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ECONOMIC AND MATHEMATICAL MODELING OF THE DEVELOPMENT OF CONSTRUCTION ENTERPRISES, TAKING INTO ACCOUNT THE PECULIARITIES OF THE FORMATION OF INTELLIGENT ECONOMIC SYSTEMS

Abstract

Introduction. The relevance of the research topic is due to the need to develop measures to ensure the development of construction enterprises (BE), using modern intellectual economic systems.

Problem Statement. Proposed measures to ensure the development of construction enterprises, which are aimed at the formation and implementation of intelligent economic systems, the creation of a basis for the growth of the completeness and quality of economic support, the use of geo-informational tools, the construction and improvement of the security and information system, the improvement of social security and standards.

Purpose. Economic and mathematical modeling of the development of construction enterprises, taking into account the peculiarities of the formation of intelligent economic systems.

Materials and methods. The article achieves the goal of economic-mathematical modeling of the integral indicator of the development of construction enterprises, taking into account the peculiarities of the formation of intelligent economic systems. Solved tasks regarding the assessment of the integral indicator of BP development; development of an economic-mathematical model of the influence of the integral factor of the formation of intellectual economic systems on the general indicator of the development of construction enterprises; formation of measures regarding the development of construction enterprises based on the results of economic and mathematical modeling of the relevant factors.

Results. As a result of the research, a theoretical and methodological platform for determining the development of construction enterprises was formed. It is proposed to define the development of construction enterprises as a set of directions for the formation and use of production, economic and human potential, aimed at the formation of strategic and tactical advantages to achieve a better position compared to the past state of BP.

Conclusions. As a result of the study, it was determined that the level of influence of the directions of formation and use of the intellectual economic system on the development of construction enterprises has decreased.This is due to the ambiguity and lack of a systematic approach to the formation and use of an intelligent economic system at construction enterprises, the inhibition of economic indicators, the low level of application of geospatial support, the reduction of social standards, difficulties in the formation of security support and the implementation of security directions. Therefore, it is proposed to develop scientifically based recommendations regarding the formation and use of the intellectual economic system of construction enterprises.

Keywords: development of construction enterprises, assessment, economic-mathematical modeling, intelligent economic systems, economic, geospatial, security, social security.

Introduction

Modern management conditions of construction enterprises are determined by inhibition of their development directions, which is determined by a decrease in the main indicators of activity, a reduction in the level of production and sale of construction products, the formation and use of production and economic potential, working capital, and the negative influence of internal and external factors. In such conditions, the development of measures to ensure the development of BP based on the application of modern intellectual economic systems is of particular importance.

The purpose of the study is the economic and mathematical modeling of the integral indicator of the development of construction enterprises, taking into account the peculiarities of the formation of intelligent economic systems.

Within the framework of the set goal, the following tasks are solved:

– carry out an assessment of the integral indicator of the development of construction enterprises;

– to develop an economic-mathematical model of the influence of the integral factor of the formation of intelligent economic systems on the general indicator of the development of construction enterprises;

– propose measures for the development of construction enterprises based on the results of economic and mathematical modeling of the relevant factors.

Therefore, the research topic is relevant in the context of ensuring the development of construction enterprises.

Analysis of theoretical provisions. Development as a complex category is determined by the multifaceted nature of the formation of factors affecting its transformation. In this context, attention is focused on the formation of a categorical apparatus for determining development, taking into account the peculiarities of the functioning of enterprises, in the works of L. S. Zapasna, G. O. Horina, and K. O. Ivanchuk [1–3].

On the permanent changes taking place in the system of formation and implementation of development directions, which are based on the technical-economic combination of material and personal factors of production, complex technical-technological relations between material elements of productive forces in the system of technical-economic relations are emphasized in the development of S.V. Mocherny. [4]. Dividing the provisions of the presented approach, some scientists highlight the peculiarities of the implementation of processes in the enterprise development system by S. M. Ilyashenko, S. I. Ashmarina [5–6].

A strategic approach to the definition of development was implemented in the scientific works of A. A. Thompson [7].

The identified theoretical provisions indicate the absence of uniform approaches to the formation of a categorical apparatus for the development of construction enterprises. Therefore, it is proposed to define the development of BP as a permanent process that takes into account economic, financial, potential, innovation-investment, security, stakeholder features, the interaction of which leads to the formation of the best state compared to the past.

Based on the theoretical provisions regarding the definition of the development of construction enterprises, the formation of a quantitative basis for making managerial decisions through the application of evaluation procedures is proposed. In this context, the parameters of development assessment are determined through the prism of the competitiveness of enterprises. Andrushkiv B. M., Malyuta L. Ya., Melnyk L. M. [8].

In order to make reasonable management decisions, it is necessary to form a quantitative foundation based on an integral indicator that determines the level of development of enterprises [9–14].

Appropriate criteria are used to assess the development of enterprises, which characterize the formation and use of: funds for the acquisition of external knowledge; the amount of new equipment

purchased; the amount of financing of information and telecommunication technologies as indicators characterizing innovative receptivity; employees who have improved their qualifications; funds spent on improving the qualifications of employees; the total amount of costs for innovative activity; technological processes; innovative products; of research and development in the field [15].

In this context, the following indicators should be noted: general coverage; intermediate liquidity; absolute liquidity; solvency; financial stability; ratio of current and non-current assets; provision of own capital; profitability of enterprises; assets; own capital; operational activity; investment capital.

Taking into account the provisions of theoretical approaches, directions for assessing the development of construction enterprises have been developed, which include a system of actions based on the formation of information and analytical support, methods and models of quantitative and qualitative analysis to determine the appropriate integral indicator, which will allow the formation of a quantitative basis for making informed management decisions.

Main part

To assess the development of construction enterprises, a multi-level system of indicators was formed (**Table 1**).

Table 1

A multi-level system of indicators for the development of construction enterprises

First level	The second level	The third level
An integral factor in the development of construction enterprises (I_R)	economic indices (R_1)	changes in sales (R_{11})
		changes in equity (R_{12})
		changes in loan capital (R_{13})
		changes in the ratio of receivables and payables (R_{14})
	innovative (R_2)	technological upgrade level (R_{21})
		the level of implementation and commercialization of innovations (R_{22})
		level of technical development (R_{23})
	investment (R_3)	level of investment formation (R_{31})
		investment application level (R_{32})
		level of investment performance (R_{33})
	social (R_4)	the level of development of the social system at the construction enterprise (R_{41})
		level of social protection (R_{42})
	corporate management ($R5$)	quality of corporate governance (R_{51})
		marketing responsibility (R_{52})
		level of development of corporate reputation (R_{53})
		market activity of construction enterprises (R_{54})
		the level of change perception (R_{55})
		the level of development of corporate culture (R_{56})

The end of Table 1

First level	The second level	The third level
An integral factor in the development of construction enterprises (I_R)	human capital (R_6)	the level of human capital formation (R_{61})
		the level of use of human capital (R_{62})
		staff qualification level (R_{63})
		level of service to consumers of construction products (R_{64})
	brand indicators of construction products (R_7)	the level of brand formation and use (R_{71})
		brand perception (R_{72})
		information protection and brand assurance (R_{73})
		experience in the operation of a construction company (R_{74})
		loyalty of stakeholders to the construction enterprise brand (R_{75})
	potential (R_8)	the level of formation and use of technical potential (R_{81})
		the level of formation and use of resource potential (R_{82})
		the level of formation and use of organizational potential (R_{83})
		the level of formation and use of marketing potential (R_{84})
		formation and use of human potential (R_{85})
		the level of formation and use of innovative potential (R_{86})
		the level of formation and use of investment potential (R_{87})

Local indicators of development, which are determined at the third level, are evaluated based on the application of qualitative and quantitative methods (**Table 2**).

Table 2

Methods of assessment of local factors of development of construction enterprises

Local factors	Evaluation methods
R_{11}; R_{12}; R_{13}; R_{14}	formal (analytical)
R_{21}; R_{22}; R_{23}	expert
R_{31}; R_{32}; R_{33}	expert
R_{41}; R_{42}	expert
R_{51}; R_{52}; R_{53}; R_{54}; R_{55}; R_{56}	expert

The end of Table 2

Local factors	Evaluation methods
$R_{61}; R_{62}; R_{63}; R_{64}$	expert
$R_{71}; R_{72}; R_{73}; R_{74}; R_{75}$	expert
$R_{81}; R_{82}; R_{83}; R_{84}; R_{85}; R_{86}; R_{87}$	expert

At the second level, system indicators are determined by applying the geometric mean model. At the first level, an integrated model for assessing the development of construction enterprises has been developed:

$$I_R = R_1 \cdot K_{R_1} + R_2 \cdot K_{R_2} + R_3 \cdot K_{R_3} + R_4 \cdot K_{R_4} + R_5 \cdot K_{R_5} + R_6 \cdot K_{R_6} + R_7 \cdot K_{R_7} + R_8 \cdot K_{R_8}, \quad (1)$$

де $K_{R_1}, K_{R_2}, K_{R_3}, K_{R_4}, K_{R_5}, K_{R_6}, K_{R_7}, K_{R_8}$ – weighting coefficients characterizing the mutual influence of system factors of the development of construction enterprises and their influence on the integral indicator, which are determined by the method of analysis of hierarchies, resp. unit.

On the basis of the evaluated indicators and the developed model, an integral indicator of the development of construction enterprises was determined (**Figure 1**).

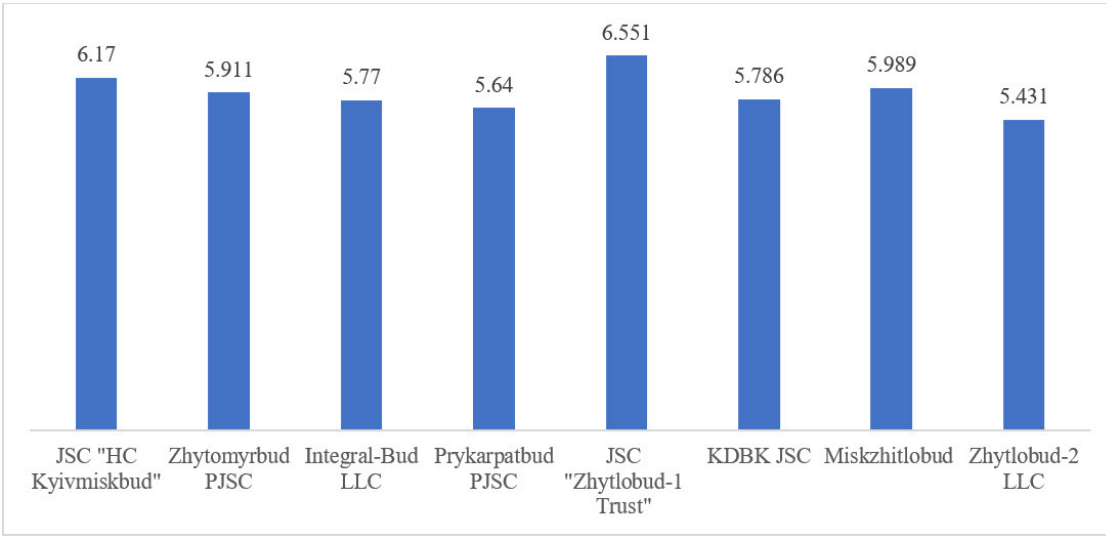

Figure 1 – The results of the assessment of the integral indicator of the development of construction enterprises, resp. unit

As a result of the study, an average level of development support was determined for Zhytomyrbud PJSC, Integral-Bud LLC, Prykarpatbud PJSC, KDBK JSC, Miskzhitlobud Construction Company LLC, Zhytlobud-2 LLC. JSC «HC Kyivmiskbud» JSC and JSC «Zhytlobud-1 Trust» observe a high level of development rates.

Economic-mathematical modeling is carried out by implementing a complex of interrelated directions, which are characterized by information and analytical support, development of the appropriate model, coefficients of correlation and determination, criteria of reliability and adequacy.

Information and analytical support is formed on the basis of the results of an integral assessment of the factors of development of construction enterprises and the formation and use of an intelligent economic system. In addition, a comparative analysis of the values of integral indicators was carried out, the results of which are presented in **Figure 2**.

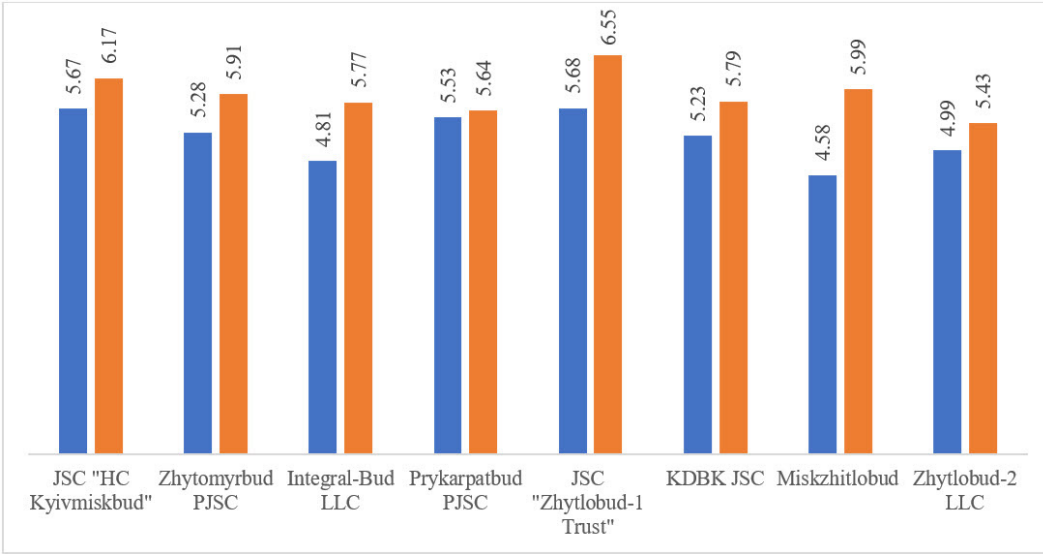

Figure 2 – Comparative analysis of integral indicators of development, formation and use of the intellectual economic system of construction enterprises, resp. unit

The economic-mathematical model of the influence of the integral factor of the formation and use of the intellectual economic system on the integral indicator of the development of construction enterprises is as follows:

$$I_R = 0.379 \; x \; I_k + 3.92. \tag{3}$$

The results of the evaluation of correlation and determination coefficients:

$$R = 0.47;$$

$$R^2 = 0.22.$$

The results of evaluating the criteria of adequacy and reliability of the economic-mathematical model of the influence of the integral factor of the formation and use of the intellectual economic system on the integral factor of the development of construction enterprises are presented in the **Table 3**.

Table 3

The results of evaluating the adequacy and reliability criteria of the economic-mathematical model of the influence of the integral factor of the formation and use of the intellectual economic system on the integral factor of the development of construction enterprises

Criteria	Calculated values	Table values
Fisher's F-test	$F_{розр.} = 111.617$	5.318
Student's t-test	$t_{розр.} = 3.289$	2.447
DW- criterion of Durbin Watson	$DW = 1.305$	d_1=0.763 d_2=1.332

The end of Table 3

Criteria	Calculated values	Table values
Testing for homo and heteroskedasticity	$t_1 = 0.098$	2.447

The economic-mathematical model is not tested for multicollinearity, as it is univariate in nature. The calculated criteria testify to the adequacy and reliability of the developed economic-mathematical model of the influence of the integral factor of the formation and use of the intellectual economic system on the integral factor of the development of construction enterprises.

Conclusions and proposal

Thus, as a result of the study, the definition of the development of construction enterprises is proposed as a set of directions for the formation and use of production, economic and human potential, aimed at the formation of strategic and tactical advantages to achieve a better position compared to the past state of BP.

As a result of the study, it was determined that the level of influence of the directions of formation and use of the intellectual economic system on the development of construction enterprises has decreased. This is due to the ambiguity and lack of a systematic approach to the formation and use of an intelligent economic system at construction enterprises, the inhibition of economic indicators, the low level of application of geospatial support, the reduction of social standards, difficulties in the formation of security support and the implementation of security directions. Therefore, it is proposed to develop scientifically based recommendations regarding the formation and use of the intellectual economic system of construction enterprises.

Proposed measures to ensure the development of construction enterprises, which are aimed at the formation and implementation of intelligent economic systems, the creation of a basis for the growth of the completeness and quality of economic support, the use of geo-informational tools, the construction and improvement of the security and information system, the improvement of social security and standards.

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ЕКОНОМІКО-МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ РОЗВИТКУ БУДІВЕЛЬНИХ ПІДПРИЄМСТВ З УРАХУВАННЯМ ОСОБЛИВОСТЕЙ ФОРМУВАННЯ ІНТЕЛЕКТУАЛЬНИХ ЕКОНОМІЧНИХ СИСТЕМ

Анотація

Вступ. Актуальність теми дослідження зумовлена необхідністю розроблення заходів щодо забезпечення розвитку будівельних підприємств (БП), використовуючи сучасні інтелектуальні економічні системи.

Постановка проблеми. Запропоновані у статті заходи щодо забезпечення розвитку будівельних підприємств, спрямовані на формування та впровадження інтелектуальних економічних систем, створення бази для зростання повноти та якості економічного забезпечення, використання геоінформаційних засобів, будівництва та вдосконалення системи безпеки та інформації, покращення соціального забезпечення та стандартів.

Мета. Економіко-математичне моделювання розвитку будівельних підприємств із урахуванням особливостей формування інтелектуальних економічних систем.

Матеріали та методи. У статті досягнуто мету економіко-математичного моделювання інтегрального показника розвитку будівельних підприємств з урахуванням особливостей формування інтелектуальних економічних систем. Вирішені задачі щодо оцінки інтегрального показника розвитку АТ; розроблення економіко-математичної моделі впливу інтегрального фактора формування інтелектуальних економічних систем на загальний показник розвитку будівельних підприємств; формування заходів щодо розвитку будівельних підприємств за результатами економіко-математичного моделювання відповідних факторів.

Результати. У результаті дослідження сформовано теоретико-методологічну платформу визначення розвитку будівельних підприємств. Запропоновано визначити розвиток будівельних підприємств як сукупність напрямків формування та використання виробничо-економічного та кадрового потенціалу, спрямованих на формування стратегічних і тактичних переваг для досягнення кращого становища порівняно з минулим станом ВР.

Висновки. У результаті дослідження встановлено, що знизився рівень впливу напрямів формування та використання інтелектуальної економічної системи на розвиток будівельних підприємств. Це пов'язано із неоднозначністю та відсутністю системного підходу до формування та використання інтелектуальної економічної системи на будівельних підприємствах, гальмування економічних показників, низький рівень застосування геопросторового забезпечення, зниження соціальних стандартів, труднощі у формуванні забезпечення безпеки та реалізації напрямків безпеки. Тому пропонується розробити науково обґрунтовані рекомендації щодо формування та використання інтелектуальної економічної системи будівельних підприємств.

Ключові слова: розвиток будівельних підприємств, оцінка, економіко-математичне моделювання, інтелектуальні економічні системи, економіка, геопростір, безпека, соціальна безпека.