Features of the factor models for the corporate cost management purposes in construction

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Abstract. The article examines the methodological aspects of constructing the multiplicative factorial analytical economic models that allow to systematically study the influence of the analyzed factors on the change in the total, including the material costs in the production (sale) of construction products, to identify negative trends and potential problems in the activities of the construction organizations. To implement the proper quality of constructing a complex of multiplicative factorial analytical economic models for the corporate cost management purposes in the construction industry, the requirements excluding the formal methods for constructing the models have been identified. When constructing the multiplicative factorial economic models, the expansion method, which reflects the fulfillment of the requirements established during the study for the development of such models, was used. Resulting the signs in the developed complex of multiplicative factorial economic models for the purposes of corporate cost management suggest the total costs of production (sale) of the construction products; production costs using the new (innovative) building materials; the specific total costs of production using the new (innovative) building materials, calculated per unit of the manufactured (sold) products in kind using the new (innovative) building materials; the specific total costs of the construction products manufacturing (sales) using the new (innovative) building materials as a part of the total production costs (sales) of the construction products; the material costs of the construction products manufactured using the new (innovative) building materials; specific material costs of products using the new (innovative) building materials in the total volume of production in physical terms by the construction organization (structural unit, construction project, separate type of work). The recommended set of multiplicative analytical economic models is aimed at developing the potential of economic analysis factor based on improving the information analytical database quality on the degree of the analyzed factors’ impact on the cost changes for the purpose of making the successful managerial decisions in the system of corporate cost management in construction

1. Introduction
Current global political, economic and technological trends have a significant impact on the change in the growth potential and the world economies development, causing the related problems of the national and corporate economies. The key problem of the countries with developed market economies is the problem of increasing the economic efficiency, the search for a solution, which is associated with the economic system efficiency theory development, aimed at substantiating the criteria and parameters of economic efficiency, developing models, methods for measuring, analyzing and evaluating efficiency, as well as performance of the management tools [1].
The relevance of the search for a solution to the problem of increasing the national economy efficiency and its economic entities is due to the material and raw materials resources growing deficit intensification at the present stage, the business globalization, the aggravation of financial and economic risks, and the increased competition. This necessitates the search for a solution to the cost optimization problem in the corporate cost management system in the construction industry, associated with the need of:

- the successful adaptation of the construction organizations management to the changes in the external environment, which prompts the qualitative monitoring, analysis and assessment of the micro and macro environment factors’ influence on economic results and the organizations’ competitiveness;
- increase the efficiency of the use of labor, material, technical, financial, organizational and managerial resources that affect the change in costs;
- increasing the efficiency of managing the process of optimizing the general and local costs in the production and sale of the construction products, including the material costs, due to their largest share in the total cost structure.

The actualization of the search for a solution to the cost optimization problem in the production activities of economic systems organizations in different countries has been extremely aggravated recently due to the fact that the world economy has become hostage to the risk factors’ influence due to the COVID-19 pandemic and the decline in oil prices since the end of 2019 and the beginning 2020. This led to disruptions in international trade, the restriction of labor migration and the growth of unemployment, the halt of the entire business sectors and the slowdown of the investment projects, the healthcare costs and business spending growth, as a result of which the world economy was in a recession phase. The experts assess this situation even worse than during the 2008-2009 crisis.

The socio-economic consequences of these processes have yet to be fully identified and evaluated in the near future, taking into account the fact that to restore the national economy growth in many countries, significant additional state funds will be required to prevent unemployment, support incomes and business activities, as well as related costs to contain inflation and increased investment activity of production organizations in various sectors of the economy, including the construction sector. In this situation, we should expect toughening competition in international and domestic markets for resources and the ability to survive, encouraging to minimize costs in the near future. This actualizes the research aimed at finding a solution to the effective cost management problem in the production organizations’ activities, including construction organizations in many countries.

2. The results of the study
One of the significant criteria for evaluating the cost management effectiveness, including material costs in the production and the construction products’ sale, are the unit costs. However, the actual costs per ruble of the work performed by the construction organizations by the economic activity type “Construction” throughout Russia for a long time remain quite high and do not reflect a downward trend (88 kopecks in 2005 and 88 kopecks in 2017 [2]). A similar negative trend persists in the material costs of construction organizations to carry out the works that have the largest share in total costs (57.4% in 2005 and 57.8% in 2017 [2]). The current negative situation objectively necessitates the adoption of the radical measures aimed at reducing the total unit costs and the construction work material consumption level with a focus on approaching the material costs structure in foreign countries to 55.0% [3].

In this regard, the role and importance of the corporate system for managing the process of improving the material, technical, financial and labor resources of construction organizations is growing in a complex relationship with the process of effective cost management in the production and sale of the construction products. An important tool for the successful corporate cost management is the effective implementation of the cost management functions, including economic analysis and assessment of the impact of external and internal factors on the construction organization’s change in costs. This objectively necessitates the improvement of the costs’ method economic analysis factor,
which contributes to an increase in the level of the managerial decision-making quality at the stage of identifying and implementing the reserves to reduce costs.

The main methodological issue in economic analysis is the factor economic analysis methodology improvement, which makes it possible to systematically study the influence of factors on changes in the results of production and economic activities of the construction organizations, to identify the trends, economic risks and potential problems of growth and development of the organizations’ economy. In this regard, the aim of the study is to develop the potential of factor economic analysis, which improves the quality of the information analytical database on the analyzed factors’ influence degree on the change in total costs, including the material costs of the construction organization, in a complex relationship with the analysis and assessment of the costs’ impact on changing its economic results based on the construction of multiplicative analytical economic models that improve the economic analysis quality and adopted the successful management solutions in corporate expense management.

Based on the goal, the research objectives are aimed at developing the potential of economic modeling as a tool to improve the quality of the corporate cost management in the construction organizations’ activities, focused on the construction of deterministic multiplicative analytical economic models that are of practical importance for identifying and assessing the internal and external environment analyzed factors’ influence degree on the change in economic indicators, including total and material costs in the sphere of production and sale of the construction products.

Guided by the well-known aphorism “going to the goal, choose the right route”, we will clarify the initial requirements for the construction of a deterministic factor analytical economic models complex that determines the features of a methodological approach to the process of constructing the factor models. Therefore, in order to implement the proper quality of constructing a complex of factorial analytical models, the study identified the requirements that exclude the formal methods for constructing the multiplicative factorial analytical economic models. The following requirements were identified as a part of the basic requirements: compliance with the identity of the left and right parts of the factorial analytical model; lack of duplicating factors in the model; each factor included in the model must have a clearly expressed economic content; the completed view of the factor model and its effective features are determined by the goals and objectives of the corporate economic analysis; factorial analytical economic model should have practical significance.

The construction of the determinate factorial analytical economic models is recommended to be carried out differentially, as applied to the process of the construction products’ manufacturing (works, services) and selectively to the process of selling the construction products (works, services). In this regard, the effective features of the factor models are determined based on the goals and objectives of the corporate economic analysis or the research objectives. In continuation of the multiplicative factor models’ complex previously developed by us, which included the profit from the sale of the innovative construction products [4], we investigate the construction of a multiplicative factor economic models complex in which the total corporate costs of the construction organization, material costs, are considered as effective indicators, including the costs with the new building materials’ use, in relation to the production process and the construction products’ sale.

In this regard, we study the features of a methodological approach to the construction of the deterministic factor economic models as applied to the production and sale of the construction products, taking into account compliance with the identified requirements for the construction of this model type. Let us consider initially the construction of a factor analytical economic model, in which the effective attribute is presented as an indicator of costs in the field of construction products manufacturing (construction and installation works). To do this, we use the cost indicator per ruble of the work performed by the construction organization, which is presented as a part of the official statistical reporting economic indicators on the construction activity. The algorithm for calculating this indicator is the basis for the factor economic model formation of the following type:
where $TC$ – is the effective indicator (actual (planned) total costs (cost of the construction and installation works) for the construction organization (structural unit, construction project, separate type of work) for the analyzed period; $VP$ – is the factor indicator (actual (planned) volume of construction and installation works for the construction organization (structural unit, construction object, a separate type of work) for the analyzed period; $UC$ – is the factor attribute (actual (planned) specific total costs for a construction organization (structural unit, construction object, separate type of work) for the analyzed period (costs per ruble of the completed work); $I_{TC}$ – is the growth rate (decrease) of actual (planned) total costs (cost of construction and installation works) for a construction organization (structural unit, construction project, separate type of work) for the analyzed period; $I_{VP}$ – defines the growth rate (decrease) in the actual (planned) volume of construction and installation work for the construction organization (structural unit, construction project, separate type of work) for the analyzed period; $I_{UC}$ – is the growth rate (decrease) of actual (planned) total unit costs for a construction organization (structural unit, construction project, separate type of work) for the analyzed period (total cost per ruble of the work performed).

The model limitations (1) for conducting a qualitative economic analysis are obvious: the model does not have any practical significance due to the formal method of its construction (the volume of construction and installation work in the reporting period is not comparable with the volume of the construction and installation work at the price of the base period). In order for the model (1) to become practically significant, the total costs of the reporting period should be brought into comparability in price with the production volume of the previous analyzed period. For this, the initial model (1) should be presented in the form of an alternative model (2), having the form:

$$\frac{TC}{OCP} = UC_{OCP}; \quad TC = OCP \times UC_{OCP}; \quad I_{TC} = I_{OCP} \times I_{UC(OCP)},$$

(2)

$OCP$ – denotes the factor attribute (actual (planned) volume of construction and the installation work for a construction organization (structural unit, construction object, separate type of work) for the analyzed period, brought into comparable price with the volume of the base (previous) period); $UC_{OCP}$ – is the factor attribute (actual (planned) specific total costs for the construction organization (structural unit, construction object, separate type of work) for the analyzed period (costs per ruble of work performed), brought into comparability at the price previous to the analyzed period).

The factor model use (2) for the purposes of economic analysis and cost management in the construction organizations’ activities allows to identify the potential opportunities to reduce the specific total costs due to the key factors’ influence (effect on the production scale and the possibility of reducing the fixed and variable costs). However, the factor economic model (3) in comparison with the factor model (2) and taking into account the use of specific total costs per unit of natural products as a key factor in competition in the Cournot duopoly model (Antoine Auguste Cournot, French mathematician, philosopher, economist [5]) should be considered more productive and in demand for practice, having the following form:

$$\frac{TC}{NO} = UC_{NO}; \quad TC = NO \times UC_{NO}; \quad I_{TC} = I_{NO} \times I_{UC(NO)},$$

(3)

$NO$ – is the factor sign (actual (planned) volume of production (sales) of construction products in physical terms by the construction organization (structural unit, construction object, separate type of work) for the analyzed period); $UC_{NO}$ – defines the factor attribute (actual (planned) specific total costs for a construction organization (structural unit, construction object, separate type of work) for the analyzed period, calculated per unit of natural products; $I_{NO}$ – is the growth rate (decrease) of the actual (planned) volume of production (sale) of construction products (sale) in physical terms by the
construction organization (structural unit, construction project, separate type of work) for the analyzed period; $I_{UC(NO)}$ – defines the growth rate (decrease) of actual (planned) total unit costs for a construction organization (structural unit, construction project, separate type of work) for the analyzed period, calculated on the production volume.

Taking into account the relevance of the new construction materials’ use in construction, we consider the features of constructing multiplicative factorial economic models that are in demand for the cost management of a construction organization using the new construction materials. Using an analogue of building a factor economic model (3), a model (4) that is needed to analyze the influence of environmental factors on the change in the cost of production of construction and installation works using new (innovative) building materials can be proposed. The model has the following form:

$$ \frac{TC_{UBM}}{NO_{UBM}} = UC_{UBM} \times TC_{UBM} = NO_{UBM} \times UC_{UBM} ; \quad I_{TC(UBM)} = I_{NO(UBM)} \times I_{UC(UBM)} ;$$

where $TC_{UBM}$ – is the productive sign (actual (planned) costs (cost) of construction and installation works for the construction organization (structural unit, construction object, separate type of work) for the analyzed period using the new (innovative) building materials); $NO_{UBM}$ – denotes the factor sign (actual (planned) volume of production (sales) of construction products in physical terms by the construction organization (structural unit, construction object, separate type of work) for the analyzed period using the new (innovative) building materials); $UC_{UBM}$ – is the factor attribute (actual (planned) specific total costs for a construction organization (structural unit, construction object, separate type of work) for the analyzed period, calculated per unit of natural products using the new (innovative) building materials).

The main drawback of the models’ practical application (2,3,4) for the corporate cost management purposes is the limited number of factors presented in the model. In the corporate cost management system, multifactor multiplicative analytical economic models are of much greater practical importance, which is possible when applying the expansion method. However, using the extension method involves many difficulties in constructing the factorial analytical models of the multiplicative type, since when constructing them, it is necessary to take into account that all the components of such a model have the possibility of economic interpretation [6]. Applying the expansion method to build the multifactor multiplicative factorial economic models, it is necessary to ensure the possibility of a systematic approach to their construction so that the influence of each factor can be considered in a complex connection with other factors.

Applying the extension method to model (4) to build a multi-factor model, we obtain the two-factor economic model of the following form:

$$ \frac{TC_{UBM}}{NO_{UBM}} \times \frac{NO_{UBM}}{NO} = UC_{UBM} ,$$

where $TC_{UBM}/NO_{UBM}$ – defines the factor sign (specific weight of actual (planned) total costs (cost) of the construction and installation works for a construction organization (structural unit, construction object, separate type of work) for the analyzed period using the new (innovative) building materials calculated on a natural measuring instrument for construction products); $NO_{UBM}/NO$ – presents the factor sign (specific weight of the actual (planned) volume of production (sale) of construction products in physical terms by the construction organization (structural unit, construction project, separate type of work) for the analyzed period using the new (innovative) building materials in the total production (sales) ) construction products in kind) in the analyzed period; $UC_{UBM}/NO$ – denotes the productive characteristic (actual (planned) specific total costs for the construction organization (structural unit, construction object, separate type of work) for the analyzed period, calculated per unit of natural products using the new (innovative) building materials, per unit of production (realized) construction products).
The disadvantage of this model is its incompleteness. To eliminate it, we use the expansion method as applied to the model (5), which allows to construct a new type of model, which is in demand for the corporate economic analysis:

\[
\frac{TC_{UBM}}{NO_{UBM}} \times \frac{NO_{UBM}}{NO} \times \frac{NO}{TC} = \frac{UC_{UBM}}{TC},
\]

where \( NO/TC \) – can be the factor sign (level of production (sales) efficiency of construction products in physical terms by the construction organization (structural unit, construction project, individual type of work) for the analyzed period calculated using the costly method); \( UC_{UBM}/TC \) – defines the productive attribute (the proportion of total costs for the volume of production (sales) of construction products produced using new (innovative) building materials in the analyzed period in the total costs of production (sales) of the construction products for the analyzed period for the construction organization (structural unit, construction object, separate type of work).

Since the factor model (6) is complete, one should consider the possibility of constructing the factor analytical models with a different composition of productive and factor attributes. We study the features of constructing the factorial economic models, the effective sign of which is the material consumption of the construction products. A similar model may have the following form:

\[
\frac{MC_{NM}}{TMC} = MCP_{NM},
\]

where \( MC_{NM} \) – is the productive attribute (material costs of construction products manufactured using new (innovative) building materials for the construction organization (structural unit, construction project, separate type of work); \( TMC \) – is the factor attribute (total material costs of production (sale) of construction products by a construction organization (structural unit, construction object, separate type of work); \( MCP_{NM} \) – is the factor attribute (the proportion of material costs of products manufactured using new (innovative) building materials in the total cost of material costs for a construction organization (structural unit, construction project, separate type of work).

The extension method’s application to the model (7) makes it possible to construct the following model type:

\[
\frac{MC_{NM}}{TMC} \times \frac{TMC}{NO} = \frac{MC_{NM}}{NO},
\]

where \( MC_{NM}/NO \) – defines the productive attribute (the proportion of material costs of products manufactured using new (innovative) building materials in relation to the total volume of production in physical terms by the construction organization (structural unit, construction project, separate type of work); \( TMC/NO \) - in the analyzed period in the total volume of production, calculated in kind, by the construction organization (structural unit, construction project, separate type of work).

A new kind of analytical model can be built on the basis of the model (8):

\[
\frac{MC_{NM}}{TMC} \times \frac{TMC}{NO} \times \frac{NO}{NO_{NM}} = \frac{MC_{NM}}{NO_{NM}},
\]

where \( MC_{NM}/NO_{NM} \) – is the productive attribute (the proportion of material costs of products manufactured using the new (innovative) building materials in relation to the volume of production in kind, produced using new (innovative) building materials, by the construction organization (structural unit, construction object, separate type works); \( NO/NO_{NM} \) – defines the factor attribute (ratio of the total volume of production (sales) of construction products in physical terms to the volume of production (sales) of construction products in physical terms using the new (innovative) building materials for the construction organization (structural unit, construction project, separate type of work).
3. Summary
The problem of the corporate cost management effectiveness occupies a leading role among the totality of problems faced by the construction organizations in the current environment of the increased competition in the construction market. It becomes especially relevant in the context of increasing the production costs and the need for their optimization in the construction organizations’ activities in a crisis development situation. In these conditions, the role and importance of the corporate qualitative economic analysis is increasing, which allows systematically investigating the factors affecting the change in the construction organizations production activities’ results. Depending on the quality of measuring the influence of factors on the economic results, the results of corporate governance decisions in cost management change.

The economic analysis effectiveness is largely determined by the deterministic analytical economic models’ construction quality. In this regard, in the course of the study, the basic requirements for the construction of multiplicative factorial economic models were identified, in accordance with which the recommended set of factorial economic models, demanded in the practice of corporate cost management in the construction organizations’ activities, was built. At the same time, the main attention in the course of the study was paid to the multiplicative factorial economic models’ construction, in which the effective features were considered:

- total costs (cost) of the construction products manufacturing (sale) for the construction organization (structural unit, construction project, a separate type of work);
- costs (cost) of the building products manufacturing using the new (innovative) building materials for the whole construction organization (structural unit, construction project, separate type of work);
- the specific total costs of the construction products manufacturing using the new (innovative) building materials, calculated per unit of manufactured (sold) products in physical terms using the new (innovative) building materials, by the construction organization (structural unit, construction project, separate type of work);
- specific total costs of production (sales) of the construction products manufacturing using the new (innovative) building materials as part of the total costs of production (sales) of construction products for the analyzed period for the construction organization (structural unit, construction project, separate type of work);
- material costs for the volume of the construction products manufacturing using the new (innovative) building materials for the construction organization (structural unit, construction project, a separate type of work);
- specific material costs of products manufacturing using the new (innovative) building materials in the total volume of production in physical terms by the construction organization (structural unit, construction object, separate type of work).

The complex of multiplicative analytical factor economic models developed in the course of the study, the productive features of which were different types of costs, improves the quality of factor analysis, which is an important tool in the successful corporate cost management implementation in the construction organizations’ activities. The construction of the factor economic models, in which the effective indicators are the performance indicators of the construction organization, and the factor signs are the construction products manufacturing costs (sale), is the subject of the further research.

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