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Optimizing the cost of acquiring construction materials

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Abstract: The article presents selected problems of construction contractors in determining the optimal financial reserve in the bid price/base budget to cover the costs associated with the increase in the cost of construction materials, as well as optimization of the cost of acquiring this price-forming component.The first part of the article analyzes the determinants of changes in the average national prices of materials, labor rates (for general construction and high-standard finishing works) in 2020-2023. The second part of the article indicates the measures that should be taken by the contractor as part of an effective program to manage the acquisition costs of construction production factors, in particular, construction materials.

Keywords: price growth, forecasts, project margins

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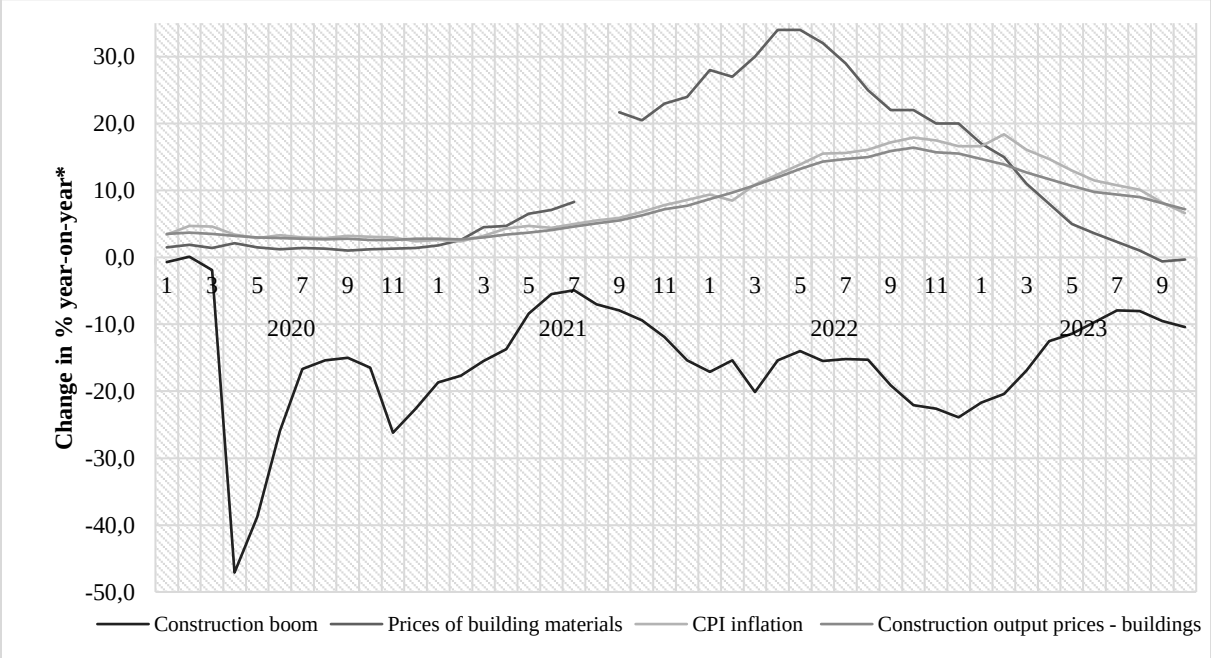
1. Introduction

Fluctuations in prices and rates of construction production factors are a natural phenomenon, and therefore the contractor, as a professional participant in economic transactions, should take this fact into account, determining in the bid price/base budget the optimal buffer for ordinary contractual risk, in order to avoid a situation of balancing on the brink of profitability of contract performance, especially without a valorization clause. This is not an easy task in view of the multitude of determinants of the cost of acquiring construction production factors variable over time, especially during the period of materialization of the negative effects of phenomena taking the form of force majeure, the accumulation of which the domestic market experienced in 2020-2023.

2. Determinants of acquisition costs of construction production factors in 2020-2023

In the period of IQ - Q3 2020, the cost of acquiring construction production factors remained relatively stable, despite the drastic downturn in the construction industry associated with geopolitical uncertainty and the need to comply with sanitary restrictions aimed at combating the spread of the SARS-CoV-2 virus from 03.10.2020 (*Figure 1*).



*does not refer to the construction boom referring to the percentage of respondents of the Central Statistical Office [% in a given month].

Fig. 1. CPI inflation [2], prices of construction materials [1], prices of construction and assembly production - buildings [3] vs. construction activity [3] in Poland January 2020 - October 2023**.**

The situation has changed significantly since Q4 2020, when the effects of the COVID-19 pandemic were dynamized by the negative effects of other events taking the form of force majeure [3, 4, 5], including, among others:

a) accumulation of adverse weather events including both heat and cold waves (e.g., Texas), rushes (e.g., Taiwan) and floods (e.g., China), hurricane-force winds (e.g., In-fa in the United States) and prolonged periods of flare,
b) armed actions and political tensions (e.g., the military coup in New Guinea),
c) transportation accidents (e.g., the accident of the mega-container Ever Given in the Suez Canal).

Construction contractors have experienced broken deliveries, uncontrolled labor shortages, and dynamic increases in the cost of obtaining construction materials, labor, and the rental and labor of equipment and process transportation.

The scale of restrictions on doing business in the construction sector increased after the outbreak of war in Ukraine, as a result of [3, 4, 5]:

a) record CPI inflation above the inflation target and acceptable deviation bands (*Figure 1*),
b) increased and uncontrolled absenteeism of workers - a derivative of the mass return of Ukrainians to their homeland,
c) unprecedented increases in the cost of energy from conventional sources - a derivative of rising coal and natural gas prices,
d) an unprecedented increase in the price of oil - including as a result of supply constraints by leading producers with a strong influence of OPEC+ and G7 policies,
e) Bottlenecks in the supply chains of apparatus, equipment and materials - a derivative of, among other things, the reduction of logistics operations during the lockdown period, congestion on major trade routes after the end of the "hard lockdown" in China, multi-directional economic sanctions imposed on the Russian Federation and Belarus, limited operation of Ukrainian plants, implementation by factories of strategies of selective production stoppages during the hours of consumption of the most expensive energy,
f) depreciation of the zloty against the euro and the U.S. dollar as a result of financial institutions' aversion to geopolitical risk,

g) The increase in transportation costs,
h) Increase in the cost of borrowing (loans and leases) - a derivative of the record rate of increase of the NBP reference rates to 6.75%.

After the outbreak of war in Ukraine, the prices of construction materials, labor rates, and the price of rental and labor of construction equipment rose sharply. In the opinion of the Public Procurement Office: "(...) *the armed conflict in Ukraine, its scope and cross-border, economic consequences, qualify as an external phenomenon that could not have been foreseen, despite the exercise of due diligence.*" The price/rate dynamics of these cost drivers significantly outpaced the record increase in CPI inflation (*Chart 2*). According to SEKOCENBUD Ltd. from Q1 2020 to Q4 2023 [6]:

– Prices for materials used in the construction industry overall rose 51.49%,
– labor rates for general investment construction work increased by 45.13%, and for high-standard finishing work increased by 45.96%,
– prices for rental and labor of construction equipment and process transportation vehicles increased by 36.82%.

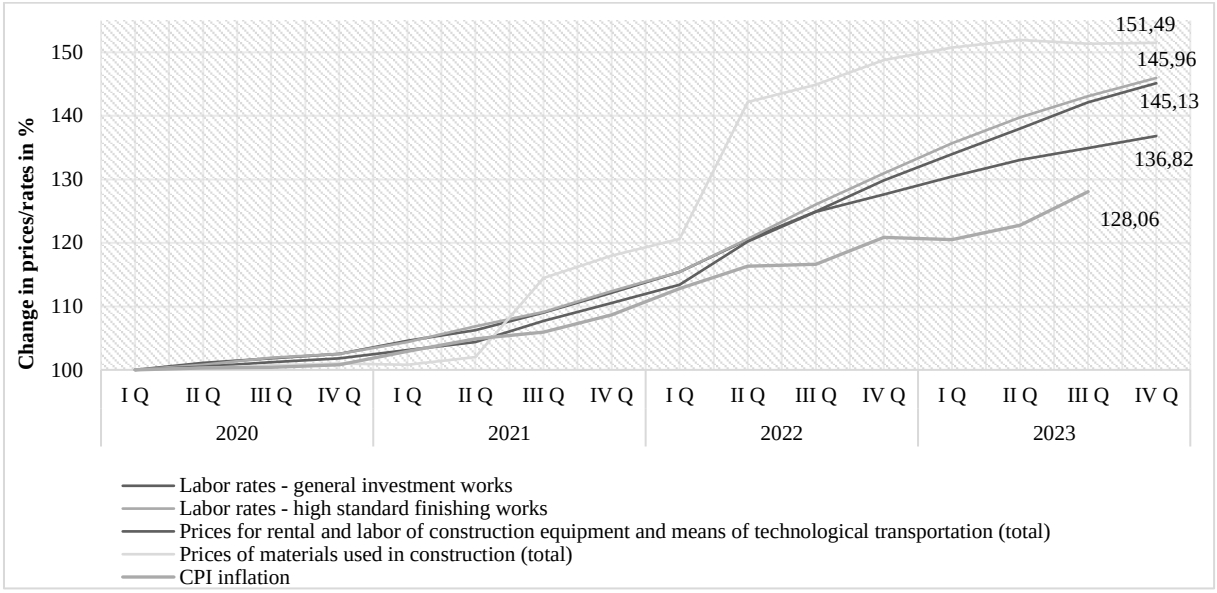


Fig. 2. Changes in prices and factor rates of construction and assembly production [2] vs. CPI inflation [2] in Poland in 2020-2023 (Q1 2020 = 100).

High prices for construction materials, apparatus and equipment in Q4 2021- Q4 2023 were mainly due to/from:

a) high CPI inflation, which stood at 18.4% year-on-year in February 2023 [2], the highest since 1997;
b) Non-ephemeral increases in production costs: increases in personnel costs, increases in the cost of obtaining strategic raw materials (*Figure 3*), increases in the price of energy from conventional sources, increases in water costs, and increases in waste management costs;
c) The high-margin policy of wholesale distributors of apparatus, equipment and materials;
d) disruptions in the supply of products and raw materials as a result of the war in Ukraine, for example:
    – steel products, semi-finished rolling products, as well as iron ore and scrap from the Russian Federation, Ukraine and Belarus, i.e. countries from which 3.03 million tons of steel were imported in 2021, or 25% of the steel consumed in Poland;
    – timber and wood products from Belarus, Ukraine and the Russian Federation, i.e. countries that accounted for about one-third of the volume of imports to the Polish market in 2021;

e) The increase in transportation costs;

f) The decreasing number of deposits with limited raw material resources;

g) the general destabilization of the global economic situation and the resulting disinformation and speculation (including gas and coal industrial rationing).

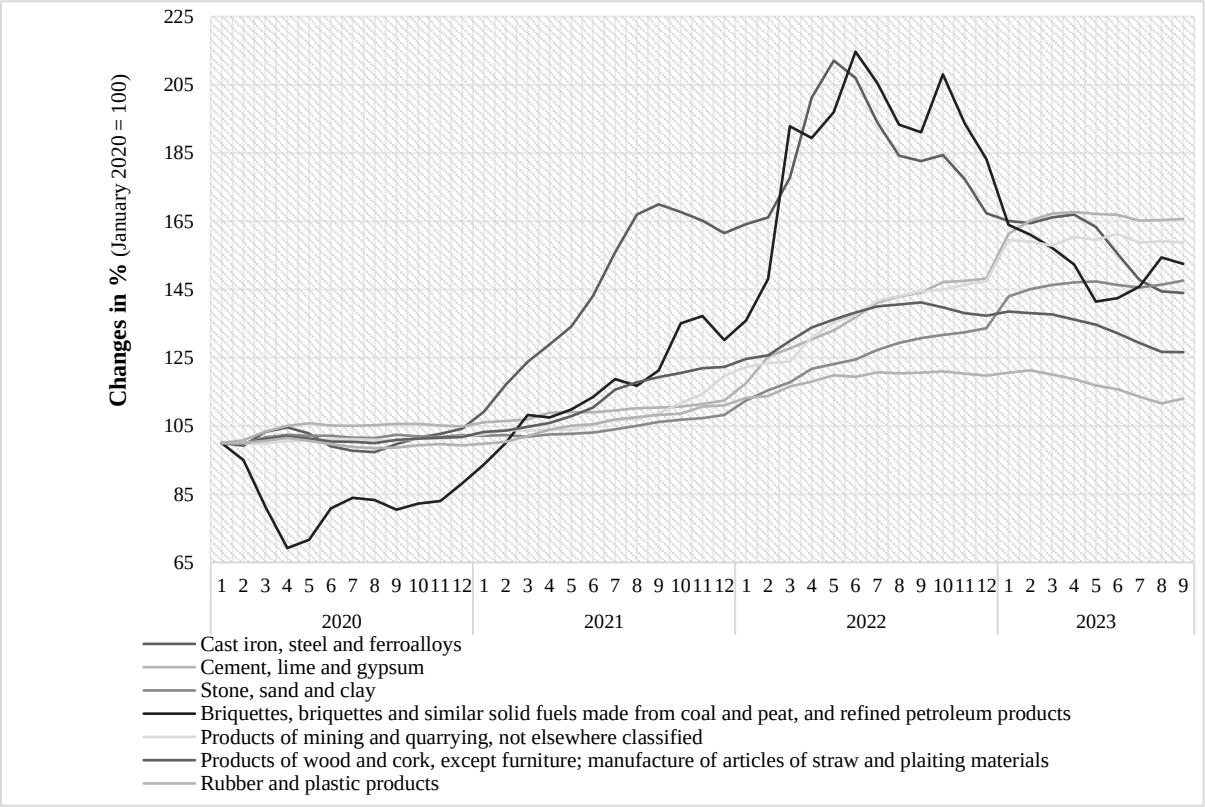


Fig 3. Changes in the price of sold production of products in Poland in January 2020. - September 2023 (January 2020 = 100) [2].

According to the PSB Group [1] and Sekocenbud Ltd. [6], the changes in the prices of steel, reinforced concrete, concrete, wood and wood-based products proved to be the most dynamic in 2020-2023. *Table 1* shows the main determinants of price increases for these materials, and others that are widely used in all segments of construction.

Table 1 Factors influencing price increases for selected materials between 2020 and 2023

Material	Factors driving up material prices
Metal products/ferrous metallurgy products	– Turbulence after the outbreak of war in Ukraine: • A ban on the import of semi-finished rolling products, as well as iron ore and scrap metal from Belarus (as of 03.03.2022) and the Russian Federation (as of 04.01.2022[1]) to European Union countries; • fear of potential payment problems for billets and billets of Russian and Belarusian origin; • Reduced capacity of Ukrainian steel mills and metallurgical plants; according to the Polish Union of Steel Distributors, in 2022 Ukraine's steel production decreased by 70.5% (i.e., to 6.26 million tons) year-on-year, and pig iron by 69.8% (i.e., to 6.39 million tons);

[1] EU Council Regulation 2022/428 of 15.03.2022 amending Regulation (EU) No. 833/2014 concerning restrictive measures in view of Russia's actions destabilizing the situation in Ukraine.

	– Increased costs of energy-intensive production (including furnace input costs, personnel costs, energy from conventional sources), resulting in the implementation of temporary shutdown policies during the most expensive energy consumption hours (e.g.among others, at China's Hebei Iron and Steel plant in Serbia, Slovakia's US Steel Kosice, the Czech Republic's Liberty Ostrava, Warsaw's ArcelorMittal, Arvedi's Cremona plant, and the former Ilva and now Acciaierie d'Italia steel plant in Taranto); – Technological transformation of steel mills to adapt them to the production of carbon-free steel; – Introduce freight tariffs and protectionist measures on imports from countries outside the European Union, – The depreciation of the zloty against the dominant currencies in foreign trade; – The high-margin policy of steel distributors; – Expanding the range of products covered by the SENT mechanism;
Styrofoam	– Price increase and shortage of graphite styrene; – A reduction in domestic resources (including as a result of the fire at the Swiecie polystyrene plant in June 2021); – Increased demand in Poland as a result of the introduction of stricter technical conditions for the physics of buildings as of 01.01.2021, as well as EU programs supporting activities in the area of thermal modernization; – Increase in energy prices and CO permit prices$_2$;
Mineral wool	– Increased demand in Poland as a result of the introduction of stricter technical conditions for the physics of buildings as of 01.01.2021, as well as EU programs supporting activities in the area of thermal modernization; – Increase in energy prices and CO permit prices$_2$;
Wood and wood-based products	– Increasing demand, including in the United States, Canada and China; – Turbulence after the outbreak of war in Ukraine: • Reduced capacity of Ukrainian sawmills after the outbreak of war, • The introduction of a ban on the import of products listed in Chapter 44 of the Combined Nomenclature from Belarus to the countries of the European Union from 03.02.2022, • The introduction by Decree of the President of the Russian Federation No. 100 of 03.08.2022 of a ban on the export of a large group of wood products to countries of the European Union, the United Kingdom, Canada, the United States, among others, – The flawed policy of selling timber resources by the State Forests;
Aggregate	– A sharp halt to aggregate imports from Belarus and Ukraine following the outbreak of war across the eastern border; – The need to increase the range of sourcing fine aggregates due to the General Directorate of National Roads and Highways' introduction of new technical requirements for their alkaline reactivity; – An increase in the cost of rail and truck transportation;
Concrete/cement	– Turbulence after the outbreak of war in Ukraine: • A ban from 03.03.2022 on cement imports from Belarus; • Reduced capacity at Ukrainian cement plants after the outbreak of war; – Imposition of an obligation on concrete producers to introduce and maintain a System of Factory Production Control from 01.01.2021 and to undergo mandatory certification; – An increase in the price of energy from conventional sources; – Price speculation about the possibility of the European Union halting imports of cheap cement from Turkey and North Africa; – An increase in transportation prices (including fuel prices and drivers' wages);
Electric cables and wires	– An increase in the price of base raw materials, including plastics, copper and aluminum; – Increase in energy prices and CO_2 ;

	– Increased demand, including in the construction and electronics industries; – Logistical disruption;
Paints	– An increase in the price of base raw materials, including epoxy and polyester resins, titanium white, solvents (including acetone and n-butyl acetate) and isocyanates; – Increasing demand; – Increases in energy prices and CO_2 ; – Logistical disruption;
Silicones	– Siloxane price increases; – Increasing demand; – Increase in energy prices and CO_2 ; – Logistical disruption.

The high cost of materials and raw materials, which dominate the cost of construction work, caused as many as 77.3% of companies to identify this factor as a barrier to doing business in the construction sector in June 2022. This was an unprecedented result in the history of economic surveys conducted by the Central Statistical Office [2].

3. Optimization of procurement costs of construction and assembly production factors

Aiming to determine in the bid price/base budget a buffer for ordinary contract risks at the optimal level, the contractor should entrust the preparation of the bid - the schedule and calculation of the bid price - to a team with complementary competencies, including those with knowledge and experience in planning and scheduling technology and costing of construction works.

The preparation of a bid in each case should be preceded by an adequate analysis of data relevant to the margins of the project, including [3, 9]:

a) terms of the construction contract, including the allocation of risks between the investor and the contractor;
b) The site of future construction - conducting a visual inspection;
c) reports of planned legislative changes, including planned amendments to the Tax Law and the Construction Law, which sets statutory deadlines for the actions of architectural and construction administration bodies and construction supervision bodies, which can have a significant impact on the allocation of physical and financial inputs over time [7, 8];
d) reports on planned government programs, including public investments forcing demand for cost drivers of construction works, and projections developed by financial institutions (e.g., the National Bank of Poland) and analytical and forecasting means, e.g.:
    - SEKOCENBUD Sp. z o.o., which publishes quarterly magazines titled *Aggregate indexes of valorization* and *prognostics ZWW* [6], containing information on changes in prices of production factors and construction objects occurring in Poland over a period of 10 years, as well as annual forecasts of net and gross labor costing rates, prices of construction materials, prices of labor and rental of construction equipment and means of technological transport, and prices of groups of construction objects. These forecasts are made on the basis of many years of empirical data, using statistical-econometric methods, verified with the knowledge and experience of experts;
    - PMR Ltd. Ltd. issuing reports containing, among other things, long-term forecasts of *"total inflation and construction output price inflation"* prepared using econometric models and historical time series. The forecasts of PMR Ltd. Ltd. for 2023-2028 include three scenarios - "*the baseline scenario - corresponds, according to the authors, to the most likely behavior of the economy and the market; the pessimistic scenario - assumes a slower pace of development of the economy, stronger inflation and a longer waiting period for EU funds under the NIP; the optimistic scenario - assumes a more favorable macroeconomic and*

market situation than in the baseline variant" [10].

At the same time, it should be borne in mind that projections/forecasts of indicators in the medium and long term of economic and political instability are subject to a high degree of uncertainty, in particular those made before the occurrence of force majeure events, as confirmed by an analysis of the CPI inflation projection prepared by the National Bank of Poland (*Table 2*) and forecasts of price indicators prepared by econometrists SEKOCENBUD Sp. z o.o. (*Table 3*), before the outbreak of war in Ukraine. The flagship example is the projection of CPI inflation in Q4 2022, developed by the National Bank of Poland in November 2021, with an error of as much as 12.9 percentage points (CPI inflation in Q4 2022 was projected at 4.4% year-on-year and was 17.3% year-on-year).

Table 2. CPI inflation projection error developed by the National Bank of Poland in November 2021

Type of data	Change to previous year quarter				
	Q4 2021	IQ 2022	Q2 2022	Q3 2022	Q4 2022
Indicator forecast	6,7	7,0	6,4	5,5	4,4
Data from the Central Statistical Office	7,7	9,7	13,9	16,3	17,3
Ex post forecast error (percentage points)	1,0	2,7	7,5	10,8	12,9

Table 3. Error of price index forecasts prepared by SEKOCENBUD Ltd. in mid-February 2022

Indicator		Forecast to previous quarter			
		IQ 2022	Q2 2022	Q3 2022	Q4 2022
Changes in prices of materials used in construction in general	Forecast	2,3	2,5	2,7	2,8
	SEKOCENBUD data	17,9	1,9	1,8	1,8
	Ex post forecast error (percentage points)	15,6	-0,6	-0,9	-1,8
Changes in the price of multifamily housing facilities	Forecast	2,3	1,7	1,6	1,6
	SEKOCENBUD data	10,6	2,7	2,5	1,9
	Ex post forecast error (percentage points)	8,3	1,0	0,9	0,3
Changes in prices of public facilities	Forecast	1,6	1,6	1,6	1,6
	SEKOCENBUD data	9,7	3,1	2,4	1,8
	Ex post forecast error (percentage points)	8,1	1,5	0,8	0,2
Changes in prices of manufacturing, service and storage facilities	Forecast	2,6	2,9	2,2	2,0
	SEKOCENBUD data	9,6	3,2	2,7	1,9
	Ex post forecast error (percentage points)	7,0	0,3	0,5	-0,1

Effective management of the cost of procurement of construction production factors, especially construction materials, during the period of execution of the object of the construction contract includes [3, 9]:

a) concluding lucrative contracts with subcontractors of construction works, services and supplies with entities that provide guarantees of proper performance, on the basis of the material and financial schedule (albeit an indicative schedule);
b) Analysis of the possibility of aggregating supplies to minimize transportation costs, and analysis of making purchases in advance taking into account the various risks involved, including:
– the financial loss of the contractor in a situation where the price of construction materials on the market is reduced after purchase or excessive storage costs are incurred;
– reduction in the performance of materials in the course of their loading, transportation, unloading and storage;
– The finality of the material solutions adopted (the risk of having to use other material solutions);
c) Optimal allocation of financial outlays for physical inputs over time, including strategic disbursement of advances;

d) Optimal use of construction materials, including efforts to minimize waste generation and avoid unwarranted employee downtime;
e) Implementing measures to reduce the risk of non-performance or improper performance of subcontracted services, including, among other things, ensuring continuous and effective monitoring and controlling of the material and financial scope of supplies, works and services and their quality;
f) Using legal instruments (e.g., contractual penalties) to mobilize subcontractors if amicable urgings prove ineffective.

At the end of each contract, the construction contractor should conduct a multi-faceted as-built analysis, from which it will learn from successes and failures for the future, begin to promote good practices and eliminate bad habits.

4. Summary

Miscalculation of the baseline project budget can result in unprofitability and, in extreme cases, undermine the financial health of the contractor. The bid price should therefore include a buffer (preferably - optimal or at least - reasonable) for the risk of exceeding the baseline project scope, budget and time, giving the contractor security. This is not an easy task, since the projections/forecasts of indicators commonly used by bidding departments of construction contractors to create scenarios for changes in construction factor prices in the medium and long term of economic and political instability are subject to a high degree of uncertainty. In view of the above, the effects of extraordinary economic risks arising from the occurrence of phenomena that are difficult or even impossible to predict at the stage of the contract award procedure should be minimized by an effective valorization clause, regardless of the status of the investor [5].

The article presents the results of empirical research and is part of the doctoral dissertation being prepared by Lidia Więclaw-Bator, M.Sc.

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