

Modelling of Competitive Construction Cost Estimate

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Abstract

Construction cost estimating, control and analyze are the main tools in construction project management. Construction cost estimating makes influence on the final project effectiveness. Construction cost estimating goals, methods and accuracy differ according to the stage of construction project. Systematically arranging construction preparation, contractor will know how to reduce construction direct cost before other competition. That is the main strategy of contractors that allows increasing competitiveness.

Keywords – Project management, construction preparation, cost estimation.

1. Introduction

Within the process of economy expansion in Lithuania construction market and cooperation relations among market members are developing. The influence on cooperation relations among market members of construction market is made by free market economy and law acts, which regulate construction business in Lithuania. The mode of behaviour and activity of construction market members has completely changed. Engineering, organizational, economical and management mode of activity of contractors has transformed essentially within the process of economy expansion. Under the influence of changing construction market adaptation of activity of construction companies is taking place. Under the current circumstances a fierce competition among contractors is prevailing. Thus, a strategy of increase of a contractor's competitiveness is the application of the method of construction project management in a company. The method of construction project management has been widely employed in the USA, Western Europe and other countries for almost 30 years [1]. The International Project Management Association (IPMA) has revealed that project management enables to shorten the period of project implementation approximately by 20-30 per cent and decrease investment value by 10-15 per cent. The mentioned method has been employed in Lithuania just recently.

The problems of economy efficiency are relevant in every stage of project management. Estimates of construction costs are of great importance too [2]. To be more exact, the estimating of construction cost as well as control, correction and analysis of efficiency constitute a major part of construction project management.

Estimates of construction costs as documents integrate knowledge from different science fields such as system engineering, technologies, economy, mathematics, computer science and law. The estimating of construction costs as well as control, correction and analysis determine the final efficiency of a project. Therefore, estimates of construction costs are a new and relevant object of integrated research in Lithuania.

The aim of the research is to prepare techniques for contractors to enable them to design competitive estimates of construction costs.

2. The Place of Estimates of Construction Costs in Project Management System

Construction project implementation system is divided into stages [1]. Construction costs are estimated in all stages of construction project: business plan, schematic design, detail design, constructs proposal, construction preparation and completion of works. In the stage of need analyses, tasks, restrictions and potential ways of project implementation are formulated. In the process of carrying out the financial analysis on the basis of consolidated rates or analogical construction projects costs considering the selection of construction plots variants are estimated. The aim of such calculations is to estimate demand in investments and financing possibilities.

Pre-project stage deal with juridical issues of project implementation as well as such questions as if it is purposeful to purchase or rent land plots as well as conditions raised for license to perform construction works are taken into consideration. In this stage principal technical decisions are provided in details, optimal project variants are selected, estimate of project costs on the basis of consolidated rates is presented and period of construction works is estimated.

Within the process of detail designing technical project of a building is prepared. Detailed estimate constitutes a part of this project. Upon conclusion of the technical project and estimate a competition for performance of construction works is arranged. The contractor, who wins the competition carries out the construction preparation, designs a project of implementation of works and performs construction works. Within the process of building transfer for usage, the discovered drawbacks of construction works are being removed. Then, the building is used; its maintenance, repair and reconstruction are carried out.

The main purpose of estimates is to estimate construction costs, value and total investment value. Estimate is the most relevant document as a means of assistance for client to adopt appropriate decisions. As for contractor, estimate has essential importance in estimating costs, controlling and analysis of efficiency.

The block scheme of construction cost estimates is provided in Figure 1. The following constructions cost estimates are estimated in the European countries [3].

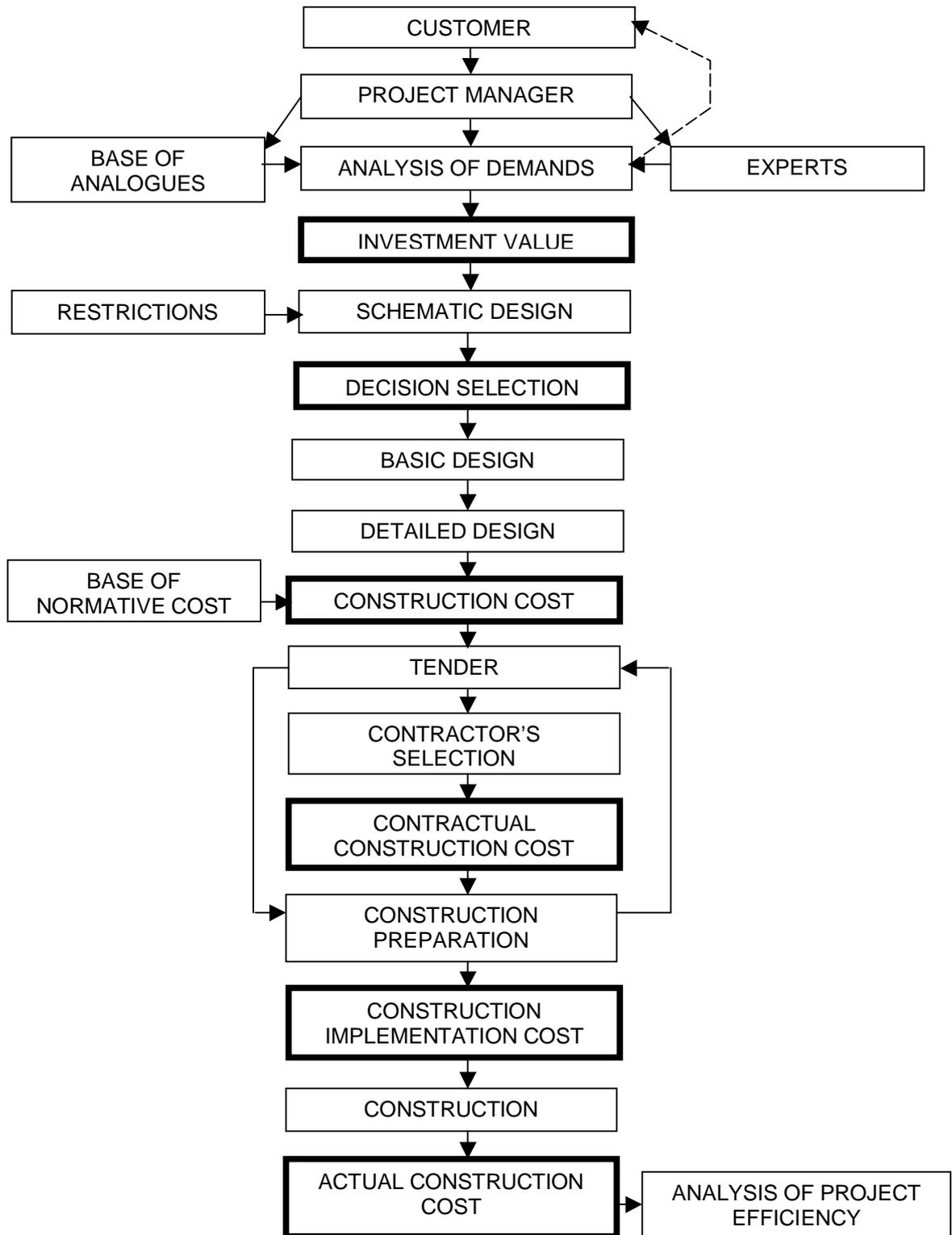


Figure 1: The place of cost estimates in construction project

Classification of costs, standard database and techniques of estimating construction cost differ in various countries [2]. Aim and techniques of estimating construction cost as well as precision of the estimated price differ according to the stage of construction project implementation.

Defining initial construction cost. Initial construction cost is defined in the stage of business plan. The main purpose is estimating cost of investment and making owner's decisions. The price reveals concept of the project. Its precision amounts 30 percent. Consolidated rates or analogical projects are used in estimating construction costs in this stage.

Construction costs estimate in the schematic design stage. It is used in comparison of principal technical decisions of construction project.

Construction costs estimate in the process of public tender for purchases. Public tender for purchases is organized on the client's initiative aiming to choose a contractor (prime contractor) for implementation of construction works. Upon choosing a contractor the client estimates the costs and proposals submitted by experts. For example, researches were done to estimate distribution order of construction bid price for homogeneous 39 objects group (Figure 2) [4]. The results of research can be used by future customer's to estimate construction bid price for analogue objects and strategy to select contractor.

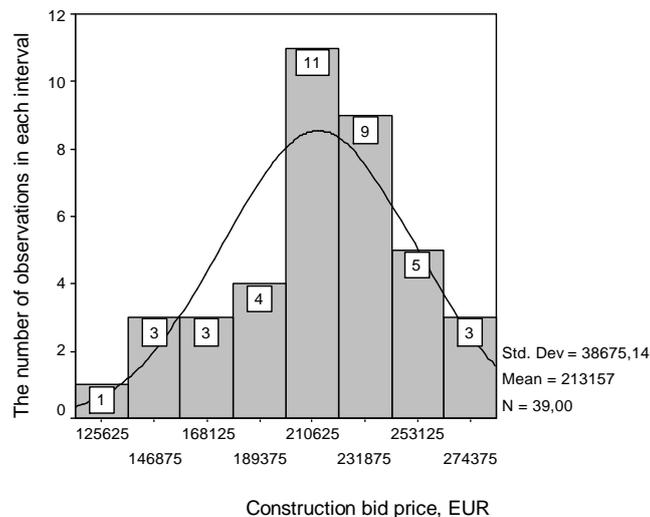


Figure 2: Histogram of construction bid price values

Estimate of construction implementation costs. It has to be prepared in the process of construction preparation (Figure 4). Within this process a contractor may prepare alternative project decisions on construction processes, optimize and integrate them into calculation of estimate of construction costs [3]. It allows a contractor to decrease construction cost up to 30 percent, and shorten the period of construction works by 50 percent [5]. Optimization of project decisions of construction processes increases competitiveness of contractor's proposal during the tender.

Actual estimate of construction costs. Within the process of building transfer for usage the actual construction costs shall be calculated. It is necessary for implementing analysis and defining the ultimate efficiency of the construction project. Actual estimate of construction costs reveals implanting level of rational decisions, effectiveness of the decisions and their reliability. According to the Figure 3, the variation limits of construction costs were calculated for the same type, homogeneous 39 objects group. It allows that contractor can forecast the means for cost reduction.

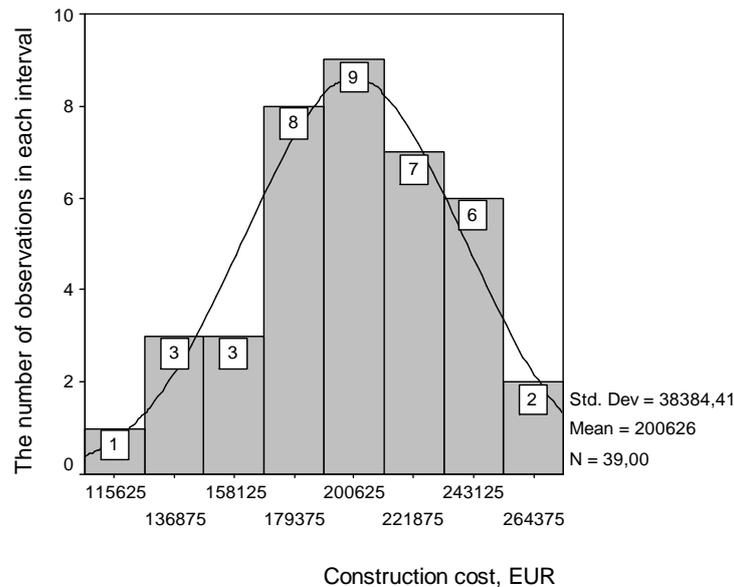


Figure 3: Histogram of construction cost values

Classification of an estimate into one of these types depends on the available information, the extent of effort dedicated to preparation, and the use for the estimate. The classification of an estimate into one of these categories is an expression of the relative confidence in the accuracy of the estimate.

3. Construction Cost Estimation in Lithuania

The concept of construction project management occurred only 4-5 years ago in Lithuania. Participants of construction business perceive this concept deeper and use the methodology of construction project management in their activity, which requires transformation of management system of construction companies.

As cooperation ways among construction participants are changing in Lithuania, the attitude towards the importance, place and drawing up of estimates changes as well. The methods of drawing up estimates in Lithuania are presented in the Table 1 below.

Table 1: Drawing up estimates of constructions in Lithuania.

	Stages of construction project			
	Stage of possibilities	Pre-project stage	Projecting	Construction
Estimate types	Estimate drawn up according to comparable economical indexes	Estimate drawn up according to large-scale indexes	Estimate drawn up according to normative valuation	Actual estimate
Data of drawing up estimates	Preliminary known volume of the building and characteristics, area of construction, engineering networks	Known main indexes and quantities of a building – foundations, framework, walls, roof, finish and others.	Known precise quantities of works of a building according to the project	Known precise quantities of works, costs and price
Methods of drawing up estimates	Eur/m ³ , Eur/m ² , Eur/m'	Drawn-up according to large-scale valuations of work groups Eur/m ³ , Eur/m ² , Eur/m	Drawn-up according to normative valuations for each piece of work or process	Drawn-up according to the actual costs by specifying prices and quantities of works

The estimate according to the comparable economical indexes is drawn up within the period of defining customer's aims and needs. The previously mentioned estimate is drawn up having such characteristics of a building as total area, volume of a building and the length of outdoor engineering networks. In this stage of the constructional project a customer estimates the value of future investments.

Having projected the construction systems of a building (foundations, walls, roof etc), the estimate according to the large-scale normative is drawn-up. The aim of drawing up such an estimate is to present comparable indexes of the project and indexes of the project parts to the customer, according which optimal project decisions are selected. Herewith the previously drawn-up estimate is specified.

Having drawn up the detailed project, the customer announces a tender for performing of construction works. Furthermore, an estimate according to normative valuations is drawn up on the customer's initiative. The basis of drawing up of such an estimate is the normative prices of construction works and quantities according to the detailed project.

The contractor upon receipt of participating in the tender calculates the price of the construction offer. For that purpose quantities of construction works according to the detailed project are used or they are recalculated. In this estimate the contractor evaluates construction implementation cost, additional costs and profit.

Having completed construction works, actual construction costs are calculated and estimate of construction are drawn up. This estimate reveals specified quantities of construction works, prices and additional works occurred in the construction processes implementation.

Currently the following contractors' decisions prevail in Lithuania, while participating in tender, contractors decrease the offer price deliberately and increase their risk to the maximum. Having won the tender such contractors frequently experience losses and problems of liquidity.

Good construction engineering preparation has great importance on assuring contractors' competitive ability and profitability (Figure 4) and requires adequate costs of engineering works. Thus, such works in Lithuania are not performed in full. Due to this reason substantiation of tender prices is insufficient an unprofitable projects and loss-making activities of some construction companies develop subsequently. Moreover, construction companies do not use estimates as an instrument of regulation, analysis and management of costs.

4. Construction Cost Estimation and Modelling

Currently the tender method based on the lowest price is employed in Lithuania, i.e. the tender is won by that contractor who offers the lowest bid, but not less than 15 % from the average price of all the competitors participating in the tender. In such way a limitation occurs, which prevents a contractor to win the tender having offered the lowest price for the performance of construction works. While using the tender method based on the lowest price a customer confronts a greater risk that a contractor, having won the tender by the lowest bid price, will not be able to perform construction works according to the price referred in the contract. [6]. Therefore, there are two possibilities aiming to win the tender:

1. Offer the lowest but reasonable price in the tender;
2. Aim to define the price close to the price, which is 15% lower from the average price of all the competitors participating in the tender.

The contractor, aiming to offer the lowest but reasonable price in the tender, should be aware of the price reducing possibilities and reserves, which depend on the type and quantity of construction works. This may be implemented in construction engineering preparation stage. Block scheme of construction preparation is provided in the Figure 4. Construction preparation is a separate system, closely related with other stages of project management.

In Lithuania the concept of construction preparation under the conditions in market economy has gained a new meaning. Therefore new construction preparation works such as preparation for participation in tenders, projecting of competitive construction estimates, risk assessment etc. emerged. The indicated work of construction preparation requires specialists of high qualification as well as provision with methodical material. In this stage optimization of project

decisions of construction processes is of great importance and their further implementation within the period of construction works (Figure 4). It enables to reduce construction costs and receive more profit. Optimization of project decisions of construction processes is made algorithmic and is implemented by the means of a PC.

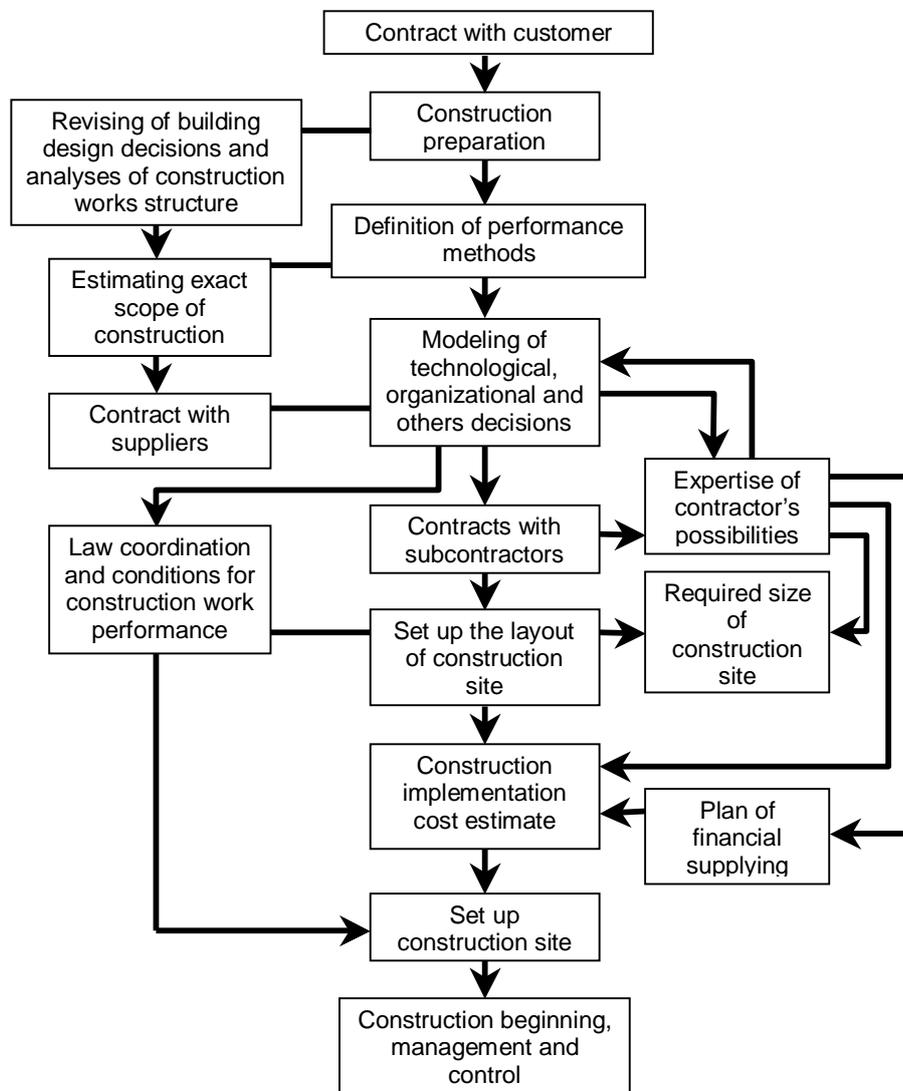


Figure 4: Scheme of construction preparation system

Within the processes of optimization and selection of rational decisions general investments into constructions in different stages of construction project implementation may be reduced (Figure 1). However, a contractor defines the possibilities of direct costs reduction and this is performed within the process of construction preparation (Figure 4). In this stage alternatives of constructions processes implementation are investigated, evaluated and optimal decisions defined which, afterwards, are implemented. For this purpose a complex construction process is divided into simple processes, possible ways, i.e. alternatives, of implementation of the mentioned simple processes are foreseen, then the alternatives are evaluated and rational decisions are selected. In order to adopt optimal decisions mathematical models of construction

processes may be projected. Research methods of operations, correlation analysis and other methods are employed in this stage. Optimal decisions of construction processes are integrated into the documentation of construction implementation. The documentation includes time and finance schedules of construction works implementation, estimates, schedules of additional project works, subcontractors' works, materials, demand for labour force and machines as well as schedules of provision and control of construction processes.

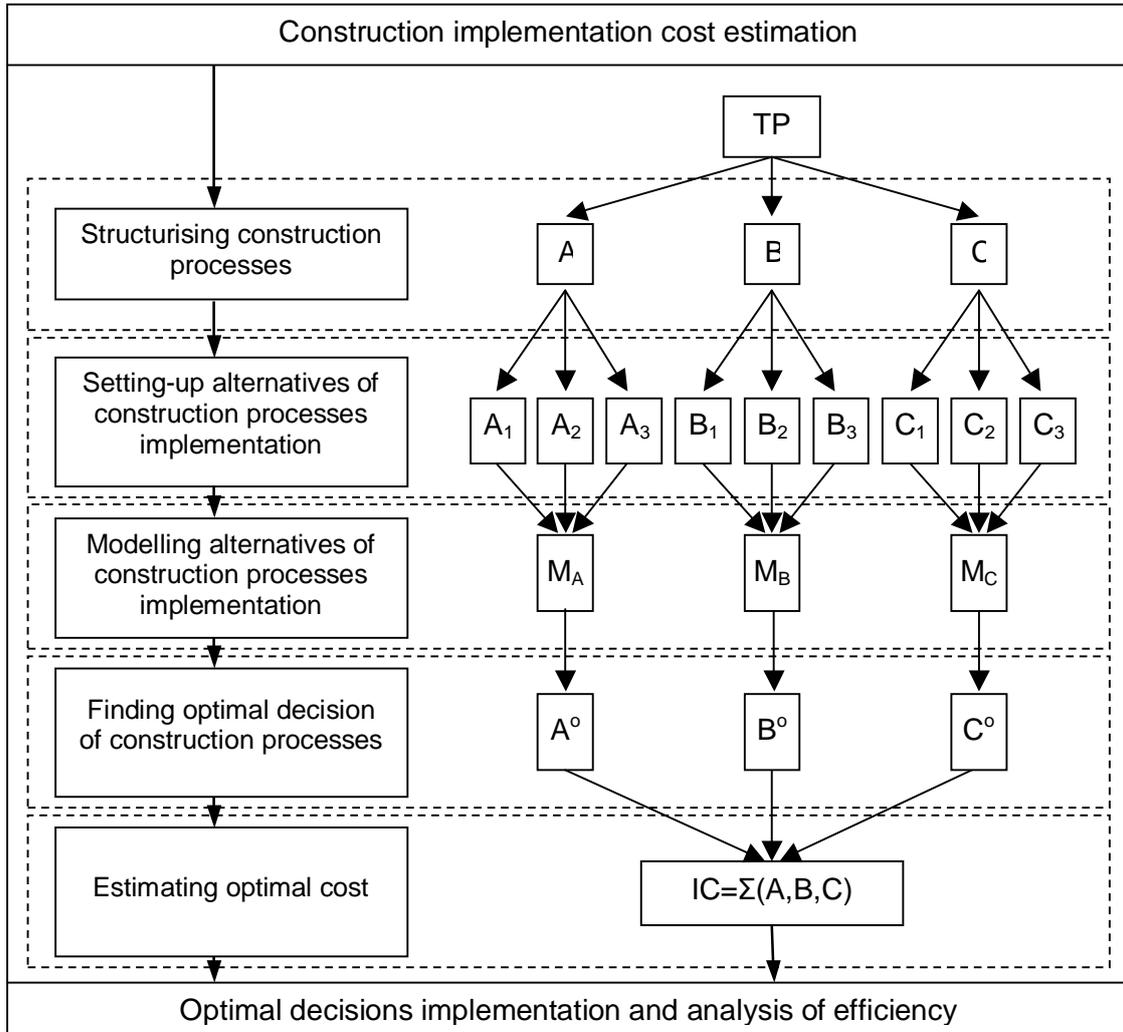


Figure 5: Block scheme of work implementation estimate

Algorithm of optimal construction decisions preparation and drawing up of work implementation estimate is shown in Figure 5. While drawing up a work implementation estimate, the terms and restrictions are followed, which are presented in the detailed project and construction standards. This is evaluated by projecting alternatives of potential decisions of construction processes. The following mathematical optimization methods are employed for evaluation and optimization of construction processes project decisions: game theory, correlation and regress analysis, mathematical programming, theory of massive service [7].

The researches carried out by Kaunas University of Technology reveal that optimal decisions of construction processes may be obtained by applying properly selected methods of optimization. Having realized the decisions practically the contractors may reduce construction costs up to 30% whereas the period of construction works may be shortened up to 50% [8], [9], [5], [10], [11], [7]. Currently software is being developed which will enable to integrate optimal construction processes project decisions into estimates.

5. Conclusions

The concept of construction project management in Lithuania occurred only 4-5 years ago. Participants of construction business perceive this concept deeper and use the methodology of construction project management in their activity, which requires transformation of management system of constructional companies. Good construction engineering preparation has great importance on assuring contractors' competitive ability and profitability. Construction estimates are a very important document of construction engineering preparation. However, Lithuanian construction companies still do not use estimates as an instrument of regulation, analysis and management of costs. The researches carried out by Kaunas University of Technology reveal that effective decisions of construction processes may be obtained by applying properly selected methods of optimization within the period of construction engineering preparation. Having realized the decisions practically the contractors may reduce construction costs up to 30% whereas the period of construction works may be shortened up to 50%. The mathematical optimization methods and system engineering methods are employed for preparation, evaluation and optimization of construction processes project decisions. Currently special software is being developed for integration of optimal project decisions of construction processes into estimates.

References

- [1] Hendrickson C. (2003). Project Management for Construction. Fundamental Concepts for Owners, Engineers, Architects and Builders, Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, 2003.
- [2] Ostwald Phillip F. (2001). Construction cost analysis and estimating, 2001, 462 p.
- [3] Juodis A. (2001). Construction industry in Europe: the market, management and development, Technologija, Kaunas, 2001, 185 p.
- [4] Juodis A., Stalioraitis P. (2004). Cost analysis for petrol stations in Lithuania, Proceedings of the 3rd Scientific Conference on Project Management (PM-03) "Clustering in Construction Project Management", Thessaloniki, Greece, ISBN 960-254-642-5.

- [5] Juodis A., Viliuniene O. (2002). Economic Mathematical Modelling of Earthwork Solutions, Inzinerine ekonomika(Engineering economics), No 4(30), Technologija, Kaunas, 2002, pp33-39.
- [6] Photios G. Ioannou, Sou-Sen Leu, Average-bid method – competitive bidding strategy, Journal of Construction Engineering and Management, Vol.119, No.1
- [7] Juodis A. (2005). Mathematical modelling and optimization of construction processes, Technologija, Kaunas, 2005, 181 p.
- [8] Juodis A.,Janushaitis R. (1998). Technological decision modelling of the dwelling house walls insulation, Statyba (Civil Engineering), Vol IV, No 2, Technika, Vilnius, 1998, pp155-160.
- [9] Juodis A., Janushaitis R. (2001). Optimization of Project Solutions of Dwelling Houses Lofts Equipment Arrangement, Inzinerine ekonomika(Engineering economics), No 2(22), Technologija, Kaunas, 2001, pp9-14.
- [10] Juodis A., Čekstaitė N. (2003). Superstructure's of building mounting process structural analysis and mathematical modelling, Lithuanian education and industry: Construction and building's engineering systems, Conference proceedings, Technologija, Kaunas, 2003.
- [11] Juodis A., Šimoliūnas E. (2003). The mathematical modelling and optimisation of buildings concrete process, Lithuanian education and industry: Construction and building's engineering systems, Conference proceedings, Technologija, Kaunas, 2003.