DOI 10.51558/2303-5161.2025.13.13.58 Scientific paper

ANALYSIS OF RISK FACTORS IN CHANGES IN CONSTRUCTION COSTS

Zahid Bašić[1], Anadel Galamić[2], Nedim Suljić[3]

[1] *Full professor, University of Tuzla, Faculty of Mining, Geology and Civil Engineering*
[2]*Full professor, University of Tuzla, Faculty of Mining, Geology and Civil Engineering*
[3]*Assistant professor, University of Tuzla, Faculty of Mining, Geology and Civil Engineering*

Summary

This paper presents the formation of construction costs and the risk factors influencing price changes in the construction of a residential-commercial building for the market, "Lamela B1," in Banovići. The building consists of a basement, ground floor, and five floors, with a planned construction period of 16 months.The study includes an analysis of labor and material costs, as well as risk factors that affect construction price fluctuations, in accordance with market demands and the surrounding conditions specific to the construction site. All relevant influences on market price formation have been identified, along with potential price changes and a risk analysis of cost variations during construction.The most significant challenges arise in aligning planned construction costs with actual expenditures and assessing their overall impact on the project. The aim of this research is to demonstrate, through a specific case study and within the context of the surrounding conditions, the importance of improving existing planning and project management processes in high-rise construction by applying scientific and professional methodologies.

Keywords: cost, construction, planning, risk, environment

1. INTRODUCTION

Specific environmental conditions directly affect the cost of construction, as well as risk factors during project execution. In the construction industry, there is always a need for precise cost estimation.

The most commonly used cost estimation method is the so-called "AD-HOC" approach, which indicates a lack of a more structured planning system. Therefore, it is necessary to apply rational project planning and management methods using software tools, construction standards, and other relevant parameters to optimize the construction process.

One of the biggest challenges in construction is aligning planned and actual construction costs while analyzing the effects these costs have on the overall project. The aim of this research is to highlight the need for improving existing planning and project management processes in high-rise construction through the application of scientific and professional methods, using a concrete example and specific environmental conditions.

This research enables:

Making optimal decisions based on modern planning and construction management methods while optimizing technological and organizational processes, construction timelines, costs, and the quality of completed work.

Improving business processes through the application of an efficient project planning and management methodology, thereby contributing to a better business environment.
The bill of quantities was prepared based on the available documentation and includes earthworks, while other construction works, such as concreting and wall masonry, were analyzed by floors. The price analysis was conducted for each item in the bill of quantities, while the cost estimate was obtained by multiplying the quantities of work by unit prices, which were determined based on the cost analysis.

2. PRICE ANALYSIS

When analyzing the prices of construction services for the items in the bill of quantities, the following empirical formula was used:

$$C_p=E_m + E_{ld} \cdot \varphi \; ; \qquad (1)$$

Where is:

C_p- the selling price of a construction service
E_m- costs of materials (basic, auxiliary and operating), with transport costs.
E_{ld}- labor costs (personal income, on which the calculation factor φ depends)

The calculative factor φ also depends on the level of mechanical equipment and includes all costs except for materials and labor. [5] [7]
Characteristic was the preparation of price analysis for complex operations, for example, for the operation of concreting a slab in which the price of the formwork was included, especially the price of the formwork and the calculation of how many m2 of formwork is needed for the installation of m^3 of concrete.
Databases on already built buildings were used and comparison was made based on experience.
The analysis of the construction structure itself is divided into phases:
- Phases of the project
- Organizational units
- Working units
- Key project resources
- Types of expenses.

In the work, and as an example, we give some of the price analyzes of the works that were done on the prescribed forms, table 1, table 2 and table 3.

- analysis of the price of 1m2 formwork for concreting the slab
- analysis of the price of installing 1 m3 of concrete with the price of formwork
- price analysis of the position of building the walls on the building.

Table 1. Analysis of the price of 1m^2 of formwork for concreting a slab

ZA OBJEKAT : STAMBENO POSLOVNI "LAMELA B1" BANOVIĆI						VRSTA RADA: TESARSKI RADOVI	
OPIS RADA: OPLATA RAVNIH,KOSIH ILI NAGNUTIH BETONSKIH PLOČA						GN:601-204	
BEZ OBZIRA NA VELIČINU SA PODUPIRANJEM						160701	
DO 3 M PODUPIRANJEM DRVENIM PODUPIRAČEM						1.1	
(OPLATA ZA BETONIRANJE PLOČA)							
Obračun po: 1m^2 oplate							
Redni broj	OPIS	Jed. mjere	KOLIČINA	CIJENE		IZNOS	
				Materijal	Radna snaga	Materijal IV x V =VII	Radna snaga IV x VI =VIII
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1.	IZRADA TV OPLATE TIII	h	0,24 0,24		4,0 3,0		0,96 0,72
2.	MONTAŽA TV TIII	h	0,25 0,25		4,0 3,0		1,0 0,75
3.	DEMONTAŽA TIII	h	0,18		3,0		0,54
4.	ČIŠĆENJE RII	h	0,14		2,5		0,35
5.	DASKA	m^3	0,004	200		0,80	
6.	GREDICE	m^3	0,002	150		0,30	
7.	EKSERI	kg	0,06	5,0		0,30	
8.	MOTKA BUNARSKA	m'	0,25	5,0		1,25	
9.	DASKA	m^3	0,0007	200		0,14	
10.	EKSERI	kg	0,09	5,0		0,45	
11.							
12.							
13.							4,32 x3,0
14.							
15.							
				SVEGA:		3,24	12,96
				PRODAJNA CIJENA: (KM)		16,20	

Table 2. Analysis of the cost of installing 1 m^2 of concrete with the cost of formwork

ZA OBJEKAT : STAMBENO POSLOVNI "LAMELA B1" BANOVIĆI						VRSTA RADA: BETONSKI RADOVI	
OPIS RADA: MAŠINSKO UGRAĐIVANJE BETONA SA HORIZONTALNIM						GN: 400-932	
TRANSPORTOM BETONA PUMPOM KAPACITETA 50 m^3/čas BETON						159967	
SPRAVLJEN FABRIKOM BETONA ZA KONSTRUKCIJE DO 0,3 m^3 NA m^2						3.1.	
(IZRADA PLOČA MB30)							
Obračun po: 1m^{3}ugrađenog betona							
Redni broj	OPIS	Jed. mjere	KOLIČINA	CIJENE		IZNOS	
				Materijal	Radna snaga	Materijal IV x V =VII	Radna snaga IV x VI =VIII
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1.	SPRAVLJANJE RII	h	0,085		2,5		0,2125
2.	UGRADIVANJE RV RIII	h	0,730 0,730		4,0 3,0		2,92 2,19
3.	BETON MB 30	m^3	1,0	86,70		86,70	
4.	OPLATA	m^2	5,6m^{2}OP./m^{3}BET.	16,20		90,72	
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							5,32 x3,0
14.							
15.							
				SVEGA:		177,42	15,97
				PRODAJNA CIJENA: (KM)		193,39	

Table 3. Analysis of the cost of building 1 m^2 of wall

ZA OBJEKAT : STAMBENO POSLOVNI "LAMELA B1" BANOVIĆI						VRSTA RADA: ZIDARSKI RADOVI	
OPIS RADA:ZIDANJE ZIDOVA „SIPOREKS" ZIDNIM BLOKOVIMA						GN:301-927	
(PRENOS KRANOM)						126869	
Obračun po:1m^2							
Redni broj	OPIS	Jed. mjere	KOLIČINA	CIJENE		IZNOS	
				Materijal	Radna snaga	Materijal IV x V =VII	Radna snaga IV x VI =VIII
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1.	SPRAVLJNJE MALTERA RII	h	0,156		2,5		0,39
2.	PRENOS BLOKOVA RII	h	0,197		2,5		0,4925
3.	PRENOS MALTERA RII	h	0,006		2,5		0,015
4.	ZIDANJE RVI	h	0,720		4,5		3,24
5.	DERSOVANJE RV	h	0,200		4,5		0,80
6.	SIPOREKS	m^3	0,206	100,00		20,60	
7.	CEM.MALTER 1:3	m^3	0,06	100,20		6,01	
8.							
9.							
10.							
11.							
12.							
13.							4,94 x3,0
14.							
15.							
				SVEGA:		26,61	14,81
				PRODAJNA CIJENA: (KM)		41,42	

The cost models used in the analysis are:
- activity-based cost model,

- a cost model based on the estimate and estimate of the works
- cost simulation.

In the construction process of the "Lamela B1" facility, appropriate cost models were applied, which included work norms, material and service norms, internal norms, as well as experiences from earlier projects with similar construction processes. This approach enabled realistic cost estimation and budget optimization, taking into account the specifics of the local market and the technical requirements of the project.
Several variants of construction plans were created, with special attention paid to cost optimization, work execution deadlines and preservation of construction quality. Through a detailed analysis, optimal strategies were selected that enable efficient management of resources and minimization of unforeseen costs. The network plans were created with maximum adaptation to the descriptions of the works from the project documentation, which ensured compliance of all phases of construction with the planned activities and the budget.
One of the key challenges in the cost formation process is the difference between planned and actual prices, which is often not adequately accounted for due to limitations in the availability of precise statistical data. [2] [3]
Although statistical data serve as a basis for cost estimation, they do not always reflect all price changes in the local market, which can lead to deviations in the project budget. A stable fixed ratio of the convertible mark (KM) to the euro (€) contributes somewhat to the stabilization of the market, but at the same time it can pose a challenge in terms of harmonizing construction costs with real market movements.
Revenues from the project are planned based on the analysis of the minimum selling price of the apartments, taking into account the expected increase in construction costs, the planned profit and the risk assessment in the implementation of the project. Proper management of these factors is essential for ensuring financial sustainability and successful implementation of the project.
This cost and revenue analysis model can serve as a reference framework for future projects, enabling more precise budget planning, more efficient risk management and better informed decision-making in the construction industry.

3. RISK FACTORS IN PRICE CHANGES

The total cost of the project was obtained as a random independent variable. We determine any random project cost as the value of the project cost components.
The individual value of the project component is the sum of the minimum value and the price increase corresponding to the random probability values of individual risks. [1]

$$\mathrm{rand}P_i = P_{i,\min} + \sum_{i=1}^{n} \mathrm{rand}P_1 \Delta P_i(\mathrm{rand}(p(x)_{i,j})) \quad (2)$$

$$P_k = \sum_{i=1}^{n} \mathrm{rand}P_i \quad (3)$$

The risk distribution within the limits of Pmax - Pmin can be different.
The risk control and risk management model consists in searching for a function that represents different distributions of changes in project components by the desired distribution while determining the differences.
The distribution of risk is monitored through the total change in the cost price according to different distributions and quantifies the impact of the risk and the probability of the cost price of the components and the total for which we set price limits. This is very practical for individual works that we group by subcontractors that influence the way these works are contracted. Changes by activity and collectively are shown with a certain distribution. The price limits are determined and the most probable price is planned by processing the databases, based on experience and similarities with the activities that have already been used in the description of the works, and comparing the differences in distributions. [4]
The determination of the impact of risk is taken according to the scale in the risk matrix:
A – insignificant risk (3%) in project costs. Includes errors in technical documentation due to calculation of areas. Error included in the contract for the sale of apartments.
B - probable risk (10%) of the price of works that are assigned to subcontractors. It enters into the contract through the assessment of the increase in construction costs and excess, subsequent and unforeseen works.
C – moderate risk (-7%) includes a real increase in the total costs of the building project,
D – the most probable risk (-10.6%) includes the risk of realizing income from the planned sale price of housing, which also includes intercalary interest on loans.
E – rare risk (over 32.7%) includes business without making a profit.
The selling price of m2 of living space is determined by the real estate market from the bid prices of other sellers in the same or similar location.
The nature of the business requires an assessment of legal risks in the overall business as a result of securing the location and approval for the construction of facilities, which was not taken into account in this case because the location was secured, and the results of these risks did not affect the overall result of the company's business.
If the projection of the investment program is made for a longer period, they can play a significant role, so they should be taken into account because the overall business success of the company depends on them. [6] [8]

4. CONCLUSION

During the construction of the residential and commercial building "Lamela B1" in Banovići, detailed price analyses were conducted for all work positions, as well as the identification of key risk factors affecting the overall construction costs. The research provided an overview of all significant factors that play a crucial role in determining the prices of individual work positions, with special attention paid to potential price changes during the course of construction.
One of the most prominent challenges in the construction process is reconciling the planned and actual costs, which may deviate significantly due to various factors. These include fluctuations in construction material prices, changes in labor costs, unforeseen technical problems, and administrative obstacles. For this reason, analyzing these variables is a key step

in accurately determining investment needs, optimizing the budget, and minimizing the risk of financial losses.

In addition to economic factors, organizational and technical aspects of construction were also considered, including the dynamics of work execution, efficiency of the employed workforce, and the impact of weather conditions on project timelines. Potential risks related to changes in legislation, market trends, and unforeseen delays were identified, enabling a more realistic assessment of total costs and the development of strategies for controlling them.

This research provides a solid foundation for further market studies and methodologies for price formation in the construction sector. The obtained data can serve as a reference for future projects aimed at improving planning, risk prediction, and informed decision-making. Understanding trends in the construction industry is particularly important for enabling more accurate cost estimation and enhancing the financial stability of projects.

LITERATURE

1. Bošković D. Process analysis and metrics of complex organizational processes, Građevinar Zagreb, 2008.
2. Cekić Z., Management of information technologies in construction, GK Belgrade, 2004.
3. Ćirović G., Organization planning problems and construction technology, Higher Civil Engineering and Geodesy School, Belgrade, 2005.
4. Ćirović G., Reengineering of business processes in construction, Faculty of Civil Engineering, Belgrade, 2005.
5. Galamić A., Diploma thesis, Faculty of Mining, Geology and Civil Engineering, Tuzla, 2009.
6. Krasulja D., Ivanišević M., Business Finances, Belgrade, 2006.
7. Savić S., Calculations in construction, GK Belgrade, 2008.
8. Bašić Z., Galamić A., Hadžikić A., Construction price and risk factors in the change in the price of building construction, International conference, Contemporary achievements in construction, April 24, 2015, Subotica, Serbia.