

Development of innovative activity of the enterprises of construction branch in the direction of increase in resource-saving and energy efficiency

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Abstract. The author studies innovative activity of enterprises and carries out the classification of conditions and factors of construction enterprises' innovative activity, and conducts systematization of specific features of this innovative activity. On the basis of statistical data on structure and dynamics of innovations the author carries out the research with the use of methods of economic-mathematical modelling in order to offer the approach which will allow construction enterprises to define the directions of innovative activity for achievement of a resource-saving and energy efficiency in construction sector.

1. Introduction

The concept of effective functioning of a construction complex has to rely on gradual change in the positive direction of growth rates of the volumes of investment into fixed capital. It has to occur at simultaneous high-quality change of character, structure and scientific and technical level of material and technical resources of a construction complex in the direction of increase in resource-saving and energy efficiency. Implementation of the similar concept is the most important condition of modernization and innovative updating of production potential of national economy.

The vector of development of national economy formed by state policy and universal tendencies, conforming to tendencies of development of construction branch, modern requirements to quality of construction objects at rather high competition, wear of fixed assets and high cost of installation and construction works defines an innovative orientation of development. It causes the necessity of overcoming innovative passivity of the construction enterprises and development of the directions of innovative activity, at least, within loan of the perspective materials and technologies promoting increase in energy efficiency in construction and to resource-saving, and also introduction of the corresponding organizational and marketing innovations.

2. Materials and Methods

The analysis of factors and condition of innovative activity [1,2] in construction have allowed to cluster them on the following groups (table 1).

Objective need of development and deployment of innovative materials and technologies at the enterprises of construction branch promoting growth of energy efficiency, environmental friendliness, resource-saving demands justification of the corresponding scientific and methodical tools.



The carried-out analysis of scientific and methodical literature has allowed to define as the main vector of innovative activity of the small and medium-sized construction enterprises introduction adopted production saving and the effect gaining of technological innovations.

Table 1. Indicators of an assessment of effectiveness of performance of innovative activity

Group of factors	State and dynamics of factors	Nature of influence on innovative activity
Economic situation in the country	GDP growth, decrease of the inflation rate, growth of investment activity; high degree of wear of fixed assets	Increase in resources for innovative activity; need of modernization of funds
General strategy of development of economy	Orientation on innovative development	State support of innovations
Economic situation in branch of construction:		
Resource capability	Growth of the volumes of investment into fixed capital at simultaneous increase in degree of depreciation of funds, the high cost of construction materials	Need of updating of fixed assets, existence of resources for performance of work, need of decrease in cost of works. Including, by introduction of new resource-saving technologies
Dynamics of volumes of installation and construction works	Growth of volumes of installation and construction works and rates of commissioning of objects, however, which isn't exceeding rates of 1991 year	Need of modernization of production on an innovative basis
Competition level	high level of the competition; existence of an oligopoly of the large regional house-building companies	Segmentation of the market when forming steady innovative competitive advantages
Quality of installation and construction works and objects	Increase in requirements to safety, quality and energy efficiency of objects	Need of introduction of new materials and technologies of performance of work
General development strategy of branch	Increase in level of quality of construction, environmental friendliness and energy efficiency of objects	Need of introduction of new products, materials and technologies
Dynamics of innovative activity:		
Dynamics of innovations	Growth of innovative activity in the extracting and processing sectors, growth of volumes of research works, growth of technological innovations; low innovative activity in comparison with foreign countries	Modernization innovations on the basis of development of innovations in the industries, a possibility of use of the new (borrowed) technologies; in general low general level of innovative activity
Condition of the interfering factors	Low profit level and own means of the enterprises, high cost of innovations, high risk level of innovative projects	Impossibility of realization of all innovative process, low innovative capacity of the enterprises

At the same time for small business product innovations (owing to a smaller capital intensity) and for an average – both product, and process innovations are primary. It should be noted that introduction of a number of innovations is inseparably linked with need of organizational or marketing transformations [3, 4].

For confirmation of results of the analysis of a theoretical arsenal on this problem we consider necessary to carry out the empirical analysis of statistical data on structure and dynamics of innovations. At the same time it is necessary to highlight that the statistics on innovations in construction, as well as in the majority of other sectors of economy, isn't conducted. Rosstat carries out collection of data on innovations only on the enterprises of the industry and communication that complicates adoption of administrative decisions in the sphere of innovative activity of the organizations of construction branch.

Thereof as basic empirical data on innovative activity of the small and medium-sized construction enterprises the statistics on innovations of small and medium-sized enterprises of the industry has been used [5,6].

For definition of a share of the small and medium-sized construction enterprises realizing product innovations we have conducted selective research. Results of poll have shown that from 300 construction enterprises of selection 204 enterprises realize product innovations. For definition of similarity of innovative activity of the small construction enterprises and enterprises of the extracting and manufacturing industry (on which there are authentic statistical data concerning all population of the enterprises showing a steady tendency) we have carried out an inspection of uniformity of selections. Data on the number of selection (population) of the enterprises of the extracting and manufacturing industry are accepted according to Rosstat [7]. Data on realization of technological innovations by the small and medium-sized construction enterprises are received as a result of the expert survey conducted by the author. Basic data for check are reduced in table 2.

Table 2. Basic data for check of uniformity of selections of small enterprises by criterion of realization of product innovations

Enterprises	Amount of selection, n	Number of the enterprises realizing product innovations, m	Probability of realization product innovations, p
The enterprises of the extracting and manufacturing industry	360740	236645	0,656
Construction enterprises	300	204	0.681

For a conclusion it is necessary to check a uniformity hypothesis

$$H_0 : p_1 = p_2 \quad (1)$$

at an alternative hypothesis

$$H_1 : p_1 \neq p_2 \quad (2)$$

For check of uniformity of two selections the following rule has been used:

1. At the first stage the statistics pays off:

$$Q = \frac{p_1^* - p_2^*}{\sqrt{\frac{p_1^*(1-p_1^*)}{n_1} + \frac{p_2^*(1-p_2^*)}{n_2}}} \quad (3)$$

2. Then value of the module of statistics $|Q|$ is compared to boundary value K which is defined from a ratio

$$K = K(\alpha) = F^{-1}\left(\frac{1+\alpha}{2}\right). \quad (4)$$

where F - function, the return to function of standard normal distribution (for 5% of significance value ($\alpha = 0.05$.) $K = 1.96$).

3. If $|Q| < K$, that is accepted a zero hypothesis of H_0 .

In our case $Q = -0.898$, therefore, the zero hypothesis of uniformity of selections is accepted. It testifies to compliance of results of selective inspection to statistical data on an assessment of structure of innovative activity of the enterprises of the extracting and manufacturing industry and, therefore, to justice of conclusions of selective inspection.

We will carry out confidential estimation of results of a selective research of innovative activity of the construction enterprises. For this purpose we will determine borders of a confidential interval by formulas:

$$p_{lower} = p^* - U(\gamma) \frac{\sqrt{p^*(1-p^*)}}{\sqrt{n}}, \quad (5)$$

$$P_{upper} = p^* + U(\gamma) \frac{\sqrt{p^*(1-p^*)}}{\sqrt{n}}. \quad (6)$$

where P_{lower} – the lower bound of a confidential interval, P_{upper} – the upper bound, $U(\gamma)$ – function of confidential probability (for $\gamma = 0,95$. $U(\gamma) = 1,96$).

3. Results

The provided analysis of a sample of the construction enterprises confirms the thesis about prevalence product to an innovation in structure of innovative activity of the small and medium-sized construction enterprises.

However, more detailed analysis of statistical information on structure of innovative activity of small and medium-sized enterprises of the extracting and manufacturing industry confirms prevalence in structure of innovations of small enterprises of product type of innovations, and in structure of medium-sized enterprises – process innovations [8]. Theoretically similar tendency can be explained with great financial opportunities for medium-sized enterprises. Empirically it is possible to confirm justice of this thesis for the construction enterprises by means of an assessment of uniformity of selections. Basic data for calculation and results are given in table 3.

Table 3. Basic data and results of calculation of uniformity of selections on criterion of structure of innovative activity

Enterprises	Amount of selection, n	Number the enterprises realizing priduct (process) innovations, m	Probability of realization product (process) innovations, p	Check conditions of uniformity of selections, $ Q \leq K$	Top and lower border confidential interval, P_{lower} , P_{upper}
Small enterprises of the extracting and manufacturing industry	189778	154953	81.65	1,87<1,96	$P_{lower}=0.70$, $P_{upper}=0.81$
Small construction enterprises	200	152	76.01		
Medium-sized enterprises of the extracting and manufacturing industry	170962	96166	56.25	1,45<1,96	$P_{lower}=0.41$, $P_{upper}=0.58$
Medium-sized construction enterprises	100	49	49.0		

Proceeding from results of the carried-out analysis it is possible to conclude that in structure of innovative activity of the small construction enterprises the share of product innovations varies from 70 to 81%; in structure of innovative activity of medium-sized enterprises process innovations (41-58%) prevail; in general the small and medium-sized construction enterprises realize from 64 to 72% of product innovations.

4. Discussion

The small and medium-sized construction enterprises for selection, we have marked out the following key features of innovative activity in the studied segment of the enterprises (figure 1).

Group of features	Specifics of small and medium-sized enterprises	Specifics of innovative activity
<ul style="list-style-type: none"> • Economic • Organizational • Production • Standard and legal • External (market) 	<ul style="list-style-type: none"> • Limitation of internal potential and dependence on internal sources of financing • simplified organizational structure • Flexibility and efficiency of formation of portfolio of projects • Legal flexibility along with low political potential • Unstable aggressive character of the environment 	<ul style="list-style-type: none"> • Prevalence saving and effectstrengthening produce adopted innovations • Absence of high cost innovations • Prevalence of product innovations • Application of innovations mainly by non-state orders • Prevalence of the saving innovations

Figure 1. Specific features of innovative activity of the small and medium-sized construction enterprises

5. Conclusions

Thus, the carried-out analysis and an assessment of specific features of activity of small and medium-sized enterprises have allowed to draw a conclusion that at most the construction enterprises use of a form (type) of a product or process innovation will take place and, mainly, already developed and introduced in other economic entities therefore development of innovative activity of the enterprises in the direction of resource-saving and energy efficiency needs to be carried out at active introduction of grocery innovations at small enterprises, product and process innovations – at the medium-sized and large construction enterprises.

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