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Contract price change during the construction phase: unforeseen market conditions

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Abstract: The unstable economic conditions that have been in place in the Slovenian and international construction markets reveal the problem of a disproportionate increase in the prices of construction materials and energy products. Such increases will therefore result in higher costs of construction services, which would ultimately affect the total value of the construction project. These events in turn bring uncertainty to the construction project and would negatively impact the business of construction companies and investors. Legal and construction practices have so far developed various ways to regulate contract changes arising due to unforeseen market conditions. The present paper offers a contribution to the contract price change solution during the construction phase. The introduction first presents the measures and guidelines that deal with the differences in contract prices in Slovenia and some other countries. Then, various methods of calculating price differences that have emerged in current Slovenian practice are described. As a result, a proposal for a hybrid method of monthly price difference calculation is presented. The hybrid method represents a balanced solution resulting from the unforeseen increase in construction material prices on the market and is applicable to all construction projects. The three methods, i.e., a calculation method, a method based on the GZS-ZGIGM index, and a hybrid method, are applied to a real example of a public contract. The calculation of the price valorisation, represented as an index of the recognised price increases of contract works, is carried out. The results are compared, and further solutions are proposed.

Keywords: construction contract, construction market, contract price, price index

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1 Introduction

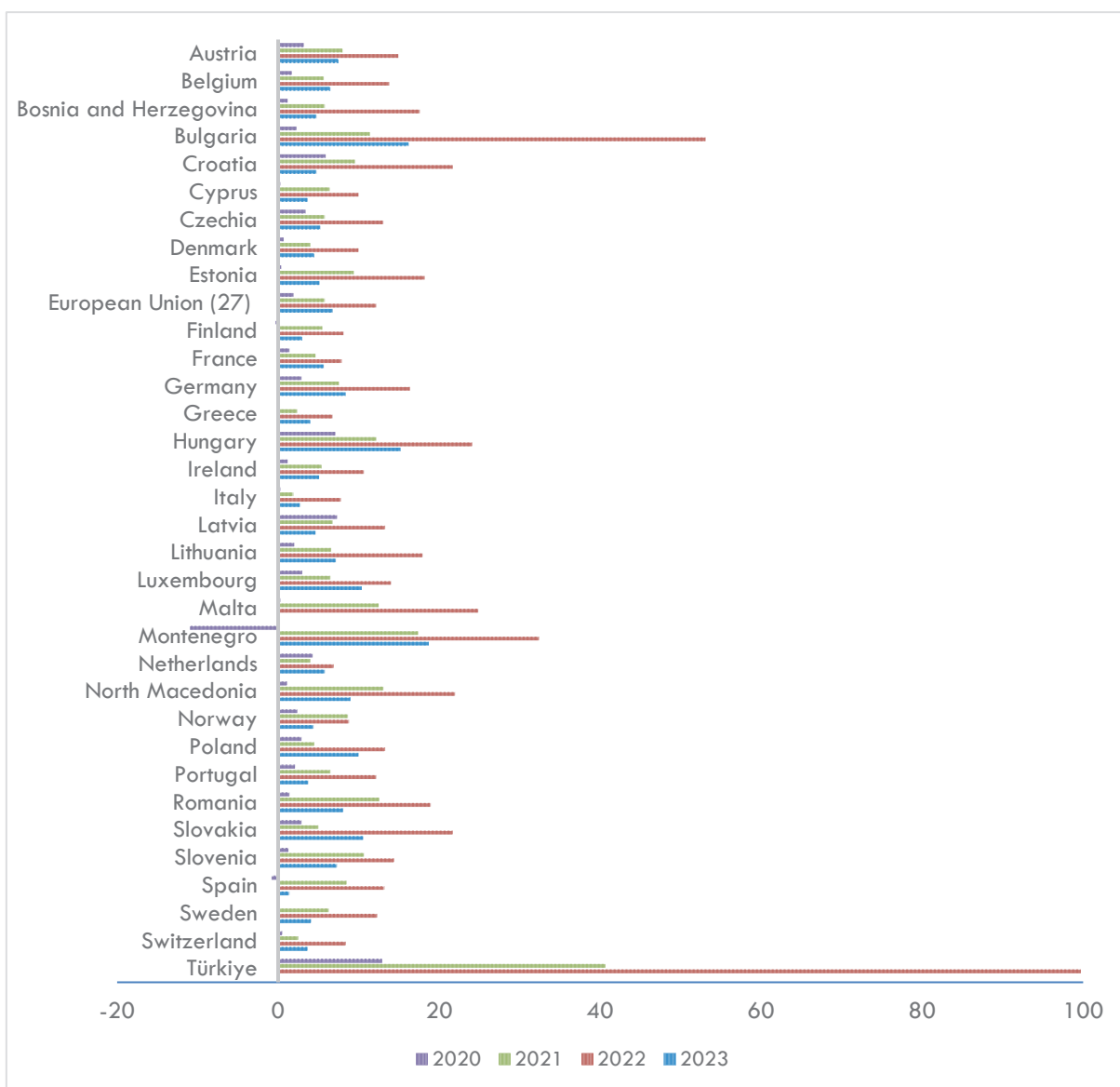
The question of how to deal with changes to the contract price has been an important issue recently, particularly in the construction industry. It is very important for a construction company to prepare a high-quality tender that is fair and includes a realistic bid price based on a preliminary review of the tender documents. However, despite the careful drafting of the tender, the complexity of construction projects makes it practically impossible to foresee all circumstances that may arise during construction. Today's changing circumstances pose various internal and external risks to construction projects and have a significant impact on project success and business performance. Therefore, in a competitive world, it is important that construction companies understand the importance of risk and follow some kind of standardised risk-management process defined by various organisations such as Institute of Risk Management (<https://www.theirm.org/>), Association for Project Management, (<https://www.apm.org.uk/>), Project Management Institute (<https://www.pmi.org/>), and ISO 31000 (2018) and also take into account the risk-management processes in the construction sector (Tserng et al. 2009; Pajares and Paredes 2011; Alfreahat and Sebestyén 2021).

Changes and therefore risks that occur during the construction phase often mean not only changes in the design and technical documentation, but also other internal changes, such as changes in quality, productivity, construction technology, and deadlines. These are the so-called internal technical risks (Widerman 1986). Less important risks in terms of scope or 'area of concern' are mainly external risks that are unpredictable, e.g., force majeure and pandemics, and predictable but uncertain risks, e.g., circumstances in the market for materials, services, energy products, inflation, exchange rate changes, etc. (Widerman 1986). Most of the changed circumstances eventually lead to a change in the contract price in one way or another. Among them, the change in contract price due to unforeseen circumstances in the market for construction materials and services has a special place.

In the construction industry today, there are situations in which the circumstances that prevailed at the time of the tender change significantly during the construction phase. These changes result from unforeseeable price changes in the input calculation elements used by the tenderer when submitting their tenders. The construction sector has been in an unprecedented situation since 2020, as the prices for construction materials and energy products have not risen as much in the previous two decades. Only reinforcing steel saw a significant price increase between 2008 and 2011. Since October 2020, the prices of PVC material and repro material have risen first, followed by steel, wood and, somewhat later, brick products. It can

be argued that the increase in prices creates insurmountable obstacles and uncertainties for the continuation of projects. In addition, in recent years, there have been disruptions in the supply of certain materials and products, causing delays on construction sites, affecting the profitability of projects, and driving up real estate prices.

The chart in Graph 1 shows the price development for new residential buildings in 33 European countries and the average of the 27 EU countries in the period from 2020 to 2023. Data are for the construction industry and in national currency on an annual basis. The unit of measurement is the percentage change compared to the same period in the previous year. For Slovenia, the output price



Graph 1: Comparison of price development for new residential buildings from 2020 to 2023. Source: Eurostat (2024).

index was 1.3% in 2020, 10.7% in 2021, 14.4% in 2022 and 7.3% in 2023. The average for the EU countries (27) was 1.9% in 2020, 5.8% in 2021, 12.2% in 2022 and 6.8% in 2023 (Eurostat, 2024). The chart shows that the largest price increase, i.e. the output price index, was recorded in Turkey, namely 40.6% in 2021 and even 99.7% in 2022. This increase is due to high national inflation and the earthquake in February 2023, which significantly increased the demand for construction services. Montenegro recorded a decrease in the percentage of the output price index in 2020 (compared to 2019), presumably due to the complete stoppage of construction activity during the coronavirus pandemic.

Changes during the construction phase are usually interpreted as unjustified additional claims by the contractor and are therefore an unpopular topic among clients or investors and laypersons. Unfortunately, the way how to deal with price changes that arise during the construction phase is rarely regulated in the contract itself, thus postponing the decision on the choice of method for calculating price increases until the construction phase. This often leads to disputes between the contracting parties, which quite a few times end up in court.

One of the biggest problems in the realisation of construction projects in recent years has been the contractual determination of the agreed fixed price. Although market conditions have changed significantly since 2020, this means changed circumstances, which are referred to in construction contracts as unforeseen circumstances in the market for construction materials and services. This makes it all the more important to have a pre-agreed method for calculating price increases. However, as this does not usually happen, investors or clients often do not receive realistic tenders, as contractors are forced to consider fixed prices at their own discretion. And unfortunately, current practice shows that despite many years of legal and construction practice in dealing with contract amendments, there are still different interpretations of their application.

In Slovenia, legal and construction practice has developed ways to regulate contract amendments for various cases. Permissible changes in construction contracts are prescribed in *Obligations Code 2007* and in Special Construction Practice Code 2020 (CPC 2020) (Chamber of Commerce and Industry of Slovenia and Chamber of Craft and Small Business of Slovenia 2020) as more and less work, as well as unforeseen and additional work. Regarding price changes, Article 655 of the *Obligations Code 2007* allows a change if the prices of the elements on the basis of which the price was determined have increased by more

than 2%, if the work was completed within the contract period, and by 5% if the work was not completed within the contract period but the prices have increased by more than 5%. In most public contracts, however, the contract price is agreed as a so-called fixed price. Under this provision, the contractor may apply for a price change under Article 656 of the *Obligations Code 2007*, but only if the difference exceeds 10%, unless the prices of the elements have increased after the contractor was in default. In addition, CPC (2020), and if they are not explicitly excluded in the contract, are used to explain the contractual relationships in detail. So, the CPC (2020) explains in Chapter V Prices, Articles 22–27, in which cases and how the contract price can be changed.

Due to changing market conditions, national economies found themselves in a situation where they were looking for ways to cope with changes in contract prices. In doing so, countries proceed from national laws on contractual obligations and Special Construction Practice Code. In the Republic of Slovenia, the Special Construction Practice Code 1977 was in force for many years. Today, the Special Construction Practice Code has been updated, namely in Slovenia apply in 2020 and in Croatia in 2021.

In Slovenia, in order to control the changing market conditions, the Ministry of Public Administration, Directorate for Public Procurement, has presented a systematic explanation of permissible contract changes due to the increase in prices of materials and services applicable for public construction contracts (Ministry of Public Administration 2021). In April 2022, the Ministry of Public Administration published additional explanations and examples of appropriate measures in connection with contract amendments (Ministry of Public Administration 2022). Furthermore, in May 2023, the Government of the Republic of Slovenia published a letter stating that the determination of the method of price change depends on the subject matter of the contract and can therefore best be determined by the customer itself. In this letter, the government wrote that the Statistical Office of the Republic of Slovenia (SORS) will begin to create its own index for construction services, which should be used to evaluate prices (Ficko 2023).

In Croatia, the Government of the Republic of Croatia adopted the first measures for the management of changes in construction contracts in September 2021, when the Government's conclusion was published (Official Gazette of Republic of Croatia, No. 107/21). In February 2022, the Croatian Chamber of Economy, in cooperation with the law firm Ljubenko & Partners,

Tab. 1: Solutions for changing the contract price in the countries described

Country	Guidelines or measure	Valid from
Slovenia	Explanation of the permissible changes to contracts due to the increase in prices of materials and services	November 2021
Croatia	Guidelines for the implementation of procedures for the recognition of price differences on the basis of construction contracts	February 2022 and April 2022
Serbia	Decision of the City of Belgrade Decision of Ministry of Construction, Transport and Infrastructure	June 2022 In preparation
Monte Negro	Methodology for determining price differences in construction services	September 2022
Germany/Bavarian government	Application of a sliding scale	No information
Italy	Unconditional payment of price difference for all contracts	No information

published for the first time the guidelines for the implementation of procedures for the recognition of price differences on the basis of construction contracts in the event of price increases for individual construction materials and products (Croatian Chamber of Economy, February 2022). These guidelines were updated in April 2022 (Croatian Chamber of Economy April 2022) and are a non-binding recommendation to all parties in these procedures. In June 2022, the government also issued a conclusion in which it proposes a methodology on how to confirm the price differences (Official Gazette of Republic of Croatia, No. 71/22). In addition, in 2022, the Croatian Chamber of Economy supplemented the publication of price indices for its members with the construction materials price index (Croatian Chamber of Economy 2024).

In the Republic of Serbia, the City of Belgrade initiated the first activities related to contract changes by adopting a resolution approving contract changes and price corrections for all contracts financed by the city (Radović 2022). The decision proposed that the price difference for construction services should be calculated according to the sliding scale formula, while for the price increase the indices published by the Statistical Office of the Republic of Serbia should be used. It is expected that a similar solution will be adopted at the national level by the Ministry of Construction, Transport and Infrastructure.

In Montenegro, the Ministry of Transport and Maritime Affairs, the Ministry of Capital Investments and Ministry of Spatial Planning, Urbanism and State Property developed a methodology for determining price differences in construction services in September 2022, which is already widely known and used (Chamber of Economy of Montenegro 2022). The guidelines are used simultaneously with the statistical data from the Statistical Office of Montenegro. In December 2022, the Chamber of Economy of Montenegro, Association of Construction and Building

Materials industry issued the so-called guidelines for the application of this method to standardise a uniform approach to the determination of price differences (Radio Television of Montenegro 2023).

After 2021, similar problems related to the increase in the price of construction materials also arose in other EU countries. For example, in Germany, the Bavarian government has established the application of a sliding scale for existing and future public construction contracts. Italy has decreed that all contractors will be paid the price difference, regardless of whether they have contractually agreed fixed prices. In Germany, as well as in some other European countries, the problems have been partially solved by not penalising companies that are late in the procurement of materials (Beti 2021). Table 1 shows solutions for changing the contract price as accepted in the countries described.

This article deals with the issue of changing the contract price set out in the construction contract. The issue of changing the contract price in some countries has been the subject discussed in Chapter 2. The following describes the currently known and most commonly used methods for determining price differences with a summary of the advantages and disadvantages. The central part of the article serves to present the hybrid method for determining price differences. The application of the proposed hybrid method and the difference to the two most used methods to date are demonstrated by calculating the index of recognised price increases of the contractually agreed works (in short index of recognised price increases of contract works) for a selected real case from practice. Other proposed solutions are also mentioned in the discussion. The issue of contract price change addressed in the article does not take the side of the investor or the contractor, but attempts to show ways of solving contract price changes that may occur during the construction phase.

2 Contract price change in the event of unforeseen market conditions

In the previous decade, there have been no major upheavals in the market for construction materials and services, so the possibility of considering price differentials, which regulated bid prices in times of inflation and higher price growth, has practically disappeared from tender documents. However, with the outbreak of the pandemic and the war in Ukraine, the situation on the market began to change significantly, which led both investors and contractors to changed circumstances. Such a situation is referred to as unforeseen market circumstances, and such circumstances are directly related to the determination of the contract price and other related provisions of construction contract.

The price difference is the difference between two values in a given period, which can be expressed by an index or in nominal value. The difference can be positive or negative. It can be determined analytically or with the help of selected indices that best reflect the change in relation to the contracted work. For the actual price differences to be calculated, the method for calculating them must already be agreed in the contract. In practice, it is unfortunately the case that the vast majority of construction contracts do not contain any agreement on the valorisation of monetary liabilities. In Slovenia, the concept of valorisation is given in Article 372 of the *Obligations Code 2007* and means the adjustment of monetary obligations due to changes in the prices of goods or services expressed by the index in the observed period. This fact puts investors or clients, contractors and lawyers to the test, who must resolve the situation within the framework of the current legislation.

2.1 Methods of determining price differences

Construction practice knows quite a few possible ways to calculate the index of price differences. Each method has its advantages and disadvantages. When calculating price differences, however, all parties involved must be aware that construction contracts are concluded for large values, so when calculating indices for price differences, each percentage point represents a nominally large amount. In practice, the following methods are most often used:

- the calculation method;
- the method of using price change indices for individual materials and services;

- the method of determining the price difference with the structural index;
- the method of determining the price difference with the GZS-ZGIGM indices.

2.2 Calculation method

The calculation method is intended for calculating the index of price differences. It is based on the calculation of the item price change according to the actual costs. The price differences of the items are calculated by comparing item price calculations by calculative elements. The price change is determined on the basis of calculation elements price lists and price analyses. The calculation of the base contract price is dated on the starting date s (CPs) using calculation elements base price lists and price analyses. The new contract price is calculated using price lists and price analyses valid on the chosen date c (CPc), according to the observed period. CPc is determined according to Eqs (2.1)–(2.3). In this way, we periodically calculate the price differences between the base (starting date) contract price (CPs) and the new (chosen date) price (CPc) (Žemva 2010).

$$CPc = CPDsc \cdot CPs \tag{2.1}$$

$$IPDsc = \frac{CPc}{CPs} \tag{2.2}$$

$$\%PD = \left(\frac{CPc}{CPs} \right) 100 \tag{2.3}$$

where $CPDsc$ is the quotient of the price difference between the start date s and the chosen date c . $CPDsc$ can be expressed as an index ($IPDsc$) as in Eq. (2.2), as a percentage ($\%PDsc$) as in Eq. (2.3) or as a nominal value.

The calculation procedures are as follows: each month, the monthly index ($IPDsc$) is calculated, which means that all items in the base estimate are recalculated with new price lists. The monthly index thus obtained is then reduced by the agreed percentage of price invariability, i.e. 2%, 5% or even 10% in the case of fixed prices. The monthly situation is then multiplied by the surplus of the monthly index ($IPDsc$) over the agreed percentages and the price differences in each month are obtained.

This method reflects the exact structure of the contract works by calculative elements. It is essentially an improved index method. The other methods described below refer only to the items as a whole and to the statistical indices, which refer only to the average structure of selected types of work. On the other hand, the calculation method does not reflect the differences in the price of the

work actually carried out. So, the bid price structure of the items is maintained throughout the duration of the project (which is better than the index method of GZS-ZGIGM), but it does not reflect the actual structure of the work carried out in the month in question.

The disadvantage of this method lies in the proof of changes in calculation elements' price lists (the burden of proof lies with the contractor), in non-standardised lists of works (in Slovenia, there are standardised descriptions of road construction work (Directorate of Roads of the Republic of Slovenia 2006); and in December 2022, a proposal for document standardised descriptions of works, materials and equipment for buildings was introduced (Slovenian Chamber of Engineers 2022)) and in various contractors own norms, which may call into question the credibility of the calculation. In any case, proof is easier if at least price analyses for the most important items and calculative price lists are submitted together with the tender. One way to improve the method could be the creation and regular publication of indices of construction material prices based on the example of Croatia.

2.3 Method of using price change indices for construction materials and services

The price differences according to this method are determined by calculating the shares based on the price analysis and multiplying them by the relevant indices. The difference between the new price and the base price is the price difference or price change caused by a change in the input calculative elements. To calculate with this method, we also need a calculative elements price list, price analyses and an index source. If the starting points were not submitted and agreed together with the tender, there is also a problem in proving the changes, as is typical of the calculation method (Žemva 2010).

2.4 Method of determining the price difference with the structural index

With this method, not only the input data on the prices of the calculative elements must be known, but also their shares, i.e. according to the contractually agreed structural index of labour, equipment and machinery as well as material. The quotient of the price difference is calculated using a modified sliding scale formula, Eq. (2.4) (Žemva 2010; Pšunder et al. 2012; Mužina and Ekart 2022).

$$CPD_{sc} = a + b \frac{L_c}{L_s} + c \frac{E_c}{E_s} + d \frac{M_c}{M_s} \quad (2.4)$$

where CPD_{sc} is the quotient of the price difference for the observed period (starting date s and chosen date c); a is fixed share, if determined by the contract; b, c, d are shares of individual price elements (labour (L), equipment (E), machinery and material (M)); L_c, E_c and M_c are indices or prices of individual price elements at the chosen date c (end of the observation period); L_s, E_s and M_s are the base indices or prices at the starting date s (beginning of the observation period).

After calculating the quotient CPD_{sc} , the new contract price (CPC) is calculated in the same way as in the calculation method (Eq. (2.1)). In this method, too, all starting points (structure of contractually agreed works and source of the indices) must already be contractually agreed.

The advantage of this method is that it does not require a wide range of data, but only for representative elements of the price (b, c, d). It is also useful for monitoring individual prices whose amounts represent the largest share in each type of work. The use of this method is also suggested by the International Association of Consulting Engineers FIDIC (<https://fidic.org/>).

In Slovenia, this method was often used in the construction of highways. When submitting the tender, the tenderer attached the bid price structure of the items on the prescribed form from the tender documents. The price structure had to be filled in according to the type of work and the share of the individual price elements. On the basis of the attached form and the data from the SORS, the index valid for the period under consideration was calculated on a monthly basis. Each type of work in the corresponding monthly situations was multiplied by the index calculated in this way. Today, this method is generally no longer used due to possible speculation when filling in the price structure. In our opinion, this is one of the most correct methods.

2.5 Method of determining the price difference with the GZS-ZGIGM indices

This method is considered as an important tool for calculating the revaluation of costs in the construction industry in Slovenia. The method was developed by the Chamber of Commerce and Industry of Slovenia and the Chamber of Construction and Building Materials Industry of Slovenia (GZS-ZGIGM) and uses indices calculated by the Chamber. The Chamber has been calculating the indices on a monthly basis since 1972. The indices are used to determine the price difference resulting from changes in construction costs in a given period. The indices are

given for (a) various types of work, such as construction, installation and finishing and (b) both main types of construction, i.e. buildings and civil engineering works. They are calculated on the basis of the average structure of the individual works and current data on price trends for all types of construction materials, hardware and transportation prices and wages (GZS-ZGIGM 2022). Eqs (2.5) and (2.6) show how the index of price difference (*IPDsc*) and the percentage of price difference (*%PDsc*) are calculated, where the GZS-ZGIGM indices are used for the chosen date (*Ic*) and the starting date (*Is*). Eqs (2.5) and (2.6) apply under the condition that all contractually agreed works are carried out in one calendar year and therefore there is no transition between years. In the case of an interannual transition, the index is recalculated via, e.g. 2 years.

$$IPDsc = \left(\frac{Ic}{Is} - 1 \right) \tag{2.5}$$

$$\%PDsc = \left(\frac{Ic}{Is} - 1 \right) 100 \tag{2.6}$$

The new contract price (*CPC*) is calculated according to Eq. (2.8), considering the price difference coefficient (*CPDcs*) according to Eq. (2.7), where *CPDcs* is expressed by the GZS-ZGIGM index for the considered period and for the corresponding type of work, and *CPs* base contract price.

$$CPDsc = (1 + IPDsc) \tag{2.7}$$

$$CPC = \frac{Ic}{Is} CPs = (1 + IPDsc) CPs \tag{2.8}$$

The calculation procedures are as follows: each monthly situation is multiplied by the corresponding monthly index, taking into account only the value of the index that exceeds the contractually agreed threshold of price invariability ($\pm 2\%$, 5% or 10%). The contractor is entitled to pay the price difference only for the part that exceeds the agreed percentage.

When using this method, doubts naturally arise as to whether the indices really reflect the actual situation of the project. There are several different indices, but regardless of which one is chosen, its structure does not exactly reflect the structure of the project. In addition, the data for the GZS-ZGIGM indices are provided by companies producing construction materials, technical goods trading companies and construction companies, although the amount of data is not always the same and the number of data received for each value also varies. The question

is also what share of the construction market the rapporteurs represent. In addition, the calculated statistical indices could also show a time lag compared to the actual situation.

3 Research objectives and methodical procedure

The main objective of the research is to confirm that the choice of the method utilised for calculating the price difference of contractually agreed works has an impact on the amount of the calculated justified price increases of the works resulting from unforeseen conditions of prices on the market.

The first step in achieving these objectives was to present the most commonly used methods in practice to calculate price differences. The following is a description and definition of the hybrid method, which takes into account the principle of ABC analysis and two methods, namely the calculation method and the method with GZS indices. For the three methods, the calculation method, the method with GZS-ZGIGM indices and the hybrid method, the calculation of the index of recognised price increases of contract works for the period March 2021 and March 2022 is shown using a real example. The calculated indices are then compared with each other and serve as a basis for confirming the main objective of the research.

4 Results

4.1 Hybrid method for calculating the price difference

Based on rich construction practice and some thoughtful solutions, a hybrid method can be used to calculate the price difference that is acceptable to both contracting parties. The following is a proposal for the introduction of a hybrid method in which the key items that represent the majority of the bid price are treated according to the calculation method, while all other items are calculated using the method of determining the price difference with the GZS-ZGIGM indices. When determining the key items and the other items, we apply the principle of ABC analysis, which is based on the fact that a small percentage of the items account for a high percentage of the construction costs. According to the concept of ABC analysis, we assume that the key items account for approximately 15% of all items, which in total account for approximately 75%

of the total costs in contract price (position A), while all other items account for the remaining 85% of the items, which in total account for the remaining 25% of the total costs in contract price (positions B and C). The method can be used for both main types of construction, i.e. buildings and civil engineering works.

For items A, the proposed method calculates the price differences by comparing the unit price calculations made on the chosen date c using the price lists and price analyses valid on the chosen date and on the start date s using the base price lists and price analyses. Their quotient represents the price difference (CPD_{sc}). The quotient for position A is therefore calculated as the ratio between the cumulative invoice amount for the month ' m ', including price differences, and the cumulative invoice amount calculated using the base contract price. The quotient for positions B and C is calculated as the ratio between the GZS-ZGIGM index for the month ' m ', i.e. on the chosen date (I_c) and the GZS-ZGIGM index on the contractually agreed starting date (I_s). In this way, we periodically calculate the price difference between the base contract price (CP_s) and the new contract price (CP_c), as well as the price difference coefficient (CPD_{sc}) as a quotient of these two values.

The calculation of price differences usually begins when the method determines that the price change has exceeded the agreed percentage of price invariability. Thereafter the calculation is made monthly on the basis of the value realised in each month in question. It can also be carried out in the final calculation of the contracted works, but the calculation must be carried out in the same way as if it were performed as an on-the-fly calculation in each month. The monthly calculation is carried out according to Eq. (4.1).

$$IAM = \left[\left(IAB_{mA} - IAB_{m-1A} \right) \frac{IAM_A}{IAB_{mA}} \right] + \left[\left(ICB_{mBC} - ICB_{m-1BC} \right) \frac{I_c}{I_s} \right] + IAM_{-1} \quad (4.1)$$

where IAM is the cumulative invoice amount per month ' m ', including price differences; IAM_{-1} is the cumulative invoice amount per penultimate month ' $m-1$ ', including price differences from the previous period (i.e. up to and including the previous month); IAB_{mA} is the cumulative invoice amount, calculated with the base contract prices for month ' m ' for positions A; IAB_{m-1A} is the cumulative invoice amount calculated with base contract prices per penultimate month ' $m-1$ ' for positions A; IAM_A is the cumulative invoice amount for the month ' m ' for positions

A, including price differences; IAB_{mA} is the cumulative invoice amount for the month ' m ' for positions A, calculated with base contract prices; ICB_{mBC} is the cumulative invoice amount calculated with base contract prices for the month ' m ' for positions B and C; ICB_{m-1BC} is the cumulative invoice amount calculated with base contract prices per penultimate month ' $m-1$ ' for positions B and C; I_c is the GZS-ZGIGM index for the month ' m '; and I_s is the index GZS-ZGIGM index on the contractually agreed starting date.

The main advantage of the proposed hybrid method is that for approximately 75% of the largest items by total value, the calculation method that best reflects how price increases affect the contract price is applied. However, for the credibility of the contract price, it is necessary to include calculation bases or at least price analysis calculations for the most important items already at the time of submitting the tender. If the investor or client has not requested these attachments, it will be very difficult to provide proof. On the other hand, index methods have the advantage of giving the client a sense of trust in the credibility of the indices, as they are prepared by official institutions.

4.2 An example of the calculation of indices of recognised price increases

In the following, the calculation of the indices of the recognised price increases of contract works is shown using the example of a public contract for the construction of sewers for two sewer sections named canal 1 (C1) and canal 2 (C2). We have chosen the example of a construction project carried out in the period from 2021 to 2022, when there was a significant increase in the prices of materials and services. All elements of the public contract in question that are essential to the purpose and credibility of the results are considered. The calculation of the recognised price increases of contract works for the period under consideration is presented by the calculation method, by the method with GZS-ZGIGM indices and by the hybrid method. The calculated indices are then compared.

4.2.1 Description of sewer sections

The two sewer sections are built by connecting to the already-built collector (Lineal 2020). The route of C1 runs from the inlet to the collector via a macadam path to the regional road and further along the pedestrian corridor of the municipal road. The route of the C2 runs along a

Tab. 2: Basic characteristics of channels

Channel	Pipeline diameter (mm)	Projected pipeline drop $i = [%]$	Length $L = [m]$
C1	DN 200	10.5–94.8	267.54
C2	DN 200	4.00	146.74

Source: Lineal (2020).
C1, canal 1; C2, canal 2.

municipal road and partly on overgrown terrain. The crossing of streams and ditches is planned by means of excavations. The house connections, i.e. the waste sewage, are connected to the planned sewage system. Table 2 shows the basic characteristics of channels.

The sewer line consists of PVC-U pipes SN8, crown stiffness SN8 or more, with minimal slopes. The shafts are made of reinforced concrete or polyethylene (PE). They consist of a DN 1,000 mm base (for depths over 1.5 m), a manhole body, a cone and a roof slab made of reinforced concrete as well as air- or air-tight cast-iron jacking covers with a diameter of 600 mm and a load-bearing capacity of 400 kN. The inspection chambers are prefabricated. The fittings for house connections are located 1.0 m from the property boundary on the wastewater collector that collects the municipal wastewater. The fittings are made of PE or PVC pipe DN 160 mm, circumferential stiffness SN8 and the house connection manhole is made of PE or PVC DN 600 mm or DN 800 mm for greater depths.

The Bill of Quantity is prepared according to the unit price estimate, while the contract price is concluded as a fixed price. The Bill of Quantity is an attachment to the contract. For both channels, the same norms and the same calculation bases are used to calculate the unit price for items of the same type. The calculation of the bid prices of the items is carried out using the computer program BLIST (Best IT d.o.o. 2024), into which the Excel files with the list of works are first imported. For most of the imported items, price analyses are carried out on the basis of the contractor’s own normative basis or on the normative basis of the BLIST program and using calculation elements price lists. For work that the contractor does not carry out itself, corresponding offers are obtained from subcontractors and material suppliers.

BLIST is a complete solution for planning, evaluating, analysing and monitoring construction projects. The program consists of six modules, of which the following are important for the creation and monitoring of contract prices: Bill of Quantity, Billing and Database. Here, the first enables the preparation of Bill of quantities and unit

price estimates. Direct access to the BEST internet database with specifications (over 25,000), norms and price lists is possible. The program also allows you to create your own database as well as bidirectional connection with Excel documents. The Billing module is intended for the accounting for executed works and enables efficient monitoring of construction costs (planned vs. actual) and the automatic preparation and printing of the Measurement Book, Construction Daily Log and Statement (interim and final). The Database module is the core of the data and comprises a database with specifications, materials, norms and prices from various sources. The database is systematically structured on several levels and can be linked to the accounting system or integrated into the Enterprise resource planning (ERP) system (Best IT d.o.o. 2024).

The base Bill of Quantity was prepared in March 2021 and amounted to 40.802,91 € for C1 and 40.002,27 € for C2. The bid prices for C1 with a length of 267.54 m and for C2 with a length of 146.74 m are almost the same. A comparison of the cost estimates for C1 and C2 shows that they are basically the same type of work, using the same materials, working techniques and price lists. The similarity of the prices for the different lengths is mainly due to the structure or technology of the work, which plays an important role in the bid price calculation: C2 is provided in the asphalt version, while C1 is provided in the gravel version.

4.2.2 Calculation and comparison of indices of recognised price increases

The calculation of the indices of recognised price increases of contract works is given for each channel for the observation period March 2021 to March 2022, using three methods: the calculation method, the method with GZS-ZGIGM indices, and the hybrid method. The index for recognised price increases of contract works is given as a ratio between the new contract price taking into account the price increases (*CPC*) and the base contract value (as base bid price) (*CPs*). The final value, i.e. new contract price is calculated only at the end of the observed period and not by an on-the-fly calculation each month.

The calculation of the new contract price according to the calculation method is based on Eq. (2.1). The *CPs* and *CPC* for C1 and C2 are the bases for the calculation of the coefficient of price difference (*CPDsc*), while index *IPDsc* is calculated according to Eq. (2.2). The procedure for calculating the new contract price is as follows: the calculation bases were first updated in the computer program

Tab. 3: Calculated indices of recognised price increases according to the calculation method

Channel	Base contract price (CPs) March 2021	New contract price (CPc) March 2022	Index
C1	40,802,91 €	45,681,93 €	111.96
C2	40,002,27 €	50907,78 €	127.26

C1, canal 1; C2, canal 2.

BLIST (Best IT d.o.o. 2024). The new value of the hourly labour rate and the estimated hourly rates for fixed assets are recalculated for the observed period in the BLIST. The offers for materials and subcontractors were also obtained at the end of the observation period. In the next step, the changed and updated data were entered into the calculation elements price list, which is linked to the base estimate. The recalculation of the price analysis results in the new value of the contract price (CPc). The calculation of the index of recognised price increases of contract works for each channel according to the calculation method in the observed period is shown in Table 3.

The new contract price at the end of the observation period (CPc) using the price difference calculation method with the GZS-ZGIGM indices is calculated according to Eq. (2.8). The price difference coefficient (CPDsc) is expressed by the GZS-ZGIGM index and calculated according to Eqs. (2.5) and (2.7). The starting points for the calculation are the base contract price (CPs) and the GZS-ZGIGM price indices for the relevant period and for the corresponding type of work. For the construction of sewage channels, we choose the index for the construction work under the number 06, other civil engineering works. The start date is 31 March 2021 (*I_s*), the chosen date is 31 March 2022 (*I_c*) and the transition to the next year is set to 31 December 2021 (*I_n*). The indices for the observed period are as follows: $I_s = I_{1.1.2021}^{31.3.2021} = 103.25$; $I_c = I_{1.1.2022}^{31.3.2022} = 107.04$; $I_n = I_{1.1.2021}^{31.12.2021} = 113.20$ (Chamber of Commerce and Industry of Slovenia, Chamber of Construction and Building Materials Industry of Slovenia 2022). The calculation of the index of work price increases for the period from 3 March 2021, to 31 December 2021, is shown in Eq. (4.2) and is up to the observed period from 31 March 2021 to 31 March 2022 in Eq. (4.3). The calculated index applies to both channels.

$$I_{31.3.2021}^{31.12.2021} = \frac{I_n}{I_s} 100 = 109.64 \tag{4.2}$$

$$I_{31.3.2022}^{31.3.2021} = \frac{\left(\frac{I_n}{I_s} 100\right) I_c}{100} = 117.36 \tag{4.3}$$

The calculation of the new contract price (CPc), expressed by the GZS-ZGIGM index, for each channel according to the GZS-ZGIGM method in the observed period is shown in Table 4.

The calculation of the new contract price (CPc) using the hybrid method is based on the principle of Eq. (4.1). In doing so, we calculate the index of recognised price increases of contract works between the estimate of the base contract price and the estimate of the price that was valid in March 2022. In the calculation, we have summarised the principle of ABC analysis. For C1, positions A (25% of the key items) account for 72.06% of the contract price, and positions B and C (75% of other the items) account for the remaining 27.94% of the contract price. For C2, position A (26% of key items) accounts for 71.59% of the contract price, and positions B and C (74% of other items) account for the remaining 28.41% of the contract price. The basis for the calculation is the base bid price, i.e. base contract value for both channels. For the calculation of the index of recognised price increases of contract works, two types of indices are used: for position A, the index (*IDPsc*) as used in the calculation method, and for positions B and C, the GZS-ZGIGM index applicable to the corresponding period and type of work under consideration. The calculation of the index of recognised price increases of contract works for each channel according to the hybrid method in the observed period is shown in Table 5.

Graph 2 shows a comparison of the indices of the recognised price increase of contract works according to all methods. The comparison shows that the use of a different method leads to greater deviations. For example, the index calculated using the calculation method is 5.4% lower for

Tab. 4: Calculated new contract price according to the GZS-ZGIGM method

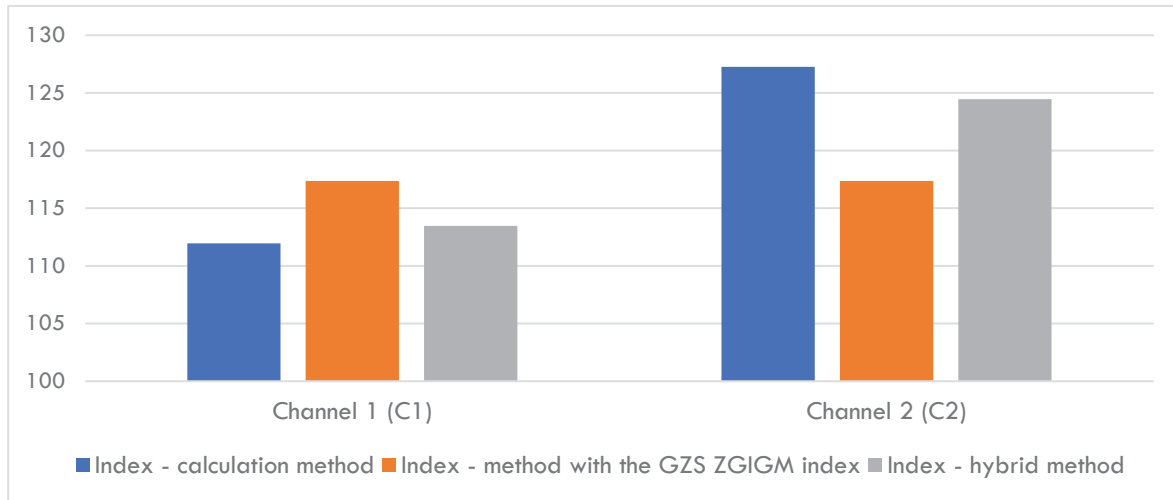
Channel	Base contract price (CPs) March 2021	Index GZS-ZGIGM	New contract price (CPc) March 2022
C1	40,802,91 €	117.36	47,886,30 €
C2	40,002,27 €	117.36	46,946,66 €

C1, canal 1; C2, canal 2.

Tab. 5: Calculated indices of recognised price increases using the hybrid method

Channel	Base contract price (CPs) March 2021	New contract price (CPc) March 2022	Index
C1	40,802,91 €	46,298,56 €	113.47
C2	40,002,27 €	49,781,79 €	124.45

C1, canal 1; C2, canal 2.



Graph 2: Comparison of the indices of the recognised price increases for the selected method. C1, canal 1; C2, canal 2.

C1 and 9.9% higher for C2 than using the GZS-ZGIGM index method. The comparison with the hybrid method shows that the index for C1 is 1.51% higher and for C2 2.81% lower than with the calculation method. The comparison of the hybrid method with the GZS-ZGIGM index method shows that the index for C1 is 3.98% lower and for C2 even 7.09% higher.

In addition, there are generally large differences in contract price increases between the channels C1 and C2. These differences are mainly due to the influence of the structure or working technique, the index lag (e.g. the input data are the invoices received, reporting delays for the GZS-ZGIGM indices) and the different price increases for materials and services. Since we have used the same bases for both channels, it is an obvious fact that the price even for the same type of work is strongly influenced by the structure of work or technology of construction. This is also the real reason for some percent of the price difference between C1 and C2: 15.30% according to the calculation method and 10.98% according to the hybrid method.

The disadvantage of both calculation methods is that price changes must be proven by price analyses and new calculation bases, especially if the starting point and the type of proof are not specified in the contract. Here, the burden of proof for recognised price increases of contract works lies with the contractor. Furthermore, the approximate index, to which the GZS-ZGIGM index belongs, reflects only the approximate average of the calculated indices, which is valid for both channels. We believe that the use of the GZS-ZGIGM indices in two separate contracts would imply an unfair calculation of price differences as far as the calculation of the price difference for C2 is concerned.

With both the calculation methods, it should also be noted that the price differences and the corresponding indices must be recalculated each month. This means a monthly collection of subcontractor offers, even for services and materials that have already been carried out at the start of construction (e.g. demolition work) or for materials that are only required at the end of the construction (e.g. asphalt). This problem could be avoided by applying the principle of ABC analysis, as we have proposed in the hybrid method.

4.3 Discussion

Despite the fact that the calculative elements of bid prices of the items have increased, many investors or clients still do not choose to regulate the method of calculating price differences already in the tender documents or in the contract, or they leave it to Article 656 of the *Obligations Code 2007* and CPC 2020 if they are not excluded. And when setting fixed prices, the risk of a price increase of up to 10% lies with the contractor, which is why he calculates the risks differently depending on his own forecasts. It is therefore very likely that the investor or client will not receive realistic and comparable tenders. In addition, the investor runs the risk of paying too much for the contractually agreed works if market prices fall. If, on the other hand, prices continue to rise, the investor even runs the risk of the contract being terminated because the contractor is unable to fulfil the contractual obligations. All this leads to a speculative rise in bid prices and a multitude of complications in solving the problem. Due to the urgency of the issue, an initiative has already been launched in

Slovenia to regulate this issue in the amendment to the CPC 2020.

Large contracting authorities of infrastructure projects in Slovenia, such as Družba za avtoceste v Republiki Sloveniji (DARS d. d), have recently decided to use the *Rules on the methods of valuing financial obligations contractually agreed upon by public sector entities 2004* in the tender documents regarding the methods for determining price differences. They refer to one of the indices compiled by Chamber of Commerce and Industry of Slovenia, SORS or EUROSTAT.

The next question that arises is the appropriateness of the application of Article 656 *Obligations Code 2007*, which transfers the risk of a price increase of up to 10% to the contractor. Due to the comparability of tenders, it would make sense for clients or investors to give the tenderer the option of indicating the level of risk in the tender documents or in the cost estimate. In order to avoid speculation, it would make sense to set the price stability threshold at a level of $\pm 2\%$, which represents an acceptable risk for both contracting parties.

An example of good practice in the calculation of price changes, which can already be found in procurement practice today, is the calculation of the valorisation from the time the tender is submitted and taking into account the corresponding GSZ-ZGIGM index, namely when the price increase exceeds the threshold value of $\pm 2\%$. The internationally used FIDIC contract can also be cited as an example of good practice, which even stipulates 28 days before the submission of the tender as the 'base date' for the calculation of price adjustments. However, it makes sense to include a provision on price variability even for contracts with a term of less than 1 year. In addition, the introduction of such a provision would provide the client or investor with information on whether and to what extent contractors have included risks related to price differences.

The methodology for calculating the price difference index is the next challenge. Usually, clients or investors defend the use of indices calculated by a state institution for reasons of credibility and simplicity of calculation. However, the price changes calculated according to the index method are usually lower than those calculated according to actual costs. In addition, the client usually does not have adequate personnel to check the calculations and take responsibility for the correctness of the calculated index. On the other hand, the calculation method carries the risk of the credibility of the calculated indices, which the contractor must prove. This is a particular challenge if the client or investor has not requested calculation

elements, price lists and price analyses for at least the most important items when submitting the tender.

5 Conclusion

The article deals with price changes in construction projects during the construction phase, which both clients or investors and contractors are confronted with due to unforeseen market conditions. Theoretically, we have described the methods for calculating price differences in general and outlined their advantages and disadvantages. As a result, we have proposed the hybrid method in which, according to the principle of ABC analysis, the key items that make up the largest part of the total bid price are treated with the calculation method, while all other items are calculated with the selected GSZ-ZGIGM index.

The occurrence of a contract price change during the period under consideration is discussed using a real example for two cases in the construction of sewer sections. The indices of recognised price increases of contract works are calculated using the three methods, namely the two most used methods today, i.e. the calculation method and the GSZ-ZGIGM method, as well as the hybrid method. The comparison of the results showed that the index according to the calculation method is 111.96 for C1 and 127.26 for C2, the index according to the GSZ-ZGIGM method is 117.36 for both channels and the index according to the hybrid method is 113.47 for C1 and 124.45 for C2. The large discrepancies between the calculated indices obtained with the two currently established methods and with the same calculation bases for the same works show that neither of these two methods satisfies both contracting parties at the same time. The indices calculated with these two methods differ significantly due to the specific structure of the works, which can vary greatly for projects of the same type. Therefore, a hybrid method is proposed that includes the two most commonly used methods and takes into account the principle of ABC analysis. The results show that this method is more acceptable for both sides. At the same time, it should be borne in mind that the vast majority of construction projects are multi-million projects, which means that any percentage change in price nominally represents a large risk for the contractor.

The dilemma about the appropriate method for calculating price differences for existing contracts for which no price increases have been agreed and for future public contracts could be resolved by one of the relevant ministries issuing a uniform instruction. So far,

institutions, i.e. ministries and chambers, have already issued guidelines, explanations or decisions on contract amendments due to price changes, but these are not binding. Uniform instructions would therefore be a suitable basis for the economical use of public funds and compliance with the principles of conscientiousness and honesty and in view of the increasingly rapid and unpredictable changes brought about by globalisation.

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