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Analysis of the coefficient of unpredictable costs in the construction industry in Slovakia

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ORIGINAL SCIENTIFIC ARTICLE

ABSTRACT

The main vision of the article is how the current situation in the construction industry affects the cost of construction equipment in Slovakia, because during the implementation, unforeseen costs enter the costs, which are not foreseen in the planning. Current inflation in Slovakia is one of the highest in Europe. The methods used during the research were initial quantitative questionnaires. The output of these was processed using statistical methods and subsequently evaluated. The current situation requires considerable attention in the calculation of individual construction costs. As it is a very challenging process due to the unpredictable market situation in terms of inflation, the price of energy increases, which also causes the rise in the prices of materials and wages. The data obtained can be used by construction companies to calculate the construction equipment. Construction companies in Slovakia can apply the information obtained in the preparation of a quote for construction work that includes construction equipment.

Keywords: *Civil engineering, Costs of construction equipment, Coefficient of unpredictable costs, Price development coefficient.*

1 INTRODUCTION

The current situation in any industry is affected by the economic crisis and the current situation in Ukraine. Of course, it also concerns the construction industry and the activities related to it. Every construction from planning to execution is challenging. [1] For this reason, it is worth considering how this affects, for example, the cost of construction site equipment. Construction industry is characterised by the ability to perform work more effectively and efficiently. [2] In 2015, a questionnaire survey was conducted, in which collected data was used to develop a multi-criteria decision-making model to evaluate the cost of construction site equipment, which had the main criteria of price, time, and quality. These criteria are also known as the "iron triangle. [3] Of course, the information obtained cannot be generalised to the entire construction sector. [4] Therefore, it would be possible to create a future model that could be used for the development and evolution of construction companies. [5] These changes should make management and planning in construction companies more efficient. [6] All stages of construction together form a single unit and are interrelated. [7] All construction projects required different types of equipment and machinery. [8] Construction management issues, in part due to the process before construction projects occurred. [9] The influence of other risks has a direct impact on investment costs, which therefore becomes a significant variable in economic assessment. [10] From this research, the need to design a contingency cost coefficient was identified. It includes, for example, financial reasons and suspension of construction, unfavourable climatic conditions or changes in the project that were not considered in the design, and others. The economic comparison focused on individual technological stages. [11] The company should be focused and adapted to customer needs and current market requirements. [12] The decision to introduce a new process is always a complex and risky process. [13] Complex construction projects require appropriate planning that allows for time and cost optimisation. [14, 15] Many contracts can suffer many delays and face problems due to procurement related issues. [16, 17] Efficient management can lead to significant savings in project costs. [18]

The cost of construction equipment is classified as an incidental budgetary cost. They include site facilities including connection to sewerage, water supply, electricity, internal site road, and fencing. However, the others should not be forgotten in the calculation:

- the cost of preparing the project documentation for the construction site facilities,
- the cost of rent from leased land and buildings of construction site equipment,
- the costs of setting up, operating, and, where appropriate, disposing of the site equipment if it is designed to be temporary,
- depreciation of own facilities (pro rata part of wear and tear),
- the cost of necessary modifications to buildings used as temporary site facilities,
- the cost of electricity, water, disposal of polluted water, heating of site facilities,
- the cost of site and building security. [19]

They are calculated by individual costing or by indicative rates. The indicative rate method can be used if it is necessary to establish an indicative price for the cost of site equipment. The calculation using this method consists in classifying the construction object according to the Statistical Classification of Construction (SCC) or the invalid Unified Classification of Construction Objects (UCCE). And according to the numerical code from the price documents, the percentage rate attributable to the object in question is deducted. The amount of the cost of construction equipment is calculated as a proportion of the indicative price of the building object by the given percentage rate [20]. The individual costing method is more detailed but also more demanding, as it requires detailed supporting documents, such as a project of the construction site equipment and a construction schedule. The site equipment cost estimation model was designed for individual costing as the objective was to ensure the competitiveness of the contractor. The above-mentioned contingency coefficient is applied when using individual costing. It will constitute a so-called surcharge on the cost of site equipment. The contingency coefficient appears in the model as k. The reason for including the coefficient in the model is to ensure a so-called reserve in the budget for site equipment. It is realistic that the construction period may be extended, e.g. due to financial reasons or climatic conditions occurring at the construction site. These have not been taken into account in planning. The financial reasons are the lack of construction coverage by the investor or misunderstandings between the investor and the contractor resulting in the suspension of construction. The decisive coefficient here is whether the site equipment is left on site and the rent for the objects must be paid, or whether the site equipment is removed and the objects redelivered to the site when construction restarts. Climatic conditions represent adverse weather conditions that prevent the continuation of construction, such as several weeks of rain or freezing temperatures, which will slow the construction of the construction work. If this coefficient is not included in the evaluation of the model, it could lead to a situation where the remaining finances are used differently, and, if necessary, solutions have to be found to cover claims. The coefficient represents the finance that can be used, for example, when construction is extended, to pay rent for living containers for workers who were planned for a shorter period of time during construction. It is also possible to use these funds to pay for the

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services of a construction site security guard. [21] On the other hand, by sharing knowledge between contractors, innovation performance will increase. [22] Project planning, if it is to be efficiently implemented, requires making a few decisions that end in the smooth running of construction work. [23]

2 RESEARCH METHODS

Data on the coefficient value were obtained from the above-mentioned questionnaires. Therefore, statistical methods were used to exclude outliers from the data set such as the Grubbs test (1) and the Dixon test (2).

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \qquad x \in R \tag{1}$$

$$Q_{min} = \frac{x_2 - x_1}{R} \qquad Q_{max} = \frac{x_n - x_{n-1}}{R} \tag{2}$$

By using the methods, it was determined whether this is a set with normal distribution. This verification was important so that outliers would not bias the resulting coefficient. Verification using multiple methods supports that the exclusion of the minimum value is unnecessary as it is not a value that is unlikely. According to the information available from the Slovak Republic Statistical Office, the annual inflation rate for February 2023 is up to 15.4 % and in May it is 11.9 %. Therefore, there are two ways to find the new value of the coefficient, either again by market research, the so-called questionnaires, or by updating the coefficient, e.g., by the price development index. The first way is time-consuming and not always effective if not enough questionnaires are answered. The second method is, of course, more time efficient, but perhaps less accurate, as it is based on statistical data and is a generic figure, which is mainly used when it is necessary to find the acquisition price of a building object in a different time period than the period from which the price is available. Two cases may occur. When moving forward along the timeline, it is necessary to "re-evaluate" the earlier price level to the current price level. When moving backward along the timeline, the task is reversed. It is determined for what price a similar construction object could have been purchased built in the past, while the current purchase price starting value is known. [24] Thus, it is possible to believe that this method can also be used to update the coefficient. Construction experts believe that complexity could adversely affect the performance of construction projects. [25] The half-year study of the Slovak construction H2/2022 was also used for a thorough analysis. When asked "What are the key criteria by which the customer chooses construction company decides?" 99 % of the companies answered that on 8.7 points out of 10 it is the bid price Fig.1. Then there are other criteria, such as the own previous experience with a construction company, the delivery date, the company size, and others. Companies must be competitive, and without detailed preparation of the bid price, this is not possible. Of course, they should have some way of calculating the contingency (risk) for the whole construction and for the site equipment. Companies have the know-how to do this. And the contingency coefficient could help them calculate the cost of construction equipment. The premises for its use are also suggested by further analysis, where, when asked "Do you overestimate your upcoming or existing buildings according to the current prices of materials?" up to 43% answered that they overestimate and update their current and upcoming buildings to the given market situation. As many as 10 % of the companies were inclined to answer that they do not overestimate the contracts, Fig.2. Unless they had built in a larger margin or risk in the contracts, they could have lost money. Since there may be a situation if they did not have somehow treated a reserve in the budget or in the contract in case of a jump in prices due to high inflation, the company could have gotten into financial problems.

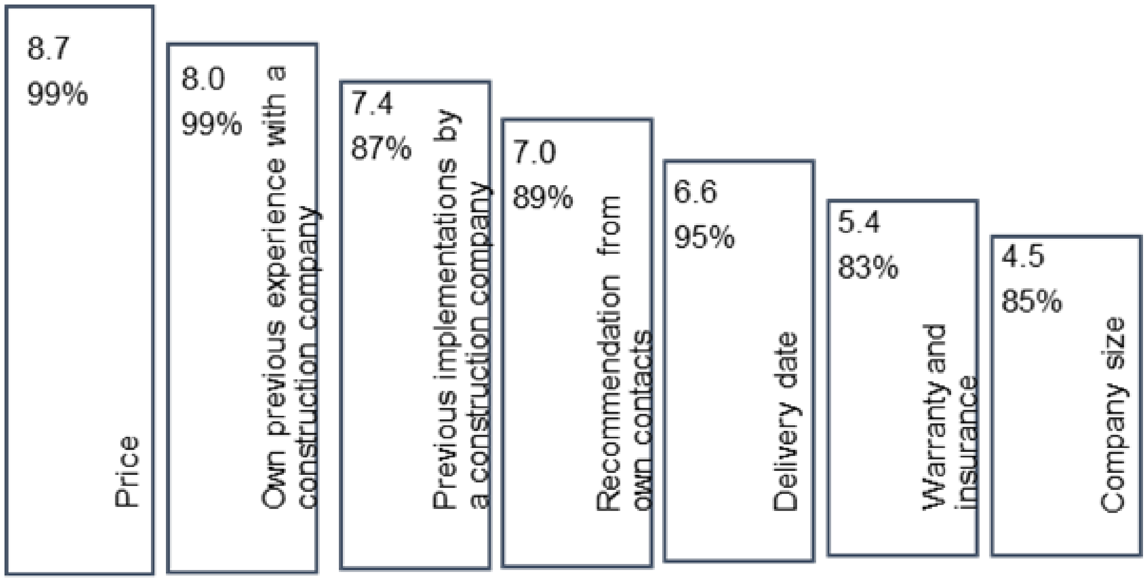

Figure 1 What are the key criteria by which the customer chooses construction company decides? [26]

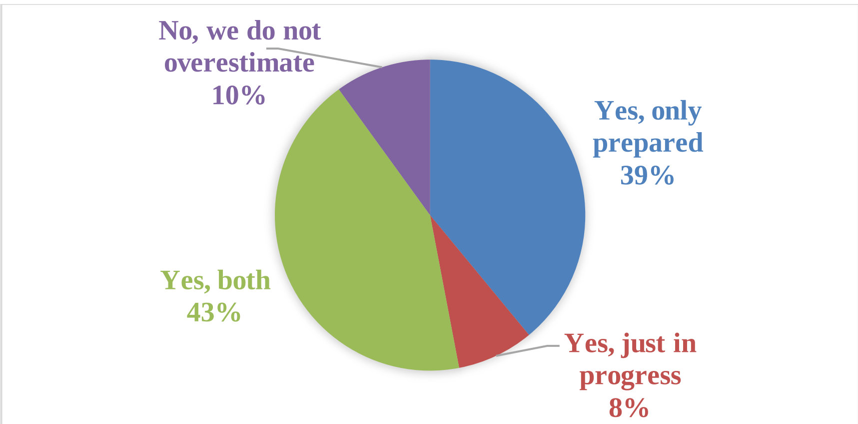

Figure 2 Are you overestimating your upcoming or existing buildings according to the current prices of materials? [27]

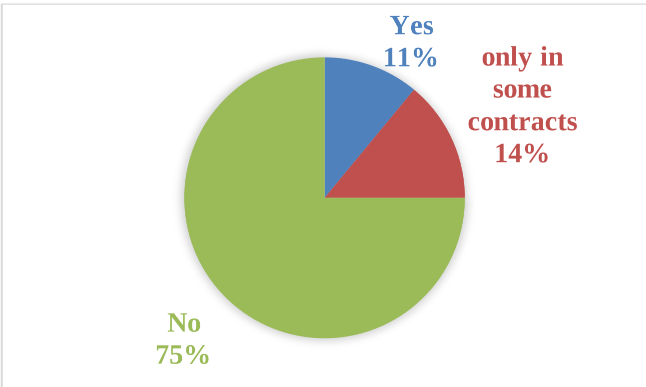

Figure 3 Is it covered in your contracts with the investor in a similar situation? [27]

This is shown in Fig.3, where the question "Is it covered in your contracts with the investor similar situation?" is answered, where up to 75 % of respondents said that such a contingency is not mentioned, and only 11 % have this covered in the contract. This shows that it is necessary to have good preparation and to have, for example, contingency costs calculated. The results of the previous research provided some guidance for the construction of the initial evaluation index in our study. [28]

In Fig.4 it is possible to see how the index of construction works and building materials has been evolving for the last quarters of 2018-2022. The values are in percentages and are the average values for a given quarter of the year. These indices are updated for the quarter of the year and are generally based after that quarter. The chart shows the change in value from 2022/Q1, where it has increased significantly. The price base is the average price for 2015. In the recalculation, the latest known construction price indices reflect changes in the prices of materials and products that occurred between the survey month of the quarter and the current month, and other known or anticipated non-material impacts.

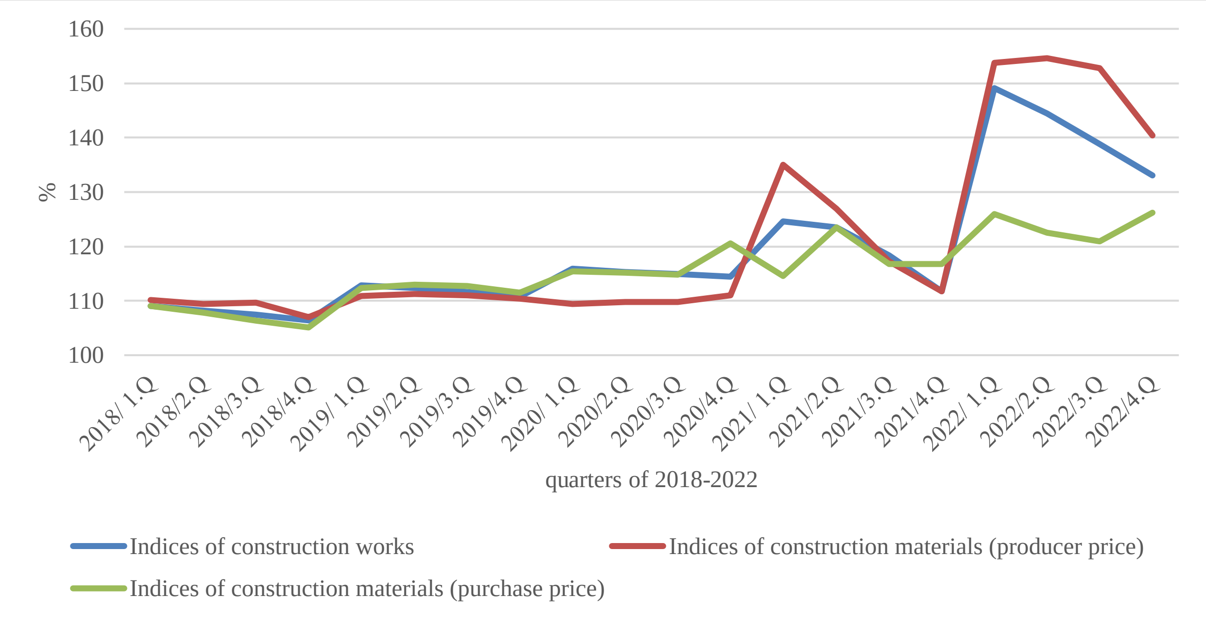

Fig. 4. Development of construction works, materials and components price indices in the years 2018–2022 [29]

After the end of each quarter, the estimates of the indices for each month of the previous quarter are refined on the basis of the data collected quarterly from the respondents. The indices are calculated from the average price indices of each representative, weighted by the relative share of the volume of value of the representative with the volume of total value of the construction output in 2015 (constant structure) according to the Laspeyres formula (3). [29]

$$I_{1/0} = \frac{\sum \frac{p_1}{p_0} p_0 \times q_0}{\sum p_0 \times q_0} \times 100 \tag{3}$$

, where:

p_1 - the price of the representative in the observation period,

p_0 - the price of the representative in the base period (Ø2015),

$p_0 q_0$ - value volume of construction works in the base period.

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3 RESULTS AND DISCUSSION

The data obtained from the questionnaires are in the range of 1 % to 30 %. This represented a large variance for determining the value, and the geometric mean of the values was 5.29 %. The maximum value of 30 % of the data set must be excluded according to the statistical operations performed, as it forms an outlier in the set. The magnitude of the coefficient after excluding the extreme is based on the geometric mean of the data set and reaches the value of 0.0489 % or 4.89 %. The resulting coefficient is 1.0489. This data is from 2015. Because the situation has changed since then, it is worth considering what value it would have in 2023 given the complicated situation in the world, which also has an impact on Slovakia.

The price indices for materials and products consumed in the construction industry include 95 groups of materials and products classified by production classification (PC). The representative indices are taken from the monthly industrial producer price indices. The weights for the index calculation were derived from the relative share of the representative volume value in the total volume value of construction materials consumed in construction products in 2015. The basis for calculating the index is the 2015 average. In addition to the producer price indices for materials and products consumed in the construction industry, the quarterly purchase price indices (the prices at which construction organisations purchase materials) are calculated. The scheme contains 97 groups of materials classified according to the Production Classification (PC). The principle of calculation is similar to that of the indices compiled from the prices of the materials. The basis for calculating the index is the average of 2015. On the basis of the research of the issue and thorough analysis, it was used the price development coefficient to update the contingency coefficient of the site equipment. There is a possibility to recalculate the price level from the older levels to the current or to which one needs, or there is also a possibility from the current price level to an older one. The first option has been used. It was based on 2015/Q4 and recalculated to the latest available index for 2023/Q1. The value of the 2015 coefficient was 1.0489. To illustrate the progression of the index over time, only the progression from 2020/Q1, when the curve starts to rise more significantly, is shown in Fig.5. The progression from 2015/Q4 to 2020/Q4 was more or less with a gradual increase. A more pronounced change in the growth of the curve occurred in 2021/Q1 and has been upward up to now. For this case, the price development index is applied with a value of 1.54, which represents an increase of 54 % since 2015. After recalculation, the contingency coefficient has a value of 1.615, which would represent that the site equipment costs would be approximately 60 % higher after multiplying by the coefficient. Similar values as shown in Fig. 1 have the construction works and materials index for the latest available period 2023/Q1 with values ranging from 126.2 % to 140.4 % for the comparative year 2015. This indicates that the current world situation is currently having a significant impact on prices. In terms of rising energy prices and consequently materials and everything related to that. Also, the war in Ukraine that limits the supply of certain materials to Slovakia. On the value of the updated site equipment cost coefficient, it can be said that the updated value of 1.615 is quite high. Therefore, the selected update method can be chosen only for indicative costs. Since companies want to be competitive, increasing the estimated site equipment cost by almost 60 % is not economically efficient. Therefore, the method to find out the new coefficient value using questionnaires is more appropriate, as it was also done in 2015. As mentioned, the market situation is different, and the contingency requirements may also have changed. In the questionnaires, construction companies could indicate the specific requirements they include and how they calculate them. Alternatively, there will be indications that they do not include these costs in the bid as they are forced into the lowest price, in order to win the contract from investors. Often, they agree to these conditions just to have the contract and be able to pay their obligations.

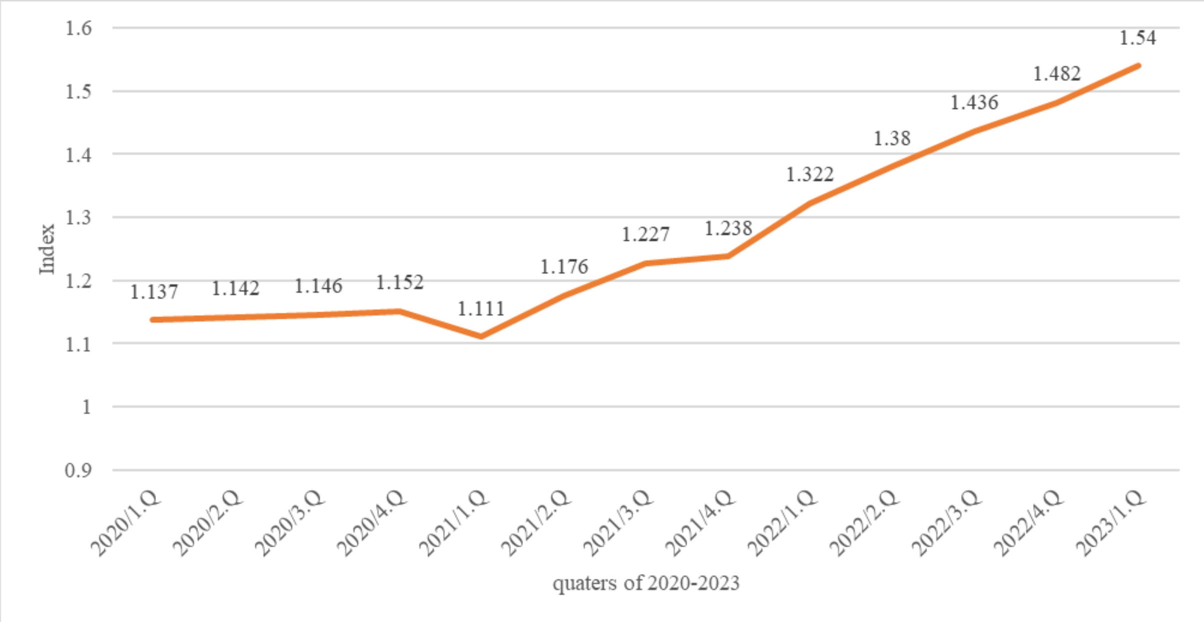

Fig. 5. Development of the price development indices for the period 2020–2023

4 CONCLUSION

The above research has addressed the possible updating of the site equipment contingency coefficient. The site facilities form an integral part of the building construction. These costs can be calculated by individual costing or by indicative rates, which vary from one publisher to another. Site equipment costs do not in themselves cover the costs of extension of the construction period or suspending construction, adverse weather conditions, etc. Of course, it depends on whether these situations are included in the works contract. Back in 2015, a market survey was carried out in the form of questionnaires, where the need for a contingency coefficient arose. This coefficient was determined by statistical methods and had a value of 1.0489. Due to the current market situation and price increases, the question of what value this coefficient should have been in place. Since, as prices rise, the liabilities to cover financial costs and the risk also rise. To update the coefficient, a statistical method was used using the price development coefficient, as it is a time-efficient method. But after a detailed analysis and calculation of the price development coefficient with a value of 1.54, it was evident that this would be only an indicative method. Since the contingency coefficient after recalculating the price development coefficient would have a value of 1.615. An increase in the coefficient of 54 % is high, and hence the reason for opting for a resurvey of the market by way of questionnaires where the construction companies could indicate the current requirements to determine the coefficient. This method is of course more time consuming in terms of creating the questionnaire and obtaining the data and then post-processing. Of course, this research has its limitations in terms of usability in practise, but with more detailed research and implementation in practise, these shortcomings can be overcome.

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