. Tehnološki zahtjevi projekta su rezultirali visinom proizvodne hale od 15 m.

3.3. Stručni nadzor

Za usluge provođenja stručnog nadzora investitor u uskoj konkurenciji nije odabrao najnižu ponudu, već se odlučio za ovlaštene inženjere iz poduzeća Međimurje-investa d.o.o. Čakovec. Radi se o poduzeću koje posjeduje referentnu listu mnogobrojnih građevina različitih namjena (proizvodne, stambene, obrazovne, zdravstvene, turističke, infrastrukturne i ostalo), a na nekima je osim stručnog nadzora odradilo i usluge konzaltinga kao i vođenje projekata. Tako su odmah po potpisu ugovora Dragutin Matotek, dipl.ing.građ. (glavni nadzorni inženjer) i Ratko Matotek, dipl.ing.građ. (nadzorni inženjer za konstrukciju, obrtničke radove i hidroinstalacije) započeli s nadzorom izrade ab montažnih elemenata nosive konstrukcije, a paralelno i sa svim pripremama glede organizacije za nesmetani početak gradilišta.

3.4. Izvođač

Glavni izvođač bilo je poduzeće TEAM d.d. Čakovec, koje je preuzelo izvođenje kompletnih radova, s time da je investitor neposredno ugovorio izvođenje instalaterskih radova s Instalomont termocentar d.o.o. Čakovec i Elcop d.o.o. Čakovec, dok je isporuka opreme lakirnice bila od strane slovenskog poduzeća SOP-International d.o.o. Krško. Investitor je s glavnim izvođačem sklopio prvo ugovor za proizvodnju i montažu ab elemenata konstrukcije, kako bi se moglo odmah pristupiti izradi nosivog građevinskog sklopa, obzirom da je ishođenje rješenja za građenje i dostava ponuda za preostale građevinsko obrtničke i instalaterske radove bilo još u fazi izrade, a puštanje u pogon je bilo neodgodivo radi ranije ugovorenih poslova investitora prema uglavnom inozemnim kupcima svojih proizvoda.

4. Izgradnja

4.1. Proizvodnja armiranobetonskih montažnih elemenata

Već se i prije ishođenja rješenja za građenje, u lipnju 2011. godine, pristupilo izradi armiranobetonske montaže konstrukcije, kako bi se ostvarili traženi rokovi od strane investitora. Krajnji rok za puštanje lakirnice u rad je bila sredina prosinca 2012. godine. Kako je već rečeno, nije bilo dopušteno nikakvo odstupanje od ugovorenog roka jer je investitor bio vezan na već ugovorene poslove sa svojim kupcima.

Slika 3. Proizvodnja glavnih nosača

4.2. Gradilište

Gradilište je organizirano unutar postojećeg poslovno proizvodnog kompleksa investitora. S radovima se započelo u srpnju 2011. godine s pripremnim radovima i izradom temelja za montažnu ab konstrukciju, koja je još bila u proizvodnji. Početkom kolovoza dopremljeni su i prvi ab stupovi na montažu. Izrada preostalih ab elemenata privodila se kraju. Kako je to i uobičajeno na gradilištima, prije i poslije početka montaže vrijeme je bilo sunčano i suho, reklo bi se idealno, a nekoliko dana prije prvog dana montaže ab konstrukcije prema terminskom planu, nastupile su obilne oborine. Međutim, do sredine prosinca 2011. godine trebalo je izvesti sve građevinsko obrtničke i instalaterske radove i nije smjelo biti produženja zadanog roka niti za jedan dan. Izvođač je imao dodatne troškove stabilizacije privremenih prometnica šljunčanim nasipom radi nesmetanog prometovanja dostavnih vozila kao i za rad auto dizalica prilikom montaže.

Slika 4. Početak montaže konstrukcije

Slika 5. Montažna armiranobetonska konstrukcija

Odmah po završetku izvođenja armiranobetonske konstrukcije započelo se s izvođenjem pokrova i fasadnih panela. Rok se jedino mogao održati paralelnim izvođenjem unutarnjih radova. Tako su se još izvodili betonski podzemni energetski kanali, a istovremeno su instalateri sa pokretnih platformi već montirali razvod instalacija pod stropom. U fazi ugovaranja je to bio jedan od značajnijih razloga za odustajanje od posla nekih izvođača jer se nisu mogli prilagoditi ovakvoj organizaciji, a koja je bila nužna radi postizanja traženih rokova.

Slika 6. Unutarnji građevinski i instalaterski radovi

Na gradilištu su osim svakodnevnog stručnog i projektantskog nadzora bili održavani redoviti sastanci koordinacije sa svim sudionicima u izgradnji (investitor, projektant, nadzor, glavni izvođač i ključni podizvođači) kako bi se pretresla sva problematika oko dokumentacije, organizacije, resursa, rokova i kvalitete. Isto tako su nakon koordinacije bili svakodnevni kratki ''brifinzi'' oko ključnih stvari kako bi izvođenje bilo nesmetano.

Tijekom građenja je radi promjene ulaznih/izlaznih rolo vrata u odnosu na protupožarnu zaštitu ishođena i izmjena dozvole jer je došlo do promjene koja utječe na bitni zahtjev za građevinu, a odnosi se na zaštitu od požara. Naime, na zahtjev investitora su dva glavna ulazno/izlazna protupožarna vrata dimenzija 800 x 900 cm. Kako bi u protupožarnoj izvedbi ista bila nepraktična radi svoje težine, pristupilo se izmjeni na način da je izvedena zaštita od požara vodenom zavjesom (sprinkler sustav). Navedena izmjena tog dijela projekta je dokazana složenim matematičkim modelom. Isto tako je izmjena donijela i značajnu financijsku uštedu investitoru, a radi čega se ponajviše išlo u izmjenu. Kako su se navedena vrata montirala na samome kraju, paralelno se s izvođenjem radova na gradilištu ishodila izmjena dokumentacije te je dostignut ugovoreni rok.

5. Pokusni rad

Projekt je na vrijeme završen i investitor je pristupio pokusnom radu kako bi se obavile sve provjere, izmjerili svi traženi parametri i obavila sva potrebna ispitivanja, a koje nije moguće odraditi bez puštanja u rad pogona lakirnice. Zbog zahtjevnosti i složenosti same tehnologije, najviše je potrajalo ishođenje pozitivnog mišljenja Ex-agencije, a nakon čega je uspješno održan tehnički pregled s manjim nedostacima koji su se ubrzo otklonili i ishođena je uporabna dozvola.

Slika 6. Završena građevina lakirnice

6. Zaključak

U radu je opisan projekt izgradnje lakirnice metalnih zavarenih konstrukcija, investitora EKO Međimurje d.d. te specifičnosti ove vrlo zahtjevne građevine. Najveći problem projektantu je bio pravilnik još iz 1985. godine, od kada je prošlo 26 godina, a na temelju kojeg je bilo potrebno zadovoljiti protupožarne zahvate. S druge strane je izvođaču dodijeljen izazovan rok. U samo 5 mjeseci od ''polaganja kamena temeljca'' bilo je potrebno izvesti i pustiti u pogon ovu složenu građevinu, a što se ostvarilo dobrom organizacijom i koordinacijom radova na gradilištu kao i pravovremenog rješavanja nedostajućih projektnih detalja te pravovremene izmjene projektne dokumentacije. I završno, možda se isti projektni tim neće naći na nekom od slijedećih projekata, ali će sigurno ovaj izvođač ugrađivati opeku investitora na nekom gradilištu, a nadzor obavljati kontrolu izvođenja prema projektnoj dokumentaciji izrađenoj od strane projektanta, koji je sudjelovao u ovome, moglo bi se reći, poduhvatu.

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OTPORNOST HRVATSKOG GRADITELJSTVA NA KRIZU*

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Sažetak

Otpornost na krizu je karakteristika koja je proporcionalna konkurentnosti. Gospodarstvo zemlje pak direktno utječe na aktivnosti u graditeljstvu, a s druge strane one mogu biti pokretač oporavka iz gospodarske krize. Prema rezultatima Svjetskog centra za konkurentnost Hrvatska je na ljestvici od 60 zemalja 2013. godine zauzela posljednje mjesto. Javni dug i nezaposlenost su se od 2008. godine udvostručili. Hrvatsko gospodarstvo nije otporno na krizu, a građevinarstvo još manje. Rad se bavi uzročno posljedičnom vezom takvog stanja i predlaže mjere kojima se može direktno i indirektno utjecati na poboljšanje takvog stanja. Daje se kraći prikaz konteksta te potvrđuje ranije dokazana činjenica da postoji visok stupanj utjecaja zakonskih rješenja građevinske regulative u širem smislu na stanje u graditeljstvu i pratećim djelatnostima, čija refleksija se direktno odražava na makroekonomsko stanje Republike Hrvatske.

Ključne riječi: građevinarstvo, gospodarstvo, Hrvatska, prikaz stanja

* The complete text is available on CD-ROM / Nahod, Jurcec

Uvod

Ranijim istraživanjem (Jurčec, Nahod, 2012) prikazan je visok stupanj utjecaja zakonskih rješenja građevinske regulative u širem smislu na stanje u graditeljstvu i pratećim djelatnostima te refleksija takvog stanja na makroekonomske pokazatelje Republike Hrvatske.
Mogućnost upotrebe graditeljskih aktivnosti putem investicija sa visokim učešćem građevinskih radova kao alata za stabilizaciju ekonomije može predstavljati ključnu odrednicu u nacionalnoj strategiji razvoja i kritična je komponenta za razvoj ekonomije uopće (Giang, Sui Pheng, 2011). Tijekom ekonomskog razvoja potrebno je da graditeljstvo ubrzano napreduje kako bi stvorilo infrastrukturni temelj i sadržaje za rast ekonomije (HGK, 2010). Njemačka je odličan primjer u kojem je izbalansiran razvoj gospodarstva sa realizacijama u graditeljstvu. Država mora poticati proizvodnju jer tako trajno dobiva i stvara bogatstvo za buduće generacije.
Ekonomska je znanost već odavno empirijski utvrdila kako je graditeljstvo kao gospodarski sektor izuzetno elastično na fluktuacije privredne aktivnosti i poslovne cikluse (Čavrak, Družić et al, 2011). Siguran znak gospodarskog oporavka neke ekonomije rast je obima radova u graditeljstvu koje svojim poznatim multiplikativnim učinkom utječe na ubrzanje ukupnog rasta. Takav bi se smjer ekonomske aktivnosti neizostavno evidentirao i u rastu graditeljskog proizvodnog kapitala, što se danas još uvijek ne događa.

2. Kretanje hrvatskog graditeljstva kroz povijest (kratak ostvrt)

Ekonomski rast u Hrvatskoj počinje tek u drugoj polovici 19. st., prodorom kapitalizma i prestankom turske opasnosti. Hrvatska je od tada prošla nekoliko ratova, što je ostavilo trag na životne prilike i standard. Usporedbe radi, životni standard se u zadnjih 5 stoljeća u SAD-u povećao za 70 puta, u Velikoj Britaniji i Nizozemskoj za 28 puta, u Italiji 17 puta i u Hrvatskoj svega 11 puta.
Razdoblja najvećeg gospodarskog razvoja i rasta životnog standarda u Hrvatskoj su 1870. - 1913.g. te 1950. - 1980.g. Usprkos činjenici da je u 20. Stoljeću Hrvatska prošla dva svjetska i domovinski rat, Hrvatska je tijekom 20. stoljeća uvećala svoj BDP gotovo 9 puta, sa prosječnim godišnjom stopom rasta od 2,19% (Čavrak, Družić et al, 2011). S obzirom na istovremeni prirast stanovništva od samo 1,4 puta, ostvaren je i znatan napredak u rastu BDP-a po stanovniku, koji je porastao za više od 6 puta. Stope rasta hrvatskog BDP-a i per capita BDP-a tijekom čitavog 20. st. mogu se u globalnim razmjerima ocijeniti vrlo zadovoljavajućim i visokim jer se sve stope iznad 1,5% godišnje u dugom roku smatraju povoljnima.

No ovakvim dugoročnim globalnim kretanjima valja pridružiti izrazito oscilirajuće kretanje makroekonomskih varijabli u specifičnim kraćim razdobljima. Naime, dugoročna slika rasta BDP-a u pojedinim manjim vremenskim segmentima (godišnjim) pomoću kretanja bruto domaćeg proizvoda pokazuje visoku nestabilnost gospodarskih gibanja. Godišnje oscilacije su primjetne gotovo u svim razdobljima, uključujući i razdoblje prije 1980. godine. Davne 1960. g., koja je poznata po gospodarskom prosperitetu, godišnje stope rasta poprimaju naizmjence vrijednosti od 7%, 2%, 10% i 3%. Takve oscilacije i kretanja ekstremnih vrijednosti na godišnjim razinama upućuju na probleme duboke strukturne neravnoteže hrvatskog gospodarstva, pri čemu promjene državno-pravnog okvira i društveno-ekonomskog sustava ne ublažavaju već u pravilu intenziviraju takvo stanje.

Za nas je u ovom trenutku posebno aktualna zadnja (poslijeratna) faza u kojoj se politika nije bazirala na proteklom iskustvu, kao što je to bilo u razvijenim dijelovima svijeta, čime se dozvolilo ponavljanje sličnih scenarija koji su se jednostavno radi ponavljanja uvjeta mogli predvidjeti.

U razdoblju od početka krize 1980-ih do stabilizacijskog programa iz listopada 1993.g. životni standard je u odnosu na SAD konstantno padao (tijekom 1980-ih je BDP u Hrvatskoj stagnirao, ali je u SAD-u nakon recesije 1982.g. počeo ubrzano rasti)., tako da je Hrvatska 1993.g. bila na 10% životnog standarda SAD-a.

Početkom '80-ih prošlog stoljeća dolazi do znatnog pada investicijskih ulaganja u Jugoslaviji i Hrvatskoj. Uzroke zastoja treba tražiti u investicijski vrlo aktivnoj drugoj polovici sedamdesetih godina, kad su investicije bile znatno iznad realnih mogućnosti društva, tj. teret investicijskog ciklusa prebacivao se na neko buduće razdoblje (Jurčec, Skendrović i Đukan, 1990). Tada je registriran relativno velik udio građevinarstva u BDP-u (12,06% 1980.g.), dok je u razvijenim zemljama stanje znatno drukčije. Austrija tih godina (1980. i 1984.g.) ima udio graditeljstva u BDP-u od 7,7% i 7,1%, Njemačka 7,1% i 6,7%, a Velika Britanija 5,7% i 5,0%).

Takvo stanje rezultat je nesposobnosti prilagodbe uvjetima tržišta, što povećava nekonkurentnost. Udio graditeljstva u BDP-u Hrvatske 1984.g. je bio 68,8% udjela graditeljstva u BDP-u u odnosu na 1980. g., a istovremeno je broj zaposlenih u graditeljstvu nerazmjeran u odnosu na BDP za isto razdoblje (1984. g. je veća zaposlenost u sektoru graditeljstva, tj. 1980.g. je za 5,8% manja od zaposlenosti u 1984.g.). Dakle, zaposlenost raste, a udio graditeljstva u BDP-u pada, što ne odgovara politici održivog razvoja. Tih godina razlozi su ležali u unutrašnjim tromostima i visokom stupnju solidarnosti kojim veliki sustavi (tadašnje OOUR-i) nisu bili prilagođeni nastalim promjenama (Jurčec, Skendrović and Đukan, 1990). 2012.g. čini se da se povijest ponovila. Umjesto da se iz prethodnog iskustva izvuku pouke, greške se ponavljaju. 2012.g. osnovna karakteristika graditeljstva je ponovo nerazmjer između raspoloživih kapaciteta i potreba domaćeg tržišta.

Uzmemo li kao prirodnu činjenicu da tržište investicijskih usluga ne može konstantno rasti onda uzroke neprimjereno duboke krize primarno treba tražiti u prevelikim oscilacijama tržišta i presporoj prilagodbi graditeljstva uvjetima recesije, čemu uvelike doprinosi česta promjena zakonske regulative u graditeljstvu Republike Hrvatske.

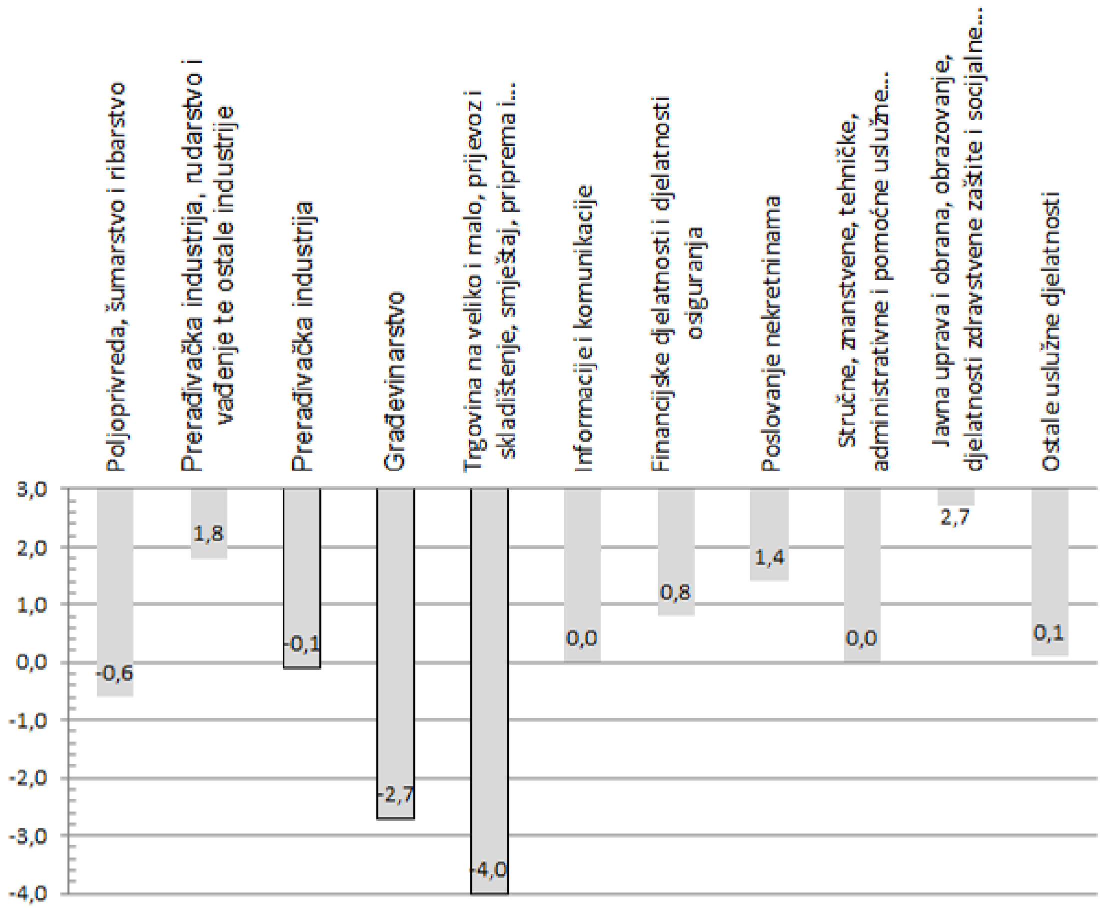
Svjetska iskustva kroz povijest pokazuju da su male organizacije najbolji amortizer tržišnih promjena. One se stvaraju i odumiru bez velikih ekonomskih potresa, prelaze iz jedne u drugu djelatnost, s jednog na drugo tržište isključivo orijentacijom prema profitu. Tako novonastale vrijednosti gotovo u pravilu kompenziraju gubitke uzrokovane preorijentacijom u proizvodnji (Jurčec, Skendrović i Đukan, 1990). U SR Njemačkoj, Velikoj Britaniji i Austriji u '80.-im godinama prošlog stoljeća većina graditeljskih poduzeća na tržištu činili su sustavi s manjim brojem zaposlenih. Austrija je imala najveći postotak tvrtki sa 100-500 zaposlenih, SR Njemačka sa 0-20 zaposlenih, Velika Britanija sa 100-500, a tadašnja SR Jugoslavija svoju graditeljsku djelatnost bazirala je na organizacijama s više od 500 zaposlenih, u gotovo 50% graditeljskih organizacija. U 90-im godinama prošlog stoljeća konstatirano je nužno hitno prestrukturiranje privrede i angažiranje sredstava koji će potaknuti ulaganja. 1988/89. godine počinju intervencije za spas gospodarstva. Politika gospodarenja je interventna politika koja nastoji u čim kraćem roku postići, makar kratkoročne, rezultate. Naglasak nije stavljen na dugoročnost jer je gospodarstvo bilo u tako velikoj krizi da se nastojalo spasiti sve što se spasiti da, čim prije tim bolje. Dno je dosegnuto 1991. godine. Vrijednost građevinskih radova pada na cca 30% vrijednosti građevinskih radova početkom 1980. godine. Ratna razaranja produbljuju patološke pojave u ionako već kriznom gospodarstvu. 1995/96. g. započinje obnova ratom razrušenih objekata, čime se graditeljstvo lagano diže sa povećanjem vrijednosti izvršenih građevinskih radova.

Danas, nakon 22 godine, ponovo se može konstatirati da gospodarski sektor nema dovoljno vlastitih potencijala za novi investicijski ciklus, a priliv stranog kapitala koji se ne bi zasnivao na kreditnim odnosima nego na bazi ulaganja ne ostvaruje se željenim tempom. Problemi konstatirani ranijim istraživanjima: naplate, neriješeni odnosi, nedovoljna uposlenost, opća nelikvidnost investitora, kooperanata i samih graditeljskih poduzeća i danas su kameni spoticaja za izlazak graditeljstva iz recesije kao što je to bilo i prije 25 godina (Jurčec, Skendrović and Đukan, 1990). Što se veličine poslovnih sustava tiče, u Republici Hrvatskoj 8,5% poduzetnika stvara više od 78% prihoda i 85,5% dobiti, te ima više od 11% zaposlenih (Privredni vjesnik, 2012.). Barem dva puta u povijesti zakonske regulative su omogućile i poticale stvaranje većih poslovnih sustava, čije tromosti nisu mogle slijediti promjene regulative i tržišnih zahtjeva te stvorile gubitke koji su svojim udjelom postale državni problem gospodarstva. Dok se male tvrtke stvaraju i raspadaju stvarajući manje, ali stabilne i održive dobiti, veliki sustavi u rubnim uvjetima kakvi su postavljeni u Hrvatskoj već dva puta su dokazale svoju neefikasnost i povukle za sobom stanje u cijelom gospodarstvu, a ono ih je postavilo na poziciju koju su imale.

Udio djelatnosti u bruto domaćem proizvodu jasno pokazuje da se u građevinarstvu događa jedna od najvećih promjena u udjelu u bruto domaćem proizvodu (v. tablica 1., graf 1.). Drugim riječima, u strukturi pada BDP-a građevinarstvo očekivano zauzima važnu poziciju. S obzirom na tu ukazanu činjenicu, o graditeljstvu kao djelatnosti potrebno je voditi brigu, a ne eventualno kretanje prepustiti slučaju.

Tablica 1. Struktura bruto domaćeg proizvoda (HGK, 2013.)

Djelatnost (prema nacionalnoj klasifikaciji djelatnosti, v. 2007.)	2008.	2013. (Q1)	Razlika
Poljoprivreda, šumarstvo i Ribarstvo	4,3	3,7	-0,6
Prerađivačka industrija, rudarstvo i vađenje te ostale industrije	16,4	18,2	1,8
Prerađivačka industrija	13,5	13,4	-0,1
Građevinarstvo	7,3	4,6	-2,7
Trgovina na veliko i malo, prijevoz i skladištenje, smještaj, priprema i usluživanje hrane	18,5	14,5	-4,0
Informacije i komunikacije	4,3	4,3	0,0
Financijske djelatnosti i djelatnosti osiguranja	5,6	6,4	0,8
Poslovanje nekretninama	8,5	9,9	1,4
Stručne, znanstvene, tehničke, administrativne i pomoćne uslužne djelatnosti	6,5	6,5	0,0
Javna uprava i obrana, obrazovanje, djelatnosti zdravstvene zaštite i socijalne skrbi	12,0	14,7	2,7
Ostale uslužne djelatnosti	2,2	2,3	0,1



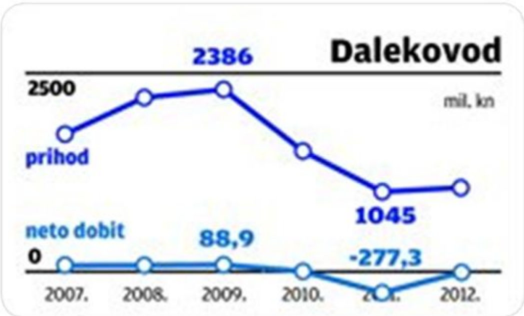
Graf 1. Struktura promjene BDP-a (odnos 2008. I 2013.g.)

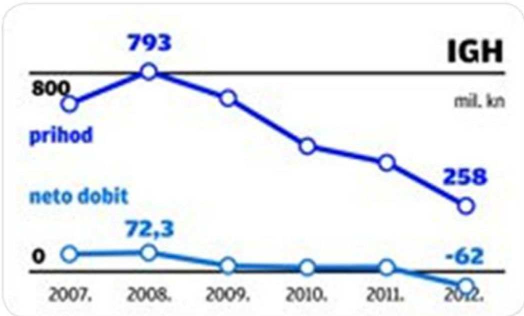
3. Poslovni subjekti u graditeljstvu RH

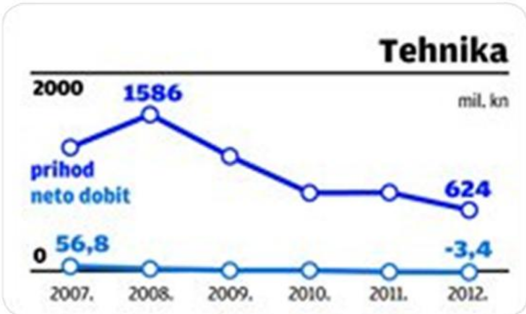
Kako je zadnjih godina obim građevinskih radova padao, poslovni subjekti u građevinarstvu ušli su u razdoblje otpuštanja radnika, novih neviđenih izazova u poslovanju i smanjenju djelatnosti. Analiza stanja poslovnih subjekata u građevinarstvu RH pokazuje da samo fleksibilni sustavi koji su se brzo restrukturiraju ili djelomično mijenjaju tržišnu nišu, ovisno o potrebama tržišta, opstaju na tržištu.
Tržište je nakon ostvarenja nerealno visokih investicija postalo divlje u nadi da će ostati na istoj razini, što se nije smjelo očekivati. Ignoriranje pravog stanja samo je otežalo i usporilo prilagodbu, u čemu mnogi nisu uspjeli.
Razina zaposlenosti iz predtranzicijskog razdoblja od preko 1,6 milijuna zaposlenih još uvijek nije ni približno postignuta. Iako se veličina radnog kontingenta između ostalog zbog starenja stanovništva smanjuje, niska participacija ostavlja prostor da se u budućem razdoblju veličina ponude rada u hrvatskom gospodarstvu može i dalje povećavati. Politiku uvoza radne snage koja pomaže usklađivanju specifičnih potreba gospodarstva također treba pomnije planirati i realizirati (i danas se usprkos visokoj nezaposlenosti uvozi deficitarna radna snaga, između ostalog i za graditeljstvo).

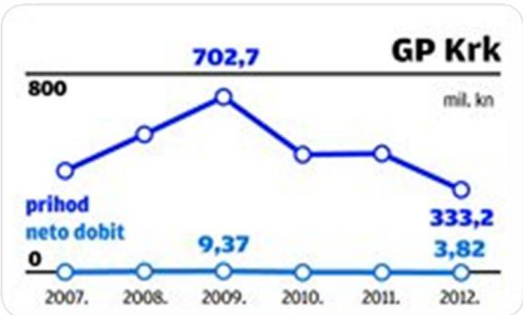
Broj zaposlenih u graditeljstvu se od 2008. g. (oko 98.850 radnika) do ožujka 2012.g. (oko 78.850 zaposlenih) smanjio za oko 20.000, tj. za više od 20%. S obzirom na stanje nakon ožujka 2012. godine, za očekivati je daljnje, sve brže raspuštanje radne snage u građevinarstvu. Prognoze ukazuju da je za očekivati raspuštanje daljnjih cca 30.000 radnika do kraja 2013. godine, što će građevinarstvo dovesti na manje od 50% zaposlenih u odnosu na 2008. g. Pribroji li se tome činjenica da je iznos neizvršenih plaćanja u građevinarstvu danas oko 9 milijardi HRK (ukupno oko 25% svih neizvršenih financijskih obaveza u Republici Hrvatskoj) (Fina, 2013.), te vrlo niska konkurentnost Republike Hrvatske, pitanje što Hrvatska može napraviti da bi se spasilo građevinarstvo postaje vrlo ozbiljno pitanje.

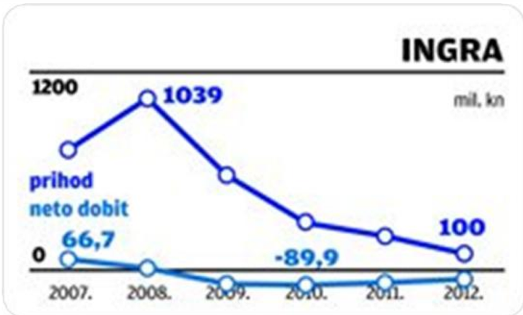
Trenutno je od 11 najvećih domaćih hrvatskih građevinskih tvrtki više od polovice u postupku predstečajne nagodbe, blokade ili velikih problema s likvidnošću.
U nastavku se dalju prikazu prihoda i neto dobiti nekih od najvećih hrvatskih tvrtki koji se mogu naći već javno objavljeni.

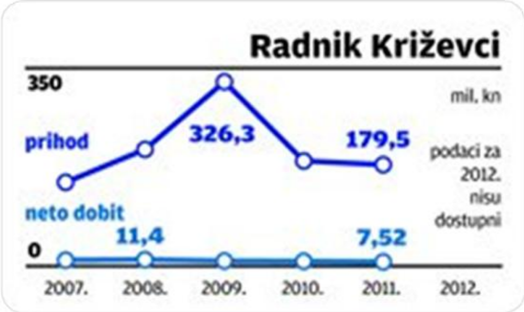


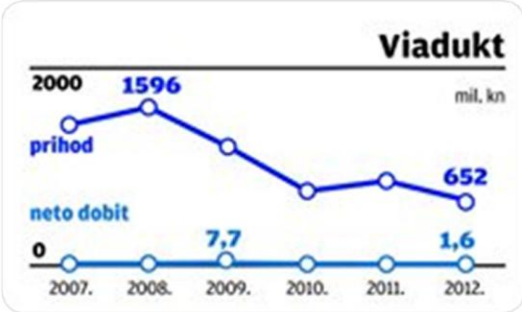


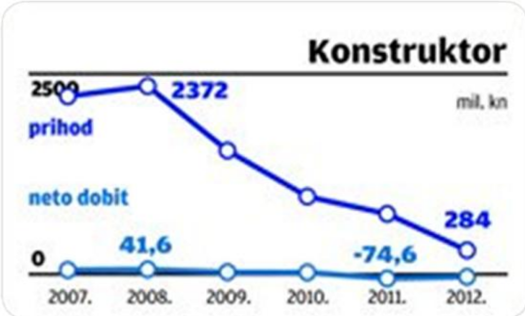


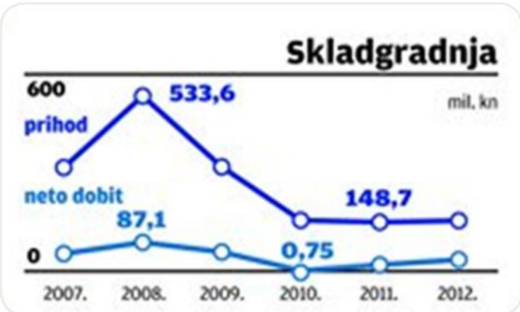


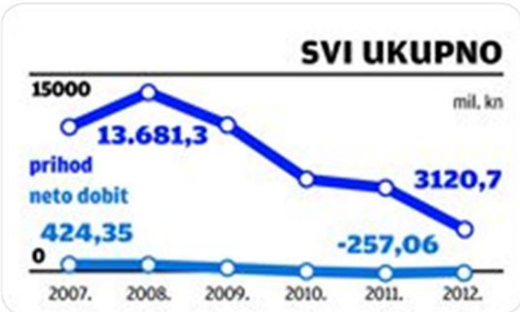












Iz grafova je očigledno da se u graditeljstvu od 2008. g. bilježi stalni trend pada prihoda i dobiti. Nijedna tvrtka koja je 2008. g. imala najveće prihode nije do 2010. g. uspjela zadržati tadašnju razinu prihoda, osim tvrtki koje su poslovale u inozemstvu pa su donekle ublažile negativni trend drastičnog smanjenja prihoda. S obzirom da se ista manifestacija dogodila svim sustavima, uzroci takvog stanja ili su vanjske prirode i ne izviru iz samih organizacija ili su sve organizacije napravile pogrešku koja ih je dovela do podjednako lošeg rezultata. Nameće se samo po sebi da je zakonska regulativa, čije se promjene poklapaju sa promjenama dinamike uspješnosti najvećih tvrtki, te nefleksibilnost sustava, dovelo do ovog stanja. Zanimljiv je podatak da se ništa od 2008. do 2013.g. nije dogodilo što bi dalo konkretne rezultate u oporavku iz krize. Usprkos svim nastojanjima da se graditeljstvo oporavi, trendovi ukazuju da je ona kao djelatnost ipak u znatno lošijoj poziciji nego ostale djelatnosti, a druga je djelatnost po redu koja negativno utječe na strukturu pada BDP-a zemlje.

Jedan od najvažnijih pokazatelja otpornosti djelatnosti na krizu je konkurentnost. Konkurentnost se mjeri prema učinkovitosti institucija, infrastrukture, zdravstva, obrazovanja, financijskog tržišta, tehnološke razvijenosti i kapaciteta inovativnosti. Podatak Svjetskog centra za konkurentnost, koji Hrvatsku prema najnovijim istraživanjima postavlja na posljednje mjesto u listi od 60 država, jest problem jer je otpornost graditeljstva na krizu proporcionalan konkurentnosti. Jačanje konkurentnosti kao alata za povećanje otpornosti graditeljstva na krizu je domena državnih institucija i poslovnih subjekata samih.

Prema provedenom istraživanju, konkurentnost je parametar o kojem se ne vodi dovoljno računa u mjerama kojima se nastoji doprinijeti oporavku iz krize ili je odnos mjera i konkurentnosti nejasno izražen, a trebao bi biti u fokusu svakog nastojanja.

4. Zaključak

Hrvatsko gospodarstvo očito nije otporno na krizu, a graditeljstvo još manje. S obzirom da takav trend može potpuno uništiti jednu domaću djelatnost, sada je više nego ikada važno sagledati razloge takvih trendova i stvoriti platformu za oporavak. Dva su osnovna razloga tako slabe otpornosti graditeljstva na krizu: objektivni i subjektivni. Objektivno, Hrvatska je malo tržište koje sada unutar Europske unije treba jačati konkurentnost na tržištu EU-a da bi se stanje popravilo. Tim dijelom izazova trebaju se baviti poslovni sustavi. Subjektivno, Hrvatska je sama sustavno stvorila funkcioniranje bazirano na velikim sustavima, što se mora promijeniti da bi tržište opstalo. To je moguće kroz prilagodbu zakonske regulative, natječaje i ostale instrumente države kojima se može približiti uvjetima u kojima se poslovni sustavi u graditeljstvu nalaze, dopuštajući im opstanak i razvoj u manjim nišama.

Zadržavajući smjer u kojem gospodarstvo i česte promjene zakonske regulative idu, moguće je daljnje nestajanje hrvatskih tvrtki u domaćem graditeljstvu. Donosioci zakona trebali bi provoditi analizu spremnosti građevinskog sektora da prihvati zahtjeve novog vremena i uvjeta, a poslovni sustavi se okrenuti akcijama za povećanje konkurentnosti.

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VERIFIKACIJSKI MEHANIZMI U PRIPREMI I REALIZACIJI KOMPLEKSNIH PROJEKATA – PRIMJER PROGRAMA ZAGREB NA SAVI*

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Sažetak

Program po svojoj definiciji označava skup međusobno povezanih projekata te kao takav pretpostavlja veliku složenost u organizaciji i stručnim područjima koje obuhvaća. Vijek pripreme i realizacije najčešće se broji u godinama i dijeli program na faze. Njegov uspjeh i izvrsnost između ostaloga vrednuje se pozitivnom ocjenom stručnjaka pojedinih, zasebnih, a zbog obuhvatnosti, povezanih područja. Greške se rade onda kad ta ocjena dolazi u završnoj fazi projekta, tj. programa. Iz toga razloga program Zagreb na Savi razvio je model Stručnog savjeta koji se sastoji od stručnjaka raznih područja - sveučilišnih profesora, predstavnika strukovnih udruženja, neovisnih stručnjaka - koji su u razvoj programa aktivno uključeni od njegova početka. Na taj način sve ključne odluke programa su verificirane na visokoj stručnoj razini, program postiže transparentnost te znanstvenu i stručnu utemeljenost. Ujedno se smanjuju rizici daljnjeg upravljanja i program sigurno prelazi u sljedeće faze svoga razvoja

Ključne riječi: verifikacija, program, mehanizmi, upravljanje, Zagreb na Savi

* The complete text is available on CD-ROM / Penović, Fajdetić

Uvod

Modeli provjere pojedinih faza programa u samome procesu vođenja jedni su od važnijih njegovih elemenata. Sam koncept programa vrlo je složen, jer obuhvaća nekoliko projekata te samim time najčešće podrazumijeva veći broj različitih stručnih područja. Osim toga vijek trajanja programa od njegove pred razvojne faze do početka implementacije je dugotrajan i kao takav podložan promjenama sustava u kojem se razvija.
Uvođenje verifikacije još u pred razvojnoj fazi projekta ključno je za izbjegavanje pogrešaka koje ponekad postaju vidljive tek u kasnijim fazama razvoja. U takvim slučajevima one se teže ili nikako ispravljaju. Osim toga utjecaj tih grešaka na program je tada veći nego da su otkrivene na vrijeme, jer više košta i dulje traje.
U upravljanu programom Zagreb na Savi uveden je koncept provjere kroz Stručni savjet. U stručni savjet su pozvani ili su imenovani stručnjaci raznih strukovnih područja. Savjet je u razvoj programa uključen u njegovoj početnoj fazi. Svojim radom utječe na odluke voditelja programa te pruža redovitu stručnu potporu u izradi projektantskih rješenja.

2. Program Zagreb na Savi

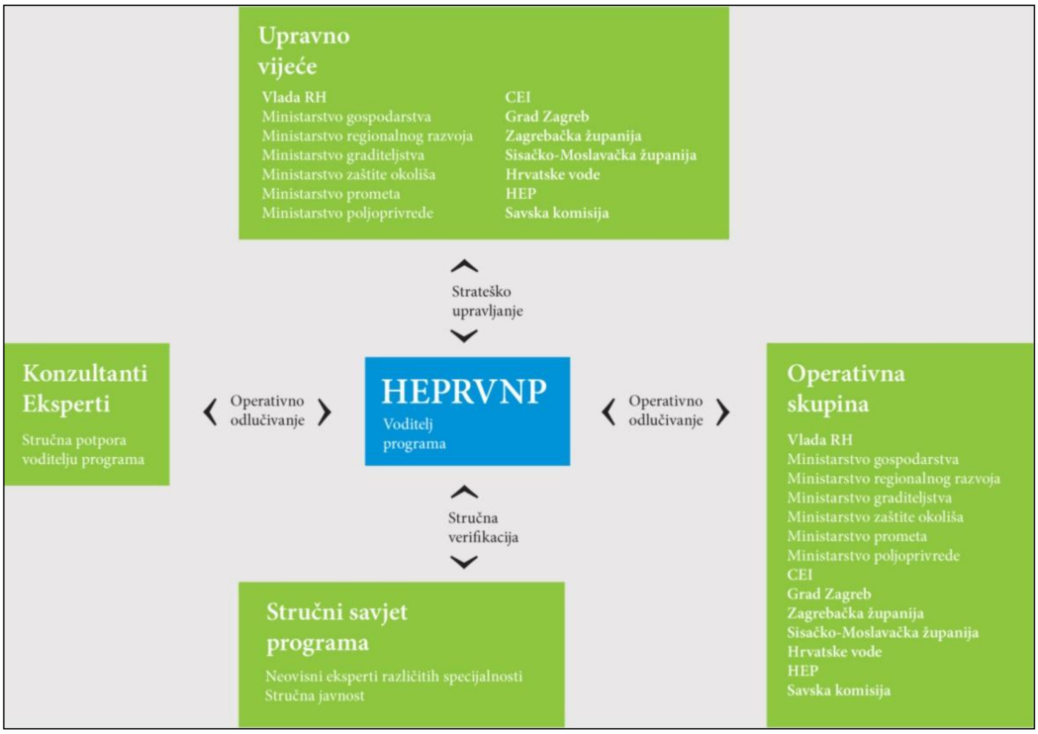
2.1. Uvodno o programu

O zaštiti priobalja rijeke Save ozbiljno se počelo razmišljati nakon velike poplave u Zagrebu 1964. godine. Projektirano rješenje profesora Srebrenovića sa izvođenjem nasipa uz rijeku te odteretnog kanala Sava-Sava završeno je 1973., ali nikada u potpunosti. Vodni potencijal same rijeke tada nije bio razmatran. Od toga vremena uvjeti na rijeci su se mijenjali, a kroz desetljeća su se postavljala nova rješenja uređenja rijeke. Međutim nisu se razvila dalje od gomilanja projektne dokumentacije i na pola završenih postupaka procjene utjecaja na okoliš.

Zagreb na Savi je višenamjenski program uređenja, korištenja i zaštite rijeke Save i zaobalja od granice sa Republikom Slovenijom do Siska. Osim spomenutih rješenja uređenja rijeke ovaj program ispitao je mogućnost takvog sustava koji će velike vode rijeke Save provoditi mimo grada Zagreba odteretnim kanalom Sava-Sava (uređenje sadašnjeg kanala Sava-Odra), osigurati plovnost dijela kanala u IV. kategoriji te osigurati pozitivan utjecaj sustava na podzemne vode.

2.2. Model upravljanja

Jedan od razloga zašto prijašnja rješenja uređenja rijeke nisu ostvarena leži i u činjenici da takvi programi okupljaju veliki broj različitih interesnih skupina, dionika. Svesti na isti nazivnik desetke ministarstava, jedinice lokalne samouprave, ovisna društva, neovisne udruge te javno mnijenje iziskuje razrađeni model upravljanja podložan brzim promjenama i trenutnom implementacijom.



Slika 1. Model upravljanja Programom

Vođenje programa povjereno je ovisnom društvu HEP Grupe, HEP-Razvoju višenamjenskih nekretninskih projekata d.o.o. Svi dionici programa okupljeni su u Upravnom vijeću. Njega čine predstavnici ministarstava, županija, HEPa, Hrvatskih voda, CEIa i Savske komisije, na najvišem svojem nivou. Uloga vijeća je donošenje odluka na strateškoj razini. Iz Upravnog vijeća imenovani su operativni predstavnici pojedinih institucija u Operativnu skupinu. Voditelj programa sa članovima operativne skupine komunicira na dnevnoj bazi tokom svih faza razvoja programa. Stručna potpora Voditelju su Konzultanti/Experti. Ona broji četiri člana, stručnjaka na području prava, vođenja projekata i organizacije. Stručni savjet programa verifikacijsko je tijelo koje se trenutno sastoji od 15 neovisnih stručnjaka različitih specijalnosti.
Model je osmišljen na način da je podložan promjenama u sastavu svojih članova ovisno o fazi programa, tj. potrebne specijalnosti.

3. Stručni savjet programa

3.1. Formiranje Savjeta

Raznovrsnost stručnih područja koje sama izrada programa obuhvaća, sve koristi koje donosi njegovo izvođenje te potencijale koje otvara stvorila je potrebu okupljanja stručnih osoba različitih, međusobno neovisnih, ekspertiza.
Početna faza programa Zagreb na Savi bila je izrada koncepcijskog rješenja te idejnih rješenja. Koncepcija je trebala utvrditi mogućnost izvođenja takvog sustava uređenja rijeke Save i priobalja kojim bi se velike vode odvele odteretnim kanalom mimo grada Zagreba te bi rijeka kroz njega protjecala samo u svome koritu uz uvjete pozitivnog utjecaja cijeloga sustava na podzemne vode.
S obzirom da izrada koncepcije podrazumijeva uža građevinska područja u Savjet su pozvani priznati stručnjaci hidrotehnike, hidraulike, hidrogeologije, hidrologije te geotehnike. S projektantima su usko surađivali tijekom izrade koncepcijskog rješenja i nakon njega tijekom izrade idejnih rješenja.
Osim spomenutog odteretnog kanala sustav obuhvaća izvedbu tri veće i četiri manje

hidroelektrane. U Savjet je stoga pozvan i stručnjak sa područja energetike.
Hrvatska komora i Hrvatski sabor građevinskih inženjera kao krovne građevinske institucije također su imenovale svoje predstavnike u Savjetu. Isto je, na poziv Voditelja programa, učinila i Hrvatska komora arhitekata.
Potencijal koji bi izvedba ove koncepcija otvorila je i nova urbanizacija grada Zagreba. Iz toga razloga u Savjet su uključeni arhitekti, urbanisti, a podršku je kroz zajedničkog predstavnika iskazala i Udruga hrvatskih arhitekata te Društvo arhitekata Zagreb.
Održiva i zelena gradnja jedan je od principa realizacije programa. Izgradnjom hidroelektrana, kanala i ostalih pripadajućih objekata u znatnoj se mjeri utječe na okoliš. Samo uvođenje najviših ekoloških standarda može osigurati opravdanost izvođenja i sigurnost implementacije programa. S toga su u tim Stručnog savjeta uključeni stručnjaci s područja ekologije koji svojim savjetima usmjeravaju Voditelja u izradi ekološki prihvatljivog programa.

3.2 Uloga Savjeta kroz razvojne faze Programa

Dobiti koje Program Zagreb na Savi ostvaruje su ekonomke, ekološke i društvene prirode. Ostvarenje Programa imati će dalekosežne posljedice na područje koje obuhvaća kao i na njegove stanovnike. Vrijeme pripreme i realizacije programa procjenjuje se na oko 15 godina, a vrijednost na oko 1,4 milijarde eura. Zanimanje stručne i ostale javnosti realnost je koje Voditelj programa mora biti svjestan. Utjecaj tih činjenica na tijek Programa je velik i donosi određene rizike. Formiranjem tima stručnjaka koji su u pred razvojnoj fazi uključeni u Program smanjuje moguće negativne utjecaje na program.

Kao što je već navedeno prva faza programa bila je izrada koncepcijskog i idejnih rješenja. Jedan od scenarija, uobičajenih za velike projekte, mogao je biti predstavljanje stručnoj javnosti gotovog koncepcijskog rješenja, odnosno gotov Programa u cijelosti. U tome slučaju sve primjedbe na njega ne bi ga više mogle mijenjati, ali negativne konotacije imale bi loše posljedice na njegov daljnji razvoj. Osim trenutnog usporavanja koje za sobom donosi povećanje troška i akumulira redovitu problematiku koje razvoj jednog projekta, tj. programa nosi, najgora posljedica mogla bi biti zaustavljanje programa u potpunosti.
Za program čija priprema i implementacija traje oko 15 godina pripremna, pred razvojna, faza može trajati i do 5 godina. Rizik ukidanja programa nakon završetka te faze prevelik je da bi se zanemario ili umanjio. Upravo uvođenje Stručnog savjeta instrument je kojim se on kontrolira i smanjuje, tj. dovodi do toga da njegov utjecaj na daljnji tijek programa ne uzrokuje više nepopravljive posljedice.

Nakon odabira projektanta za izradu koncepcijskog rješenja održana je prva sjednica Stručnog savjeta na kojemu su osim njenih članova i investitora prisustvovali projektanti. Svima je dostavljen projektni zadatak prema kojemu se koncepcija izrađuje, a na sjednici je objašnjen princip otvorene suradnje projektanata i članova savjeta. Iz tima Voditelja određena je osoba preko koje se odvija komunikacija, tj. koja u svakom trenutku mora biti upoznata sa problematikom u izradi koncepcije. Taj oblik suradnje pokazao se učinkovitim, a komunikacija sa članovima Savjeta bila je svakodnevna. Koji mjerodavni hidrološki niz uzeti za proračune, varijantna rješenja pojedinih postrojenja, lokacije, pregled i analiza modela površinskog tečenja i model podzemnih voda samo su neka od pitanja, tj. cjelina u kojima se konzultiralo članove savjeta i zajedno s njima dolazilo do najboljih rješenja. Projektanti su iskoristili činjenicu da im jedni od najvećih stručnjaka iz područja hidraulike, matematičkog modeliranja, hidromehanike i hidrogeologije mogu pomoći u rješavanju nedoumica tokom projektiranja.

Tijekom izrade koncepcije održane su još dvije sjednice na kojemu su članovi upoznavani sa dotadašnjim tijekom izrade koncepcije te budućim koracima. Sve primjedbe članova savjeta uključene su u rješenje i ono je kao takvo zaključeno. Posljedica takve suradnje bila je 14 pozitivnih recenzija članova Savjeta na cjelovito koncepcijsko rješenje te niti jedna negativna kritika na njega nakon predstavljanja koncepcije stručnoj javnosti. Najveće priznanje članova može se očitovani u ovome citatu iz recenzije jednoga od njih: „.. jedan od najvrednijih i najboljih elaborata istraživačkog tipa vezanih za uređenje prostora u posljednje vrijeme."

Osim koncepcije u pred razvojnoj fazi započelo je izrađivanje projektnog zadatka za izradu *Feasibility, Environmental and Social Impact Study.* Naime HEP RVNP je dobio grant sredstva od Western Balkan Investement Frame-a za izradu navedene studije. Ona će obuhvaćati studiju izvodljivosti i Stratešku studiju utjecaja na okoliš. Osim opisanog sustava studija će usporediti i prijašnja višenamjenska rješenja uređenja rijeke Save te između njih izabrati najprihvatljiviju. Ne želeći nakon godinu i pol dana, koliko će trajati njena izrada, dobiti gotovu studiju bez imalo znanja o tome što će i kako obuhvaćati Voditelj je inzistirao na svom uključivanju u rad na izradi projektnog zadatka. Osim toga, najbolje vrijeme da se Program izradi po najvišim ekološkim standardima, uzimajući u obzir svu zakonsku regulativu, i postane prihvatljiv sa toga aspekta je upravo ova pred razvojna faza. Prilagođavanje već gotovih pojedinih projekata novonastalim, dodatnim zahtjevima bilo koje vrste složen je postupak koji za sobom povlači neko novo vrijeme i resurse. U tome slučaju moglo bi se dogoditi da se zahtjevima ne može udovoljiti i da se mora mijenjati veći dio samoga koncepta. Takav scenarij unazadio bi i dodatno zakomplicirao program. Uključivanje ovih principa prije početka projektiranja i samo osvješćivanje svih sudionika razvoja Programa u pogledu važnosti zaštite okoliša sigurniji je način da se taj standard i ostvari. Članovi Savjeta ovoga strukovnog područja svojim su radom utjecali ne samo na smjernice u izradi projektnoga zadatka za Studiju nego usmjeravaju vođenje programa na način da zadovolji sve ekološke zahtjeve. Kome se obratiti, s kim i o čemu razgovarati, što očekivati, na koji način pristupiti problematici i ljudima, na što obratiti pažnju, na čemu inzistirati u izradi dokumentacije samo su dio pitanja čijim su odgovorima svojim iskustvom i znanjem savjetovali Voditelja.

Već je spomenuto da je jedan od potencijala koje Program oslobađa prostorno-urbanističke prirode. S obzirom da se on proteže kroz tri županije, Grad Zagreb, Zagrebačku te Sisačko moslavačku županiju, i kao takav obuhvaća različite prostorne cjeline za potrebnim je bilo dobiti cjelovitu i točnu sliku zone obuhvata. HEP RVNP stoga je raspisao natječaj za izradu Studije strateških prostorno planskih potencijala uređenja rijeke Save na potezu od granice sa Republikom Slovenijom do Siska. U izradi projektnog zadatka kao sastavnog dijela dokumentacije za nadmetanje sudjelovali su i članovi Savjeta. Član tima Voditelja programa zadužen za izradu dokumentacije prije konačne objave konzultirao je savjetnike te dokumentaciju upotpunio i zaključio.

Nakon izrade koncepcijskog rješenja koje je označilo kraj jedne faze programa Voditelj je organizirao stručnu prezentaciju svim njegovim dionicima. Na tim prezentacija uz projektante prisustvovali su i članovi Savjeta koji su i na taj način podržali razvoj programa.
Osim konkretnih zadataka koje pred njih stavlja Voditelj programa, savjetnici se svojevoljno uključuju u svakodnevni rad programa posebno sa prijedlozima promocije Programa te komunikacije prema stručnoj javnosti i udrugama.

3.3 Razvoj modela

Višenamjenski program uređenja, zaštite i korištenja rijeke Save kompatibilan je i sa drugim projektima u razvoju. Željeznička i cestovna obilaznica poklapaju se sa plovnim putem, tj. lukom na odteretnom kanalu čiji razvoj implementacija Programa omogućuje. Vodoprivredni dio programa kroz sustave navodnjavanja utjecati će na poljoprivredu. Financiranje programa koje se većim dijelom planira osigurati kroz apliciranja na Europske fondove, a ostalim dijelom mora biti

prihvatljiva energetskim tvrtkama zahtjeva ekspertizu ekonomskih stručnjaka. Gradnja 7 hidroelektrana, dovršenje odteretnog kanala, ostvarivanje plovnosti dijela kanala, mogućnost izvođenje luke, otvaranje prostornog potencijala, novi mostovi preko rijeke, prometne mogućnosti, uređenje okoliša, vodoprivredni potencijali ... sve to utječe prvenstveno na svakidašnjicu ljudi koji nastanjuju područje obuhvata, ali i šire.
Stručne osobe iz područja prometa, poljoprivrede, ekonomije i sociologije prostora sljedeći su koraci koje Voditelj poduzima u smislu proširenja Savjeta. Svjesnost važnosti besprijekorne izvedbe koncepcije Stručni savjet okupio je većinom eksperte sa užih građevinskih područja. Međutim Savjet je formiran na način da prema potrebi trenutne faze, tj. razvoja Programa okuplja nove članove određenih specijalnosti dok, s druge strane, stručnost nekih članove prestaje biti nužna. Fluidnost ovakvoga sustava omogućuje brze promjene te nesmetani rad ovisno o trenutnom fokusu interesa programa.

Zaključak

Uvođenjem verifikacijskog sustava u model upravljanja osigurana je šira stručna potpora razvoju Programa. Svojim radom Savjet prati Program i na taj način smanjuje rizike koji nosi te predviđa prepreke koje bi mogao očekivati u budućnosti. Uspješno upravljanje rizicima jedna je od važnijih kvaliteta koju mora imati Voditelj jednog programa. Osim toga potpora stručnjaka od velike je važnosti za potpuno i uspješno ostvarenje programa.
Iako tek u početnoj fazi ovaj Program za sada nije pokazao negativne konotacije kako stručne tako ni ostale javnosti. Razlog u tome leži u sigurnosti u ispravnost njegove pripreme i vođenja. Potvrda priznatih stručnjaka te njihovo aktivno sudjelovanje u Programu Voditelju daje sigurnost za zaključivanje jedne i prelazak u drugu fazu razvoja. Ovaj mehanizam verifikacije pokazao je lakoću implementacije, a reakcijama na rezultate Programa opravdao svoju postojanost.
Uspjeh i izvrsnost Programa vrednovati će se pozitivnom ocjenom neovisnih stručnjaka, njegovom praktičnom koristi i prihvaćanjem javnosti. Namjera formiranja ovakvog modela upravo je postizanje tih ciljeva. Vlasnici program svi su oni koji u konačnici od njega imaju koristi. Ostvarivanje transparentnosti, znanstvene i stručne utemeljenosti te pravovremeno upoznavanje svih zainteresiranih strana, dionika i javnosti sa projektima koji će se događati u njihovom okruženju i utjecati na njihovu svakodnevnicu put je ka uspješnom ostvarenju Programa.

POVIJESNI PRIKAZ DONOŠENJA PROPISA IZ PODRUČJA GRADITELJSTVA I PROSTORNOG UREĐENJA*

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Sažetak

U tijeku je postupak donošenja novih zakona iz područja graditeljstva i prostornoga uređenja. Nakon što stupe na snagu novi zakoni biti će potrebno, gdje je to moguće, uskladiti postojeće podzakonske akte sa odredbama novih zakona, odnosno biti će potrebno donijeti nove podzakonske akte. U članku će se dati povijesni prikaz donošenja zakona koji uređuju područje graditeljstva i prostornoga uređenja počevši od zadnjih zakona koji su se primjenjivali samo u Socijalističkoj Republici Hrvatskoj pa do ovih koji su danas u primjeni u samostalnoj Republici Hrvatskoj. Često donošenje zakona te njihovih izmjena i dopuna sigurno nije doprinijelo pravnoj sigurnosti pravnog poretka, kao i adresata.

Ključne riječi: Često donošenje zakona, pravna nesigurnost.

* The complete text is available on CD-ROM / Rajčić, Kontrec

Uvod

U tijeku je postupak donošenja novih propisa iz područja graditeljstva i prostornoga uređenja. U ovoj će se godini donijeti nekoliko zakona i podzakonskih akata koji će, izvjesno je, donijeti promjene u području graditeljstva i prostornoga uređenja. Donijeti će se Zakon o gradnji, Zakon o prostornom uređenju i Zakon o građevinskoj inspekciji, novi propisi čijim će se stupanjem na snagu prestati primjenjivati Zakon o prostornom uređenju i gradnji koji je donesen na sjednici Hrvatskog sabora 6. srpnja 2007. godine i objavljen je u „Narodnim novinama", br. 76/07 od 23. srpnja 2007. godine. Zbog svoje složenosti Zakon o prostornom uređenju i gradnji je stupio na snagu nekoliko mjeseci kasnije, odnosno 1. listopada 2007. godine, osim članka 204. stavka 3. i stavka 4. koji je trebao stupiti na snagu danom prijama Republike Hrvatske u Europsku uniju.
U radu će se dati pregled donošenja temeljnih propisa iz područja graditeljstva i prostornog uređenja u samostalnoj Republici Hrvatskoj, pregled donošenja propisa koji su se primjenjivali i u Socijalističkoj Republici Hrvatskoj i u samostalnoj Republici Hrvatskoj te pregled posljednjih propisa koji su se u cijelosti primjenjivali samo u Socijalističkoj Republici Hrvatskoj.
U radu će se dati i razmišljanja vezana uz često donošenje novih propisa iz područja graditeljstva i prostornog uređenja, čestih donošenja njihovih izmjena i dopuna te (ne)pravovremenog (ne)donošenja podzakonskih propisa, propisa neophodnih za provedbu zakona.

Propisi iz područja graditeljstva, prostornog uređenja

Područje graditeljstva, prostornog uređenja i stanovanja, temeljem Zakona o ustroju i djelokrugu ministarstava i drugih središnjih tijela državne uprave (državni uredi i državne upravne organizacije), u nadležnosti je Ministarstva graditeljstva i prostornoga uređenja. Područje graditeljstva i prostornog uređenja uređeno je i s nekoliko drugih zakona, primjerice Zakonom o arhitektonskim i inženjerskim poslovima i djelatnostima u prostornom uređenju i gradnji koji je donesen na sjednici Hrvatskog sabora 15. prosinca 2008. godine i objavljen je u „Narodnim novinama", br. 152/08 od 24. prosinca 2008. godine, te člankom 76. Zakona o reguliranim profesijama i priznavanju inozemnih stručnih kvalifikacija koji je donesen na sjednici Hrvatskog sabora 12. listopada 2009. godine i objavljen je u „Narodnim novinama", br. 124/09. od 16. listopada 2009. godine. Područje graditeljstva i prostornog uređenja uređeno je i cijelim nizom provedbenih propisa (uredbama, pravilnicima, tehničkim propisima, odlukama).
Ministarstvo graditeljstva i prostornog uređenja dostavilo je radi davanja mišljenja Nacrt prijedloga Zakona o gradnji, Nacrt prijedloga Zakona o prostornom uređenju i Nacrt prijedloga Zakona o građevinskoj inspekciji. Na dostavljene nacrte prijedloga zakona ostavljen je rok do 20. lipnja u kojem je mišljenja trebalo dostaviti pisanim putem ili putem elektroničke pošte. Nacrti prijedloga dostavljeni su svim značajnim subjektima (primjerice socijalnim partnerima, svim građevinskim fakultetima), predstavnici Ministarstva graditeljstva i prostornog uređenja održali su mnogobrojna predavanja diljem države, a tekstovi nacrta prijedloga zakona objavljeni su na mrežnim stranicama Ministarstva graditeljstva i prostornog uređenja.
U nastavku članka dati će se povijesni prikaz donošenja propisa koji uređuju odnosno koji su uređivali područje graditeljstva i prostornog uređenja. Zbog ograničenosti dati će se samo prikaz donošenja osnovnih zakona koji uređuju ova područja, a ne i prikaz drugih zakona kojima se uređuju neka pitanja iz tih područja odnosno prikaz odgovarajućih podzakonskih akata.
Zakon o prostornom uređenju i gradnji ima ukupno 354 članaka i podijeljen je na opće odredbe (od 1-22 članka), na prostorno uređenje (od 23-176 članka), na gradnju (od 177-276

članka), na nadzor (od 277-304 članka), na kaznene odredbe (od članka 305- 324 članka) i na prijelazne i završne odredbe (od 325-354 članka). Prvi puta je Zakon o prostornom uređenju i gradnji mijenjan donošenjem Zakona o izmjenama i dopunama Zakona o prostornom uređenju i gradnji koji je donio Hrvatski sabor na svojoj sjednici održanoj 20. ožujka 2009. godine i koji je objavljen u „Narodnim novinama“, br. 38/09. od 27. ožujka 2009. godine. Slijedeća novela objavljena je u „Narodnim novinama“, br. 55/11. od 18. svibnja 2011. godine. Iduća opsežna i značajna novela Zakona o prostornom uređenju i gradnji izvršena je donošenjem Zakona o izmjenama i dopunama Zakona o prostorom uređenju i gradnji kojeg je donio Hrvatski sabor na svojoj sjednici održanoj 15. srpnja 2011. godine i koji je objavljen u „Narodnim novinama“, br. 90/11. od 2. kolovoza 2011. godine, a stupio je na snagu osmoga dana od dana objave u „Narodnim novinama“. Posljednja novela objavljena je u „Narodnim novinama“, br. 50/12. i imala je 7 članaka.

Danom stupanja na snagu Zakona o prostornom uređenju i gradnji prestali su važiti:

(1) Zakon o prostornom uređenju osim odredbi koje prestaju važiti danom stupanja na snagu posebnog zakona kojim se uređuju pitanja obavljanja stručnih poslova prostornog uređenja od strane ovlaštenih arhitekata koji stručne poslove prostornog uređenja obavljaju u vlastitom uredu.

(2) Zakon o gradnji

- osim odredbi koje prestaju važiti danom stupanja na snagu posebnog zakona kojim se uređuju pitanja građevnih proizvoda,

- odredbi koje prestaju važiti danom stupanja na snagu posebnog zakona kojim se uređuju pitanja obavljanja poslova projektiranja, stručnog nadzora građenja i djelatnosti građenja,

– odredbi koje prestaju važiti danom stupanja na snagu propisa iz članka 105. stavka 2. ovoga Zakona.

Ministarstvo izdaje lokacijsku dozvolu za zahvate u prostoru, koje Vlada određuje uredbom, te za zahvat u prostoru koji je planiran na području dviju ili više županija, odnosno Grada Zagreba.

– odredbi koje prestaju važiti danom stupanja na snagu propisa iz članka 209. stavka 5. ovoga Zakona.

Jednostavne građevine i radove čijem se građenju, odnosno izvođenju može pristupiti bez akta kojim se odobrava građenje određuje ministar pravilnikom.

– odredbi članka 225. stavka 2. osim u dijelu koji se odnosi na članak 40. Zakona o gradnji koje prestaju važiti danom stupanja na snagu propisa iz članka 201. ovoga Zakona.

Obvezni sadržaj i elemente projekta, način opremanja, uvjete promjene sadržaja, označavanja projekta, način i značenje ovjere projekta od strane odgovornih osoba kao i način razmjene elektroničkih zapisa, u skladu s posebnim propisima, propisuje ministar pravilnikom.

(3) Zakon o prestanku važenja Zakona o postupanju s objektima građenim protivno prostornim planovima i bez odobrenja za građenje (»Narodne novine«, br. 33/95.).

(4) Zakon o postupanju s objektima građenim protivno prostornim planovima i bez odobrenja za građenje (»Narodne novine«, br. 33/92.).

(5) Uredba o određivanju građevina od važnosti za Republiku Hrvatsku (»Narodne novine«, br. 6/00. i 68/03.) ostaje na snazi do stupanja na snagu propisa iz članka 104. stavka 2. ovoga Zakona.

(6) Uredba o javnoj raspravi u postupku donošenja prostornih planova (»Narodne novine«, br. 101/98.).

(7) Uredba o uređenju i zaštiti zaštićenog obalnog područja mora (»Narodne novine«, br. 128/04.).

(8) Pravilnik o načinu vođenja očevidnika o obavljenim inspekcijskim pregledima građevinske inspekcije (»Narodne novine«, br. 1/98.).

Dakle poslovi prostornog uređenja i gradnje bili su prije Zakona o prostornom uređenju i gradnji uređeni posebnim zakonima, jednim kojim je bilo uređeno prostorno uređenje i drugim kojim je bila uređena gradnja.

Tako je Zakon o prostornom uređenju („Narodne novine“, br.30/94) u članku 2. propisivao „da se gospodarenjem, zaštitom i upravljanjem prostorom ostvaruju uvjeti za društveni i gospodarski razvoj, zaštitu okoliša, racionalno korištenje prirodnih i povijesnih dobara na načelu integralnog pristupa u planiranju prostora. Integralni pristup u planiranju prostora obuhvaća naročito: - poznavanje, provjeru i ocjenu mogućnosti razvoja u prostoru, - izradu dokumenata prostornog uređenja, - praćenje provedbe dokumenata prostornog uređenja“. Ovaj je zakon mijenjan četiri puta.

Donošenjem Zakona o prostornom uređenju prestali su važiti:

(1) Zakon o prostornom planiranju i uređivanju prostora ("Narodne novine", br. 54/80., 16/86., 18/89., 34/91., 61/91. i 59/93.),

(2) članak 17. Zakona o određivanju poslova iz samoupravnog djelokruga jedinica lokalne samouprave i uprave ("Narodne novine", br. 75/93.),

(3) Uredba o prostornom uređenju u ratom zahvaćenim područjima Republike Hrvatske ("Narodne novine", br. 14/94.) i

(4) Uredba o izmjeni Zakona o prostornom planiranju i uređivanju prostora ("Narodne novine", br. 14/94.).

Zakon o prostornom planiranju i uređivanju prostora donesen je u Socijalističkoj Republici Hrvatskoj i imao je 79 članaka. Članak 1. je propisivao „prostorno planiranje i uređivanje prostora temelji se na pravu i dužnosti radnih ljudi i građana da raspolažu prostorom za život i ljudski rad i da čuvaju prirodne i radom stvorene vrijednosti čovjekove okoline, sprečavaju i otklanjaju štetne posljedice koje ugrožavaju te vrijednosti, te da osiguravaju društveni i privredni razvoj za zdrav, siguran i humaniziran život i rad sadašnjih i budućih generacija.“

Zakon je u samostalnoj Republici Hrvatskoj tri puta noveliran.
Stupanjem na snagu Zakona o prostornom planiranju i uređivanju prostora prestao je važiti Zakon o prostornom uređenju i korištenju građevinskog zemljišta („Narodne novine“, br. 14/73) zakon koji se u cijelosti primjenjivao u Socijalističkoj Republici Hrvatskoj.

Zakon o gradnji je u članku 1. propisivao “ da se ovim Zakonom uređuje projektiranje, građenje, uporaba i uklanjanje građevine, tehnička svojstva, uporabljivost i promet građevnih proizvoda, ustrojstvo građevinske inspekcije, određuju se bitni zahtjevi i drugi uvjeti za građevinu, uređuje se provedba upravnih i drugih postupaka te prava i obveze tijela državne uprave, pravnih i fizičkih osoba s tim u vezi.

Odredbe ovoga Zakona ne odnose se na projektiranje, građenje i uklanjanje rudarskih objekata i postrojenja određenih posebnim zakonom.“

Ovaj je Zakon imao 226 članaka, a mijenjan je novelom objavljenom u „Narodnim novinama“, br. 100/04 koja je imala čak 84 članka.

Stupanjem na snagu Zakona o gradnji („Narodne novine“ br. 175/03) prestao je važiti Zakon o gradnji (»Narodne novine«, br. 52/99., 75/99., 117/01. i 47/03.).

Stupanjem na snagu Zakona o gradnji („Narodne novine“ br. 52/99.) prestao je važiti Zakon o građenju (»Narodne novine«, br. 77/92., 82/92., 26/93., 33/95. i 91/96.).

Stupanjem na snagu Zakona o građenju prestao je važiti Zakon o izgradnji objekata ("Narodne novine", br. 52/81., 12/82., 47/86., 54/86. - pročišćeni tekst, 18/87, 42/88., 29/89., 33/89.i 34/91.) koji je bio donesen i mijenjan i dopunjavan šest puta u Socijalističkoj Republici Hrvatskoj ali je doživio i jednu novelu u samostalnoj Republici Hrvatskoj.

Stupanjem na snagu Zakona o izgradnji objekata prestao je važiti Zakon o izgradnji objekata („Narodne novine“ br. 20/75.) koji se je u cijelosti primjenjivao u Socijalističkoj Republici Hrvatskoj i koji je u članku 1. propisivao „ izgradnjom objekata prema ovom zakonu smatra se obavljanje prethodnih radova u vezi s izgradnjom objekata, izrada tehničke dokumentacije i građenje odnosno rekonstrukcija objekta.

Objektom u smislu ovoga zakona smatra se građevinski objekt kada se, obzirom na tehničku i funkcionalnu, odnosno tehnološku cjelinu, može samostalno koristiti.

Objektom se smatra i više građevinskih objekata kada su funkcionalno i tehnološki povezani u jednu ekonomsku cjelinu za određenu namjenu.“

Iz ovog kratkog kronološkog prikaza donošenja zakona iz područja graditeljstva i prostornog uređenja vidljivo je da su se zakoni iz područja graditeljstva u samostalnoj Republici Hrvatskoj donosili tri puta, a iz područja prostornog uređenja jedanput te da je ukupno doneseno jedanaest novela. Zakon o prostornom uređenju i gradnji noveliran je četiri puta.

Kao primjer zakona koji je dugo bio na snazi daje se Zakon o općem upravnom postupku. Dana 27. ožujka 2009. godine Hrvatski sabor donio je novi *Zakon o općem upravnom postupku*. Ovaj *Zakon*, sukladno članku 171., na snagu je stupio 1. siječnja 2010. godine. Time je prestao važiti *Zakon o općem upravnom postupku*, koji je uz četiri ranije izmjene, preuzet u pravni sustav Republike Hrvatske *Zakonom o preuzimanju Zakona o općem upravnom postupku*.

Dodatni problemi uz tako često mijenjanje zakona je i pitanje donošenja posebnih zakona koji neka pitanja pobliže uređuju te donošenja provedbenih propisa.
Valja naglasiti da u pravilu nema određenja koja se pitanja donose zakonom, a koja se ostavljaju da ih se uredi provedbenim propisima.
Naime temeljem Zakona o sustavu državne uprave ministri donose pravilnike, naredbe i naputke za provedbu zakona i drugih propisa kad su na to izrijekom ovlašteni, u granicama dane ovlasti. Pravilnikom se detaljnije razrađuju pojedine odredbe zakona radi njihove primjene. Naredbom se naređuje ili zabranjuje određeno postupanje. Naputkom se propisuje način rada u tijelima državne uprave, tijelima jedinica lokalne i područne (regionalne) samouprave i pravnim osobama koje imaju javne ovlasti.

Pravilnici, naredbe i naputci objavljuju se u »Narodnim novinama«, a stupaju na snagu najranije osmoga dana od dana objave, ako tim propisima nije iznimno određeno da zbog osobito važnih razloga stupaju na snagu danom objave.

Kod donošenja provedbenih propisa problemi nastaju u dvojbi kod mnogih adresata,prvenstveno kod onih koji nisu pravnici, da li i kako primjenjivati provedbeni propis koji je donesen temeljem zakona koji je prestao važiti te kako primjenjivati zakon dok provedbeni propisi još nisu doneseni?

Problemi čestog mijenjanja i dopunjavanja zakona uočljiv je i u otežanom korištenju zakonskog teksta te njegovih izmjena i dopuna. Zato se često ovlašćuje Odbor za zakonodavstvo Hrvatskoga sabora da utvrdi i izda pročišćeni tekst zakona kako bi se adresati mogli lakše služiti zakonom i njegovim izmjenama i dopunama.

Zaključno

Temeljni zakoni koji uređuju područje građenja i prostornog uređenja često su se mijenjali i novelirali. To sigurno nije doprinijelo pravnoj sigurnosti adresata.

Valjalo bi ubuduće što rjeđe mijenjati zakone, a provedbene propise donositi u zadanim rokovima.

Posebno treba paziti da se, koliko je to moguće, izbjegavaju slučajevi da se donošenjem jednog zakona van snage stavljaju neki članci nekog drugog zakona jer i to ne pridonosi pravnoj sigurnosti, a ni lakšem snalaženju adresata.

Popis literature

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Zakon o gradnji, „Narodne novine“ br. 175/03.

Zakon o gradnji ,»Narodne novine«, br. 52/99.

Zakon o građenju ,»Narodne novine«, br. 77/92.

Zakon o izgradnji objekata, "Narodne novine", br. 52/81.

Zakon o izgradnji objekata „Narodne novine“ br. 20/75.

Zakon o arhitektonskim i inženjerskim poslovima i djelatnostima u prostornom uređenju i gradnji, „Narodne novine“, br. 152/08.

Zakon o reguliranim profesijama i priznavanju inozemnih stručnih kvalifikacija, „Narodne novine“, br. 124/09.

Zakon o ustroju i djelokrugu ministarstava i drugih središnjih tijela državne uprave, „Narodne novine“, br. 150/11.

Zakon o općem upravnom postupku,“Narodne novine“, br. 47/09.

Zakon o preuzimanju Zakona o općem upravnom postupku, „Narodne novine“, br. 53/91.

Zakon o općem upravnom postupku, „Službeni list SFRJ“, br. 47/86.

Zakon o sustavu državne uprave, „Narodne novine“, br. 150/11.

PROVOĐENJE GRAĐEVINSKIH RADOVA NA OBJEKTIMA KULTURNE BAŠTINE*

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Sažetak

U Republici Hrvatskoj kulturna baština zakonom uživa poseban tretman. U Hrvatsku kulturnu baštinu spadaju i mnoge zgrade naših gradova. Skoro svaka od ovih zgrada zahtjeva redovno održavanje, a često i veće radove u svrhu poboljšanja uvjeta života u njima. Nerijetko korisne građevine propadaju zbog zakonskih restrikcija, a često i zbog ne poznavanja pogodnosti koje su pružene u zakonskim okvirima Republike Hrvatske.
Provođenje radova na zgradama kulturne baštine u bilo kojem pogledu ograničeni su zakonski definiranim okvirima, koji se najčešće prepoznaju kao prepreke. No nije uvijek tako. U okvirima zakona koji obuhvaćaju graditeljske radnje na ovakvim građevinama implementirane su i smjernice koje postupak prilagodbe i održavanja postojećih zgrada graditeljskog nasljeđa olakšavaju i potpomažu njihovu provedbu. U ovom članku prikazani su zakonskim okvirima planiranja i provođenja radova na zgradama kulturnog nasljeđa.

Ključne riječi: postojeće zgrade, kulturna baština, zakoni, građevinski radovi

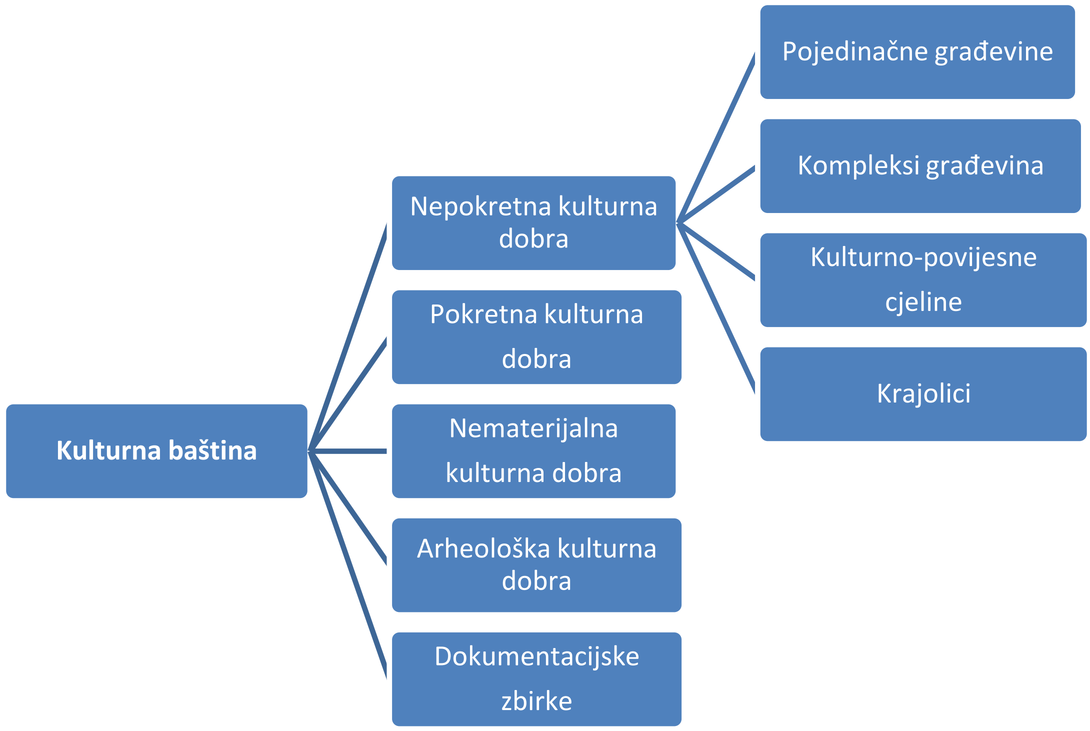
* The complete text is available on CD-ROM / Sigmund, Braun

Uvod

U Republici Hrvatskoj zgrade koje spadaju u okvire kulturne baštine zastupljene su sa čak 35% ukupno postojećih građevina. Skoro svaka od ovih zgrada zahtjeva redovno održavanje, a često i veće radove u svrhu poboljšanja uvjeta života u njima. Nerijetki su slučajevi da korisne građevine zubom vremena propadaju zbog zakonskih restrikcija ili čak samo zbog ne poznavanja procedure provođenja i planiranja građevinskih radnji na takvim zgradama.
Provođenje radova na zgradama kulturne baštine u bilo kojem pogledu ograničeni su zakonski definiranim okvirima, koji se najčešće prepoznaju kao prepreke. No nije uvijek tako. U okvirima zakona koji obuhvaćaju graditeljske radnje na ovakvim građevinama implementirane su i smjernice koje postupak prilagodbe i održavanja postojećih zgrada graditeljskog nasljeđa olakšavaju i potpomažu njihovu provedbu.
U okviru ovog članka, čitatelja se upoznaje sa zakonskim okvirima planiranja i provođenja radova na zgradama kulturnog nasljeđa.

2. Pojam graditeljske baštine

Kao uvod u problematiku koju predstavlja provođenje graditeljskih radova na građevinama kulturne baštine, iliti objektima graditeljskog nasljeđa potrebno je prije svega uvidjeti što to kulturna baština, odnosno graditeljsko nasljeđe predstavlja. Tako se prema *Zakonu o zaštiti i očuvanju kulturnih dobara* graditeljska baština može definirati kako slijedi:
Graditeljsku baštinu s utvrđenim svojstvom kulturnog dobra čine pojedinačne građevine, kompleksi građevina i kulturno-povijesne cjeline koje mogu biti cjelovito ili dijelom sačuvane. Pojedinačne građevine ili kompleksi građevina imaju izrazit povijesni, umjetnički, znanstveni ili tehnički značaj. Kulturno-povijesne cjeline, koje čine skupine gradskih ili seoskih građevina međusobno dovoljno povezanih da nose prostorno prepoznatljiva obilježja, imaju izrazitu povijesnu, arheološku, umjetničku, znanstvenu, društvenu i tehničku važnost ("Zakon o zaštiti i očuvanju kulturnih dobara," 2012).
Prikaz podjele kulturne baštine može se vidjeti na shemi ispod (Slika 1).



Slika 1: Prikaz podjele kulturne baštine

Za sve oblike djelovanje na zgradama koje su deklarirane kao kulturno dobro, ili su pak preventivno zaštićene ograničenja i potrebni postupci ophođenja definirani su u okvirima sljedećih propisa:

a) *Zakona o prostornom uređenju i gradnji* ("Zakon o prostornom uređenju i gradnji," 2012)
b) *Pravilnik o jednostavnim građevinama i radovima* ("Pravilnik o jednostavnim građevinama i radovima," 2013)
c) *Zakon o zaštiti i očuvanju kulturnih dobara* ("Zakon o zaštiti i očuvanju kulturnih dobara," 2012)

Važno je imati na umu da su kulturna dobra pod posebnom zaštitom Republike Hrvatske, što je i specifično definirano u sklopu *Zakona o zaštiti i očuvanju kulturnih dobara*, a tako je i svako poduzimanje mjera bez posebnog odobrenja nadležne ustanove, kao i narušavanje integriteta kulturnog dobra, kažnjivo, kako će biti razjašnjeno dalje u tekstu.

3. Definiranje pojmova u okvirima *Zakona o prostornom uređenju i gradnji*

Svako kulturno dobro unutar Republike Hrvatske uživa posebnu zaštitu, pa tako svaka radnja na kulturnom dobru, dakle i zgradama graditeljskog nasljeđa, zahtjeva posebne postupke planiranja i provođenja radova. Jasno je da rušenje, uklanjanje, ili zamjena postojeće zgrade nije dozvoljeno, ako je ista zaštićena kao kulturno dobro, pa je potrebno definirati radnje koje jesu prihvatljive u okvirima *Zakona o prostornom uređenju i gradnji* i *Zakona o zaštiti i očuvanju kulturne baštine*.
U okvirima *Zakona o prostornom uređenju i gradnji* definirani su pojmovi rekonstrukcija građevine i održavanje građevine, koji kao oblik poduzimanja građevinskih mjera na zaštićenim objektima ulaze u okvire radova koji su prihvatljivi. Tako prema *Zakonu* vrijedi:

a) rekonstrukcija građevine - je izvedba građevinskih i drugih radova kojima se utječe na ispunjavanje bitnih zahtjeva za postojeću građevinu i/ili kojima se mijenja usklađenost postojeće građevine s lokacijskim uvjetima u skladu s kojima je izgrađena (dograđivanje, nadograđivanje, uklanjanje vanjskog dijela građevine, izvođenje radova radi promjene namjene građevine ili tehnološkog procesa i sl.). ("Zakon o prostornom uređenju i gradnji," 2012)

b) održavanje građevine - je izvedba građevinskih i drugih radova radi očuvanja bitnih zahtjeva za građevinu tijekom njezinog trajanja, kojima se ne mijenja usklađenost građevine s lokacijskim uvjetima u skladu s kojima je izgrađena. ("Zakon o prostornom uređenju i gradnji," 2012)

Za primijetiti je da se u obije definicije pojavljuju pojmovi **bitni uvjeti za građevinu** i **lokacijski uvjeti**, pa je s toga bitno razjasniti što točno definiraju ovi pojmovi.

Prema ovom *Zakonu* bitni zahtjevi za svaku građevinu su zahtjevi koje svaka građevina ovisno o svojoj namjeni tijekom svog trajanja mora ispunjavati. Tako su bitni zahtjevi u okvirima *Zakona ("Zakon o prostornom uređenju i gradnji," 2012)*:

a) mehanička otpornost i stabilnost tako da predvidiva djelovanja tijekom građenja i uporabe ne prouzroče:
    - rušenje građevine ili njezina dijela
    - deformacije nedopuštena stupnja
    - oštećenja građevnog sklopa ili opreme zbog deformacije nosive konstrukcije
    - nerazmjerno velika oštećenja u odnosu na uzrok zbog kojih su nastala
b) zaštita od požara tako da se u slučaju požara:
    - očuva nosivost konstrukcije tijekom određenog vremena utvrđena posebnim propisom
    - spriječi širenje vatre i dima unutar građevine
    - spriječi širenje vatre na susjedne građevine
    - omogući da osobe mogu neozlijeđene napustiti građevinu, odnosno da se omogući njihovo spašavanje
    - omogući zaštita spašavatelja
c) higijena, zdravlje i zaštita okoliša tako da ih posebice ne ugrožava:
    - oslobađanje opasnih plinova, para i drugih štetnih tvari (onečišćenje zraka i sl.)
    - opasno zračenje
    - onečišćenje voda i tla
    - neodgovarajuće odvođenje otpadnih i oborinskih voda, dima, plinova te tekućeg otpada
    - nepropisno postupanje s krutim otpadom
    - sakupljanje vlage u dijelovima građevine ili na površinama unutar građevine
d) sigurnost u korištenju tako da se tijekom uporabe izbjegnu moguće ozljede korisnika građevine koje mogu nastati uslijed poskliznuća, pada, sudara, opeklina, električnog udara i eksplozije
e) zaštita od buke tako da zvuk što ga zamjećuju osobe koje borave u građevini ili u njezinoj blizini bude na razini koja ne ugrožava zdravlje i osigurava noćni mir i zadovoljavajuće uvjete za odmor i rad
f) ušteda energije i toplinska zaštita tako da u odnosu na mjesne klimatske prilike, potrošnja energije prilikom korištenja uređaja za grijanje, hlađenje i provjetravanje bude jednaka propisanoj razini ili niža od nje, a da za osobe koje borave u građevini budu osigurani zadovoljavajući toplinski uvjeti

Lokacijski uvjeti definirane prema ovom *Zakonu* su kvantitativni i kvalitativni uvjeti i mjere za provedbu zahvata u prostoru utvrđeni lokacijskom dozvolom ili rješenjem o uvjetima građenja na temelju dokumenta prostornog uređenja i *Zakona o prostornom uređenju i gradnji*.

4. Planiranje radova

Postupak provedbe na postojećim zgradama je specifičan, te se od planiranja izvedbe novih zgrada razlikuje u toliko što se svi planirani poslovi obavljaju u okvirima već postojećeg prostora. S tim u svrsi prikuplja se sva postojeća dokumentacija, ali i izvode nove arhitektonske podloge kao priprema za sva daljnja planiranja, pa je takva priprema izvršena i na Francuskom paviljonu, kako će biti prikazano dalje u tekstu.

4.1. Primjer provedbe

Kako bi se zorno mogli opisati postupci planiranja i provođenja radova na zgradama kulturne baštine u ovom članku koristiti će se primjer Francuskog paviljona nekadašnjeg sajmišta u Zagrebu. Danas je Francuski paviljon u okvirima Studentskog Centra Sveučilišta u Zagrebu. Francuski paviljon sadašnjeg Studentskog Centra prvi puta je otvoren u travnju 1937. godine, a izveden je prema projektima francuskih arhitekata i građevinskih inženjera.
Ova građevina predstavlja jedinstvenu inženjersku inovaciju na kojoj je po prvi puta primijenjena tankostjena vitoperna konstrukcija za nosivu konstrukciju u visokogradnji, pa se time ova zgrada ističe kao građevina od iznimne kulturno-povijesne i tehničko-tehnološke vrijednosti. Rješenjem Regionalnog zavoda za zaštitu spomenika kulture u Zagrebu, Francuski paviljon je 1987.g. stavljen pod preventivnu zaštitu, a rješenjem Uprave za zaštitu kulturne baštine Ministarstva kulture Republike Hrvatske u 2003.g je i upisan u Registar nepokretnih kulturnih dobara, Listu zaštićenih kulturnih dobara.
Kako je bilo vidljivo, a i kako je kasnije dokazano u „Rezultatima konzervatorsko-restauratorskih istraživanja“ zgrada Francuskog paviljona je konstruktivno bila u izrazito lošem stanju. Zbog godina lošeg održavanja i propusta u konstrukciji od samog početka Francuski paviljon je kontinuirano propadao, da bi se krajem 90'ih godina prošlog stoljeća i zatvorio i iz sigurnosnih razloga bio zabranjen za uporabu.

4.2. Uvjeti kada je potrebna samo građevinska dozvola

Za planiranje radova, bitno je upoznati se sa postupcima zahtijevanim od strane dvaju zakona koji utječu na provedbu radova i ishođenje dozvola za radove, pa su tako u okvirima *Pravilnika o jednostavnim građevinama i radovima* definirane olakotne okolnosti za koje vrijedi:

- Provođenju manjih građevinskih radova kojima se ne utječe na usklađenost građevine sa lokacijskim uvjetima, niti se utječe na ispunjavanje bitnih zahtjeva na građevini, može se pristupiti bez akta kojim se odobrava građenje i lokacijske dozvole, te bez glavnog projekta. U ovu skupinu radova spada ju i radovi koji se provode u svrhu usklađivanja građevine osobama s teškoćama u kretanju, ali pod uvjetom da se pri tome ne utječe na ispunjavanje bitnih zahtjeva za građevinu i /ili zadovoljavanje lokacijskih uvjeta ("Pravilnik o jednostavnim građevinama i radovima," 2013).
- Planiraju li se provoditi građevinski radovi, a koji prema definiciji spadaju u rekonstrukciju građevine, ali kod koje se ne mijenjaju se lokacijski uvjeti u skladu s kojima je ista izgrađena, tada se od nadležnog tijela županije, a u nadležnosti Ministarstva graditeljstva, ne treba tražiti lokacijska dozvola, već se zahtjeva akt u skladu s kojim se odobrava građenje ("Pravilnik o jednostavnim građevinama i radovima," 2013).
- Za sve ostale radove potrebno je ishođenje i lokacijske, a kasnije i građevinske dozvole.

Primjer Francuskog paviljona je reprezentativan primjerak radova na zgradama kulturnog nasljeđa kako zbog samog značaja objekta, tako i zbog opsega potrebitih zahvata. Zbog izrazito lošeg stanja skoro svih njegovih konstruktivnih elemenata bilo potrebno izvršiti

rekonstrukciju građevine u smislu restauratorsko-konzervatorskog pojmovnika, a u okvirima *Zakona o prostornom uređenju i gradnji* provodilo se održavanje konstrukcije s obzirom na to da lokacijski uvjeti nisu bili mijenjani.
Ovim opsegom radova i obzirom na to da se u krajnjim crtama očekivalo utjecanje na bitne zahtjeve na građevini, prema *Pravilniku o jednostavnim građevinama i radovima* ishođenje lokacijske dozvole nije bilo moguće zaobići.
S obzirom na kulturnu vrijednost Francuskog paviljona prije predavanja zahtjeva za izdavanjem posebnih uvjeta bilo je za očekivati da će biti potrebno ishoditi „Rezultate konzervatorsko-restauratorskih istraživanja", pa je tako i učinjeno. Značaj ovih istraživanja prikazati će se dalje u tekstu.

4.3. *Posebni uvjeti*

U posebnim uvjetima definiraju se međe i razmjeri zaštite na kulturnom dobru. Ovisno o tomu ishodi li se za radove lokacijska dozvola ili samo građevinska dozvola, tako je prema *Zakonu o prostornom uređenju i gradnji* prije predavanja zahtjeva za izdavanjem bilo kojeg od ta dva dokumenta, zadaća investitora je tražiti posebne uvjete. Posebni uvjeti ishode se od nadležnih organa, ovisno o tipu radova koji se provode na zgradi.
U slučaju da investitor do trenutka predavanja zahtjeva za izdavanjem posebnih uvjeta u prilogu nije predao i „Rezultate konzervatorsko-restauratorskih istraživanja", a isti ne postoje već prethodno napravljeni, što je slučaj isključivo samo za visoko važna kulturno dobra, tada konzervatorsko restauratorski ured u okvirima posebnih uvjeta izdaje nalog za izradom istih. Tada se ujedno i definira koji tip konzervatorsko-restauratorskih istraživanja je potrebno provesti.

4.4. *Rezultati konzervatorsko-restauratorskih istraživanja*

Rezultati konzervatorsko-restauratorskih istraživanja su elaborat u kojem su skupljeni svi traženi podaci o trenutnom stanju, korištenim materijalima i tehnologijama izgradnje ispitivane zgrade. Ova istraživanja ujedno, često, predstavljaju i podlogu za donošenje posebnih uvjeta konzervatorsko-restauratorskog zavoda Ministarstva kulture. Rezultati konzervatorsko-restauratorskih istraživanja smatraju se zaduženjem investitora, pa je on za provedbu istih i terećen.
Za primjer Francuskog paviljona Rezultati konzervatorsko-restauratorskog istraživanja prikazali su postojeće stanje materijala i konstruktivnih elemenata na zgradi. Provedena ispitivanja su obuhvatila ispitivanje korištenih materijala čelične, betonske, kao i drvene konstrukcije. Istraživanja su pokazala inicijalne debljine i formacije čelične konstrukcije, te napredovanje korozije, trenutno stanje čeličnih elemenata, kao i karakteristike korištenog materijala. Isto je provedeno i za drvenu i betonsku konstrukciju na Francuskom paviljonu.

4.5. *Konzervatorski elaborat*

Prije početka graditeljskog planiranja provedbe radova na pojedinačno zaštićenim zgradama kulturne baštine izvodi se i Konzervatorski elaborat. Ovaj elaborat na jednom mjestu sumira sva dosadašnja saznanja, kao i potencijalno planiranje iskoristivosti postojećeg prostora.
U slučaju Francuskog paviljona, Konzervatorski elaborat je izrađen i sastoji se od pregleda povijesnog značaja zgrade, njene izvedbe, kao i saznanja o prethodnom korištenju prostora. Nadalje on sadrži saznanja iz „Rezultata konzervatorsko-restauratorskih istraživanja", te smjernice za provedbu restauracije, kao i prijedloge o tomu koji elementi postojeće zgrade moraju biti zadržani, a koje će biti potrebno zamijeniti. Konzervatorski elaborat sadrži i smjernice za provedbu graditeljskih zahvata i na kraju arhitektonski snimak postojećeg stanja.

4.6. *Ishođenje građevinske dozvole*

Prije izdavanja građevinske dozvole investitor je dužan od nadležnog tijela tražiti rješenje o uvjetima građenja. Ovaj dokument je oblik potvrde kojom se potvrđuje de je da je izvedeni objekt, odnosno planirani pothvat na objektu, u skladu sad prostornim planom, da su projekt, građevna čestica, kao i mjesto i način priključenja na prometnu, komunalnu infrastrukturu i drugu infrastrukturu izrađeni ili planirani u skladu s odredbama *Zakona*, no za projekte rekonstrukcije najvažniji uvjeti su je zahtjevu za izdavanje rješenja priloženi:

- idejni projekt sa prikazom situacije na posebnoj geodetskoj podlozi, odnosno na kopiji katastarskog plana ako je zahtjev za izdavanje rješenja o uvjetima građenja predan za rekonstrukciju postojeće zgrade kojom se ne mijenjaju njezini vanjski tlocrtni gabariti
- posebni uvjeti tijela državne uprave nadležnog za poslove kulturnih dobara za građevinu koja se nalazi u naselju ili dijelu naselja, koje je upisano u Registar kulturnih dobara Republike Hrvatske kao kulturno-povijesna cjelina ili je građevina upisana u taj Registar kao kulturno dobro

4.7. *Prethodno odobrenje za radove na kulturnom dobru*

Radnje koje bi mogle prouzročiti promjene na kulturnom dobru, odnosno koje bi mogle narušiti cjelovitost kulturnoga dobra, mogu se poduzimati uz prethodno odobrenje nadležnog tijela. A kao navedene radnje smatraju se osobito: konzerviranje, restauriranje, premještanje kulturnoga dobra i drugi slični radovi, kao i rekonstrukcija, sanacija i adaptacija kulturnoga dobra u smislu zakona("Zakon o zaštiti i očuvanju kulturnih dobara," 2012). Također su sve radnje poduzete bez ovog odobrenja kažnjive.

5. Specifične okolnosti za provođenje radova na objektima kulturne baštine

U okvirima *Zakona o zaštiti i očuvanju kulturne baštine* definiraju se odgovornosti i obaveze vlasnika kulturne baštine, koje se u glavnom daju svesti u nekoliko crtica, a to je da je vlasnik, odnosno imatelj kulturnog dobra zadužen za održavanje i očuvanje kulturnog dobra. Ovaj dio zakona je u glavnim okvirima poznat skoro svim imateljima kulturnog dobra, no ovo objašnjenje niti približno ne objašnjava postupak na koji se očuvanje i održavanje kulturnog dobra može i treba provoditi.

5.1. *Održavanje i očuvanje kulturnog dobra*

U okvirima zakonodavstva ne postoje generalne smjernice koje bi dale naslutiti koji oblik radova se na pojedinom zaštićenom objektu smije provoditi. Smjernice za očuvanje i zaštitu kulturnog dobra mogu se dobiti na zahtjev investitora (vlasnika). Na osnovu tih smjernica vlasnik je dužan provoditi mjere propisane njima.

5.2. *Obavljanje poslova na zaštiti i očuvanju kulturnih dobara*

Prema *Zakonu o zaštiti i očuvanju kulturne baštine* poslove na zaštiti i očuvanju kulturnih dobara mogu obavljati samo specijalizirane pravne i fizičke osobe. Pri tomu su uvjeti koje mora ispunjavati fizička ili pravna osoba za dobivanje dopuštenja za obavljanje poslova propisani od strane Ministarstva kulture, na čijim se Internet stranicama može naći i popis ovlaštenih osoba. Uvjeti prema kojima se specijalizirane pravne i fizičke osobe moraju odnositi definirani su *Pravilnikom o uvjetima za fizičke i pravne osobe radi dobivanja dopuštenja za obavljanje poslova na zaštiti i* *očuvanju kulturnih dobara ("Pravilnik o uvjetima za fizičke i pravne osobe radi dobivanja dopuštenja za obavljanje poslova na zaštiti i očuvanju kulturnih dobara," 2010).*

5.3. Izuzeće od bitnih zahtjeva

U okvirima *Zakona o prostornom uređenju i gradnji* moguće je ishoditi odobrenje za odstupanja od bitnih zahtjeva za građevinu:

- Ako se rekonstruira pojedinačna građevina upisana u Registar kulturnih dobara Republike Hrvatske, može se odstupiti od bitnih zahtjeva za građevinu ako bi se njima narušila bitna spomenička svojstva, a prema pribavljenoj suglasnosti nadležnog Ministarstva ("Zakon o prostornom uređenju i gradnji," 2012)

Ova izuzeća odnose se na sve bitne zahtjeve. No, pri ovom zahtjevu potrebno je dokazati da bi djelovanje suprotno zahtijevanoga narušilo spomeničke vrijednosti, te da izvođenje izvan okvira bitnih zahtjeva za građevinu neće narušiti ostale bitne zahtjeve na građevini. Odobrenje za ne ispunjavanje bitnih zahtjeva za građevinu dobija se prijedlozima nadležnog tijela za pojedina pitanja.
Tako na primjer na projektu Francuskog paviljona nije bilo moguće ispoštovati uvjeta fizike zgrade na betonskom dijelu zgrade zbog čega je traženo izuzeće na Ministarstvu kulture zbog očuvanja karakteristika kulturnog dobra. Na dobiveni prijedlog Ministarstva kulture zadovoljavaju se potrebe za izdavanje rješenja o uvjetima gradnje. Nadalje, na primjer u uvjetima kada nije moguće ispuniti zahtjeve o sigurnosti na radu potrebno tražiti izuzeće od bitnih zahtjeva za građevinu pri Ministarstvu zdravlja. Tako je zbog širine stepeništa za pristup sanitarnim čvorovima unutar Francuskog paviljona bilo nemoguće ispoštovati zahtjev za omogućavanje pristupa sanitarnom čvoru osobama smanjene tjelesne pokretljivosti, te je s toga bilo potrebno dokazati kako se ovaj zahtjev može ispuniti korištenjem drugih sanitarnih čvorova u okvirima Studentskog centra.

5.4. Troškovi održavanja i olakšice

Prema *Zakonu o zaštiti i očuvanju kulturnih dobara*, vlasnik je dužan brinuti o očuvanju kulturnog dobra, no ovim zakonom je također propisano kako u slučaju da održavanje kulturnoga dobra ili radovi na njegovu popravku, konzerviranju ili provedbi mjera tehničke zaštite zahtijevaju izvanredne troškove koji premašuju redovite troškove održavanja i prihode ili druge koristi koje vlasnik ima od kulturnoga dobra, vlasnik ima pravo podnijeti zahtjev za naknadu izvanrednih troškova.
Ove olakšice smatraju se državnim udjelom u očuvanju kulturnog dobra, a financiranje se vrši iz budžeta ustanove pod čijom se zaštitom nalazi pojedina zgrada. Tako to može biti općina, grad, županija, ili sama država. Održavanje budžeta za održavanje kulturnih dobara provodi se kroz skupljanje spomeničke rente.

5.5. Zaštita kulturnih dobara u izvanrednim okolnostima

U okvirima zakona izvanrednim okolnostima se smatraju oružani sukob, potres, poplave, požari, ekološki incidenti i katastrofe. Pripremu kulturnog dobra radi zaštite i čuvanja za slučaj izvanrednih okolnosti dužni su obavljati ustanove koje obavljaju poslove zaštite i očuvanja kulturnih dobara i vlasnici kulturnih dobara. Ministar kulture može radi zaštite kulturnih dobara narediti poduzimanje posebnih mjera zaštite, pri čemu župan, gradonačelnik ili općinski načelnik na čijem se području nalazi kulturno dobro osigurava sredstva potrebna za provedbu mjera.

5.6. Prekršajne odredbe

Kako je već prethodno spomenuto, sva kulturna dobra su od posebnog značaja za Republiku Hrvatsku, pa sukladno tomu i uživaju posebnu zaštitu. Tako su u okvirima *Zakona o zaštiti i očuvanju kulturnih dobara* definirane prekršajne odredbe. Tako je određena novčana kazna do 500.000,00kn u slučaju da se kulturnom dobru nanese šteta, provode radovi bez prethodnog odobrenja nadležnog tijela, ili se pak ne postupa sukladno odredbama *Zakona*.

6. Spomenička renta

Sukladno *Zakonu o zaštiti i očuvanju kulturnih dobara* jedinice lokalne samouprave donose odluku o visini spomeničke rente. Obveznici spomeničke rente su fizičke osobe i pravne osobe koje obavljaju gospodarsku djelatnost u građevinama kojima je rješenjem utvrđeno svojstvo nepokretnog kulturnog dobra (ili su preventivno zaštićeni), odnosno na području kulturno povijesne cjeline kojoj je rješenjem utvrđeno svojstvo kulturnog dobra (ili je preventivno zaštićena).

Iz sredstava spomeničke rente u pravilu se sufinanciraju projekti obnove pročelja i krovova nepokretnih kulturnih dobara. Jedinice lokalne samouprave posebnim pravilnicima utvrđuju kriterije dodjele sredstava – prednost imaju građevine smještene u samoj povijesnoj jezgri, pojedinačno zaštićene kao kulturna dobra, u lošijem građevinskom stanju i pretežno privatnom vlasništvu.

Vlasnicima nepokretnih kulturnih dobara pružena je mogućnost da troškove održavanja sufinanciraju iz sredstava spomeničke rente. Jedinice lokalne samouprave raspisuju natječaje za sufinanciranje projekata iz sredstava spomeničke rente kojima pozivaju vlasnike (ili korisnike) nepokretnih kulturnih dobara da se jave s pripremljenim projektima obnove izrađenim od strane projektanta koji ima dopuštenje Ministarstva kulture za obavljanje poslova na zaštiti i očuvanju kulturnih dobara.

7. Zaključak

Provođenje građevinskih radova na postojećim zgradama je zahtjevan postupak sam po sebi, no projekt obnove, ojačanja, održavanja ili rekonstrukcije zgrada koji su označeni kao kulturno dobro predstavlja zahtjevan postupak. Ovakvi projekti obilježeni su iscrpnom pripremom i planiranjem, a osnovni zahtjevi definirani su u okvirima zakona Republike Hrvatske.

U ovom članku prikazane su osnovne smjernice za provedbu pripreme projekata građevinskih zahvata na zgradama kulturne baštine. Prikazani su i prava i mogućnosti provedbe građevinskih pothvata u okvirima održavanja i zaštite zgrada kulturne baštine koja omogućuju financijsku pomoć u provedbi ovakvih projekata. Smjernice su potkrijepljene zahtjevima definiranim kroz Zakon o prostornom uređenju i gradnji, Zakon o zaštiti i očuvanju kulturnih dobara i Pravilnik o jednostavnim građevinama i radovima.

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UPORABA „TRENCHLESS“ METODA ZA IZGRADNJU MAGISTRALNOG VODOOPSKRBNOG CJEVOVODA STRMEC – MALA MLAKA*

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Sažetak

Danas postoje razne „trenchless“ metode postavljanja cjevovoda, no iako postoje, u Hrvatskoj se rijetko upotrebljavaju, prvenstveno zato što su nepoznanica većini građevinara.
Graditeljski odjel Tehničkog veleučilišta u Zagrebu pokušava svojim studentima pružiti adekvatna znanja iz područja primjene „trenchless“ metoda u postavljanju i sanaciji cjevovoda. Navedena znanja studenti usvajaju kroz gradivo predmeta Moderne tehnologije građenja na Politehničkom specijalističkom diplomskom stručnom studiju graditeljstva.
Ovaj rad će pokazati „trenchless“ tehnologiju polaganja cjevovoda prilikom izgradnje Magistralnog vodoopskrbnog cjevovoda Strmec – Mala Mlaka ispod Autoceste A2 – Zagreb – Macelj, te ispod dvije manje prometnice. Rad će također prikazati prednosti i mane primijenjenih metoda, koje su se pokazale na terenu tijekom procesa izgradnje.
Intencija autora je postavljanje temelja za dalje istraživanje i veću primjenu „trenchless“ metoda u građevinskoj praksi, te pružanje adekvatnih znanja o njima.

Ključne riječi: trenchless, cjevovod, zemljani radovi, bušenje, potiskivanje cijevi, zabijanje cijevi

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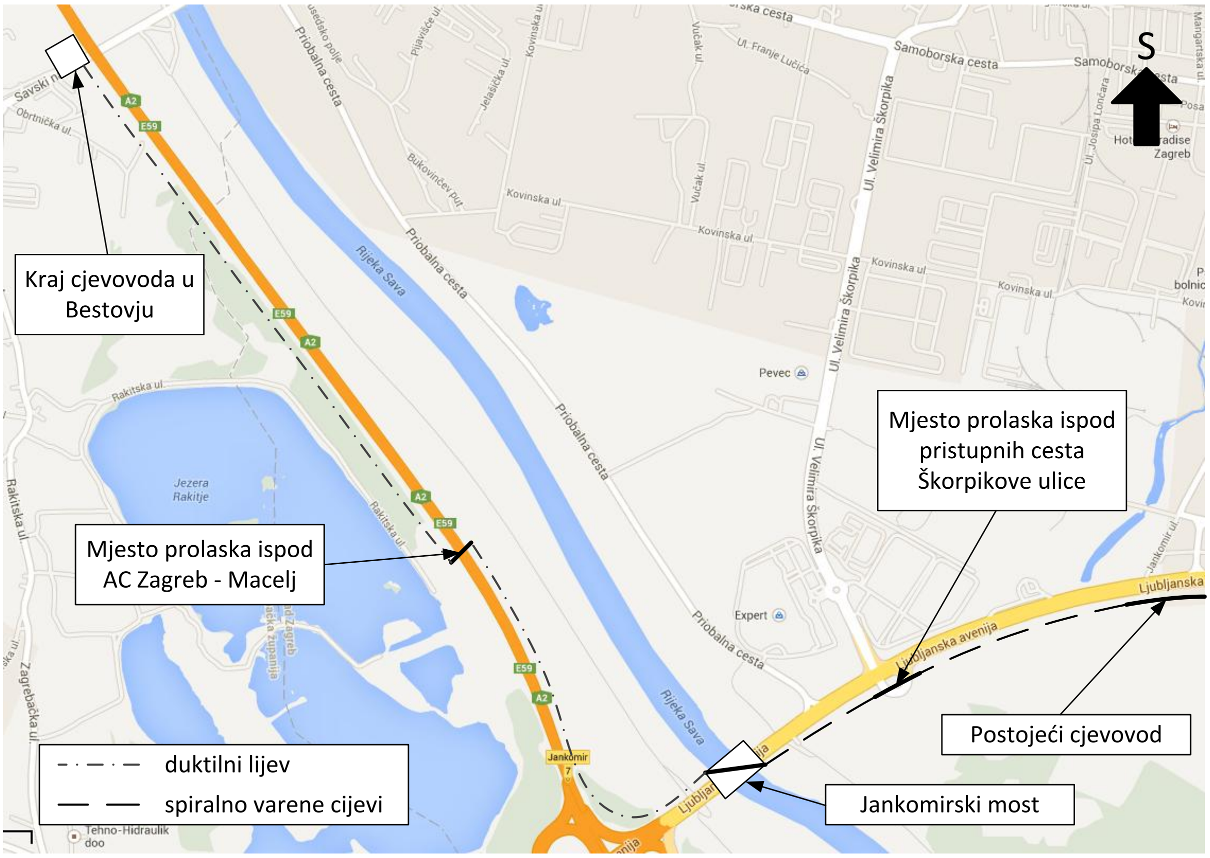
* The complete text is available on CD-ROM / Uremović, Dunović, Bajić

Uvod

Iako trenchless metode polaganja cjevovoda u svijetu postoje već više od 50 godina, njihov pojačan razvoj je počeo tek zadnjih 25 godina. U Hrvatskoj se navedene tehnologije koriste, ali još uvijek nedovoljno, a razloga za to je više. Jedan od razloga je što su hrvatski građevinari općenito, uz izuzetak onih koji su usko specijalizirani za navedene radove, slabo upoznati s raznim trenchless tehnologijama i njihovim mogućnostima primjene. Također, jedan od razloga je što se kod usporedbe trenchless i klasičnih metoda često uspoređuju samo troškovi građenja dok se zanemaruju nevidljivi, ili teško vidljivi, troškovi koji nastaju upotrebom klasičnih metoda (npr. usporavanje ili preusmjeravanje prometa, dobivanje potrebnih dozvola).
U ovom radu bit će prikazan slučaj polaganja dijela magistralnog vodovoda Strmec – Mala Mlaka, te trenchless tehnologija koje su bile korištene za polaganje navedenog vodovoda ispod AC Zagreb – Macelj i prilaznih cesta Škorpikove ulice u Zagrebu.

1.1. Magistralni vodovod Strmec – Mala Mlaka

Magistralni vodovod Strmec – Mala Mlaka služi za povezivanje naselja Strmec, Strmec Samoborski, Bestovje i Orešje s vodocrpilištem Mala Mlaka. Radi se o cjevovodu izrađenom od čeličnih cijevi, koji je građen u više faza.



Slika 1. Zadnja/promatrana faza izgradnje Magistralnog vodovoda Strmec – Mala Mlaka

Promatrani objekti se nalaze u zadnjoj fazi, koja povezuje dosad izgrađeni dio cjevovoda od njegovog kraja u naselju Savska Opatovina do postojeće infrastrukture i zasunske komore u Ulici Dr. Franje Tuđmana u naselju Bestovje. Ta se zadnja, promatrana faza cjevovoda sastoji

od dva dijela. Prvi dio, duljine oko 1250m, ima trasu koja prati trasu Ljubljanske avenije s njene južne strane od naselja Savska Opatovina do Jankomirskog mosta preko rijeke Save. Drugi dio, duljine oko 3200m, u konstrukciji Jankomirskog mosta prelazi na suprotnu stranu Ljubljanske avenije, te prati njenu trasu sa sjeverne strane do čvora Jankomir, gdje potom skreće prema sjeveru, te nastavlja pratiti AC Zagreb – Macelj s njene istočne strane između AC i zaštitnog nasipa rijeke Save. Na približno 2000m od kraja u Ulici Dr. Franje Tuđmana, cjevovod prelazi s istočne strane AC na zapadnu stranu, te tom stranom ide do kraja (Slika 1.).
Prvi dio cjevovoda od Savske Opatovine do Jankomirskog mosta je izrađen od segmenata spiralno varenih čeličnih cijevi promjera 700mm. Drugi dio cjevovoda, od Jankomirskog mosta do kraja u naselju Bestovje, izrađen je od čeličnih cijevi duktilnog lijeva, i promjera 711,2mm.
Na prvom dijelu trase cjevovod mora proći ispod pristupnih cesta Škorpikove ulice, a na drugom dijelu trase cjevovod prolazi ispod AC Zagreb – Macelj. Na oba mjesta, projektom izvođenja, predviđena je upotreba trenchless metode polaganja cjevovoda vodoravnim bušenjem uz istovremeno potiskivanje cijevi (Auger Drilling). Cijevi koje se polažu prilikom bušenja će služiti kao zaštitne cijevi za konačni cjevovod, te će iz tog razloga biti većeg promjera. Veći promjer zaštitne cijevi bi također trebao pomoći ukoliko dođe do manjih odstupanja osi bušenja od projektirane osi cjevovoda. Prema projektu izvođenja, zaštitna cijev ispod AC Zagreb – Macelj bi trebala biti poliesterska, vanjskog promjera 1026mm i unutarnjeg promjera 906mm, te debljine stjenke 60mm. Zaštitna cijev ispod pristupnih cesta Škorpikove ulice bi trebala biti promjera 914,4mm s debljinom stjenke od 10(9,5)mm.

2. Korištene trenchless tehnologije

2.1. Vodoravno bušenje uz istovremeno potiskivanje cijevi (auger drilling)

Jedna od najjednostavnijih trenchless metoda uopće, a najčešće se koristi za postavljanje čeličnih cijevi u pravcu, uz promjer cjevovoda i do 2000mm. Duljine ovakvih cijevi mogu biti i do 200m, ali se najčešće polažu cijevi duljine do 100m (ISTT, 2005; Najafi et al. 2005). Ova metoda bušenja i polaganja cijevi radi na način da stroj za bušenje i potiskivanje buši rupu i paralelno gura/potiskuje cijev (Slika 2.).
Strojevi i oprema koji se koriste za bušenje i postavljanje cjevovoda ovom metodom su:

- stroj za bušenje i potiskivanje
- porozna glava za bušenje, a čiji oblik i poroznost ovise o vrsti materijala kroz koji se buši
- svrdlo sa spiralnim tijelom za izbacivanje materijala, sastavljeno iz više segmenata, i koje se postepeno produljuje tijekom bušenja
- dizalica izvan ulazne jame, koja se koristi za postavljanje stroja i opreme, postavljanje segmenata cijevi, te izbacivanje iskopanog materijala pomoću posebne posude

Proces takvog bušenja počinje izradom ulazne i izlazne jame s dnom na potrebnoj dubini. Nakon izrade jama, u ulaznoj jami se izrađuje AB podloga i AB uporište na zadnjoj strani ulazne jame. Na podlogu se postavljaju tračnice, a koje će služiti za usmjeravanje stroja za bušenje i svrdla. Kako metoda ne omogućava dodatno usmjeravanje svrdla tijekom bušenja, važno je da se podloga i tračnice u ulaznoj jami postave dobro i po visini i po smjeru. Na tračnice se potom postavlja stroj koji služi i za okretanje svrdla i za potiskivanje cijevi u rupu. Na stroj se potom priključuje svrdlo s glavom, te se postavlja prvi segment cijevi. Tijekom bušenja, svrdlo s glavom rotira i uklanja materijal ispred cijevi, a materijal potom kroz poroznu glavu i dalje kroz cijev putuje prema stroju, te na posebnom otvoru na spoju cijevi i stroja izlazi van iz cijevi. Materijal se zatim prebacuje u posudu koja se dizalicom podiže iz jame i prenosi materijal na deponiju ili u vozilo.

Kako svrdlo i cijev postepeno ulaze u izbušenu rupu, tako se dodaju novi segmenti svrdla i cijevi. Prilikom dodavanja svakog novog segmenta stroj se pomiče prema natrag, kako bi se segmenti mogli spojiti sa segmentima koji su već ušli u rupu. Novi segmenti cijevi se vare na već postojeće, dok se za spajanje novog segmenta svrdla koristi tvornički mehanizam za spajanje.

Slika 2. Vodoravno bušenje uz istovremeno potiskivanje cijevi (Auger Drilling) – shematski prikaz – preuzeto s www.istt.com

S obzirom na opisani postupak, ova metoda je najprikladnija za bušenje u materijalima koji su stabilni, poput gline ili ilovače, te nekim šljunčanim materijalima, ali uvijek iznad razine podzemne vode. Također je bitno da se u materijalu ne nalaze veći komadi čvrste stijene, koji bi mogli skrenuti cijev i svrdlo sa zadane putanje (ISTT, 2005; Najafi et al. 2005).

Prednosti ove metode su jednostavna tehnologija, te razmjerno mali troškovi rada, a glavni nedostaci su ti što je metoda prikladna samo za određene vrste terena, te što ne smije biti prisutna podzemna voda (ISTT, 2005; Najafi et al. 2005).

2.2. Zabijanje cijevi (Pipe Ramming)

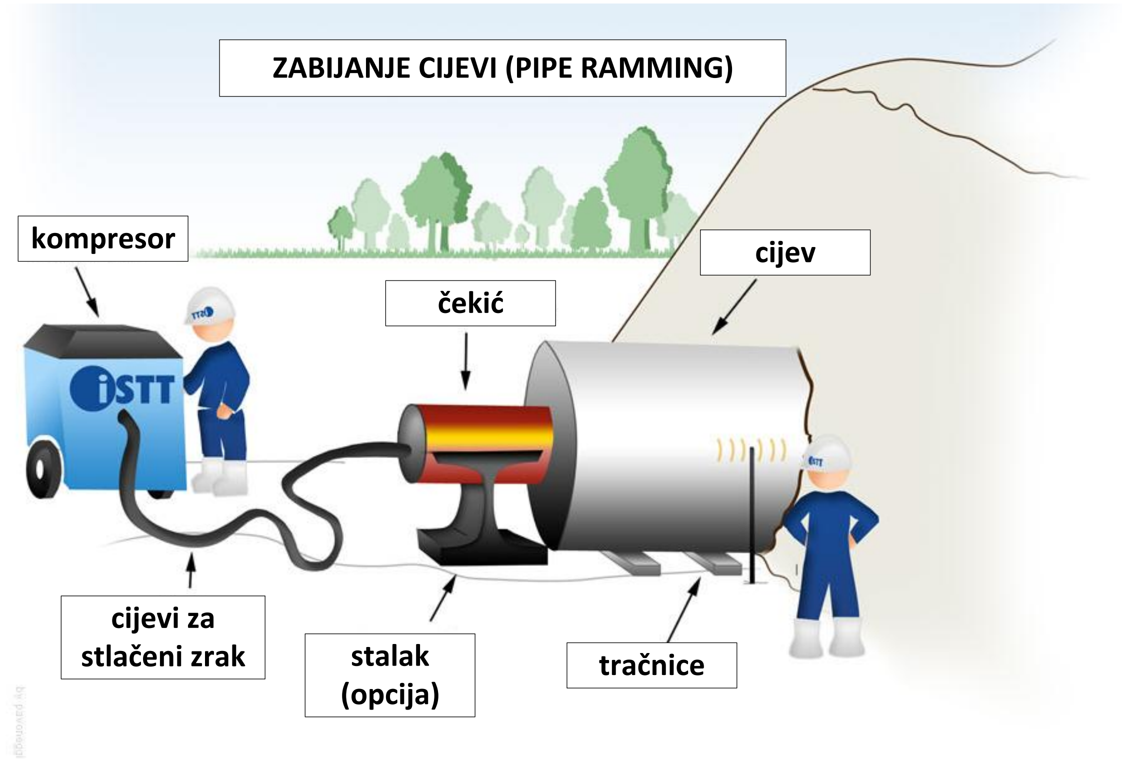
Trenchless metoda zabijanja cijevi je metoda kojom se postavljaju čelične cijevi raznih promjera i duljina. Promjeri cijevi koje se polažu mogu varirati od 200mm, pa čak i do 4000mm, ali se najčešće metoda koristi za polaganje cijevi promjera do 2000mm. Duljine cijevi koje se polažu mogu biti i preko 200m, ali se metoda najčešće koristi za cijevi duljine do 100m. Promjer i duljina cijevi koji se mogu polagati ovom metodom ovise prvenstveno o vrsti tla kroz koje se polaže cijev (Simicevic et al., 2001; Najafi et al. 2005). Ova metoda polaganja cijevi radi na način da se cijev zabija u teren pomoću „čekića“ pokretanog stlačenim zrakom (čekić) (Slika 3.).

Strojevi i oprema koji se koriste za postavljanje cjevovoda ovom metodom su:

- čekić pokretan stlačenim zrakom
- kompresor za pokretanje čekića, te sustav cijevi

- tračnice za usmjeravanje cijevi
- dizalica izvan ulazne jame, koja se koristi za postavljanje stroja i opreme, postavljanje segmenata cijevi, te izbacivanje iskopanog materijala pomoću posebne posude

Za uspješno izvođenje ove metode potrebno je izraditi ulaznu i izlaznu jamu na potrebnoj dubini. U ulaznoj jami je potrebno izraditi betonsku podlogu na pravoj visini i s pravim nagibom, jer ova metoda ne omogućava korekcije putanje cijevi nakon početka potiskivanja. Na betonsku podlogu se potom postavljaju tračnice za usmjeravanje cijevi. Na tračnice se postavlja prvi segment cijevi kojem se prema potrebi na prednjem obodu postavlja rezni prsten za lakše prodiranje cijevi u materijal. Na drugi kraj cijevi se postavlja konusni prsten, koji služi za bolje nalijeganje cijevi i čekića, a na prsten se potom pričvršćuje čekić, sustav cijevi i kompresor. Ovisno o veličini ulazne jame i duljini polaganja cijevi, moguće je spojiti više segmenata cijevi i potiskivati ih istovremeno. Na taj način izbjegava se potreba za čestim odvajanjem čekića i cijevi, te se ubrzava postupak zabijanja.



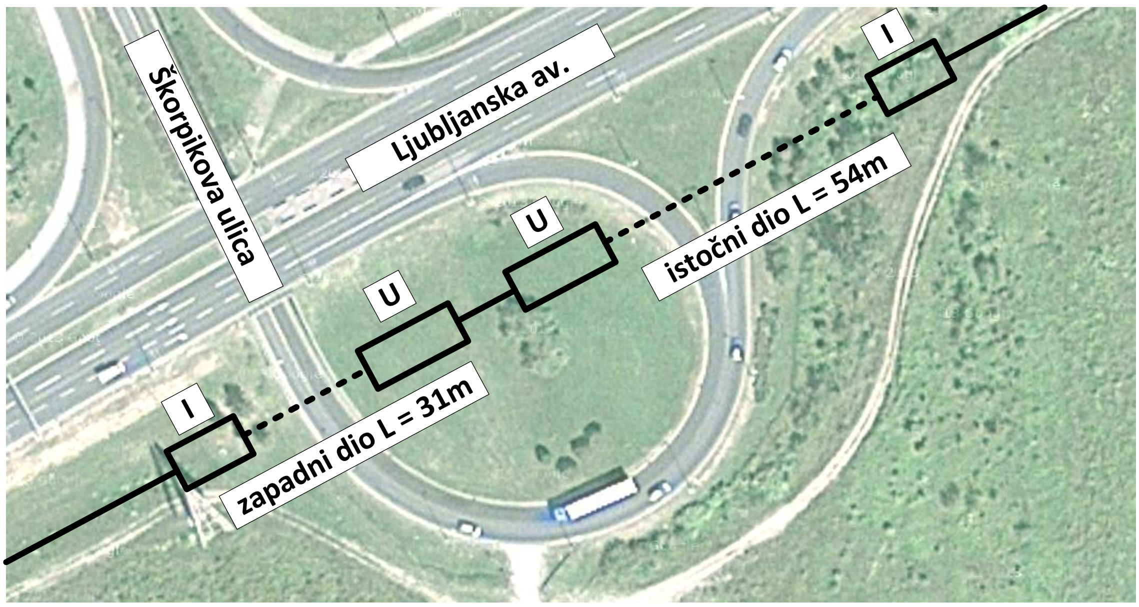
Slika 3. Zabijanje cijevi (Pipe Ramming) – shematski prikaz – preuzeto s www.istt.com

Tijekom polaganja cijevi, cijev je najčešće otvorena s prednje strane, te na taj način materijal ulazi u nju tijekom zabijanja. Na taj način se smanjuje mogućnost urušavanja površine terena iznad cijevi, pa je na taj način metoda prigodna za upotrebu iznad prometnica ili drugih objekata. Cijev je zatvorena samo kod malih promjera cijevi. Materijal unutar cijevi otežava zabijanje cijevi zbog trenja između materijala i cijevi, pa se zbog olakšavanja procesa zabijanja kod cijevi velikog promjera materijal tijekom zabijanja postepeno vadi iz cijevi. Materijal se iz cijevi manjeg promjera najčešće izbacuje ispiranjem ili propuhivanjem, a u slučaju cijevi većeg promjera koriste se svrdla i strojevi za bušenje. Prilikom izbacivanja suvišnog materijala, izbacuje se samo dio materijala, a „čep“ materijala na ulazu u cijev se ostavlja, kako ne bi došlo do urušavanja tla na ulazu u cijev.
Prema opisanom postupku, ova metoda je prikladna za skoro sve vrste materijala i tla, a zapravo je neprikladna za rad u stijeni. Također, gotovo je nevažan položaj cijevi u odnosu na razinu podzemne vode (Simicevic et al., 2001; Najafi et al. 2005).

3. Trenchless metode – Magistralni vodoopskrbni cjevovod Strmec – Mala mlaka

3.1. *Pristupne ceste Škorpikove ulice*

Po vremenskom planu izgradnje, prvo se pristupilo polaganju cjevovoda ispod pristupnih cesta Škorpikove ulice. Polaganje cijevi se radilo iz dva dijela, istočnog i zapadnog. Predviđene duljine bušenja su bile 31m za zapadni dio i 54m za istočni dio (Slika 4.). Projektom je bilo predviđeno da ulazne jame za polaganje cjevovoda budu jame izvan prometnice, te da se prvo pristupi polaganju cijevi u istočnom dijelu. Polaganje cijevi u oba dijela je trebalo biti kroz trup prometnice, tj. materijal je trebao biti jednoliki nasipani materijal C kategorije, bez pojavljivanja podzemne vode. Predviđena duljina trajanja cijelog procesa je trebala biti oko dvadeset radnih dana za istočni dio, od čega je deset radnih dana trebala trajati priprema i izgradnja ulaznih i izlaznih jama, pet radnih dana je trebalo trajati bušenje i polaganje cijevi, a još pet dana je bilo predviđeno za demontažu opreme i zatrpavanje jama. Za zapadni dio proces je trebao trajati između deset i petnaest radnih dana, s tim da bi se dio radova vezan uz izradu ulazne i izlazne jame radio paralelno s radovima na istočnom dijelu. Cijeli proces je započeo početkom srpnja 2012. postavljanjem čeličnog žmurja tipa ARBED AU16 za zaštitu iskopa ulaznih i izlaznih jama za istočni dio, a očekivani kraj radova je bio do sredine kolovoza 2012.



Slika 4. Konačni raspored jama i bušenja ispod pristupnih cesta Škorpikove ulice – shematski prikaz – podloga preuzeta s maps.google.com

Prilikom izrade ulaznih i izlaznih jama za istočni dio naišlo se i na prve probleme, jer se ispostavilo da na mjestu ulazne jame postoje položene telekomunikacijske instalacije, koje nisu bile ucrtane u geodetskim situacijama u projektnoj dokumentaciji. Sretna okolnost je bila da su navedene instalacije bile položene svega 0,5m ispod površine, te su bile otkrivene prilikom skidanja površinskog sloja humusa (Slika 5.).

Slika 5. Telekomunikacijske instalacije na mjestu ulazne/izlazne jame s istočne strane

Slika 6. Deformirano žmurje (lijevo) i ojačano žmurje dodatnim redom (desno)

Neovisno o pronađenim instalacijama, odlučeno je da će položaj jame ostati isti, ali da će se promijeniti smjer polaganja cijevi, tj. da će ulazna jama postati izlazna, a izlazna jama postati ulazna, kako ne bi bilo potrebno izvršiti izmještaj pronađenih telekomunikacijskih instalacija. Navedena promjena utjecala je na veličinu jama, jer je ulazna jama zbog potrebe strojeva i opreme veća od izlazne jame, a i u ulaznoj jami je potrebno izraditi podlogu i uporište za opremu. Kako je izlazna jama već bila napravljena, a bilo ju je potrebno prenamijeniti u ulaznu jamu, moralo se položiti dodatno žmurje i produljiti jamu za dodatna 3m.

Slika 7. Stroj za bušenje i potiskivanje postavljen na tračnice (slika lijevo) – AB upornjak na zadnjoj strani ulazne jame (slika desno)

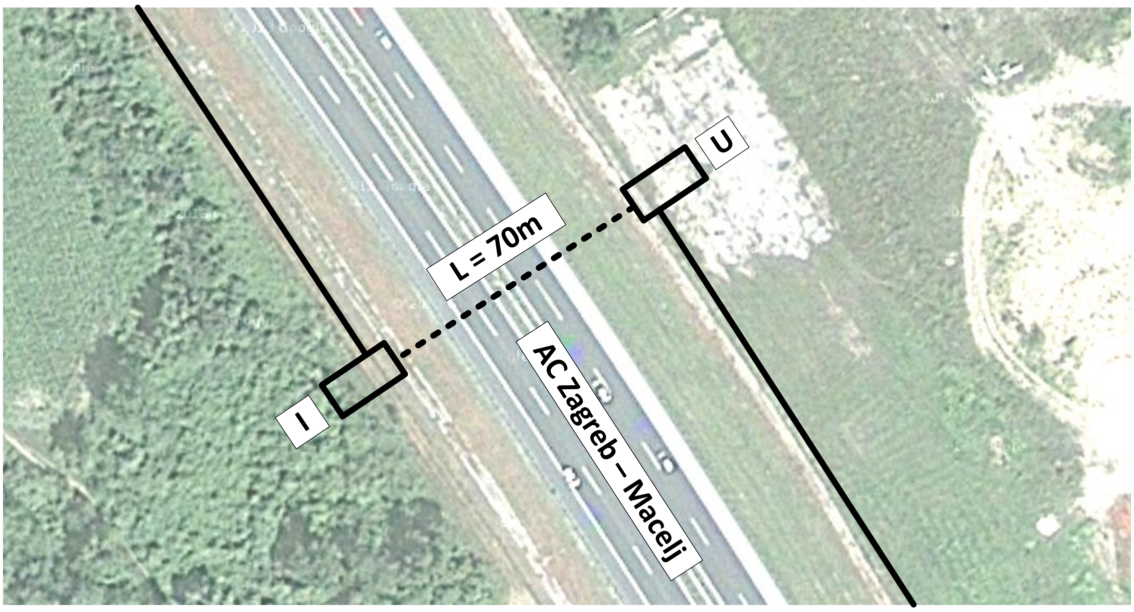
Slijedeći korak je bio izraditi rupu u žmurju kako bi kroz nju mogla proći cijev i svrdlo. Kako bi se bez opasnosti po stabilnost žmurja mogla izraditi navedena rupa, bilo je potrebno dodatno ojačati konstrukciju žmurja. Propustom izvođača, potrebna ojačanja nisu bila izvedena prije bušenja rupe, te je došlo do deformiranja žmurja na ulaznoj strani rupe (Slika 6. – lijevo). Kako bi se sanirale nastale deformacije, unutar rupe je dodan još jedan red žmurja, koji je prije bušenja nove rupe ojačan dodatnom konstrukcijom (Slika 6. – desno). Nakon izvedbe ojačanja, pristupilo se izradi betonske podloge i uporišta (Slika 7. – desno), a nakon toga se krenulo sa postavljanjem tračnica za stroj za bušenje i potiskivanje. Geodetskim mjerenjem, određen je točan položaj tračnica, kako bi se dobila zadovoljavajuća trasa budućeg cjevovoda. Na tračnice je postavljen stroj za bušenje i potiskivanje (Slika 7. – lijevo), American Augers 36/42-600 (Slika 8.), pokretan Diesel motorom snage 86,5kW, i maksimalnim raspoloživim okretnim momentom od 145,5kNm. Na stroj je potom pričvršćen prvi segment svrdla, i pričvršćena je glava za bušenje, te je ubačen prvi segment cijevi.
Svi navedeni problemi su do početka bušenja doveli do kašnjenja od skoro mjesec dana, pa je polaganje cijevi počelo polovinom kolovoza 2012. Prilikom bušenja i polaganja cijevi, nailazilo se na razne probleme, koji su prouzročili dodatno kašnjenje i odmak izvedene osi cjevovoda od projektirane osi. Predviđeno trajanje bušenja i polaganja cijevi bilo je pet radnih dana, i to prvenstveno zbog potrebe da se polaganje cijevi vrši u segmentima, uz varenje svih spojeva. S obzirom na duljinu segmenata od 5m, bilo je potrebno izraditi 10 spojeva varenjem, pa je ukupno trajanje varenja svih deset spojeva trebalo trajati približno dva radna dana, tj. dva sata po jednom spoju.

Slika 8. Stroj za bušenje i potiskivanje – American Augers 36/42-600

Prvi problem s kojim su se izvođači susreli bila je pojava velike količine nepredviđenog otpadnog materijala na trasi bušenja. Osim otpadnog materijala, naišlo se i na veću količinu komada kamenja većeg promjera (30cm do 50cm). Otpadni materijal i pronađeno kamenje su dovodili do otežanog okretanja svrdla, te često do potpunog zaustavljanja bušenja. Osim toga, na približno 15-om metru bušenja izvođač je naišao na prevelik komad kamena, koji nije mogao proći kroz cijev, te je prouzročio okomiti otklon osi od približno 80cm na izlaznoj jami.
Osim navedenih problema, na početku bušenja je dolazilo i do pretjeranog urušavanja materijala na početku cijevi, koje je izvođač uspio ublažiti smanjivanjem otvora za prolaz materijala na glavi za bušenje.
Također, zbog problema s otpadnim materijalom i kamenjem na trasi cjevovoda, došlo je i do nekoliko kvarova strojeva i opreme, koji su dodatno produljili trajanje cijelog procesa.
U konačnici, umjesto planiranih pet radnih dana, za bušenje i polaganje cijevi za istočni dio je utrošeno preko trideset radnih dana, te je tako cijeli proces bušenja cijevi ispod istočnog dijela pristupne prometnice Škorpikove ulice završio krajem rujna.
Na zapadnom dijelu bušenja problema je bilo znatno manje, materijal je bio sukladan onome predviđenom u projektu, a izvođač je poučen negativnim iskustvima s prethodno napravljenog istočnog dijela prilagodio opremu i postupak, te je cijeli proces bušenja i postavljanja cijevi bio završen u planiranom roku od pet radnih dana.
Cijeli proces postavljanja cijevi ispod pristupnih prometnica Škorpikove ulice počeo je početkom srpnja 2012., a završio sredinom listopada 2012., što je bilo približno dva mjeseca kasnije od predviđenog roka. Zbog problema s vertikalnim otklonom osi u odnosu na projektiranu os, bilo je potrebno izraditi dodatne dvije komore, kako bi se omogućio spoj postavljenih cijevi ispod pristupnih prometnica Škorpikove ulice s ostatkom cjevovoda.

3.2. AC Zagreb – Macelj

Nakon završenih radova na polaganju cjevovoda ispod pristupnih prometnica Škorpikove ulice, pristupilo se pripremi radova za polaganje cjevovoda ispod AC Zagreb – Macelj (Slika 9.), a uz sva saznanja i probleme s prethodnog bušenja, svi sudionici su pristupili preispitivanju primjenjivosti projektirane metode bušenja.
U odnosu na prethodno napravljeno bušenje, na ovom bušenju postojali su dodatni otežavajući uvjeti kao što su, puno veća važnost prometnice i njezino opterećenje, veća duljina bušenja, veći promjer cijevi koja se polaže, puno manji nadsloj materijala iznad cijevi, te povremeno pojavljivanje podzemne vode. Zbog svih ovih razloga odlučeno je da se promijeni metoda postavljanja cjevovoda, tj. da se upotrijebi metoda zabijanja cijevi (Pipe Ramming) (Slika 10.).



Slika 9. Konačni raspored jama i bušenja ispod AC Zagreb - Macelj – shematski prikaz – podloga preuzeta s maps.google.com

Slika 10. Čekić pričvršćen na čeličnu cijev za zabijanje

Zabijanje je trebalo biti napravljeno istovremeno ispod oba traka AC s ukupnom duljinom zabijanja od 70m, materijal je trebao biti C kategorije, a s obzirom na blizinu rijeke Save i doba godine (studeni, prosinac), očekivalo se i pojavljivanje podzemne vode. Zaštitna cijev koja se zabijala, trebala je biti poliesterska, vanjskog promjera 1026mm i unutarnjeg promjera 906mm, te

debljine stjenke 60mm. Zbog veličine spojnih elemenata cijevi cjevovoda, koja je morala proći kroz zaštitnu cijev, zaštitna cijev je promijenjena u čeličnu cijev promjera 1222mm s debljinom stjenke 12,5mm. Zbog promjene metode polaganja cjevovoda, proces polaganja cjevovoda je počeo početkom prosinca 2012., s predviđenim trajanjem od deset radnih dana za pripremu ulazne i izlazne jame, te deset radnih dana za postavljanje cjevovoda. Kako su na mjestu ulazne i izlazne jame bile projektirane zasunske komore, jame nije bilo potrebno zatrpavati. Radovi su počeli postavljanjem čeličnog žmurja tipa ARBED AU16 za zaštitu iskopa ulaznih i izlaznih jama, a očekivani kraj radova je bio do sredine siječnja 2013.
Ulazna jama je bila predviđena s istočne (Savske) strane, te je zbog veličine opreme i stroja za zabijanje, morala biti produljena u odnosu na dimenzije buduće zasunske komore.
Zbog veličine ulazne jame, nije bilo moguće izraditi cijelu cijev i zabijati je odjednom, nego je cijev morala biti zabijana u segmentima od po 5m. To je usporavalo polaganje, jer je prilikom svakog dodavanja novog segmenta bilo potrebno odvojiti čekić od cijevi, dodati novi segment, zavariti ga na postojeću cijev, te potom spojiti čekić i nastaviti zabijanje. Također kod dodavanja svakog drugog segmenta, materijal iz cijevi se izbacivao klasičnim strojem za bušenje, kako bi se smanjilo trenje cijevi i materijala unutar nje.
Tijekom cijelog procesa nije se pojavio niti jedan problem, te je polaganje navedenog komada cijevi završeno u planiranom roku od deset radnih dana. Iako je proces zabijanja cijevi trajao deset radnih dana, stvarno trajanje zabijanja je bilo svega dva radna dana. Ostatak vremena je utrošen na spajanje segmenata cijevi, spajanje i odvajanje čekića i pražnjenje cijevi. Također, navedeni dio radova je bio dodatno usporen zbog loših vremenskih prilika (hladnoća, kiša, snijeg).
U konačnici, svih 70m cijevi je bilo postavljeno u zadanom roku od deset radnih dana, te tijekom postavljanja cijevi nije došlo do značajnijih odstupanja osi postavljene cijevi u odnosu na projektiranu os.

4. Zaključak

Trenchless metode općenito predstavljaju dobru alternativu klasičnim metodama polaganja cijevi s kopanjem rova. Pogotovo se to odnosi na slučajeve gdje bi primjena klasičnih metoda s kopanjem rova donijela prevelike probleme i troškove u „odvijanju života na površini“.
Tijekom izgradnje Magistralnog vodoopskrbnog cjevovoda Strmec – Mala Mlaka pojavilo se nekoliko problema vezanih uz korištenje trenchless tehnologija, a svi su se pojavili kod postavljanja cjevovoda ispod istočnog dijela pristupne prometnice Škorpikove ulice.
Kako bi se navedeni problemi u potpunosti izbjegli kod sličnih projekata u budućnosti ili kako bi se barem smanjila vjerojatnost njihovog pojavljivanja, važno je prije svih radova trenchless metodama napraviti bolje istražne radove, te na osnovu njih odabrati pravu trenchless metodu, a prilikom izgradnje poštovati sve prednosti, pravila i uvjete koje nam određena metoda daje. Na opisanom primjeru možemo zaključiti da bi umjesto trenchless metode vodoravnog bušenja uz istovremeno potiskivanje cijevi (auger drilling), prikladnija bila metoda zabijanja cijevi (Pipe Ramming). Zamjenom metoda, otpadni materijal i veći komadi kamenja ne bi smetali za postavljanje cjevovoda, a također ne bi došlo do značajnih pomaka osi cijevi. U tom slučaju, ne bi bilo potrebe za dodatnim radovima i troškovima, a došlo bi i do manjih vremenskih kašnjenja. Proučavanjem više primjera poput navedenog, moguće je stvoriti bazu slučajeva, koja može poslužiti za bolji odabir pogodnih trenchless metoda, te za njihovu lakšu primjenu u građevinskoj praksi.

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ROUNDTABLE WORKSHOPS (IN CROATIAN)

RADIONICE OKRUGLOG STOLA

OKRUGLI STOL 1.
LICENCIRANJE IZVOĐAČA: CILJEVI I MOGUĆNOSTI

Voditelji: **L. Fučić, J. Izetbegović**

Problematika prosudbe sposobnosti izvođača građevinskih i drugih radova prisutna je u graditeljstvu već duže vrijeme. U Republici Hrvatskoj je prva realizacija rješavanja tog pitanja ostvarena Pravilnikom o uvjetima i mjerilima za davanje suglasnosti za započinjanje obavljanja djelatnosti građenja iz 2006. godine, a drugo rješenje je dao Zakon o arhitektonskim i inženjerskim poslovima i djelatnostima u prostornom uređenju i gradnji iz 2008. godine. Trenutačna izrada novih zakona koji uređuju područje graditeljstva, te članstvo Republike Hrvatske u Europskoj uniji, upućuju na potrebu preispitivanja dosadašnjih dosega i ostvarenja sustava izdavanja suglasnosti izvođačima za obavljanje djelatnosti građenja - licenciranja.

Na okruglom stolu „Licenciranje izvođača: ciljevi i mogućnosti“ utvrdili bi se i raspravili mogući ciljevi prosudbe sposobnosti izvođača, razmotrila svrsishodnost zakonskog uređivanja ove aktivnosti te ocijenili do sada primijenjeni sustavi u Republici Hrvatskoj. Isto tako, sukladno saznanjima sudionika okruglog stola, razmijenile bi se informacije o sustavima prosudbe sposobnosti izvođača koji se primjenjuju u drugim zemljama a isto tako, promotrile bi se i preporuke i/ili ograničenja koje donosi zakonodavni okvir Europske unije. Na kraju, razmotrile bi se mogućnosti koje su primjenjive u Republici Hrvatskoj kako bi se putem zapisa o raspravi na ovom okruglom stolu mogle dati preporuke za budući pravni okvir kojim bi se uredilo licenciranje izvođača.

Orgaizatori ovog okruglog stola pozivaju zainteresirane sudionike da iznesu svoja viđenja i saznanja o ovoj temi, kako bi se promišljenom raspravom, uz iznošenje argumenata pridonjelo čim boljem rješavanju ovog, za graditeljstvo značajnog pitanja.

OKRUGLI STOL 2.
NORMATIVI RADOVA U GRAĐEVINARSTVU

Voditelji: **I. Završki, I. Burcar Dunović**

Normativi radova jedan su od važnih i neophodnih alata u mnogim aktivnostima u procesu građenja. Njihova je uloga u planiranju resursa kod izvođenja građevinskih radova, kalkulaciji troškova i cijena, obračunu izvedenih radova te postupcima vještačenja i arbitražama. Ne smijemo zaboraviti niti edukativni karakter normativa u procesu obrazovanja studenata te učenika u strukovnim građevinskim školama.

U Republici Hrvatskoj tijekom decenija su bili korišteni normativi čija je metodologija bila razvijana izvan njenih granica. Krajem osamdesetih godina prošlog stoljeća ostvaruje se projekt Standardne kalkulacije radova u visokogradnji u izdanju IGH s pratećim biltenom aktualnih cijena. Nešto kasnije, realiziraju se daljnji pokušaji u sistematizaciji normativa i njihovoj aktualizaciji poput izdanja prof. Bučara. Svaki od navedenih projekata međutim, bez obzira na nivo inicijalne kvalitete, bi u cilju potpune primjenjivosti u praksi, trebao biti stalno, sustavno i objektivno ažuriran.

Cilj ovog okruglog stola je potaknuti sudionike da izraze svoje mišljenje u pogledu potreba, mogućnosti i raspoloživih koncepcija za uspostavu kvalitetnog i trajnog sustava izrade i aktualizacije normativa i radova u građevinarstvu Republike Hrvatske. Takva diskusija te njeni zaključci bila bi osnova za poduzimanje koraka ka realizaciji svrsishodnog i kvalitetnog pristupa problemu izrade građevinskih normativa.

SPONSORED PRESENTATIONS (IN CROATIAN)
PREZENTACIJE SPONZORA

PERI OPLATE I SKELE

Anita Dedić, struč.spec.ing.grad.
Voditelj Tehničkog ureda
Marin Protrka
Stručni savjetnik za oplate i skele
Drago Maleta, ing.građ.
Stručni savjetnik za oplate i skele

Sažetak

PERI proizvodi primjenjuju se u cijelom svijetu kao jedan od prepoznatljivih sustava skela i oplata. Prikazuje se proizvodni program tj paket usluga koji obuhvaća oplate i skele za gradnju, Inženjering i savjetovanje, logistiku i održavanje te podršku i edukaciju. Prikazuju se referentni projekti u Hrvatskoj u periodu od 2005-2013 godine s posebnim osvrtom na Most Drava uz primjenu PERI sistemskih rješenja.

PRIMJENA NOVIH (VEĆ USVOJENIH) SUSTAVA ZA ZAŠTITU OD ŠTETNOG DJELOVANJA VODA

Dejan Mračkovski, dipl.ing.građ.
„Werkos“

Sažetak

U trenutku kad prijeti izlijevanje vode iz korita rijeka, najvažnija je brzina kojom se može zaštititi branjeno područje. Sustavi za zaštitu od štetnog djelovanja voda, koje je Werkos razvio samostalno, ali uz konzultaciju sa stručnjacima Hrvatskih voda, nude upravo ono što je bitno u situaciji kad se poplava dogodi: brzu reakciju, optimizaciju troškova i smanjenje materijalne štete.
Analiziraju se problemi postojećih nasipa: slijeganje, erozija pokosa i odroni, oštećenje krune nasipa, pristupi lokaciji, procjeđivanje kroz nasip i prelijevanje preko nasipa.
Daju rješenja izgradnju novih nasipa koji rješavaju sve navedene probleme te poboljšanja za probleme pristupa lokaciji, procjeđivanje kroz nasip i prelijevanje preko nasipa.