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POSSIBILITIES AND LIMITATIONS OF CONSTRUCTABILITY CONCEPT IN CONSTRUCTION INDUSTRY IN CROATIA

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Preliminary notes

The constructability concept development was triggered by the attempts to integrate the contractor knowledge and experience at the design stage. The very selection of the appropriate procurement model during the contract stage represents one of the concept implementation models. This paper deals with the stage and project participant integration, those being the essential constructability concept implementation elements. For this purpose a research including five Croatian building construction projects was conducted. The construction projects were analysed and described by applying the "multiple case study" scientific method. This paper presents the processing algorithm and results for the two selected cases, the first of which with the traditional procurement model and the second with the alternative management oriented procurement model, as well as the results of the case study conducted on all five projects. The results lead to specific conclusions and recommendations for applying the models at the markets of less developed countries. The changes in construction project traditional procurement model domination cannot be made radically due to cultural and financial reasons. They require a change of awareness and investment of significant resources. Due to the stated reasons an improved traditional procurement model introduction is proposed. The measurement introduction must be adapted to every single project. In order to improve the construction project procurement procedures, one must make an influence on the wider community where the project takes place and influence the changes primarily within the legislative and the institutional frames.

Keywords: *comparative analysis, constructability, multiple case study, procurement models*

Mogućnosti i ograničenja implementacije koncepta izgradivosti u građevinskoj industriji u Hrvatskoj

Prethodno priopćenje

Razvoj koncepta izgradivosti (constructability) bio je ponukan pokušajem integracije izvođačkog znanja i iskustva već u fazi projektiranja građevine. Upravo odabir odgovarajućeg modela nabave u fazi ugovaranja predstavlja jedan od načina implementacije ovog koncepta. Cilj članka je ukazati na prednosti integracije faza i sudionika u projektu, kao bitnih elemenata implementacije koncepta izgradivosti. U tu svrhu provedeno je istraživanje koje je uključivalo pet građevinskih projekata visokogradnje realiziranih u Hrvatskoj. Projekti su istraženi i opisani primjenom znanstvene metode studija više slučajeva (multiple case study). U ovom članku prezentiran je algoritam obrade i prikaz rezultata za dva odabrana slučaja, prvi, s primijenjenim tradicionalnim modelom nabave, te drugi, s alternativnim upravljačkim modelom nabave, kao i rezultati provedene studije slučaja na svih pet projekata. Rezultati upućuju na određene zaključke i preporuke za primjenu alternativnih modela na hrvatskom građevinskom tržištu. Promjene u dominaciji tradicionalnog modela nabave građevinskih projekata ne mogu se izvesti radikalno. Zahtijevaju promjenu stanja svijesti i ulaganje značajnih resursa. Zbog navedenih razloga predlaže se uvođenje poboljšanog tradicionalnog modela nabave. Primjenu mjera treba prilagoditi svakom pojedinačnom projektu. No, u cilju unaprjeđenja postupaka nabave građevinskih projekata treba utjecati i na širu okolinu u kojoj se projekt odvija, djelujući na promjene prvenstveno unutar zakonskog i institucionalnog okvira.

Ključne riječi: *izgradivost, komparativna analiza, modeli nabave, studija više slučaja*

1 Introduction

At time of the ever-growing general complexity of construction projects today's time is an essential factor. However, due to the economical crisis, the price also plays an important role. The client's growing requirements regarding the complexity, the aesthetic component and the shortness of the construction period are to a great extent determined by the complexity increase which is also characteristic for the construction field and the possibilities offered by new technological solutions and new material development. Primarily the contractors and the clients and then the designers try to find new solutions regarding both the construction and the mutual relationships which would contribute to construction period reduction, cost reduction, quality increase and achieving other significant project objectives. One of the solutions is the alternative procurement models based on the buildability/ constructability concept. The model essence is the integration of design and construction processes which are traditionally separated in construction engineering and later, their maintenance.

The buildability (constructability) concept is one of the attempts to regulate the relations among participants in a different way which would then lead to a general project objective achievement improvement. One of the commonest ways is an early inclusion of the contractor into the design stage. However, the very concept has a meaning that goes deeper than just trying to reduce the construction time or the costs. It is based on the systematic approach to the construction problem pursuing the interaction of all participants, trying to acquire positive effects of mutual exploration of their experience as well as achieving a positive synergy effect. Following this line of reasoning, different construction project procurement models have been created which, although offering considerable advantage, have not shown their full potential, especially in less developed countries, due to different reasons.

The paper presents state of the procurement models and constructability concept application both in the world and in Croatia.

Procurement model application is analysed on five different construction projects using multiple case study as the research method with the explanation of its selection. For two specific projects (the first is traditional procurement model and the second is management-oriented one) research results are presented in detail. The analysis enabled the recommendation of measures for the implementation of improved traditional procurement models for two cases: public and private building projects adapted to Croatian construction industry conditions.

2 Procurement model role in buildability/constructability concept implementation

Despite the guidelines [1] for buildability/ constructability concept implementation, it can be concluded from the present point of view that these guidelines can be of assistance, but the attitude, the knowledge, the willingness, the orientation, the way of thinking of the designer and the contractor and primarily of the client are crucial for accepting this concept. If there is no clear orientation, decision, the guidelines will not be sufficient.

It is quite a sensitive matter and a conflict of interests is quite an obvious issue which will prevent the concept implementation in certain situations despite numerous positive experiences and the opinion that its implementation is justified.

The concept has been developing under the term „constructability“, especially in the USA and Australia, hence the use of the term in this paper. The terms for project and company level implementation have been determined so that the concept is defined as "the optimum integration of construction knowledge and experience into all project activities, starting from feasibility and continuing throughout the life of the project, to achieve the desired project objectives" [1].

However, at least some of the theses can provoke opposition, primarily from the architects, because the theses basically limit what is usually called "the freedom of artistic creation", "the freedom of expression" and other. In other words, the theses limit the freedom of design to some extent and therefore influence the final outcome – the appearance, the impressiveness, the monumentality and other characteristics of the structure, those being for some architects the parameters of greater importance than those of construction and maintenance, functionality, durability and other.

Over the years, from the 1960s to the present, the ever-growing client requirements regarding the complexity, the aesthetics, the functionality, the shortness of deadline, the cost benefits and other have brought about the development of several procurement models. The very selection of the procurement model can significantly influence the constructability concept application.

The construction project procurement model division can be performed in different ways, that is, according to different criteria [2].

The most common and usually the most appropriate procurement model classification method is the one in which the interaction between the design and construction and sometimes the financing and the operation of the project is managed. According to this criterion the procurement models are divided into 4 basic groups and several subgroups which are the separated (traditional, conventional) procurement systems, the integrated procurement systems, the management-oriented procurement systems and the discretionary systems. Hence, the project P1 which is discussed in this paper is a traditional procurement model, while the P2 is a traditional one in its first part and partly in the second stage and the management-oriented one in the second and the third stage. Therefore, only the characteristics of those procurement models will be discussed in this paper.

Shortly, it can be said that the conventional procurement model is characterised by a complete separation of the design and the construction stage. The responsibility for the design documentation lies exclusively on the designer selected by the client. The design is mostly completed prior to the construction start. The payment is based on the fee basis. This procurement model is inappropriate for constructability concept implementation. Due to its serial nature it is also the slowest procurement model of all.

Several factors have contributed to the management oriented procurement model development. Those are the client requirements, especially those in commercial sector for a construction time reduction, a better cost control, a higher functionality and quality standard and the requirements regarding the more effective and systematic project management.

Within the group there is the professional construction management model in which the contractor is an equal design team member providing the construction expertise. The works are performed by the subcontractors who are hired, whose work is coordinated and supervised by the construction manager. The construction manager has a contract with the client and is usually paid according to the Cost+Fee model which means that he is paid a lump sum for his management services or a percentage fee for his management services and the actual prime cost of the construction. The role of construction manager is specific just for this type of procurement model and is not equal to the usual role of the project manager.

Within the group there is a subgroup in case when the client directly deals with the subcontractors which is then called the construction project management. The client also makes a contract with the construction manager who assumes the role of the consultant directly liable to the client for the whole construction management, including the collaboration with the designers. The construction manager is paid for his management services based on a lump sum or a percentage fee.

3 Procurement models in the Republic of Croatia

3.1 Problem defining and research objective

The practice mostly points to the construction project traditional procurement models. The stage separation, especially between the design stage and the construction stage, often results in problems in performance. It can quite realistically be expected that the inclusion of the contractor during the earlier project stages, especially during the design stage, could result in better design solutions and definitely decrease the number of problems occurring during the construction.

The research [5] has been conducted in order to determine the expected advantages of alternative procurement models, the buildability/constructability concept implementation tools and the possible limitations and risks in less developed posttransition countries such as Croatia. Therefore five more complex building construction projects were analysed which were

constructed in Croatia from 2002 to 2008. Particular projects lasted with interruptions for several years.

3.2 Research procedure – multiple-case study method

3.2.1 Reasons for selecting multiple-case study method

The convenience of alternative procurement model application as an important buildability/constructability concept implementation instrument is especially prominent in more complex projects. With regard to this aspect as well as to the established suitability of multiple-case study application as an appropriate research method, at least three more complex projects had to be analysed when elaborating this issue. As it was later established, the selected cases do not represent a model in the usual statistical sense, which when applying this method is not necessary at all, because the essence of this method is not a statistical generalization but conclusion-drawing based on both theoretical and analytical and synthetic deliberations and conclusions. The relative homogeneity of case groups is thus made less important. When selecting the projects for this analysis, private and public building construction structures were selected so that the improvement measures could be defined for both the public and the private client. The data of analysed projects are shown in table 2 [5].

The multiple-case study method was assessed as the most appropriate one for conducting this research due to the reasons explained under.

The method which was applied is the case study method. It was described by R. K. Yin [4] in his book Case Study Research, Design and Methods. According to Yin, "a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used".

Despite numerous reviews of this method inspired by its alleged lack of scientific qualities because of the reduced case pattern, Yin has managed to refute this way of thinking by pointing out that the value of this method should be considered in another perspective of the collected data. "This method is appropriate if a complete and detailed approach to the research is sought. It enables the themes to be analysed from more than one perspective. Besides collecting opinions from key examinees, the researcher is given the possibility of monitoring the participants interaction" [5]. A special significance of this method is that, unlike a strictly analytical approach, it enables the synthesis of the analytical and the integral holistic consideration about real events such as particular project life cycles.

The cases analysed by the case study method can be generalized only according to the theoretical propositions and not according to the basic group as in statistical generalization. "In this sense, the case study, like the experiment, does not represent a 'sample', and the investigator's goal is to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization) " [4]. The previously developed theory is applied as a paradigm by which the empirical results of the study are compared.

3.2.2 Multiple-case study algorithm implementation

The multiple-case study implementation procedure requires formulation of an algorithm which defines research stages [4]. With regard to specific characteristics of the analysed cases, some smaller algorithm modifications are possible.

This research defines the multiple-case study implementation by the structured algorithm in the following way:

1) Study design
a) theory development
b) case selection
c) data collection protocol design
2) Single-case data collection and analysis
a) data collection
b) data analysis
c) individual case report writing
3) Cross-case analysis
a) comparison and cross-case conclusions
b) theory modification
c) cross-case report and conclusions. [5]

Table 1 Examined project fields [5]

Ordinal number	Project stage	Project field
1	Inception stage	Project manager, objectives, project stages and procurement model.
2	Feasibility and scheme design stage	Selection of the design engineer, scope of design services, project team structure.
3	Structural design stage	Design difficulties, participation and influence of the contractor on the design, quality and level of detailed engineering design completion, design and construction overlap.
4	Contract stage	Selection of the contractor, procedure, criteria and tender documentation, payment model and contract model.
5	Construction stage	Construction manager, costs, duration, subcontractors, prime contractor liability, change management, design team role during construction stage, quality, relations and improvement of participant relationship, communication.
6	Commissioning stage and use of the structure	Specific characteristics of the project and additional comments of the participants.

3.2.3 Research presentation

The presented research has analysed the following five projects mostly from the building construction field:
1) P1 – indoor swimming pool
2) P2 – multi-storey office building
3) P3 – hotel complex
4) P4 – multi-family housing unit
5) P5 – housing and office building.

While conducting the case study method research a multiple data source application is recommended. This research has applied the following:

1) **Interview – main data source**
   During the research interviews with all key participants were conducted – the client, the chief designer, the main contractor and the construction supervisor. A semi-structured interview was conducted which is based on the list of defined subjects and questions. The questions are formed through a matrix of project stages/participants. The matrix contains structured questions according to the "six stages – six project fields" model (Tab. 1). Note: in every stage several design fields were questioned.
2) **Documents**
   Documents provided by the examinees were used as well as those available on internet pages.
3) **Direct observation**
   All the interviews were conducted by the chief researcher, the main author of the paper by contacting the examinees in person when visiting the described structures.

Pursuant to the defined algorithm, a protocol of data collection and presentation was defined for each analysed case according to project fields shown in Tab. 1. The protocol anticipates a very precise, clearly defined and structured data presentation which consists of a textual part, data tables and corresponding schemes. Due to the scope of the entire presentation, two indicative projects, P1 and P2 were singled out, the first of which was made for the public client with a traditional procurement model and the second which is a private management-oriented one.

The paper hereafter presents a brief review of the selected cases – P1 and P2, the indoor swimming pool Kantrida with its facilities and the project P multi-storey office building.

Tab. 2 presents a review of all projects encompassed by the research and their main characteristics. Hereafter two projects, P1 and P2, are presented.

Table 2 Analysed projects [5]

Ordinal number and project title	Investment value (in kuna*) [1]	Total project duration time [2]	Construction stage duration [3]	Client type [4]	Contractor selection procedure [5]	Payment model [6]
Project P1 Indoor swimming pool Kantrida	180 000 000	ca 6 yrs	24 months	public	Tender	unit prices and performed quantities
Project P2 – in the text project P Multi-storey office building	700 000 000	ca 5 yrs	ca 5 yrs	private	1st substage: direct agreement	1st substage: unknown
					2nd substage: direct agreement	2nd substage: "cost+fee" model
					3rd substage: direct agreement	3rd substage: unit prices and performed quantities
Project P3 Hotel complex	150 000 000	ca 4 yrs	12 months	private	direct agreement	unit prices and performed quantities
Project P4 Multi-family housing unit	48 000 000	ca 4 yrs	16 months	public	Tender	single price
Project P5 Housing and office building	80 000 000	ca 3 yrs	18 months	public	direct agreement	single price

* 100 kuna = 19,23 US $

P1 – Indoor swimming pool Kantrida with facilities

1) Project description

Indoor swimming pool Kantrida whose client is the City of Rijeka is an extremely complex project consisting of twenty-five single structures (swimming pool construction, beach area filling in one part, engine room construction for the existing swimming pool, reconstruction of two streets within the construction zone, construction of the required infrastructure, pavement and pedestrian surfaces and the square and other) the centre of which being the construction of an Olympic swimming pool with accompanying swimming pools and other facilities of about 12 000 m^2 total netto surface.

2) Case analysis

Project stages. The project was started in 2002 by creating the feasibility and scheme designs and was completed in 2008. The working design completion partially overlapped with the construction stage. In the beginning of the construction stage about 70 % of the working design was completed. The project life cycle and the stage review are presented in Fig. 1.

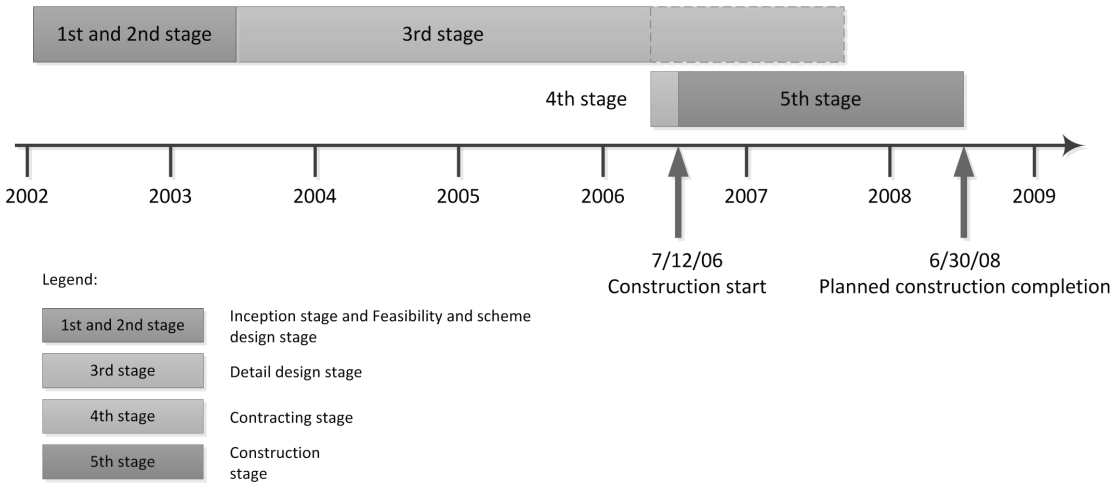

Figure 1 Life cycle and project stages of project P1 - Indoor swimming pool Kantrida [5]

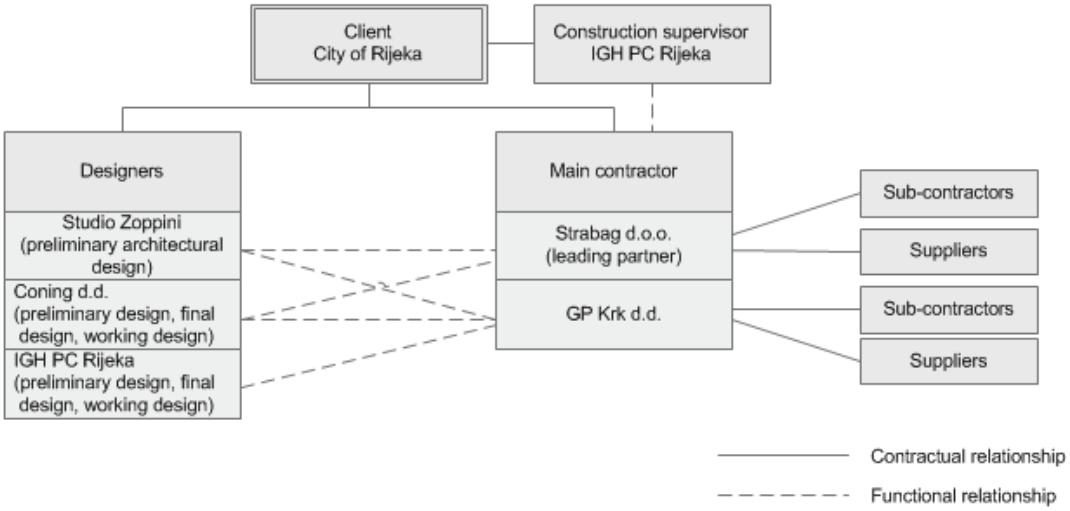

Figure 2 Management structure of project P1 - Indoor swimming pool Kantrida [5]

Procurement model and relations among participants. The traditional procurement model was used in the project. The organization structure is presented in Fig. 2.

Project manager. Project manager is a client's employee in charge of the financial, technical and administrative project management through all the stages.

Design team structure. Due to the multiple design companies participating in the preliminary and final design stage (Fig. 2) which result in a larger number of project supervisions, the participants consider the relations as more complex and requiring more time and effort because of the occasional responsibility overlap.

Contractor involvement during design stage. The contractor was not known during the preliminary and final design stage. During the working design stage which partially overlaps with the construction stage several contractors and suppliers draw detailed designs by themselves.

Designer involvement during construction stage. The designer is of opinion that all the details of such a complex project cannot be resolved until all subcontractors and their specific construction technologies are not known and selected. The client is of opinion that working designs must be fully completed prior to construction start. During the construction stage the client has given over the communication with the designer to the contractor. The contractor tried to speed up the process of working design completion although he does not have a contract relationship with the designer.

P2 – Multi-storey office building P – Rijeka

1) Project description

The project P in Rijeka involves the construction of a large multi-storey office and trade building in the south-east part of Rijeka whose total usable floor area is about 130 000 m^2 and the investment value about 700 million kuna (100 kuna = 19,23 US$). The complex consists of an office and trade building with garages and an office tower. During the construction the owner and the contractor were changed. The traffic solution comprises the construction of the road around the structure with an entry road to the city transportation facility.

2) Case analysis

Project stages. The life cycle of this project is characterized by many significant changes; from the change of the owner and the client, the name, the main contractor to the change of use of different parts. The construction started at the end of 2002. The project life cycle and stages are presented in Fig. 3. The project has not been completed yet.

Procurement model and relations among participants. Due to the numerous changes, the procurement model and relations among participants have been changing during different design stages. The

procurement model can be distinguished by the construction substages.

Three construction substages, each with the corresponding procurement model, can be differentiated:

1) substage – traditional procurement model
2) substage – traditional procurement model with professional construction management procurement model elements
3) substage – construction project management procurement model (direct contracting between the client and the subcontractors).

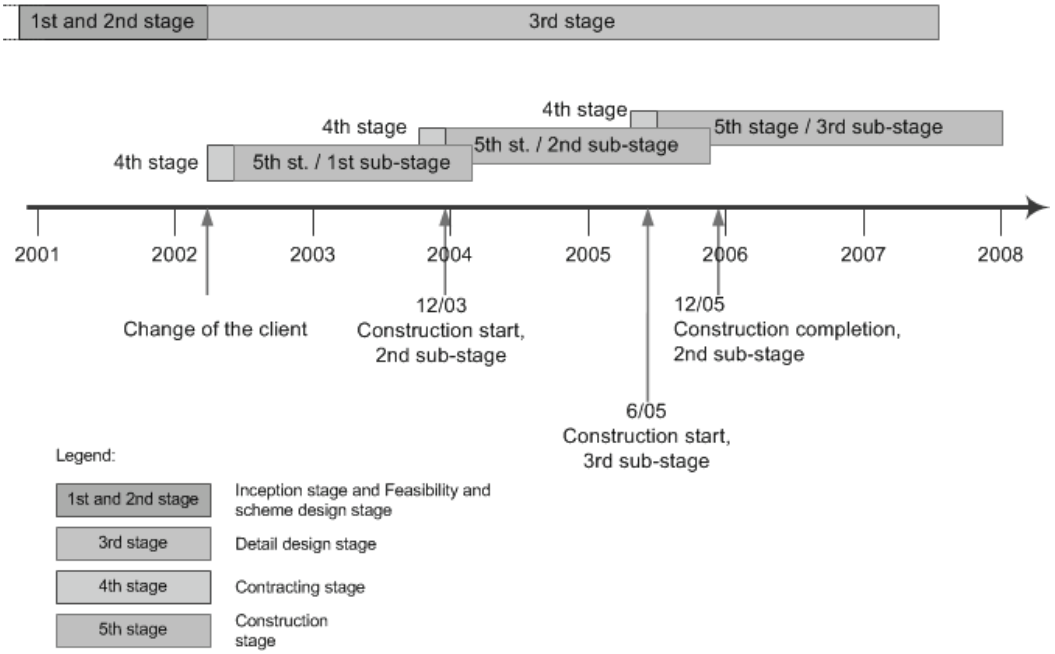

Figure 3 Life cycle and project stages of project P2 – Multi-storey office building P in Rijeka [5]

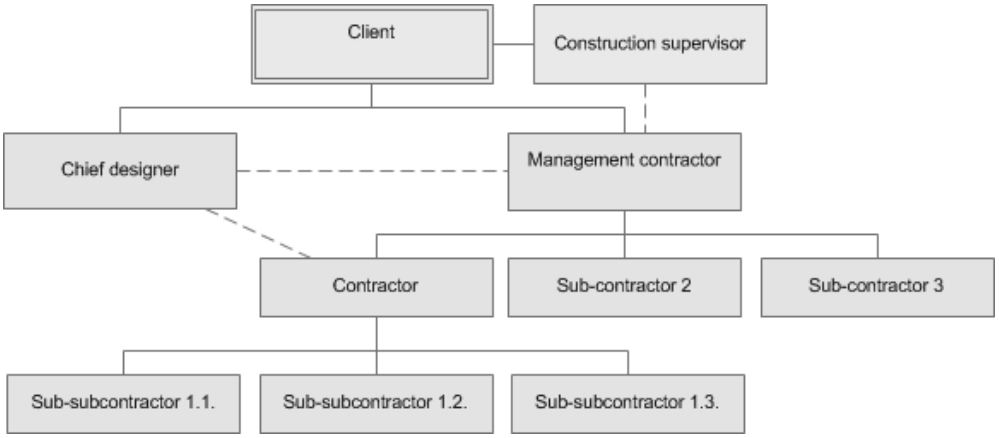

Figure 4 Management structure of project P2 - Multi-storey office building P in Rijeka, 2nd substage [5]

Fig. 4 and Fig. 5 present the organization structure of the participants during the second and the third construction stage.

Project manager. During the design stage the client contracted his own consultant for monitoring, control and communication with the client. This enabled the client to be very present during the design completion stage, which was well liked by the designer. During the construction the project management was taken over by a client employee on behalf of the client both in technical and in the sense of coordination. Most project management activities during the second and the third construction substage were left to the contractor so that the models were therefore assessed as being management-oriented. During the second substage a procurement model was used which by its features is close to the management-oriented models, that is, to the construction management model, however still retaining some characteristics of the traditional models (e.g. taking over construction-related risks and subcontractor performance from the main contractor, that is, the construction manager).

During the third substage the client directly makes contracts with subcontractors in order to reduce costs. He also employs a company for construction management which means that here the management-oriented procurement model-construction project management model was applied.

Design team structure. The chief designer contracted the whole structure design based on direct contracting with the client. The designer of preliminary design has given up authorship and had the chief designer do further design, which simplified otherwise complex relations among the project team members.

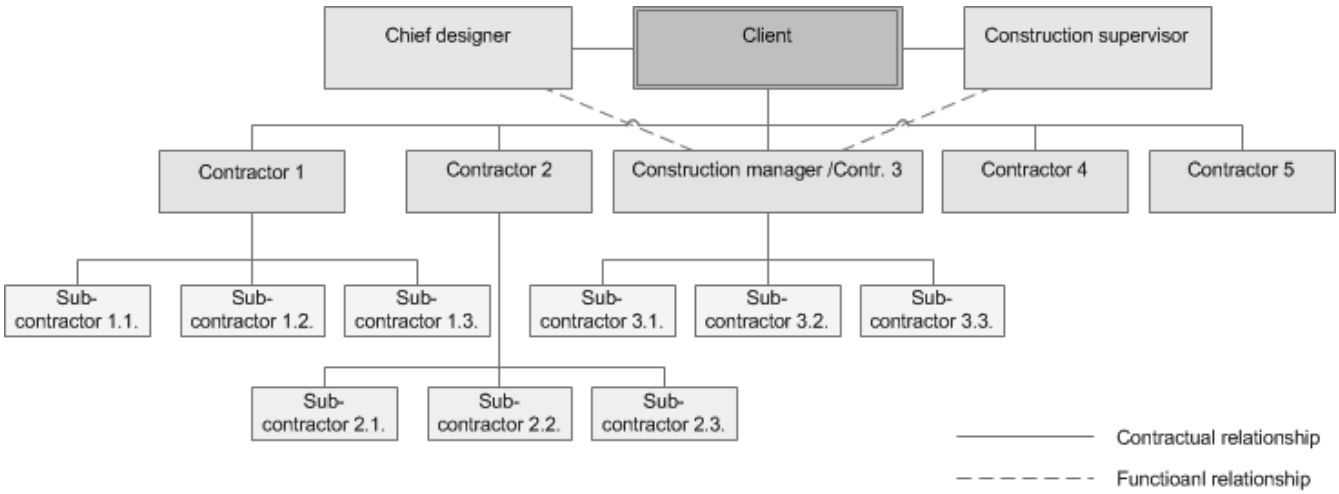

Figure 5 Management structure of project P2 - Multi-storey office building "P" in Rijeka, 3. substage [5]

Table 3 Cross-case study analysis

Ordinal number and project title	Project procurement model [1]	Project stage sequence [2]	Stage overlap [3]	Involvement of participants in the project during single stages [4]	Buildability/constructability concept implementation [5]
Project P1 Indoor swimming pool Kantrida	**traditional model**	1, 2, 3, 4, (3 i 5)	3rd stage and 5th stage (detailed engineering design)	1. i 2. stage: C, U 3. stage: C, D, U 4. stage: C, Con 5. stage: C, D, Con, CS, U	*b/c* concept was not introduced, the project stages and participants are separated
Project P2 Multi-storey office building	1. sub-stage: **traditional model** 2. sub-stage: **traditional model** with **professional construction management** elements 3. sub-stage: **construction project management**	1, 2, (3, 4 i 5)	3rd stage, 4th stage and 5th stage (mutually overlap, there have been many changes in the project – detailed engineering design, main contractor, procurement model)	1. i 2. stage: C 3. stage: C, D, U, Con (3. sub-stage) 4. stage: C, Con 5. stage: C, D, Con, CS, U	*b/c* concept was not introduced during the 1st and the 2nd substage, was partly introduced during the 3rd substage; several subcontractors influenced the selection of technical solutions and/or participated in creating the detailed engineering design
Project P3 Hotel complex	**traditional model** with **novated design & build** elements	1, 2, 3, 4, (3 i 5)	3rd stage and 5th stage (final design for the garage facility and detailed engineering design for all projects)	1. i 2. stage: C, D 3. stage: C, D 4. stage: C, Con 5. stage: C, Con, CS, U	*b/c* concept was minimally introduced, the project stages and participants are separated (the contractor had a partial influence on the particular technical solutions)
Project P4 Multi-family housing unit	**traditional model** with **novated design & build** elements	1, 2, 3, 4, (3 i 5)	3rd stage and 5th stage (detailed engineering design)	1. i 2. stage: C, D, U 3. stage: C, D 4. stage: C, Con 5. stage: C, D, Con, CS, U	*b/c* concept was minimally introduced, the project stages and participants are separated (informal involvement of a potential contractor in design)
Project P5 Housing and office building	**traditional model** with **novated design & build** elements	1, 2, 3, 4, (3 i 5)	3rd stage and 5th stage (detailed engineering design)	1. i 2. stage: C 3. stage: C, D, Con (informal) 4. stage: C, Con 5. stage: C, Con, CS	*b/c* concept was minimally introduced, the project stages and participants are separated (informal involvement of a potential contractor in design)

STAGES	KEY PARTICIPANTS
1. stage: Inception stage	C – client
2. stage: Feasibility and scheme design stage	D – designer
3. stage: Detail design stage	Con – contractor
4. stage: Contracting stage	CS – construction supervisor
5. stage: Construction stage	U – end-users

The relations are complex due to the more than fifty designers and the project complexity.

Contractor involvement during design stage. The contractors were not involved during the design stage because due to the complexity of the project it would have been extremely difficult to have them involved.

Designer involvement during construction stage. Detailed design was completely made parallel with the construction in order to save time. The designer is of opinion that the clients make unrealistic demands already at progress chart stage, especially regarding the design.

Project design supervision was agreed upon in order to interpret the detailed engineering design. Several designers subcontracted construction supervision with the chief construction supervisor who was one of the designers.

3.3 Cross-case analysis, conclusions and improvement measures

3.3.1 Cross-case analysis

Taking every single analysis, a cross-case analysis was conducted in relation to the research subject. Analysis results are presented in Table 3.

Management-oriented procurement models were used during the 2nd and the 3rd stage of the presented P2 project while other projects were conducted partly according to the traditional procurement model and partly according to the improved traditional model with elements of innovated design and build model.

3.3.2 Constructability concept application within the valid law regulations

Constructability concept application is analysed within the Law on Spatial Planning and Construction and Law on Public Procurement. It can be generally concluded that the possibility of applying this concept is complicated or limited by some specific regulation of these laws. In these terms, article 170, item 3 of Law on Spatial Planning and Construction prevents the designer to be the employee of the contractor constructing the structure in question which is opposite to the "design and build" concept application. This law regulation is motivated by protecting the public interest. However, when analysing the problems occurring during construction of several structures and usually resulting in the delay and price increase which could have been avoided by integrating the contractor knowledge into the design stage, the expediency of such regulation is eventually questioned. There is a certain rigidity of Law in this segment which prevents implementation and application in new procurement model practice whose application could bring about new quality in construction project realization. A private client has the option of engaging the contractor during the design stage because he is not tributary to the Law on Public Procurement [14] and can therefore freely choose the contractor in the design stage, too. In case of a public client, the concept cannot be applied due to the obligation of implementing the Law on Public Procurement according to which the public client must initiate a tender procedure based on the drawn technical documentation and pursuant to regulations of this Law [14]. In practice, the selection of a bidder is mostly performed according to the lowest price criterion, although economic criteria are allowed by the Law [6, 14]. The analysis conducted among the public clients has shown that they are not in favour of applying the economic criteria for two reasons:

1) They usually do not have a developed model of assessing the tenders according to pre-defined criteria and corresponding ponders.
2) Should such assessment model even be developed, the clients fear possible appeals submitted by rejected bidders and adoption of arguments explaining the selection of the bidder according to this model before competent bodies.

Nevertheless, even if the lowest price criterion is applied, a quite high level quality guarantee offered by the selected bidder can be assured by well-defined specifications, the parameters of which must be met by the bidder. This is an important issue for building construction segment, both for construction and especially the expert supervision. However, the reality is often quite different and things do not function according to this model, regardless if they are result of client's ignorance or even an attempt of manipulating the procedure implementation.

It is quite clear that such situation completely prevents the "design and build" concept implementation. It also means that the intention of the legislator to protect the public interest in cases where public, budget money is invested is lost in practice. This is the very segment where the legislator should enable implementation of contractor knowledge during the design stage in order to avoid oversights in the design which later result in construction problems, prolongation of terms, increase of costs and, what is worst of all, impair the quality of the structure to such extent that some of the faults cannot be corrected and no amount retained for damages can compensate the real damage to the client. It is often the case that some faults increase the structure maintenance costs during the exploitation period.

3.3.3 Conclusions

The obtained results of quality analysis result in the following conclusions regarding the state, possibilities and limitations of non-traditional procurement model application in the markets of less developed countries:

1) The dominant construction project procurement model is the traditional procurement model which points out the falling behind the construction industry regarding the application of new, more modern procurement models which could positively influence the integration of stages and the participants as is recommended by the world research and practice. However, the client's requirements for modification of the traditional procurement models is getting more obvious by the day in which one part of the risk, the responsibility and construction organization and the design documentation financing is shifted to the contractor, this being one of the main design and build procurement model features. At present moment this only relates to the contractor taking over

the financing and the communication with the designer, while the design documentation and contract conditions regarding the design still remain the issue to be directly resolved between the client and the designer.

2) It is quite clear that the clients have recognized the advantages of joining the designer and the contractor during the design and the construction stage which enables them to reduce the amount of work and simplifies the communication.
3) Those clients who have enough resources and experience tend to choose the management-oriented procurement models requiring greater contractor involvement but being more flexible regarding design alterations. In comparison to the pure construction procurement model, if the client can conduct separate contracting with numerous subcontractors, the construction project management enables the client better control over costs and avoidance of management function multiplication which results in cost increase.
4) The traditional payment models are usually applied (the price-based or the output-based model). In the conducted research only one project included the payment model based on costs and fees and the client was not pleased. Based on that separate opinion no company conclusions can be made but a successful cost+fee model application requires experience and additional resources of the client and the contractor oriented towards cost monitoring and control.
5) The procedure of selecting the contractor can be related to the type of the client. Public clients must obey the Law on Public Procurement and choose the contractor through tender. Thereat, the mentioned Law on selecting the most favourable contractor allows the lowest-price criterion application, as well as the cost-benefit criterion application. The cost-benefit criteria are not defined by law; their selection and pondering is left to the client. However, all research points out dominant predominance of the lowest-price criterion. This is explained by stating that the application of this criterion is simpler but the application practice also point out a potential danger and sensitiveness when applying this criterion especially when dealing with the sensitive areas such as design and construction.
6) Private clients mostly use nonprocedural direct agreement or biddings. A private client has the possibility of early involvement for all the participants who usually get involved in the project just at the construction stage, those being the contractor and the construction supervisor, which positively influences the buildability/constructability concept effectuation even when this is not agreed upon by contract.
7) Most of the examined participants had doubts about the real possibilities of correlating the designers and the contractors during the project stages. However, they all agree that an earlier inclusion of contractors or contractor experts for the selected technical solutions and the technology could positively influence the project success.
8) The project design supervision contracting during the construction stage was also positively assessed. It is, however, rarely contracted so that the designer is mostly excluded from the project after the detailed engineering design has been completed.
9) The presence of an expert project management on behalf of the client which is actively included into all project stages is, in our opinion, of key importance for the project success. However, the research has shown an insufficient or very poor knowledge of those issues so that the issues have not been regulated either by the law or in practice. Even if the projects are of great complexity, the best case scenario has the management left to individuals who do not have the project manager licence and quite often lack knowledge about the issues. The project managers are seldom met in practice.

3.3.4 Improvement measures and future research guidelines

The changes in construction project traditional procurement model domination cannot be made radically due to cultural and financial reasons. They require a change of awareness and investment of significant resources.

Due to the stated reasons an improved traditional procurement model introduction is proposed. For building construction field two procurement models are suggested:

- the improved traditional procurement model for building construction projects of private clients and
- the improved traditional procurement model for building construction projects of public clients.

Both models imply introduction of the following measures:

1) Participant objective adjustment.
2) Appointment of the project manager by the client.
3) Inclusion of the contractor or a construction expert during design stage at projects of private clients and a construction expert at public clients
   Explanation: Since public clients abide the Law on Public Procurement, the contractor cannot be included during construction stage.
4) Inclusion of future end-user at an as early project stage as possible.
5) Inclusion of the designer during construction stage through project design supervision.
6) Increase of the role and inclusion of the construction supervisor during construction stage.
7) Interaction of all participants in projects of a private client and application of cost-benefit bidding in projects of a public client.
   Explanation: The lowest-cost criterion hardly ever provides the best results in practice.

The measurement introduction must be adapted to every single project. However, in order to improve the construction project procurement procedures, one must make an influence on the wider community where the project takes place and influence the changes primarily within the legislative and the institutional frames.

Future research must define legal prerequisites which enable application of non-traditional procurement models. This specially relates to Law on Spatial Planning and Construction and Law on Public Procurement.

Furthermore, the research should be directed towards establishing appropriate new procurement models in public and private sectors under the circumstances of an amended legislation and establishment of requirements which must be met (not only at a legal, but also at a real operative and functional level), especially in the design and construction segment so that the models could take hold and be applied in practice. The analysis of the stated issues will become even more interesting when the Republic of Croatia enters the European Union.

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