Modeling the effect of using the innovative materials on the construction organizations economic performance

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Abstract. The article describes a methodical approach to the development of modeling tools to improve the factor analysis quality and assess the innovations using effect on the economic performance of the building contractors. To solve this problem, the innovation process management methodological principles determining the requirements for modeling and the factor models development for the purpose of analyzing and evaluating the impact of innovations, including innovative materials, on the efficiency of construction organizations, were substantiated. The key criterial parameters of the comparative evaluation were identified and structured during the study, characterizing the innovation impact, including the innovative building materials, on the construction organizations performance. This allowed to form an information and analytical database for the factor models development, which allow the system to identify the studied factors influence on the construction organizations final results. At the factor models development, the type of multiplicative models was used. In the developing analytical factor models process, a method for constructing deterministic factor models was implemented using the extension method and following the requirements for developing such models. Taking into account the compliance with these requirements, a complex of multiplicative factor models, in which the profit from the sale of innovative construction products is a productive indicator, has been developed. The developed factor models improve the quality of analysis and innovation causal relationship evaluation with the construction organizations efficiency, realizing the external and internal factors influence complex interrelation potential on the change in profits from the sale of innovative products.

Introduction

The use of innovative technologies and new building materials in the activities of industrial enterprises and organizations is an actual scientific and applied task. In this regard, the importance of developing methods to justify the impact of innovation on the performance of construction organizations is increasing. In the applied aspect, this necessitates the development of modeling tools, factor analysis and assessment of the impact of innovative technologies in production and management on the economic results of construction companies.

The lack of a unified approach to evaluating the effectiveness of innovations until recently [1], as well as to assessing the impact of innovative building materials on the efficiency of construction organizations, aggravated by the imperfection of the method of measuring the effective activity of construction organizations [2, 3, 4], as well as the method of measuring and evaluating the impact.
innovation to change the growth potential and the construction organizations development [5], actualizes the search for solutions to the complex of these tasks. In this regard, improving the method of assessing the impact of innovative building materials on the final results of construction organizations based on the realization of the potential to develop analytical factor models that improve the quality of factor analysis is an important task.

**Theoretical part**

In a market economy, only those construction organizations capable of striving to increase the efficiency of their activities can function successfully. Thus, the cost of one ruble of the work performed by construction organizations in the form of economic activity "Construction" for 2005-2017 amounted to 88 kopecks or more [6], and the share of material costs in the structure of the actual cost of organizations for the production of works for the same period reached at least 75% [6]. In this situation, the role of innovation potential in the formation of a financial block of indicators of the effective activity of construction organizations, coupled with changes in unit costs and material consumption of building products (works, services), is significantly increased.

In this regard, the purpose of the study is to use the potential of modeling as a tool for analyzing and assessing the impact of innovation, including innovative building materials, on the performance of construction organizations. In accordance with the goal of the research tasks are considered:

- study of the potential of modeling to identify the extent of the impact of innovation, including innovative building materials, on the performance of construction organizations;
- identifying the potential areas of research related to the justification of criteria and methods for evaluating the effectiveness at the stage of development and implementation of investment projects based on statistical calculation methods;
- justification of the methodological principles of innovation process management, which determine the requirements for modeling and the development of factor models for the purposes of analyzing and evaluating the impact of innovations;
- identification and arrangement of criteria parameters of a comparative assessment of the potential for the use of innovations;
- development of multiplicative factor models for the purposes of factor analysis and assessment of the impact of innovations, including innovative building materials, on the results of effective activities of construction organizations.

The use of innovations at the design stage of buildings and structures necessitates the improvement of methods for evaluating the effectiveness of innovative construction projects as an independent research direction. At the same time, the potential opportunity to increase the volume of construction contributes to the formation and development of an innovative economy in the activities of construction participants. In this regard, the development of new tools for managing innovation processes is required from the standpoint of enhancing their impact on the economic performance of construction organizations. Improving the methods of measuring, monitoring, analyzing and evaluating the impact of innovative technologies and building materials on the performance of construction organizations is considered by us as one of these tools.

Both potential research directions are associated with the justification of the criteria and methods for evaluating the effectiveness, both at the stage of developing investment projects and at the stage of their implementation. Conceptually, an alternative approach is also possible from the standpoint of following the basic tools of economic theory — theories, laws, principles, models [7], the characteristics of which can be used in the applied aspect in the development of new tools in managing innovation processes in construction activities. An important basis for the development of economic theory is the development of the theory and practice of managing the competitiveness of enterprises based on the economic law on managing their competitiveness [8]. At the same time, it is important to understand the dominance of the principle of competitiveness of a construction organization with respect to the principle of their efficient operation [9], which should be taken into account when
developing factor models for the purposes of analyzing and evaluating the impact of innovations on the efficiency of construction organizations.

At the same time, each of the approaches we are considering is associated with finding a solution to the problem of justifying the choice of rational tools for managing the innovation process. In this case, a special problem lies in the interaction of different types of efficiency among themselves.

On this basis, a productive direction in achieving the goal of the study, we consider the following methodological principles:

- an integrated approach to the identification of influencing factors internal and external, affecting the performance of construction organizations;
- formation of a high-quality information database of a construction organization for the development of deterministic factor models that increase the quality of factor analysis;
- the principle of a differentiated approach to the development of deterministic factor models;
- feedback principle;
- the principle of differentiation of criteria parameters of a comparative assessment of the success of the use of innovative building materials in the activities of construction organizations.

Following the principle of differentiation criterion parameters allows you to:

- to purposefully identify and structure key criterial parameters of a comparative assessment of the degree of influence of the application of innovations on the economic performance of construction organizations (Table 1);
- to form an information and analytical database necessary for the development of multiplicative factor models, which allow to systematically identify the influence of the studied factors on the final results of construction organizations.

**Table 1.** Key criteria parameters of construction organizations associated with the results of the application of innovations (innovative materials)

| Criteria parameters | Name of criteria parameters |
|---------------------|-----------------------------|
| Financial block parameters |                          |
| RS(i)/TR≥1          | RS(i) is the revenue from the sale of innovative construction products; TR is the total revenue from the sale of construction products |
| Irs(i)>Itr          | Irs(i) – is the growth rate of revenue from the sale of innovative products; Itr is the growth rate of revenue from the sale of all construction products |
| GP(i)/TGP>1         | GP(i) is the gross profit from the sale of innovative products; TGP is the total gross margin |
| PS(i)/TPS>1         | PS(i) is the profit from the sale of innovative building products; TPS is the total profit from the sale of construction products |
| Ips(i) > Itps       | Ips(i) – is the growth rate of profits from the sale of innovative products; Itps is the profit growth rate from the sale of all construction products |
| RS(i)/TSM>1         | TSM is the overall profitability of the sale of construction products |
| Irs(i)>Itsm         | Itsm is the growth rate of sales profitability of all construction products |
| Parameters cost unit |                          |
| CS(i)/TCP<1         | CS(i) – is the cost of sold innovative construction products; TCP – is the total cost of sales of building products |
| UCP(i)v/TUCPv<1     | UCP(i)v – is the unit costs for the production of innovative construction products; TUCPv – is the total unit costs of construction products, calculated in terms of value |
| UCS(i)n/TUCSn<1     | UCS(i)n – is the unit costs in terms of sales of innovative products; TUCSn – is the total unit costs in terms of product sales |
| UCS(i)v/TUCSv       | TUCSv – is the total unit costs in terms of sales of products, calculated in |
<1 terms of value

| BES(i)/TBES<1 | BES (i) – is the business expenses in terms of sales of innovative products; TBES – is the total selling expenses by product sales |
| MES(i)/GMES<1 | MES (i) – is the administrative expenses for sales of innovative products; GMES – is the General management expenses in terms of product sales |
| MCS(i)/TMCS<1 | TMCS – is the total material costs in terms of product sales |
| CM P(i)/TMCP<1 | CMP (i) – is the material consumption of the production of innovative products; TMCP – is the total material consumption of production |

Parameters of the potential comparative advantage of the internal environment of the organization

| SP(i)c< SP(i)e | The situation of price competition: SP(i)c – is the selling price of innovative products; SP(i)e – is the product sales price without innovation |
| PG(i) > PGW(i) | PG(i) – is the quality of innovative products; PGW(i) – is the product quality without innovation |
| TC(i) <TCW(i) | TC(i) – is the construction period of the object with the use of innovations; TCW(i) – is the term of construction of the object without the use of innovation |
| MS(i) >TMS | MS(i) – is the market share of innovative products; TMS – total product market share |

Parameters of potential competitive advantage of a construction company

| PPO(i) < PPC(i) | PPO (i) – is the price of innovative products of the organization; PPC(i) – is the price of innovative products of the main competitor |
| GPO(i) > GPC(i) | GPO(i) – is the quality of innovative products of the organization; GPC(i) – is the quality of innovative products of the main competitor |
| DCO(i) < DCC(i) | DCO(i) – is the period of construction and commissioning of an organization with the use of innovations; DCC(i) – is the period of construction and commissioning of the main competitor of objects using innovations |
| MPO(i) >MPC(i) | MPO (i) – the market share of innovative products of the organization; MPC(i) – is the market share of innovative products of the main competitor |

Source: Personal research of authors

The recommended criteria parameters (Table 1) allow to develop purposefully and put into practice the models for carrying out factor analysis. Profit from the sale of innovative construction products is considered by us as one of the significant economic results of the effective activities of construction organizations. This is explained by the fact that the profit from sales of products used to calculate the profitability of product sales is of the greatest interest to internal and external users [10]. When developing factor models, the type of multiplicative models was used:
- factor model should provide the possibility of quantitative measurement of the influence of factors on the value of the effective indicator;
- all indicators in the model should be quantifiable and have a pronounced economic meaning;
- factors included in the model should be in a causal relationship;
- the identity of the left and right parts of the factor model must be fulfilled;
- factor model should have the possibility of practical use.

Subject to these requirements, we developed a complex of multiplicative factor models, which is an effective indicator of the profit from the sale of innovative construction products \( PS(i) \):

\[
PS(i) = \frac{PS(i)}{SV(i)p} * SV(i)p, \tag{1}
\]
where \( PS(i)/SV(i)p \) is the specific profit of the sale of innovative construction products; \( SV(i)p \) is the volume of sales of innovative construction products in the physical dimension.

\[
PS(i) = \frac{PS(i)}{RS(i)} \times RS(i),
\]

(2)

where \( PS(i)/RS(i) \) – is the profitability of selling innovative building products; \( RS(i) \) is the revenue from the sale of innovative building products.

\[
PS(i) = \frac{PS(i)}{RS(i)} \times SV(i)p \times MP(i),
\]

(3)

where \( MS(i) \) – is the market price for the sale of innovative building products.

\[
PS(i) = \frac{PS(i)}{RS(i)} \times \frac{RS(i)}{CS(i)} \times \frac{CS(i)}{SV(i)p} \times SV(i)p,
\]

(4)

where \( RS(i)/CV(i) \) is the profitability of selling innovative building products; \( CS(i)/SV(i)p \) – unit costs calculated by the sales volume of innovative products in the physical dimension.

\[
PS(i) = \frac{PS(i)}{MCS(i)} \times \frac{MCS(i)}{CS(i)} \times \frac{CS(i)}{SV(i)p} \times SV(i)p,
\]

(5)

where \( PS(i)/MCS(i) \) – is the product profitability by the level of material costs, calculated by the volume of sales of innovative construction products; \( MCS(i)/CS(i) \) – is the material intensity of innovative products.

\[
PS(i) = \frac{PS(i)}{RS(i)} \times \frac{RS(i)}{CS(i)} \times \frac{CS(i)}{RS(i)} \times \frac{RS(i)}{CS(i)} \times \frac{CS(i)}{SV(i)p} \times SV(i)p \times MP(i),
\]

(6)

where \( CS(i)/RS(i) \) – is the unit cost, calculated by the sales volume of innovative products in terms of value (kopecks).

\[
PS(i) = \frac{PS(i)}{RS(i)} \times \frac{RS(i)}{CS(i)} \times \frac{CS(i)}{RS(i)} \times \frac{RS(i)}{CS(i)} \times \frac{CS(i)}{SV(i)p} \times SV(i)p \times MP(i),
\]

(7)

where \( RS(i)/\sum RS(i) \) is the competitiveness of a construction organization in terms of the share of the market for innovative products; \( \sum RS(i) \) – market capacity of innovative products.

\[
PS(i) = \frac{PS(i)}{RS(i)} \times \frac{RS(i)}{TR} \times TR,
\]

(8)

where \( RS(i)/TR \) – is the share of innovative products in the total revenue from the sale of construction products; \( TR \) – is the total revenue from the sale of construction products.

**Summary**

As the potential for introducing innovations in the production activities of enterprises and organizations increases, the objective conditionality of improving the methodology for analyzing and evaluating the effectiveness of this process increases, which is demanded by practice. The methods improvement is considered as constituent elements of a similar methodology by us:

– measuring, analyzing, monitoring and evaluating the innovations impact on the construction organizations activities final results;

– the economic indicators corporate information database formation for a comparative assessment of the potential for the innovations use;

- converting a set of indicators of the information database into private criteria for the innovation implementation process effectiveness;

- modeling the innovation impact on the economic results of construction organizations based on the development of factor models.
It should be noted that modeling is a fairly progressive, but still a tool involving the use of reliable information and, accordingly, reasonable criteria of comparative efficiency. To solve this problem, the key criteria parameters for assessing the impact of innovation on the economic performance of construction organizations have been identified and structured. The complex of multiplicative factor models developed in the course of the study allows to selectively identify the analyzed factors influence on the change in profits from the innovative construction products sale which improves the factor analysis quality.

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