Analysis of price increases in construction in Slovakia and the impact on construction equipment

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Abstract: The construction industry has recently been very erratic in terms of price calculation. The price is affected by many factors, such as high inflation, war conflicts abroad, and others. Of course, increasing prices after contracting is difficult. This also affects the equipment on the construction site itself. If construction is extended compared to the planned date, additional costs are also incurred for the construction site facilities. On a regular basis, the costs of construction equipment are calculated with a margin. Delay reasons were classified into six groups: Contractor-Related, Design-Related, Labour-Related, Management and Administrative, Financial and Payment-Associated and Technical Elements. These "extra" costs are called the coefficient of unpredictable costs for construction equipment. And they cover the reasons for construction delays. The coefficient was proposed from a market survey in the form of questionnaires a few years ago. Here, there was a reason to update this coefficient for the given period.

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

Abstrakt: Stavebníctvo bolo za posledné obdobie veľmi nevyspytateľné z hľadiska kalkulácie cien. Cenu ovplyvňuje mnoho faktorov ako napríklad aj vysoká inflácia, vojnové konflikty v zahraničí a iné. Samozrejme navýšenie cien po zazmluvnení je náročné. Toto ovplyvňuje aj samotné zariadenie staveniska. Ak sa výstavba predĺži oproti plánovému termínu vznikajú aj náklady navyše pre objekty zariadenia staveniska. Sporadicky sú náklady zariadenia staveniska kalkulované s rezervou. Dôvody omeškania sú rozdelené do šiestich kategórií: dodávateľské, projektové, pracovné, riadiace a administratívne, finančné a platobné a technické zložky. Tieto náklady "naviac" sú pomenované koeficient nepredvídateľných nákladov pre zariadenie staveniska. A pokrývajú vyššie spomenuté dôvody omeškania stavby. Koeficient bol navrhovaný z prieskumu trhu formou dotazníkov pred pár rokmi. Vznikol dôvod tento koeficient aktualizovať k danému obdobiu.

Kľúčové slová: Pozemné stavby, náklady zariadenia staveniska, koeficient nepredvídateľných nákladov zariadenia staveniska, Index vývoja cien

1. Introduction

Almost every sector of the economy is affected by market developments, and construction is no exception. High inflation and war conflicts abroad are one of the reasons for the increase in the prices of building materials and construction works. 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. The construction industry is characterized 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 generalized 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 evaluation [10]. From this research, the need to design a contingency cost coefficient was identified. It includes, for example, financial reasons and construction suspension, unfavorable 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 the needs of the customer and the 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 optimization of time and cost [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 the 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 of the price documents, the percentage rate attributable to the object in question is deducted. The amount of construction equipment cost 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 because the objective was to ensure the competitiveness of the contractor. The contingency coefficient mentioned above 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 considered in the planning. Financial reasons are the lack of construction coverage by the investor or misunderstandings between the investor and the contractor that result in 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 model evaluation, it could lead to a situation where the remaining funds are used differently, and, if necessary, solutions have to be found to cover claims. There are many reasons why construction was delayed, for example, design changes during construction, delay in contractor payment, incomplete or improper design, shortage or delay of material, ineffective project planning and scheduling, political situation, slowness in decision-making, price fluctuations, poor quality control, changes in material types and specifications during construction, conflicts between consultant and design engineer and others. 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 during construction. It is also possible to use these funds to pay for the 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. Materials and Methods

Research on the coefficient of unpredictable costs of construction site equipment was carried out in the form of questionnaires. Where construction companies, whether of a larger or smaller nature, were approached. Subsequently, the data was processed using statistical methods. Methods such as the Grubbs test (1) or the Dixon test were used to exclude extreme values (2).

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

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

These methods were used to determine whether it is a file with normal distributions. How could it be affected by an extreme value and the resulting coefficient would be distorted? It was also checked whether it was necessary to exclude even the minimum extremum, but this was not necessary. How unlikely it was. According to information available from the Slovak Republic Statistical Office, the annual inflation rate for February 2023 is up to 15.4%, in May it is 11.9% and in October it is 7,1% (Figure 1).

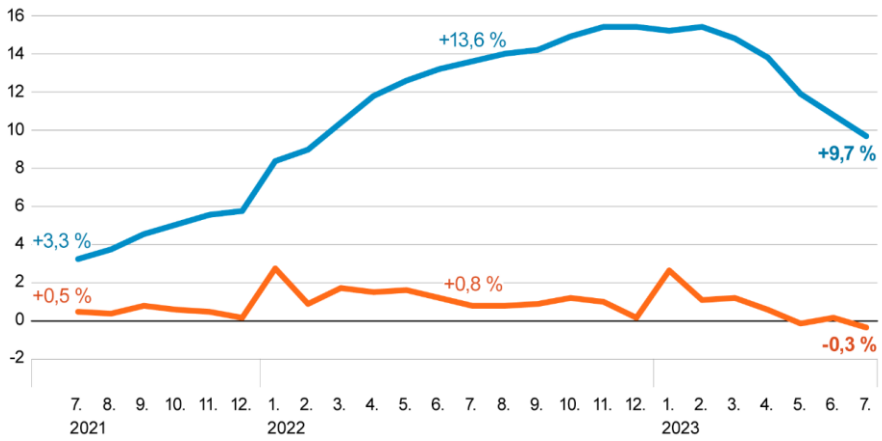

Figure 1. Inflation - Development of consumer prices in Slovakia [28]

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

"reevaluate" the earlier price level to the current price level. When moving backward along the timeline, the task is reversed. For what price a similar construction object could have been purchased built in the past, while the current starting value of the purchase price 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]. 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 got into financial problems.

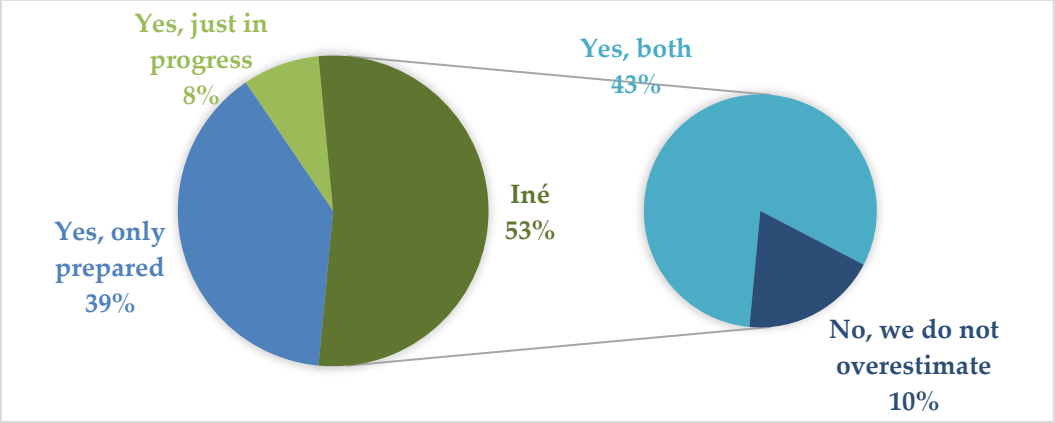

Figure 2. Are you overestimating your new or existing buildings based on current materials prices? [26]

This is shown in Figure 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 previous research provided some guidance for the construction of the initial evaluation index in our study [27].

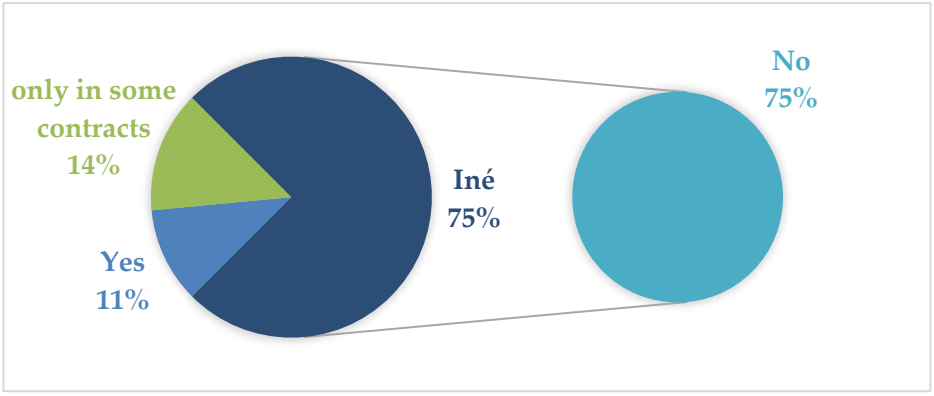

Figure 3. Is it covered in your contracts with the investor in a similar situation? [26]

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 2018-2023. Values are expressed as 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 graph shows the change in value from 2021 / 3.Q, 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.

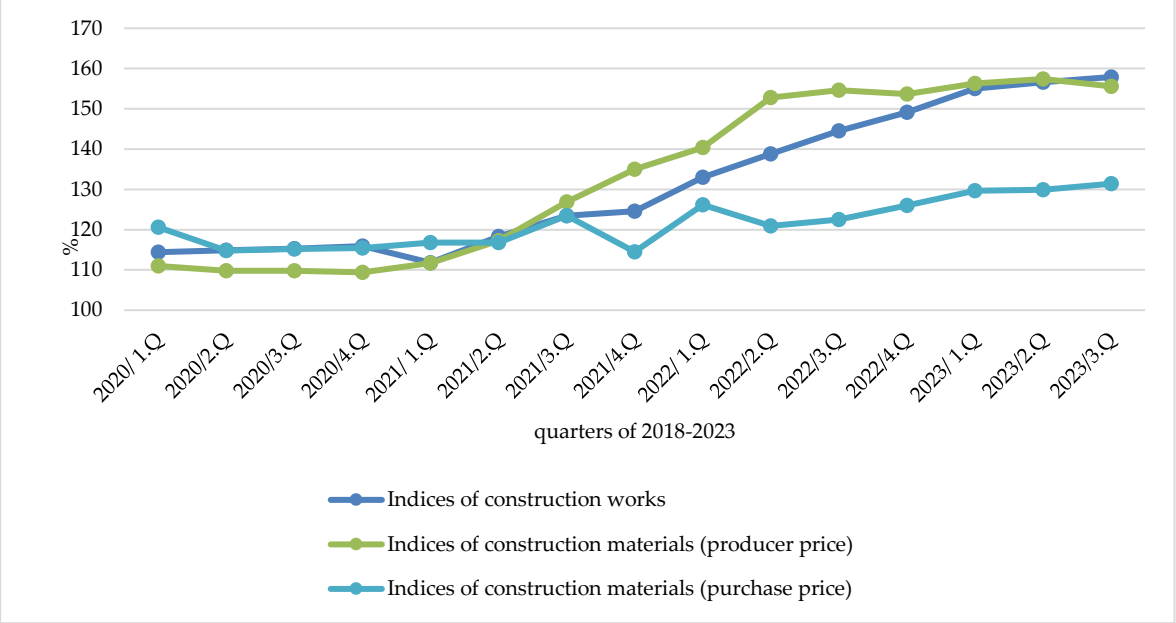

Figure 4. Development of construction work, materials, and **c**omponent price indices in the years 2018–2023 [29]

After the end of each quarter, the indices estimate for each month of the previous quarter are refined on the basis of the data collected quarterly from the respondents. Indexes 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 the total value of the construction production in 2015 (constant structure) according to the Laspeyres formula (3) [28].

$$\boldsymbol{I_{1/0} = \frac{\sum \frac{p_1}{p_0} p_0 \times q_0}{\sum p_0 \times q_0} \times 100} \quad (3)$$

p_1 - the price of the representative in the observation period,
p_0 - the representative price in the base period (2015),
p_0q_0 - volume of construction work value in the base period.

3. Results and discussion

A summary of the research data is that they range from 1 to 30%. These values represented a large range of values and had to be adjusted if they were to be used for further investigation. The geometric mean of the values was 5.29%. The statistical methods performed pointed to the exclusion of extremes from the series of data. The value of 30% represents the extreme. The coefficient value after excluding the extreme is based on the geometric mean of the data set and reaches a value of 0.0489 or 4.89%. The coefficient of unpredictable costs with a value of 1.0489 was determined. This figure 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 affects 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 average for 2015. 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 organizations 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, the price development coefficient was used 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/Q3 and has been upward up to now. For this case, the price development index is applied with a value of 1.569, which represents an increase of 56,9% since 2015. After recalculation, the contingency coefficient has a value of 1.645, which would represent that the site equipment costs would be approximately 60% higher after multiplying by the coefficient. Similar values as shown in Fig. 5 have the construction works and materials index for the latest available period 2023/Q3 with values ranging from 131,4 to 157,9 % 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 1.655 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.

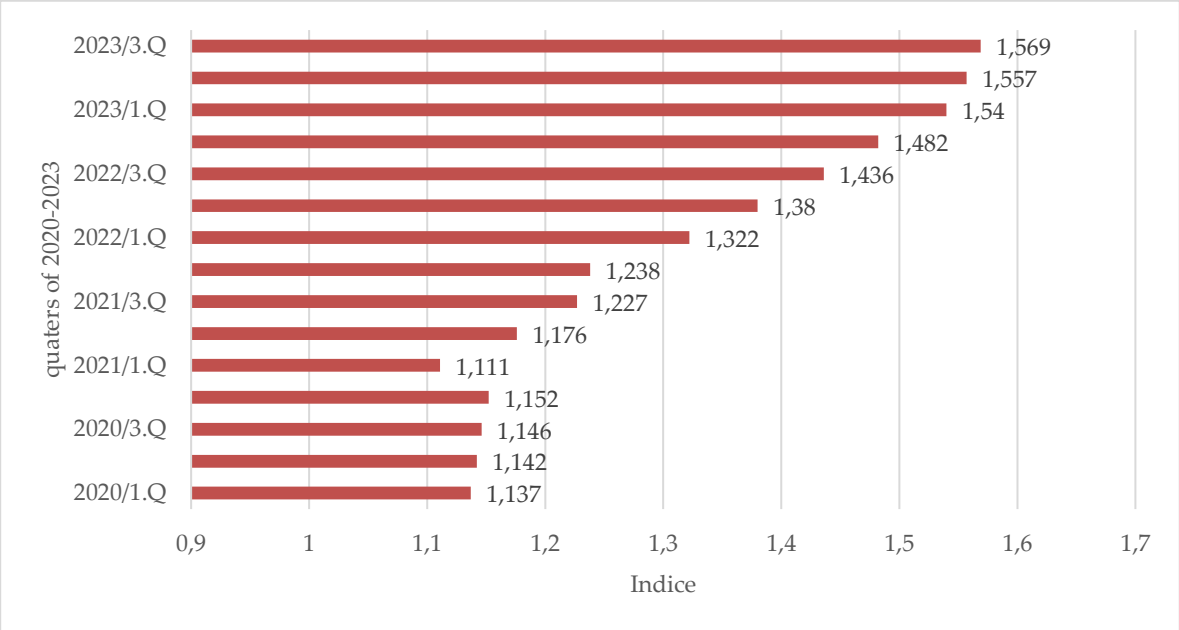

Figure 5. Development of the price development indices for the period 2020–2023

4. Conclusions

Every construction and implementation of construction works depend on finances. They should be used efficiently to avoid overcharging. The current high inflation situation and the situation abroad raised prices sharply. Many times, are very unpredictable. Construction equipment and costs for these objects are also related to construction. In 2015, research was conducted to determine the coefficient of unpredictable costs of construction equipment. Questionnaires were used and then the data were processed using statistical methods. The coefficient can be said to have formed a kind of reserve for the calculated costs. Therefore, the question arises of whether it is possible to update this coefficient in a time-efficient manner. The available price development index for the construction industry was used for the update. After the update, there was an almost 60% increase in the coefficient, which is no longer realistic for practical use. Therefore, a more appropriate and thorough method is to use the re-filling of questionnaires, where the contractors would fill in the actual values for the given period and it was not just statistically updated by the index. This may not reflect the actual need to cover the unpredictable costs of construction equipment.

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