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## THE REASONS FOR DIFFERENCES IN CALCULATIONS IN INVESTOR'S AND CONTRACTOR'S ESTIMATIONS

### PRZYCZYNY RÓŻNIC W KALKULACJACH KOSZTORYSOWYCH INWESTORSKICH I OFERTOWYCH

#### Abstract

The occurrence of differences between the employer's estimate and the bid quotation is widespread and difficult to avoid. The differences between the investor's and contractor's calculations are often quite significant. This article analyses the differences between the value of the contract and the bid submitted for construction work carried out on a multi-storey buildings in 2013. An attempt was also made to analyse the reasons for such differences, providing possible ways to solve the problem.

*Keywords: cost estimation, differences in cost estimations, investor's estimations*

#### Streszczenie

Występowanie różnic pomiędzy kosztorysem inwestorskim a kosztorysem ofertowym jest zjawiskiem powszechnym i trudnym do uniknięcia. Różnice pomiędzy kalkulacjami inwestorskimi a ofertowymi są jednak zbyt duże. W artykule dokonano analizy różnic między wartością zamówienia a złożonymi ofertami w 2013 roku na wykonanie robót budowlanych dotyczących budynków wielokondygnacyjnych. Podjęto również próbę analizy przyczyn pojawiania się takich różnic, a także podano możliwe sposoby rozwiązania problemu.

*Słowa kluczowe: kosztorysowanie, różnice w kalkulacjach kosztorysowych, kosztorys inwestorski*

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## 1. Introduction

Estimates prepared for the needs of the employer are designed to provide an estimated total cost of the construction project. The estimate is usually obtained on the basis of indicative calculations, and is approximate, additionally burdened with an extensive “fuzziness” of results. The wide range of variation in estimates is due to, among others, the initial lack of detailed information on the planned project and related methods of cost calculation. It is obvious that in the early stage of the project, the employer has only a general idea of the project, for example, in the form of a project brief or a conceptual design. Cost analysis carried out on the basis of general information will obviously lead to a considerable price scatter [5].

It is important, however, to seek to minimize them, in particular by the appropriate determination of the planned construction costs. According to [7], the goal of the discussion should not be to point the finger of blame, but to evaluate the differences in the employer’s estimate and the bid quotation, between different bid quotations, and indicating the reasons for this situation.

## 2. Analysis of differences between the contract value and bids.

The occurrence of differences between the employer’s estimate and the bid quotation is widespread and difficult to avoid. The scale of this phenomenon can be shown using the example of public procurement. An the analysis of public contracts carried out for construction work on multi-storey buildings. Such contracts were identified using the CPV code 45.21.13.40-4.

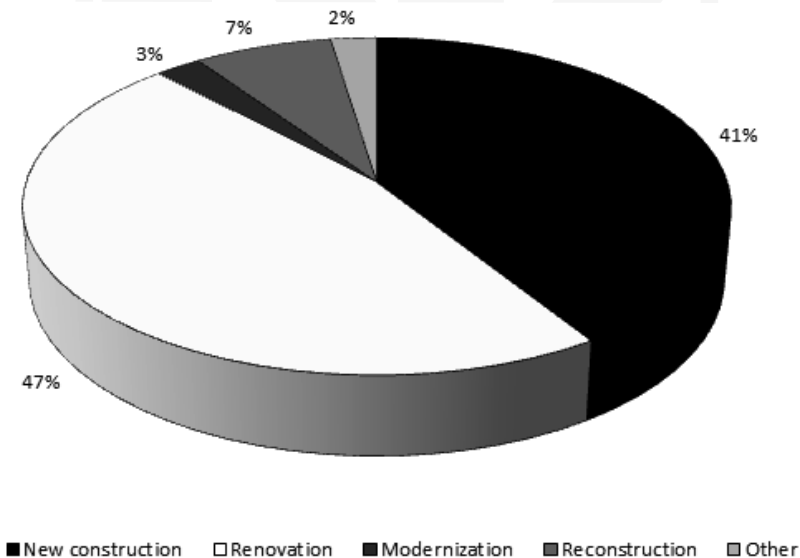


Fig. 1. Types of construction works on multi-storey buildings

In 2013, there were 72 public contracts for construction works on multi-storey buildings, including 6 partial orders. In total 85 contracts were awarded for such construction works. However, two cases concerned different types of contract as the employer made an incorrect identification of the contract confusing the CPV codes. Among the remaining 83 contracts, 39 were for renovation works and 34 were contracts for the construction of new facilities. The distribution of works contracts is shown in Fig. 1.

In 79 cases, the contractor was selected using the open tender procedure, and 4 using single source procurement. In the vast majority of contracts (94%) the only criterion for the selection of the contractor was the lowest price. In other cases, two criteria were distinguished: the lowest price with a weight of 80% or 90%, and the second criterion was the implied warranty period, warranty or the contract completion date.

The average number of bids submitted by contractors is 4.8 bids per contract. The minimum number of bids submitted in a tender procedure was 1, and the maximum number was 17. The average estimated value of the contract amounted to PLN 2 298 875,45. The minimum value of the contract amounted to PLN 18 700,53 and the maximum to PLN 19 589 819,90.

The main objective of the analysis is to determine the differences between the employer's estimates defining the value of the works contract, and the contractors' bid quotations. In as many as 82 of the analysed cases, the estimated value of the contract was higher than the bid selected, in only 1 case it was lower. The differences between the value of the contract and selected bids are very large and 98,8% of the contracts exceeded 10%, and 81,9% of the contract were 20% or more (Fig. 2).

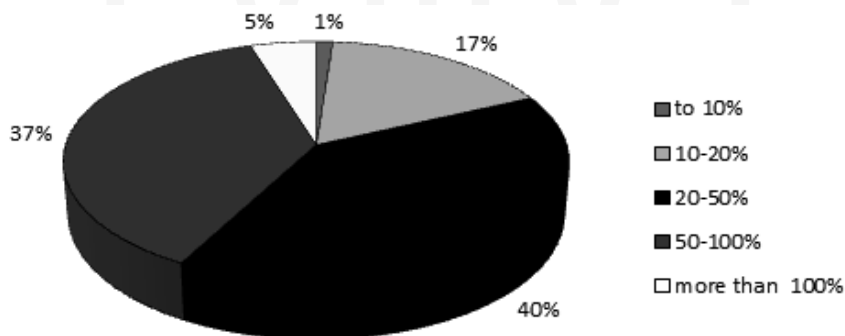


Fig. 2. Differences between the estimated value of the contract, and the selected bid

In the case of bids submitted by the contractors, the differences are even greater. After the rejection of public procurement, in which only one bid was submitted (17 contracts) the remaining 66 contracts were analysed. The differences between the minimum and the maximum bid submitted in as many as 91% of the contracts exceeded 10%, and in 65% of the contract are 20% or more (Fig. 3).

The criterion for the selection of a construction contractor (100% lowest price) adopted in the vast majority of cases justifies the importance of a correct estimate value of the contract using the employer's estimate. In contrast, the differences seen between the employer's calculations and bid calculations, and the differences between the different contractor's bids forces consideration to be applied to the causes of such differences.

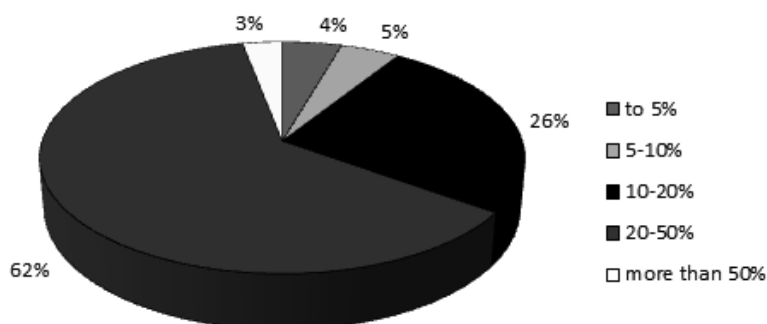


Fig. 3. Differences between the lowest and the highest submitted bid

### 3. Analysis of the reasons causing the difference between the contract values and bids

#### Competition

The primary cause of the differences in prices between the employer's estimate and the bid quotations is competition. The market situation in Poland is characterised by a relatively small number of potential employers, and a large number of contractors. This causes difficulty in obtaining works contracts, and hence the need to reduce the prices of construction works. Builder's price books available in Poland do not take this factor into account, which often causes the prices in employer's estimates. Also, the level of overhead published in a minimum, average and maximum arrangement results in differences between the employer's calculations (which is most often an adopted the average arrangement), and the bid calculations.

#### Project size

The project size also has a significant impact on the direct costs of construction. The basic principles of economics lead to the conclusion that the greater the volume of a building, the greater the opportunity to obtain discounts on the purchase of materials. A bigger batch of ordered materials results in lower prices of materials due to the possibility of obtaining high discounts. An example of a price difference depending on the obtained discount is shown in Table 1

Table 1

#### The walls of multi-storey buildings made using with "YTONG" blocks 225 m<sup>2</sup>, thickness of 30 cm with and without a discount.

Walls	Without discount	10% discount	20% discount
Price	21 991,50 zł	21 082,50 zł	20 173,50 zł
Percentage difference compared to the amount without discount	0%	4.13%	8.26%

In addition, the productivity of the work performed is greater in case of large volumes and surfaces (Table 2). The smaller the work space the more difficult the construction plan and the more detail work. This of course affects the cost of the works (Table 3), and is rarely taken into account in employer's estimates.

Table 2

**Labour intensity of constructing 1 m<sup>2</sup> of flooring using artificial stones laid on the adhesive, 40 × 40 cm tiles, combined method**

Room size	Method of laying tiles		
	Straight	Offset	Diamond
Up to 10 m <sup>2</sup>	1.00248 r-g/m <sup>2</sup>	1.10272 r-g/m <sup>2</sup>	1.30322 r-g/m <sup>2</sup>
Above 10 m <sup>2</sup>	0.8354 r-g/m <sup>2</sup>	0.91894 r-g/m <sup>2</sup>	1.08602 r-g/m <sup>2</sup>

Table 3

**Cost of constructing 1 m<sup>2</sup> of flooring using artificial stones laid on the adhesive, 40 × 40 cm tiles, combined method**

Room size	Method of laying tiles		
	Straight	Offset	Diamond
Up to 10 m <sup>2</sup>	113,13 PLN/m <sup>2</sup>	116,57 PLN/m <sup>2</sup>	123,42 PLN/m <sup>2</sup>
Above 10 m <sup>2</sup>	108,78 PLN/m <sup>2</sup>	111,80 PLN/m <sup>2</sup>	117,78 PLN/m <sup>2</sup>

### Quality

The required level of quality of construction works directly affects the cost. For example, higher-quality lumber or chemicals will cost a lot more than regular quality products (Table 4). In addition, if high quality of work is required, labor intensity also increases.

Table 4

**Prices of selected construction materials depending on their quality**

Edged oak boards 32–45 mm thick, Class 1	Edged oak boards 32–45 mm thick, Class 2	Edged oak boards 32–45 mm thick, Class 3
3289,00 PLN/m <sup>3</sup>	3080,00 PLN/m <sup>3</sup>	2145,00 PLN/m <sup>3</sup>
Solid brick 25 × 12 × 6.5 cm class 100	Solid brick 25 × 12 × 6.5 cm class 150	Solid brick 25 × 12 × 6.5 cm class 200
1,07 PLN/unit	1,15 PLN/unit	1,30 PLN/unit
Concrete paving flag 35 × 35 × 5 cm, class 1, grey	Concrete paving flag 35 × 35 × 5 cm, class 2, grey	–
7,90 PLN/unit	4,85 PLN/unit	–

### Complexity

Similarly, the cost is affected by the complexity of the construction project. Comprehensive structural systems typically consume more materials and are often of a larger size, which increases the cost of materials. This results in increased workload associated with more materials, for example, per 1 sq. m. of the element's surface leads to an increase in labor intensity and thus increases the related cost of labor. Equipment costs may also contribute to increasing the cost of construction, because it is very likely that the erection of complex multi-storey buildings will result in additional requirements for equipment which would not be the case for one simple construction project.

### Location

Location of the construction project may have a significant impact on costs. The cost and availability of labor and materials can vary considerably depending on geographic location. Building regulations vary depending on location and can significantly increase the complexity of the project (restrictions regarding the building permit – technologies, noise, etc.). Each project has different restrictions related to the access to materials and access to equipment park areas and work areas, which can significantly impact productivity and costs. Equipment mobilisation costs also depend on the project location. Delivery of equipment to a site 30 km away from the equipment park will be much cheaper than importing the equipment from a distance of say 300 km. This will affect the investment costs (Table 5).

Table 5

**Examples of one-off costs of equipment depending on the transport distance**

Construction equipment	Transport of 30 km	Transport of 300 km
Single-bucket crawler excavator 0.60 m <sup>3</sup> – transport using haulage equipment	761,54 PLN	6 580,04 PLN
Truck-mounted tower crane 100 tm – transport using haulage equipment without assembly and disassembly	9 124,25 PLN	69 693,35 PLN

An important issue is also the fact that the construction market is a local market. Therefore, the location of the project also influences the price levels adopted in estimates. Contractors preparing bid quotations use the prices of materials from builders' merchants or factories nearby the project location. An example of the prices of materials provided by the Sekocenbud system is shown in Table 6, and prices of labour in Table 7.

Overheads, such as indirect costs and profit are highly individualized and depend on, among others, the deadline for completion of the works and their plan, the size of the company, processes of the company management and the process of construction at the given site. Average values of indirect costs and profit published in available builder's price books are used to formulate employer's estimates. This may be a cause of large differences between the employer's estimates and bid quotations. Overheads costs and profit calculation problems has been described inter alia, in [8] and price variability in estimates has been thoroughly described in [2]. It should also be noted, that cost estimate calculations lack an

item estimating the level of risk. Contractors must include the construction risk in their bids, especially in the case of a lump-sum contract. Therefore, in practice, they take the risk of carrying out works into account in the profit calculation, indirect costs, and labor input, and even in the prices of materials. Risk analysis in employer's calculations hardly exist at all.

Table 6

**Examples of one-off costs of equipment depending on the transport distance**

Material	unit	Minimum price [PLN]	Average price [PLN]	Maximum price [PLN]
POROTHERM breeze blocks type 30 P+W with dim. 30.0 × 24.8 × 23.8 cm, class 10	pc	3,35	4,01	4,45
Round smooth steel bars for concrete reinforcement Ø 16–28 mm	kg	2,34	2,51	2,70
Styrofoam board EPS 100 (PS) double-sided laminated with traditional bitumen underfelt, thickness of 8 cm	m <sup>2</sup>	25,55	32,10	36,04
Natural aggregate concrete B-25 (concrete mix)	m <sup>3</sup>	186,00	222,45	264,00
Light expanded clay t 5–10 mm	m <sup>3</sup>	168,50	193,69	252,00

Table 7

**Examples of net prices for general construction labour in Poland**

City	Unit	Minimum price [PLN]	Average price [PLN]	Maximum price [PLN]
National average	PLN/r-g	9,00	14,10	25,00
Kraków	PLN/r-g	11,00	15,00	18,00
Warszawa	PLN/r-g	14,00	19,00	25,00
Lębork	PLN/r-g	9,60	12,80	15,80
Suwałki	PLN/r-g	10,00	12,00	15,00

**Estimate calculations**

In principle, employer's calculations are estimate calculations. According to the Regulation of 18 May 2004<sup>1</sup> the employer's estimate is prepared using the simplified method. The cost analysis

<sup>1</sup> Regulation of the Minister of Infrastructure of 18 May 2004 on determining the methods and basis for the preparation of employer's estimates, calculation of the planned costs of design work and the planned costs of construction works specified in the project brief.

is therefore mainly based on unit prices of construction works. It is therefore difficult to make any adjustment of the unit price in the absence of data on the labor, materials, equipment, or overheads.

The above causes are not exhaustive but are the basic factors affecting the differences between the employer's estimates and bid quotations. But, as is apparent from the examples shown, differences between the cost estimates should not be so great.

One which question which arises concerning the employer's estimates: Should the cost estimation be close to the selected bids, or to the actual cost of the project? According to the author, the employer's calculation, in the presence of the most commonly used type of remuneration in Poland for construction works, namely a lump sum (constant price), should aim to be close to the value of the selected bid. The reasoning is simple – in today's market conditions, the employer is only interested in a constant price, not the actual costs incurred by the contractor. Of course, we should assume that only selected bids are taken into consideration. These are those that were successful (implemented). For this purpose, we can use various types of mathematical models which employ knowledge based on data mining and which allow for learning. For example, we can use neural networks or inference of cases based on prices from selected and implemented bids. Such attempts have already been made, for example, in [3] the authors attempted to estimate the cost of construction of residential buildings using groups of artificial neural networks, or in [4, 6], using Case Based Reasoning. The combination of the existing normative price database, residual statistical base with the experience of people involved in the implementation, allows for estimating the risk [1] in the cost estimate calculation.

#### 4. Conclusions

Currently in Poland, differences in the employer's calculations and bid calculations, as well as between the bids submitted by building contractors, are considerable. There are many reasons, most of them mentioned in this article, which lead to this. It is important to strive for the greatest precision in cost estimate calculations, as well as to minimize the differences between the employer's and bid calculations. Situations in which the differences between the employer's estimated value, and the bids submitted often exceed 20%, 50% and even 100% are not acceptable. Using the cost estimate calculations the entity contracting construction works should arrive at a number which is as close as possible to the market prices, and therefore the most realistic prices in the bids submitted by contractors. It is therefore necessary to verify employer's calculations based on a knowledge base containing the bid prices from selected and successfully completed works.

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