COST ESTIMATE FOR THE CONSTRUCTION OF RESIDENTIAL-COMMERCIAL BUILDINGS

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This paper analyzes a cost estimate for construction works within the scope of execution of investment projects, i.e. residential-commercial buildings. The proposed estimate is based on previous experience with the constructed residential-commercial buildings and it allows us to approximately estimate construction costs of future residential-commercial buildings. An estimate model consists of the cost analysis of completed construction projects, statistical data processing, and the definition of construction cost structure. The model can also be used in various phases of execution of other investment projects.

KEY WORDS: cost estimate, construction costs, bills of quantities, cost structure.

INTRODUCTION

High-rise buildings have always been very significant for the development of each community. When it comes to the construction of buildings, i.e. various projects, they accumulate good ideas, technologies and resources.

Based on one classification, buildings can be divided according to their purpose into public buildings (kindergartens, schools, gymnasiums, hospitals), infrastructure buildings (telephone exchanges, telecommunications, water storage facilities, industrial facilities), commercial buildings (for production, services, trade), and residential-commercial buildings (RCBs), Table 3). Accordingly, each such successfully completed project also generates a number of medium-sized and smaller projects, both on local and strategic national level, giving a development cycle an optimum impact. Construction of buildings represents an investment of own resources, but nowadays increasingly of foreign creditors' resources.

The Republic of Croatia experienced extensive construction activities with high investment values in the last few years.

The construction of motorways, which are of enormous strategic importance for the country, was accompanied by the construction of buildings, which is illustrated in Table 1. Buildings in the total value of HRK 35,861,146 were constructed in the period from 2004 to 2008.

YEAR	TOTAL [HRK]	BUILDINGS [%]	BUILDINGS [HRK]	OTHER FACILITIES [%]	OTHER FACILITIES [HRK]
DEC 2004	14,369,787	31.40	4,512,113	68.60	9,857,674
DEC 2005	14,996,797	35.70	5,353,857	64.30	9,642,940
DEC 2006	18,451,584	39.30	7,251,473	60.70	11,200,111
DEC 2007	19,663,275	41.50	8,160,259	58.50	11,503,016
DEC 2008	23,260,319	45.50	10,583,445	54.50	12,676,874
TOTAL	90,741,762		35,861,146		54,880,616

Table 1: Value of executed works, in thousand kuna

If we focus only on residential-commercial buildings (RCBs) quoted in areas, approvals were issued for construction of 14.506.648 m² in the same period, with an apparent annual growth trend (Croatian Central Bureau of Statistics, 2009).

Table 2: Area of r esidential-commercial b uildings (RCBs) f or which c onstruction a pprovals were issued

YEAR	TOTAL [m ²]	RCBs [m ²]	NON-RESIDENTIAL BUILDINGS [m ²]
DEC 2004	4,202,942	2,434,488	1,768,454
DEC 2005	4,773,236	2,840,236	1,933,000
DEC 2006	5,155,445	3,167,992	1,987,453
DEC 2007	5,524,936	3,009,703	2,515,233
DEC 2008	5,156,169	3,054,229	2,101,940
TOTAL	24,812,728	14,506,648	10,306,080

The mentioned construction helped accumulate quite a lot of knowledge and experience through preparation, designing, execution, supervision etc. This will make an estimate of some future costs, in our case for residential-commercial buildings, easier and more accurate.

Cost estimate is a demanding task, which is especially true at the early stage of investment realization, when the technical documentation is at the level of conceptual design or the like. It is very important to make use of experience from the projects completed up to that point. According to the available references, a few cost estimate models are used around the world, such as: parametric models, element models, bills of quantities, etc., but the most frequently used model relies on a bill of quantities (Marenjak, El-Haram, Horner, 2002). The bill-of-quantity model is based on detailed descriptions of construction works and has to be structured so as to provide the contractors with a good and clear basis for bid preparation and execution of works, and an investor with a possibility of simple planning, analyzing and monitoring of construction costs.

The bill-of-quantity model has its advantages in the early phase of investment project realization because it allows one to apply previous experience from similar projects in the structure of construction works. It is important that the given structure always contains the same elements, to allow a comparison. This enables a cost estimate for certain facilities, buildings, groups of works, or simply types of works (Building Cost Information Service, 1999). The total construction costs can be quoted in various units, such as: pieces, km, m, m², m³, etc. The very same approach was used in the cost estimate model below.

Cost estimate model

The theoretical model arises from an assumption that the construction costs of a certain building can be presented by the structure of construction works, which is a result of a familiar construction technology, and by certain groups of works making up the total costs of facility construction. Another significant element is description of works that have to be standardized in a way to make them comparable and unambiguous.



Figure 1: Flow chart of facility selection (Martinec, Bezak, Čaklović, 2004),(Martinec, Bezak, Linarić, 2006)

The flow chart in Figure 1 illustrates that the facility selection is connected with the selection of a building as a type of facility, in our case a residential-commercial building, or a group of works. The criterion for selection of a certain group of works is how they fit into the

respective construction technology and their share in the total construction costs. Should the analyzed building prove not to possess the characteristic elements, according to the set criteria, the procedure should be terminated and repeated for another building from the selected facility or repeated for another one. Once we have chosen a group of works and construction technology, we analyze the selected building further through the descriptions of works, and we establish the quantities of works. A criterion for selection of the quantity of works is the existing documentation or previous experience with the same or similar types of buildings (Martinec, Bezak, Linarić, 2006).

Application of the model

The theoretical model of selecting a facility for which we want to estimate costs starts with the selection of building we want to build and ends with the comparative analysis. Accordingly, the research basis includes the construction costs, while the selection of building as a whole relies on the theoretical model. The building we chose is a residential-commercial building as a type of facility.

Table 3: Classification of facilities

No.	BUILDINGS			
1.	PUBLIC BUILDINGS			
	Kindergartens			
	Schools			
	Sports halls			
	Hospitals			
2.	INFRASTRUCTURE FACILITIES			
	Telephone exchanges			
	Telecommunications			
	Water storage facilities			
	Industrial buildings			
3.	COMMERCIAL BUILDINGS			
	Production facilities			
	Service-providing facilities			
	Shops			
4.	RESIDENTIAL-COMMERCIAL BUILDINGS (RCBs)			

The theoretical model was tested by analyzing the quantities of works from five bills of quantities for various residential-commercial buildings, approximately at the same locations and with the same geomorphological conditions in the north-west Croatia. The gross areas of selected residential-commercial buildings ranged from 6,741 to 15,000 m², number of storeys from 2 underground levels (UG2) to 5+loft, while their bearing structure was made of reinforced concrete.

BASIC DATA	RCB1	RCB2	RCB3	RCB4	RCB5
Load carrying structure	Reinforced- concrete structure	Reinforced- concrete structure	Reinforced- concrete structure	Reinforced- concrete structure	Reinforced- concrete structure
Storeys	UG+GF+4+loft	UG2+GF+5+ loft	UG2+GF+4+ loft	UG+GF+5+loft	UG+GF+5+loft
Gross area [m ²]	10,615	10,147	6,741	11,490	15,000

Table 4: Overview of basic data of the analyzed residential-commercial buildings

The analysis has shown that most bills of quantities had the same or very similar structure with average shares of specific groups of works in the total value (Đukan, 1986).

Table 5: Overview of the bills of quantities structure with averages shares

No.	STRUCTURE OF THE BILL OF QUANTITIES	AVERAGE SHARE [%]		
1.	Construction works	52.36		
2.	Craftworks	21.97		
3.	Mechanical installations	8.80		
4.	Electrical installations	6.68		
5.	Water pipeline and sewage	6.40		
6.	Sprinkler	0.70		
7.	Elevators	3.09		
	TOTAL	100.00		

Table 5 also illustrates that construction works and craftworks together account for 75% of construction costs on average and are therefore most interesting to be considered further.

Comparing and analyzing the bills of quantities for the respective residential-commercial buildings, we discovered differences in the number, description, type and execution technology of residential-commercial buildings, their outfit and functionality, all this with respect to a unit of measure. We have extracted and presented the structure of construction works and craftworks as the most interesting. We have focused our further analysis on the processing of the construction work group because of its uniformity and comparability, and the share level. The structure of construction works was identical in all studied bills of quantities and it comprised eight groups of works, as presented in Table 6, which we called a typical structure.

The craftwork group is more extensive, diverse, and largely connected to the choice of finishing materials, which of course depends on the investor's wishes and buyers' needs. This, more complex group of works can be a subject of another analysis.

Table 6: Typical structure of construction works

No.	CONSTRUCTION WORKS
1.	Earthworks
2.	Concrete works
3.	Reinforced-concrete works
4.	Steel bending works
5.	Carpenter's works and scaffold
6.	Masonry works
7.	Miscellaneous construction works
8.	Insulation works
9.	External plastering

Comparative analysis

The studied typical structure of construction works has been broken down into groups of works in Table 7. It is obvious that the largest portion, as much as 60 %, refers to reinforced-concrete works, steel bending works and masonry work, which indicates that these three groups of construction works account for 32% of the total construction price. These groups of works contain most items constituting the largest share within the construction works group, and consequently of construction costs, with respect to the total value.

Different percentages of individual groups of works point out to differences in prices, which is understandable if we take into account various contractors, different terrain configuration, and construction technology applied.

TYPE OF WORK	RCB1 [%]	RCB2 [%]	RCB3 [%]	RCB4 [%]	RCB5 [%]	AVERAGE [%]
Earthworks	1.98	6.16	1.68	3.98	2.00	3.16
Concrete works	2.17	0.99	2.67	0.85	1.22	1.58
Reinforced-concrete works	15.69	16.10	20.19	18.05	22.45	18.50
Steel bending works	26.02	17.89	20.06	19.52	18.37	20.37
Carpenter's work and scaffold	14.79	10.73	14.23	12.04	8.76	12.11
Masonry works	20.89	24.17	24.92	19.66	23.12	22.55
Miscellaneous construction works	5.14	10.51	3.92	16.84	14.35	10.15
Insulation works	5.66	6.17	6.49	4.77	3.28	5.27
External plastering	7.67	7.27	5.83	4.29	6.45	6.30
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

Table 7: Comparative overview with shares of the group of works in the bills of quantities (Institut IGH)

Values in Table 8 are classified according to the minimum, mean and maximum value. It is indicative that deviations from the average prices in all five bills of quantities toward the extreme values were almost completely identical, and they amounted to 6% maximum.

Differences in percentages among the bills of quantities regarding the share of work groups in the total value reached up to 8% for reinforced-concrete works and steel bending works, and the maximum of 13% for various construction works having a very small, negligible share in the total value. We can see that percentages of specific groups of works in the total value are very similar, if we disregard the minimum and maximum percentage.

TYPE OF WORK	min [%]	average [%]	max [%]
Earthworks	1.68	3.16	6.16
Concrete works	0.85	1.58	2.67
Reinforced concrete works	15.69	18.50	22.45
Steel bending works	17.89	20.37	26.02
Carpenter's work and scaffold	8.76	12.11	14.79
Masonry works	19.66	22.55	24.92
Miscellaneous construction works	3.92	10.15	16.84
Insulation works	3.28	5.27	6.49
External plastering	4.29	6.30	7.67
TOTAL		100.00	

Table 8: Overview of characteristic values

Figure 2 comparatively shows the average and the five studied residential-commercial buildings according to a group of construction works. Findings of the analysis indicate to the biggest deviations in the reinforced concrete works, steel bending works and masonry works.



Figure 2: Overview of deviations of construction works from the average

As already mentioned, the group of construction works accounts for 52% of the total construction value, whereas reinforced-concrete works, steel bending works and masonry work account for 60% of construction works on average and 32 % of total construction costs of residential-commercial buildings.

If we want to get more accurate forecasts of future construction costs for residentialcommercial buildings using a cost estimate, we definitely have to focus on the construction works group and the three above groups of works in the order of their appearance. Deviations among the considered residential-commercial buildings amount up to 10%, which seems acceptable for a cost estimate.

The presented cost estimate model for construction works, based on the average calculated for five considered residential-commercial buildings, can be relatively reliable for use in the early phases of estimating the costs of construction groups in the construction of residential-commercial buildings at similar locations and in similar geomorphological conditions.

CONCLUSION

Cost estimate is an extremely difficult and demanding task, particularly in the early phase of project realization, when the technical documentation is still a conceptual design. Awareness of the cost structure of construction works based on previously finished residential-commercial buildings is an important element of estimating and controlling the costs on similar future projects (Horner, 1991). The recognizable structure makes planning and monitoring of construction costs simpler. That way we can achieve the main purpose of cost estimate, which is a relative safety in planning the final costs for the whole project, or for a part of project.

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