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EVALUATION OF INNOVATION ACTIVITY OF CONSTRUCTION ENTERPRISES

Urgency of the research. *Globalization of the economy and social development needs the ensuring the effective functioning of enterprises on innovative principles.*

Target setting. *Today the issues of quality, effective and efficient business management and evaluation of innovation activities are very important for the building industry.*

Actual scientific researches and issues analysis. *Proceedings of leading scientists, such as: Vytvytsky Y., Verkhoglyadova N. and Demchuk N., Kandyeyeva V., Mykytyuk P., Stelmashchuk A., Shkromyda V. and others - were dedicated to the research of innovation efficiency and innovation enterprises.*

Uninvestigated parts of general matters defining. *We note that this issue is not explored enough in their works, so the problems require researches on forming a system of indicators for the level of innovation activity of the construction industry evaluation and justification of methodological approaches on it's base.*

The research objective. *The article is devoted to development of theoretical and methodological framework, practical guidelines and methodological approaches to the evaluation of construction enterprise innovation activity and their probation.*

The statement of basic materials. *In order to study the innovative level of business, was proposed methodical approach which involves five blocks: 1) methodological; 2) digital data / informational; 3) calculation; 4) evaluation; 5) interpretation (reasonable assessment scale integrated parameter values). The system of indicators built on sustainable development conception allows it to introduce and detail the division them into three levels. The proposed approach was used to analyze the innovation activities of construction enterprises Carpathian and range them at the base of the integral indicator of innovation and indicator of economic growth that were proposed.*

Conclusions. *Methodical approach to evaluation of innovation activity and approach to ranking companies in terms of innovation and economic growth was proposed, which revealed the crisis, adverse and favorable areas of enterprise operation. The represented evaluating makes it possible to argue that, despite the partial implementation of certain types of innovation, existing level can not provide these companies growth.*

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ОЦІНЮВАННЯ РІВНЯ ІННОВАЦІЙНОЇ ДІЯЛЬНОСТІ ПІДПРИЄМСТВ БУДІВЕЛЬНОЇ ГАЛУЗІ

Актуальність теми дослідження. *Глобалізація економіки та суспільного розвитку зумовлює необхідність забезпечення ефективного функціонування підприємств на інноваційних засадах.*

Постановка проблеми. *Сьогодні питання якісного, результативного і ефективного управління підприємствами й оцінювання рівня інноваційної діяльності є дуже важливими для будівельної індустрії.*

Аналіз останніх досліджень і публікацій. *Наукові праці провідних вчених: Я. Витвицький, Н. Верхоглядова, Н. Демчук, В. Кандєєва, П. Микитюк, А. Стельмащук, В. Шкромида та інших, - присвячено дослідженню ефективності інновацій та інноваційного розвитку підприємств.*

Виділення недосліджених частин загальної проблеми. *Зазначаємо, що дане питання в їхніх працях недостатньо висвітлено, тому потребують дослідження проблеми формування системи показників для оцінки рівня інноваційної діяльності підприємств будівельної галузі та обґрунтування методичних підходів на її основі.*

Постановка завдання. *Стаття присвячена розвитку теоретико-методичних засад та розробленню практичних рекомендацій і методичних підходів до оцінювання рівня інноваційної діяльності підприємств будівельної галузі та їх апробації.*

Викладення основного матеріалу. *З метою дослідження рівня інноваційної діяльності підприємств запропоновано методичний підхід, який передбачає п'ять блоків: 1) методичний; 2) інформаційний; 3) розрахунковий; 4) оціночний; 5) інтерпретація результатів. Сформовано систему показників на засадах концепції сталого розвитку, що дозволило впровадити їх поділ і деталізацію за трьома рівнями. За допомогою запропонованого підходу проаналізовано рівень інноваційної діяльності підприємств будівельної галузі Прикарпаття та здійснено їх позиціювання на основі інтегрального показника рівня інноваційної діяльності й запропонованого коефіцієнта економічного зростання.*

Висновки. *Пропонується методичний підхід до оцінювання рівня інноваційної діяльності підприємств та підхід до позиціювання підприємств за рівнем інноваційної діяльності та економічного зростання, який дозволив встановити кризові, несприятливі та сприятливі зони функціонування підприємств. Проведене оцінювання дає змогу стверджувати, що, не дивлячись на часткове впровадження певних видів інновацій, їх рівень не дозволяє забезпечити цим підприємствам економічне зростання.*

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Keywords: *innovation activity; evaluation of innovation activity level; integral index; index of economic growth; matrix positioning; construction industry.*

Ключові слова: *інноваційна діяльність; оцінювання рівня інноваційної діяльності; інтегральний показник; коефіцієнт економічного зростання; матриця позиціювання; будівельна галузь.*

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The relevance of the research topic. The dominance of the concept of innovative development in modern economic doctrines diversifies the directions of development and functioning of enterprises, highlighting innovative activity as a priority. Under the influence of globalization of economy and public development, there is a need to ensure the effective functioning of enterprises based on innovative principles. A protracted economic crisis, internal and external destabilization of the economy contribute to the emergence of new opportunities and threats for the functioning of construction industry.

Target setting. Today the enterprises of the construction industry form the backbone of the economy of the Precarpathian region, as they demonstrate stable economic growth and have considerable development potential in the short term. This is due to increase in volumes of housing and industrial construction in the region and beyond. Therefore, in the period of contemporary large-scale transformations of the Ukrainian state economy, the issues of quality, efficient and effective management of the companies in this sector and assessment of the level of innovative activities are very important for the studied enterprises.

Analysis of recent researches and publications. Many domestic and foreign scientists have studied the issues of efficiency of enterprises functioning assessment, in particular: O. Arefieva [1], S. Dovbnia [2], O. Shkarupa [3], M. Voinarenko [4], M. Paliichuk [5], V. Petrenko [5], O. Rats [6], J. Harington [7] and others; assessment of the innovative activity of the construction industry enterprises level, among which: Ya. Vytvytskyi [8], N. Verkhohliadova [9], N. Demchuk [10], V. Kandieieva [11], P. Mykytiuk [12], A. Stelmashchuk [13], V. Shkromyda [14] and others.

Highlighting unexplored aspects of the problem. Famous scientific papers fail to highlight the problems of formation of indicators system for assessing the level of innovative activity of the enterprises of the construction industry and the development of methodological approaches on its basis.

Setting objective. The article aims at development of theoretical and methodical bases as well as practical recommendations and methodological approaches to the assessment of level of innovative activity of the enterprises of the construction industry and their testing.

Presentation of basic material of the research. In conditions of tough competition, innovative activity provides increased competitiveness and market leadership. The development of any enterprise requires the establishing of strategic activity areas on the basis of innovations.

We agree with A. Amoshi [15], whose views are confirmed by official statistics [16] as for the crisis state of innovation activity in Ukraine. The results of the research of industrial enterprises activities show a decline in innovation activity, the introduction of minor innovations, which is a very negative factor for innovation development in general.

According to the ranking of most innovative countries of the world formed by the international Agency Bloomberg Rankings as of 2017, Ukraine is in the 42nd place out of 50 countries. According to the ranking seven factors related to scientific, educational and technological spheres influence the innovation development. We rank 44th by the level of expenditure on research and development, 47th – by value added production, 50th – by the performance of the industry, 34th – by the density of high-tech companies, 4th – by the efficiency of production, 44th – by scientific work and 27th – by the intensity of research [17].

Innovation activity in Ukraine is passive, despite the considerable potential for transition of the economy and the construction industry to the innovative path of development. The diffusion of innovations and innovation activity will ensure the transformation of the transitive economy into the developing one.

It is known that information that is generated through a system of indicators, reflecting different aspects of the enterprise is a working medium of any management system. Therefore, for a correct evaluation of the level of innovation activities of enterprises in the construction industry it is necessary to create an appropriate system of indicators.

For evaluation, they apply many methods, which are based on different points of view regarding the problems of efficiency. The use of a particular method depends upon the evaluation objectives, its theoretical foundations, the depth, the applicable standards, and the choice of objects of comparison.

In the opinion of domestic scientists and practitioners "eco-social market economy and sustainable development of society are based on three foundations; this is an organic combination of economic efficiency, social equity and resource sustainability" [3; 5], which is reflected by descriptive models, such as "bio-socio-economic complex" of "socio-eco-economic system", etc. [5]

To use these models, they apply a system of indicators in certain areas and priority development directions within their boundaries.

To assess the level of innovative activity of the enterprises of the construction industry we offer a methodological approach presented in Fig. 1.

Methodological approach proposed in Fig. 1 consists of five blocks: methodological (includes determining goals, indicators to assess the state of innovation activity of enterprises of the construction industry in the following areas: environmental, economic and social; formation of system of indicators for the priority development areas of enterprise and key functional activities). Let us detail the performance system by the established types of indicators of development of enterprises as follows:

a) the economic direction of development indicators of the construction industry enterprises is made up of 11 groups of indicators:

- the volume of economic activity;
- volume of production of own energy and material resources;
- level of profitability;
- the level of material intensity and energy intensity of products [166];
- condition and efficiency of use of fixed assets;
- the liquidity of assets;
- indicators for assessing financial stability;
- the volume and structure of investment activities;
- the scope and structure of innovation activities;
- development of information support;
- development of international cooperation.

b) social direction of development indicators for the studied companies is formed by 4 groups of indicators:

- the level of human resource development;
- the level of development of education;
- the level of availability of specialists;
- the level of development of the socio-cultural sphere;

c) ecological direction of development indicators for the construction industry is formed by 2 groups of indicators [1; 2; 5]:

- indicators of the level of environmental safety;
- indicators of environmental activities

2) information block (a combination of information gathering and the formation of the information base for the assessment of innovation activity of enterprises);

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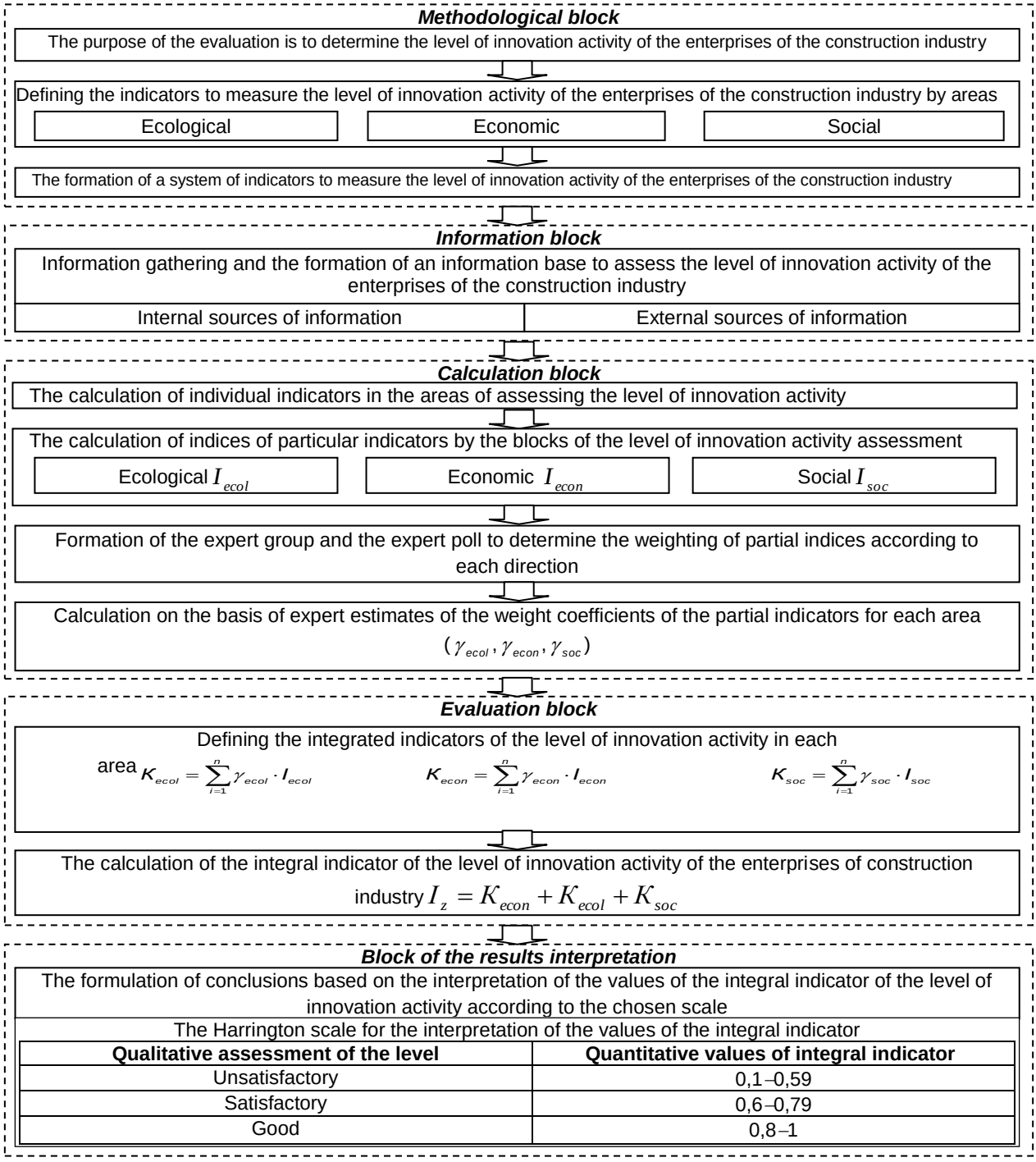

Fig. 1. Methodical approach to assessing the level of innovation activity of the enterprises of the construction industry (authoring)

3) calculation block (includes the calculation of the partial indicators for evaluation areas; the calculation of indices of partial indicators for evaluation areas (ecological, economic, social); formation of the expert group and the expert poll to determine the weighting of partial indices according to each direction; calculation of the weight coefficients of the partial indicators for each area. The latter are determined by the conversion of the development indicators of the enterprises into the index form:

- for indicators increase of which improves the condition of enterprises, the index I_i is calculated according to the formula:

$$I_i = \frac{X_i - X_{i\min}}{X_{i\max} - X_{i\min}}, \quad (1)$$

Thus, with a larger value of X_i within the range of the oscillations value I_i., will be more approximated to 1.

- for indicators, the decrease in which improves the condition of enterprises, the index I_i is calculated according to the formula:

$$I_i = \frac{X_{i\max} - X_i}{X_{i\max} - X_{i\min}}, \quad (2)$$

i.e., value I_i will be closer to 1 when approximating the actual value X_i to $X_{i\ min}$;

4) evaluation block (provides for the definition of complex indicators for each area and calculating the integral index, which reflects the state of innovation activity of the enterprise as a whole. The calculated indexes are the basis of integrated indicators of the enterprises' state for specific development priority; they are calculated according to the formula:

$$I_{(П)} = \sum_{i=1}^{n} \gamma_i \cdot I_i , \quad (3)$$

where γ_i – the weight of specific indicators;

I_i – the value of specific indicator in the index;

n – the number of indicators ($i=1,2…,n$).

Integral indicator for individual components as weas total indicator may be calculated by arithmetic average [4, p. 80, 6];

5) interpretation of results (contains rating scale of the integral indicator values of the level of innovation activities and interpretation of their level). For the qualitative assessment of the integral indicator, it is advisable to use the enhanced Harrington scale [7].

However, this methodological approach has some shortcomings, which may affect the objectivity of the evaluation results:

- there is no comparable information base for determining threshold values of a large number of indicators;
- the evaluation of dynamics of development of the enterprises by individual indicators does not provide the formation of system understanding of its level;
- rating by the maximum and minimum values from the sample of indicators does not allow for a qualitative assessment of their development state .

The proposed list of indicators is not permanent and requires adjustment when the trends and factors of development of the construction industry change.

The results of calculation of integral indicator of the innovation activities of enterprises level according to the developed methodical approach to assessment of the level of innovation activity of the enterprises of building industry of the Precarpathian region are provided in Tab. 1.

Table 1

The dynamics of integrated indicators of assessing innovation activities of enterprises during 2011-2016

Enterprise	Years					
	2011	2012	2013	2014	2015	2016
SE «Spetszalizobeton»	0,612	0,607	0,582	0,403	0,444	0,625
Dolyna Plant of Reinforced Concrete Products	0,480	0,49	0,48	0,278	0,281	0,201
PJSC «Budivelni materialy»	0,401	0,422	0,371	0,354	0,296	0,321
PJSC «Budzalizobeton»	0,501	0,526	0,502	0,298	0,402	0,304
Plant of concrete products and structures «Monolit»	0,438	0,426	0,411	0,278	0,385	0,214
PJSC «Ivano-Frankivsktsement»	0,560	0,636	0,635	0,417	0,621	0,689
PJSC «Kalushzalizobeton»	0,430	0,473	0,461	0,258	0,481	0,382
ALC «Ivano-Frankivskzalizobeton»	0,499	0,604	0,526	0,405	0,581	0,622
Production bases «Beton Group»™	0,515	0,546	0,517	0,275	0,398	0,425

Source: calculated by the authors based on the enterprises' data

Graphical interpretation of the integral index of assessing the level of innovation activity of construction enterprises of the Precarpathian region is provided in Fig. 2.

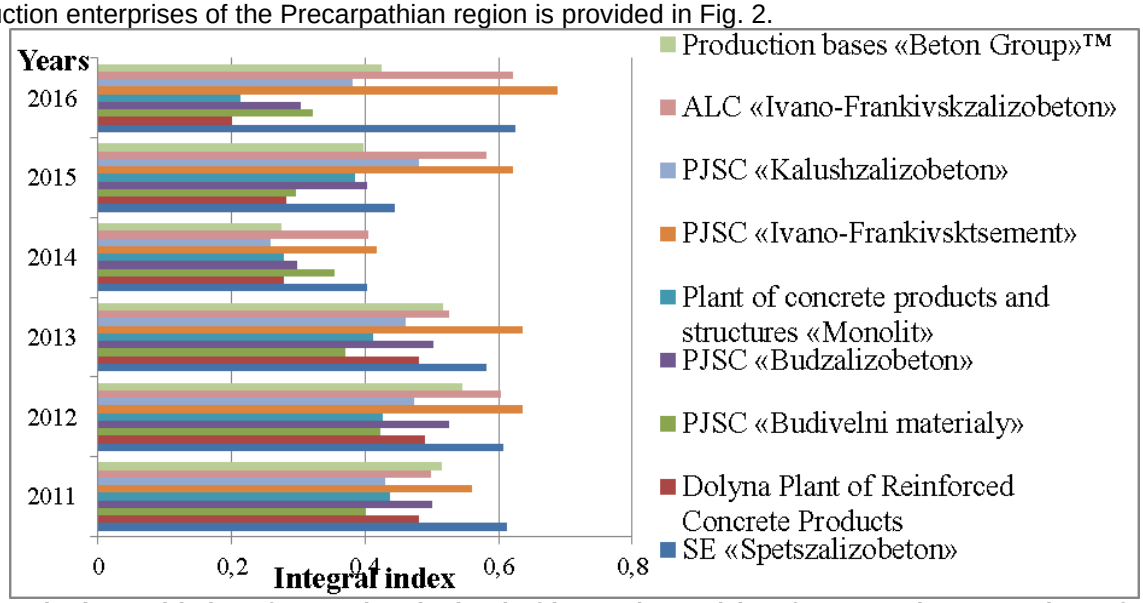

Fig. 2. The integral index of assessing the level of innovation activity of construction enterprises of the Precarpathian region

Practical implementation of the proposed methodological approach to assessment of the level of innovation activity of construction enterprises of the Precarpathian region developed according to the author's scale (Fig. 1) provided for the identification of the deterioration of the level of innovation activity of the majority of enterprises from satisfactory to unsatisfactory.

The condition of the subsidiary enterprise "Spetszalizobeton", whose activity is based on the production of concrete and concrete columns of different sizes, with its boom coming in the years 2011-2012, was satisfactory. In 2013, its condition deteriorated according to the results of calculations

of the integral indicator and the company was on the verge of satisfactory and unsatisfactory condition of operation. In 2014, there was deterioration of this enterprise to an unsatisfactory level. All this leads to the need for radical management decisions to improve the condition of the company by applying re-engineering and other technologies. In 2016 the analyzed enterprise reached a satisfactory level of its activities.

The innovative development of Dolyna plant of reinforced concrete products during the review period is unsatisfactory, according to the level of the integral indicator of innovation activity of the enterprise, and in 2016, the efficiency of innovation activities decreased, which indicates the necessity of introducing the foresight technology to predict performance.

PJSC «Budivelni materialy» during the period of 2011-2016 shows the poor state of development of innovation activity. The company's management needs to work more on the introduction of innovative management methods, implement managerial techniques, in particular controlling, into the control mechanism.

The operation of PJSC "Budzalizobeton" in 2011-2013 was unsatisfactory. In 2014 the situation deteriorated significantly. The negative trend is due to the crisis in the country, reduction of profits of the enterprise, a decrease in the volume of consumption of goods by construction companies and a substantial reduction in the expenditure on innovation activities. However, in 2016 the effectiveness of innovation activities increased, but the condition remained unstable and required a lot of efforts for the management to gain and strengthen the competitive position of the company's products in the market.

A similar trend is observed for the functioning of the plant of concrete products and structures «Monolit». For this enterprise it is expedient to introduce managerial techniques, such as reengineering of business processes aimed at organizational structure change, benchmarking in the implementation of strategic management, outsourcing to enhance competitiveness of the analyzed enterprises without large additional investments in new expensive technologies and focus on the priority development directions.

Innovation activity of PJSC "Ivano-Frankivsktsement" is more effective than that of the analyzed enterprises. Since 2011, the analyzed enterprise has been constantly increasing its production capacity, although the economic crisis of 2014 slowed its development, and innovation activities are unsatisfactory. Despite the deterioration of its financial condition the company is constantly working on technology upgrading, introducing technological innovations (in 2016 plant tippler with line conveyor for automatic unloading and cleaning of cars was commissioned; construction of the third line of dry process of cement production began). PJSC "Ivano-Frankivsktsement" is effectively working on updating its equipment, mastering the latest technology of production of construction materials, improving the quality of the products, and expanding sales markets of construction materials.

Innovative development of PJSC "Kalushzalizobeton" as well as other enterprises in the sample during 2011-2013 was unfavorable and deteriorated rapidly due to the economic and political crisis in 2014 – 2015.

ALC "Ivano-Frankivskzalizobeton" manufactures precast concrete and concrete structures. The main products of the company are: concrete structures for industrial, civil, hydrotechnical, road and other construction (production of wall materials, foundation blocks, intermediate floors, architectural details, load-bearing arches, reinforced concrete piles, bridge beams, etc.).

The results of assessing the level of innovation activity of the enterprise in 2011-2013 characterize the stable development due to the introduction of the newest technological processes for the production of building materials, which led to the expansion of the product range. In 2014, the innovative development and the efficiency deteriorated. This happened due to the drop in production volumes and sales under the influence of the reduction in the volume of real estate construction (according to the statistics the Ivano-Frankivsk region ranked 6th in 2013 in the rating of Ukrainian cities and 8th in 2016 in terms of construction and housing commissioning) [16]. Despite the existing threats, in 2016 the company entered new markets and achieved satisfactory level of innovation activity.

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In conclusion, we can say that the best level of innovation activities according to the proposed methods of assessment is demonstrated by PJSC "Ivano-Frankivsktsement", SE "Spetszalizobeton" and ALC "Ivano-Frankivskzalizobeton".

To deepen the results of assessment of innovation activity level, it is necessary to calculate the index of economic growth I_{EG} [18], which informs about the influence of innovation activity on economic growth of enterprises, industries, economy, provides for the assessment of the innovation activity improvement as for ensuring economic growth and is calculated by the formula:

$$I_{EG} = \frac{L_P \cdot R_{PC} \cdot R_{PS} \cdot R_{TCA} \cdot R_{CL} \cdot R_{SL/R} \cdot R_{R/P} \cdot R_{DS/AP} \cdot R_{CDC} \cdot R_L}{R_{CP} \cdot R_{CL}}, \quad (4)$$

where L_P – labor productivity;
R_{CP} – capital productivity ratio;
R_{CL} – capital-labor ratio;
R_{PC} – profit capitalization ratio;
R_{PS} – profitability of sales ratio;
R_{TCA} – turnover of current assets ratio;
R_{CL} – current liquidity ratio;
$R_{SL/R}$ – short-term liabilities and receivables ratio;
$R_{R/P}$ – ratio of receivables and payables;
$R_{DC/AP}$ – debt capital to accounts payable ratio;
R_{CDC} – concentration ratio of debt capital;
R_L – leverage ratio.

To interpret the results of the I_{EG} calculation based on the method of "three sigma" we have developed a rating scale of economic growth levels (Tab. 2).

Table 2

The scale of evaluation of values of economic growth levels

Qualitative assessment of the economic growth level	Quantitative values of the economic growth ratio
Critical level	0,1 – 0,39
Unstable level	0,4 – 0,59
Satisfactory level	0,6 – 0,79
Stable level	0,8 – 1

The results of calculations of the economic growth ratio values of a sample of the construction industry enterprises during 2011-2016 are provided in Tab. 3.

Table 3

The ratio of economic growth of the construction industry enterprises during 2011-2016

Enterprise	Years					
	2011	2012	2013	2014	2015	2016
SE «Spetszalizobeton»	0,243	0,304	0,475	0,462	0,312	0,501
Dolyna Plant of Reinforced Concrete Products	0	0	0	0	0	0
PJSC «Budivelni materialy»	0,168	0,113	0,114	0,119	0,085	0,08
PJSC «Budzalizobeton»	0	0	0	0	0	0
Plant of concrete products and structures «Monolit»	0	0,074	0	0	0,001	0,005
PJSC «Ivano-Frankivsktsement»	0,470	0,424	0,646	0,515	0,445	0,612
PJSC «Kalushzalizobeton»	0	0	0	0	0	0
ALC «Ivano-Frankivskzalizobeton»	0,321	0,253	0,398	0,421	0,398	0,411
Production bases «Beton Group»™	0,119	0,168	0,217	0,292	0,201	0,281

Source: calculated by the authors based on the enterprises' data

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The analysis of the ratio of economic growth dynamics indicates that over the study period SE "Spetszalizobeton" and ALC "Ivano-Frankivskzalizobeton" have been on the verge of unstable and critical levels of economic growth and PJSC "Ivano-Frankivsktsement" for the analyzed period has passed to a satisfactory level of economic growth, as evidenced by the results of the calculations. Other enterprises under consideration have an unsustainable level of growth.

According to the results of the calculation of an integral indicator of the level of innovation activities and ratio of economic growth, the positioning of the construction industry enterprises is visualized through the matrix (Fig. 3).

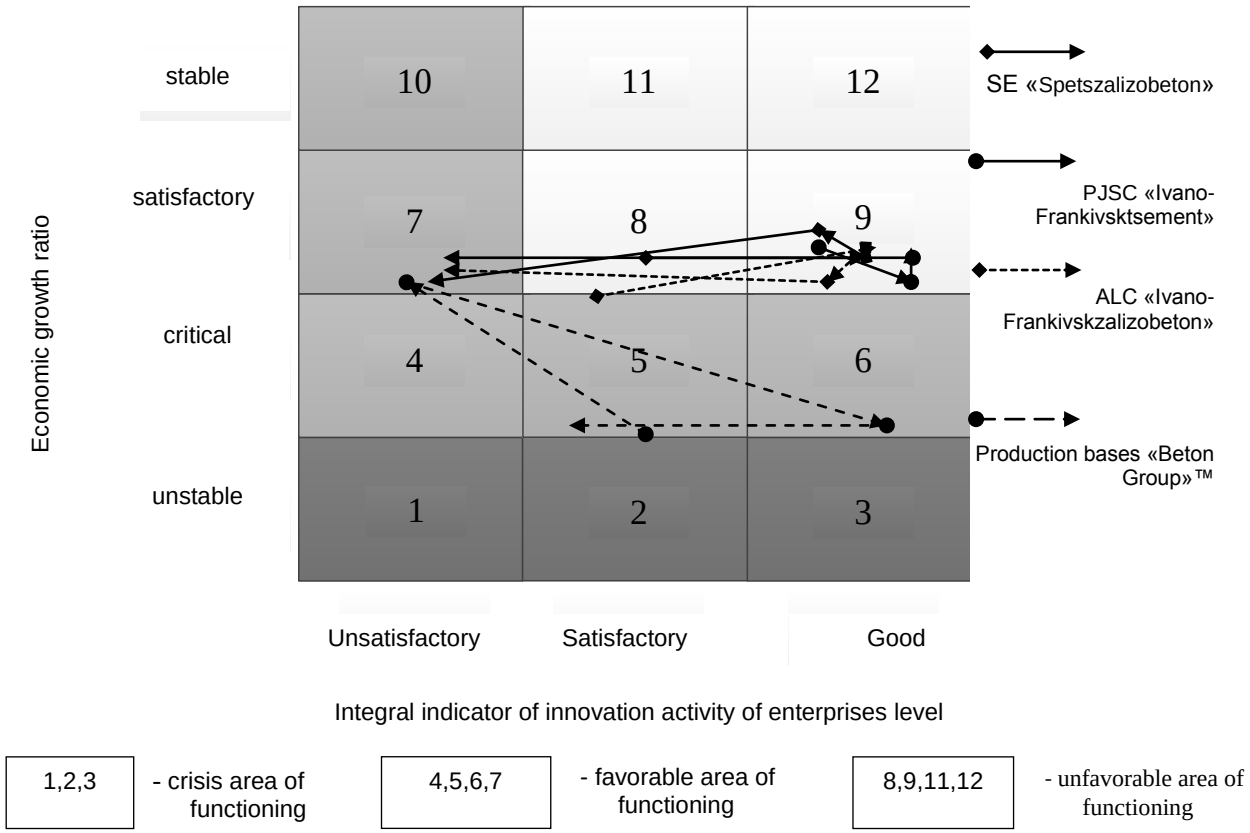

Fig. 3. The matrix of positioning of the construction industry enterprises in terms of innovation activity and the ratio of economic growth

Source: authoring

The matrix is built on the results of solving the problem of finding the necessary level of factor indicators on a specified interval to achieve the desired level of function under the proposed mathematical model of the process under study. The solution of these tasks is implemented as a search of the function parameter value, which corresponds to a specific factor.

The target values of the analyzed indicators (the ratio of economic growth and indicators of the level of innovation activity of the enterprise) are determined based on finding the boundary conditions (min, max), which characterize the boundaries of the possible values of the variables, provided the optimal solution.

According to the results of the positioning, PJSC "Ivano-Frankivsktsement", SE "Spetszalizobeton" and ALC "Ivano-Frankivskzalizobeton" (quadrants 8 and 9), are located in the favourable area of operation, which is characterized by a satisfactory level of economic growth, a satisfactory and good level of innovations. Production bases "Beton Group"™ are situated in a troublesome area of operation that is intermediate between the crisis and the favorable areas. The rest of the studied enterprises are not reflected because they did not manage to leave the crisis zone during 2011-2016.

Functioning on the boundary of acceptable zone indicates the need to make drastic management decisions to improve the level of innovation activities of enterprises using modern management technology.

Conclusions. The conducted research of existing approaches to formation of system of indicators for assessing the level of innovation activity of the enterprises of the construction industry on the basis of the concept of sustainable development allowed us to offer improved performance system by three levels. The first level includes the indicators that characterize the main functional aspects of activities of enterprises by environmental, economic and social blocks. The second level presents indicators that characterize the innovation activity of the enterprise according to the detailed blocks. The third level features integral indicator of the innovation activity of the enterprises of the construction industry level as a result of the development of all functional activities.

We have developed the methodical approach to assessment of the level of innovation activity of the studied enterprises. This approach offers an integral indicator that takes into account the activities of the company in three areas: economic, social and environmental. It also provides for analyzing functional spheres of activities, interpreting the results according to the improved Harrington scale and identifying the most important priorities of the innovation activities of enterprises. For a more detailed analysis this approach is complemented by the development of the approach to the positioning of enterprises of the construction industry in terms of innovation activities and economic growth. It is based on the construction of the matrix of positioning of enterprises and allows for identifying crisis, unfavorable and favorable areas of functioning to determine the target level of innovation activity and economic growth.

Assessment of the innovation activity level of the provided nine enterprises of the construction industry allows to assert that, despite the partial implementation of certain types of innovations (technological, organizational, economic and others), its level does not contribute to the economic growth of these enterprises.

Further studies will be focused on the development of effective and innovative measures to increase the level of innovation activity of the enterprises of the construction industry and economic growth.

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