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Econometric modeling of the level of stakeholder interaction at construction enterprises

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Abstract

The article presents the directions and results of econometric modeling of the level of interaction of stakeholders of construction enterprises. They are defined as natural and (or) legal entities or groups of persons interacting in the construction sector on the basis of strategic contours and social directions and are defined by functional, resultant, structural, process, strategic, complex features, the interaction of which has a certain level of risk and threat. That allows to form contractual relations in capital construction, to carry out architectural control, the corresponding calculations, which is provided by the design documentation, material and labor resources. To implement econometric modeling, a mathematical model of factors is constructed that characterizes the level of stakeholder engagement. A general indicator of the financial condition of construction enterprises is proposed, and a mathematical model for its determination is constructed.

Within the framework of econometric modeling, criteria have been proposed that confirm the adequacy of the developed mathematical models. Interpreting the results of econometric modeling, the indirect influence of the level of formation and implementation of stakeholder interaction on the financial condition of construction enterprises is determined. This indicates that other factors influence the process and determines the need to increase the efficiency of stakeholder engagement in order to strengthen the financial condition of construction enterprises.

The result of the study is the application of methods and models of econometric modeling and construction of the model of the influence of the integrated indicator of the level of stakeholder interaction of construction enterprises on the systemic factor of their financial condition. This created a quantitative basis for the application of directions and mechanisms for improving the effectiveness of stakeholder interaction in order to strengthen the financial condition of construction enterprises.

Keywords: construction enterprises; econometric modeling; stakeholders; level of stakeholder interaction.

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Introduction

In modern conditions of economic turbulence, the formation and maintenance of the development of enterprises that affect the functioning of the state are of particular importance. These include construction enterprises that affect the development of the many other industries.

The current conditions of functioning of construction enterprises are characterized by the lack of clear tendencies of their development. This requires a study of the current state and identification of the interaction between stakeholders of construction enterprises in order to develop recommendations for improving the effectiveness of their activities. In this context, the pressing issue is to determine the level of influence of stakeholder engagement on the functioning of construction enterprises by ecometric modeling methods.

Analysis of recent research and publications

Theoretical and practical foundations for managing stakeholder interaction are investigated by A. Ammari [1], M. Clarkson [2], D. Cleland [3], T. Donaldson [4], P. D'Anselmi [5], E. Gritskov [6], A. Zub [7], K. Mamonov [8], A. Mendelow [9], Mitchell [10], B. Parmar [11], J. Post [12], D. Prunenko [13], J. Savage [14], I. Selender [15] and others.

The work of the scientists substantiates the directions of formation and assesses the level and characteristics of the interaction between the stakeholders. However, the questions of their impact on the functioning of construction enterprises, their financial status, remain unresolved.

Econometric modeling of the influence of the level of interaction of stakeholders on the financial condition of construction enterprises

For the implementation of economic modeling in the system of interaction of stakeholders of construction enterprises, factors are identified and an integrated indicator is determined. To shape the financial condition of construction companies is affected by a set of local factors: change in the profitability ratio of sales

of products (works, services) (SKV_{11}); change in cost-effectiveness ratio (SKV_{12}); change in the coefficient of financial autonomy (SKV_{13}); change in asset turnover ratio (SKV_{14}); change in the overall liquidity ratio (SKV_{15}). These local factors form a systematic indicator of the financial condition of construction companies (SKV_1), for which a common mathematical model is constructed:

$$\{SKV_{11}, SKV_{12}, SKV_{13}, SKV_{14}, SKV_{15}\} \subset SKV_1. \quad (1)$$

The study developed a mathematical model for evaluating the systematic indicator of the financial condition of construction enterprises:

$$SKV_1 = \sqrt[5]{SKV_{11} x SKV_{12} x SKV_{13} x SKV_{14} x SKV_{15}}. \quad (2)$$

The value of the systematic indicator of the financial condition of construction companies varies from 0 to 10 and more. The values of local factors for construction enterprises are used for estimation: JSC "Trust Zhitlobud-1", JSC "Zhitlobud-2", PJSC KGB, "HC "Kyivmiskbud", PJSC "EKO-DIM", PJSC "INTERGAL-BUD", PJSC "Prykarpatbud", PJSC "Sumbud". The results of the calculation of the indicator financial condition of construction enterprises are presented in Fig. 1. The formation of the financial state of construction enterprises is affected by the level stakeholder interaction, which is given by the corresponding integrated indicator (I_s).

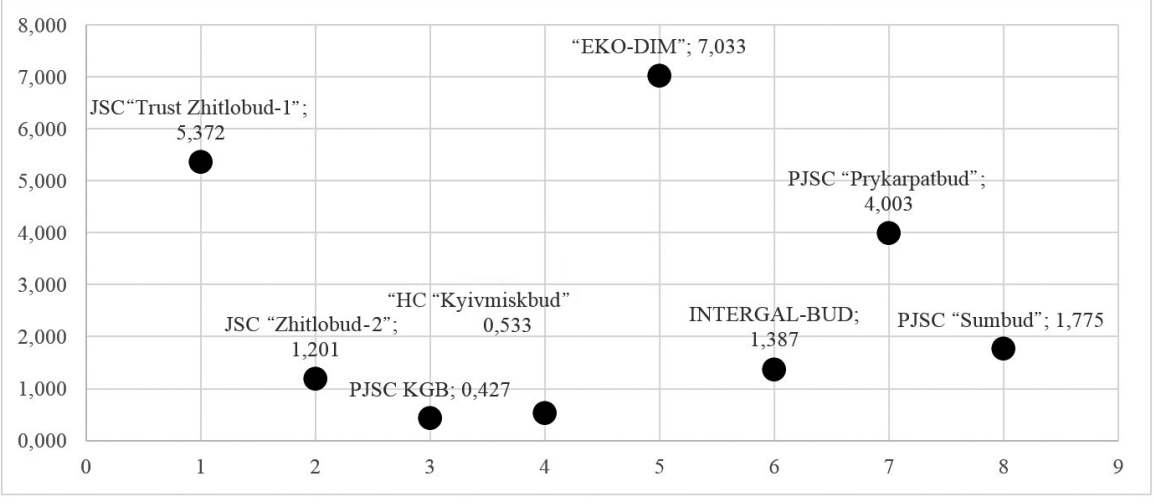

Fig. 1. The results of the calculation of the indicator of financial condition of construction enterprises, relative units

Diagram of the development of a methodological approach to integrated assessment of the level of stakeholder interaction of construction enterprises is presented in Fig. 2.

Given the results of the research, significance of the obtained systemic factors and weighting factors on the basis of the offered directions of implementation of methodological approach, the integrated indicator of the level of stakeholder interaction of construction enterprises is assessed: JSC "Trust Zhitlobud-1" – 4.96; JSC "Zhitlobud-2" – 4.82; PJSC KGB – 4.97; "HC "Kyivmiskbud" – to 5.84; PJSC "EKO-DIM" – 4.34; PJSC "INTERGAL-BUD" – 3.21; PJSC "Prykarpatbud" – 4.24; PJSC "Sumbud" – 3.11.

The level of influence of the integrated indicator of the level stakeholder interaction of construction enterprises on the systemic factor of their financial condition is based on the application of the methods and models of econometric modeling, which include the following steps:

1. The use of information and analytical support based on the results of evaluation of the integrated indicator of the level stakeholder interaction (I_s) and the systemic factor of the financial condition of construction enterprises (SKV_1).

2. The establishing of the dependencies between the integrated indicators of the level of stakeholder interaction of construction enterprises and systemic factor of the financial condition on the basis of correlation coefficient (r) and determination (R^2).

3. The construction of correlation area, mathematical model of the impact of the integrated indicator of the level of stakeholder interaction on the systemic factor of the financial condition of construction enterprises.

4. The determination of the adequacy criteria of the developed mathematical models.

5. The interpretation of the established connections between the integrated indicator of the level of stakeholder interaction of construction enterprises and the systemic factor of financial condition.

The results of econometric modeling

Applying the proposed stages of econometric modeling, a mathematical model is developed, correlation and determination coefficients are obtained, which determine the impact of the integrated indicator of the level of stakeholder interaction of construction enterprises on the systemic factor of their financial condition, the results of which are shown in Fig. 3.

To confirm the level of the econometric model developed, the criteria of adequacy are applied:

the Student's *t*-test and Fisher's *F*-test are used to determine the reliability, completeness of the established relationships in the mathematical model;

the criteria for checking the residuals in the mathematical model for homogeneity of distribution (homoscedasticity) are carried out according to the criterion (μ_{rozx});

Darbin-Watson (*DW*) test, which checks the model for the presence of residual autocorrelation.

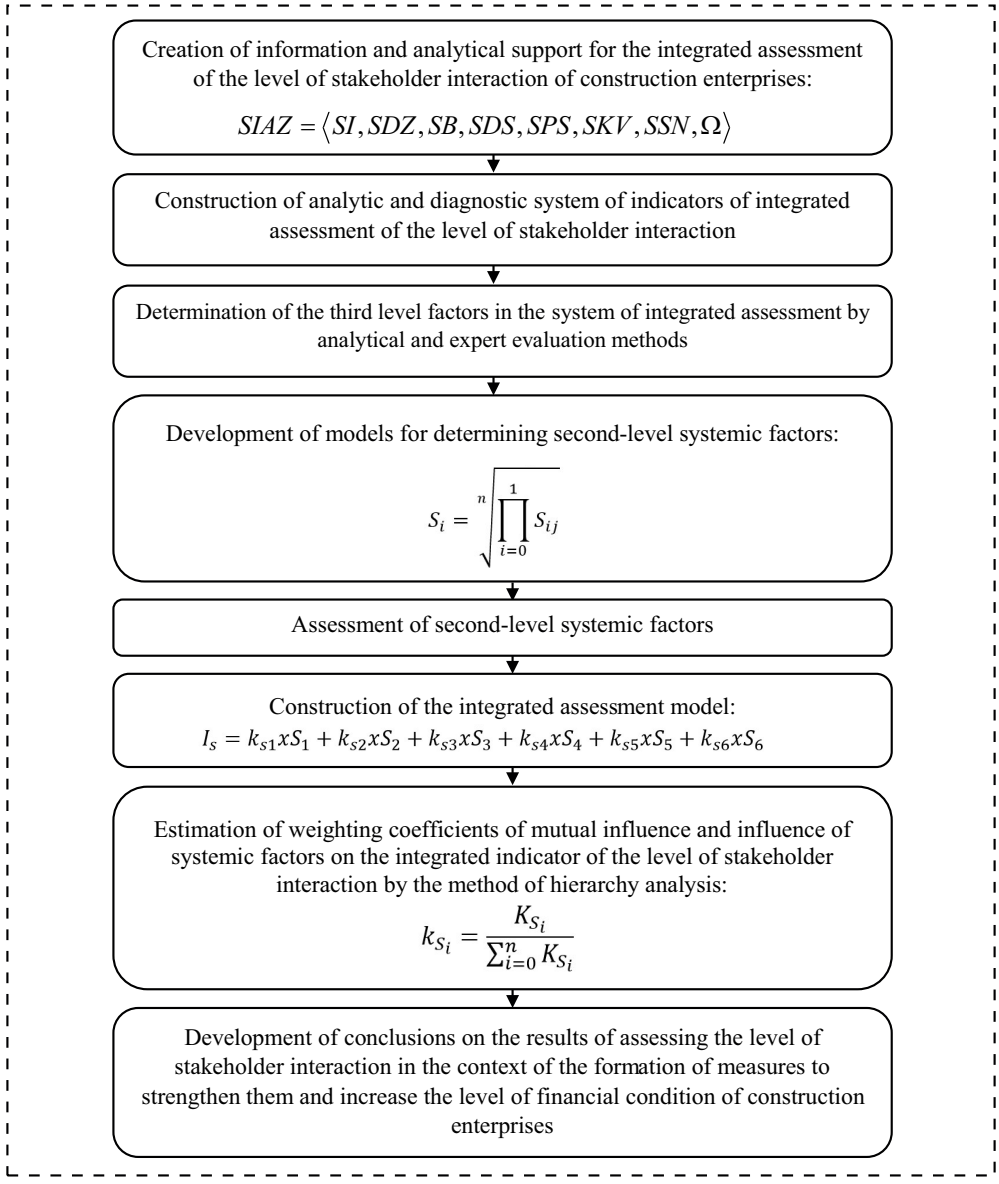

Fig. 2. The scheme of development of methodological approach to integrated assessment of the level of stakeholder interaction of construction enterprises

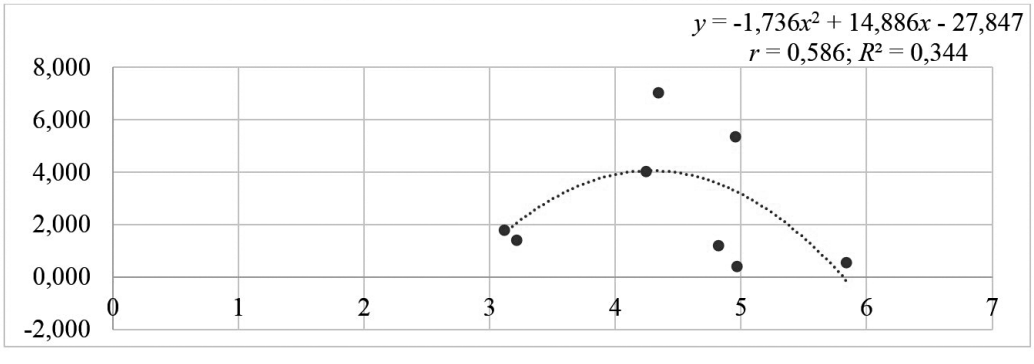

Fig. 3. Mathematical model, coefficients of correlation and determination, which determine the influence of the integrated indicator of the level of stakeholder interaction of construction enterprises on the systemic factor of their financial condition, relative units

The calculated values of the presented criteria are compared with the normative (tabular) ones.

The results of determining the Student's *t*-test and Fisher's *F*-test are presented in Table.

The calculated values of the Student's *t*-test and Fisher's *F*-test ($F_{I_S} = 22.3$, $t_{I_S} = 17.6$, $t_p = 5.1$) exceed their standard values ($F_H = 3.44$, $t_H = 2.31$).

The calculated value of the criterion for the homoskedasticity test indicates that the condition ($\mu_{rozx}(1.12) < \mu_{norm}(2.36)$).

Residual autocorrelation in the developed mathematical models is absent – the Darbin-Watson criterion exceeds the value of 2 ($DW = 2.54$).

Results of Student's *t*-test and Fisher's *F*-test, relative units

Calculated values of *F* and *t* of the Fisher's and Student's criteria	Standard values of *F* and *t* of Fisher's and Student's criteria (at significance level of 0.05)
$F_{I_S} = 22.3$ $t_{I_S} = 17.6$ $t_p = 5.1$	$F_H = 3.44$ $t_H = 2.31$

Thus, the proposed criteria confirm the adequacy of the developed econometric model of the influence of the integrated indicator of the level of stakeholder interaction of construction enterprises on the systemic factor of their financial condition.

Interpreting the results of econometric modeling, the indirect influence of the level of formation and implementation of stakeholder interaction on the financial state of construction enterprises is determined. This indicates that other factors influence the process and determines the need to increase the effectiveness of stakeholder engagement to strengthen the financial condition of construction companies.

Conclusions

The research resulted in econometric modeling of the impact of the integrated indicator of the level of stakeholder interaction on the systemic factor of their financial condition, which created a quantitative basis for the application of directions and mechanisms for improving the effectiveness of stakeholder interaction for strengthening the financial condition of construction enterprises.

The criteria for the adequacy of mathematical models are proposed (the Student's *t*-test and Fisher's *F*-test that are used to determine the reliability, completeness of the established relationships in the mathematical model; the criteria for checking the residuals in the mathematical model for homogeneity of distribution (homoscedasticity) are carried out according to the criterion (μ_{rozx}); Darbin-Watson (*DW*) test to check the model for the presence of residual autocorrelation), which confirm the quantitative parameters of the established relationships between the level of stakeholder interaction and systemic factor of the financial condition of construction enterprises.

Економетричне моделювання рівня взаємодії зацікавлених сторін на будівельних підприємствах

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Анотація

Представлено напрямки і результати економетричного моделювання рівня взаємодії стейкхолдерів будівельних підприємств. Вони визначаються як фізичні та юридичні особи або групи осіб, що взаємодіють у будівельній сфері на основі стратегічних контурів і соціальних напрямів та визначаються функціональними, результатними, структурними, процесними, стратегічними, комплексними ознаками, взаємовідносини яких мають певний рівень ризику й загроз, що дозволяє сформувати підрядні відносини у капітальному будівництві, здійснити архітектурний контроль, відповідні розрахунки, забезпечити проєктною документацією, матеріальними й трудовими ресурсами. Для реалізації економетричного моделювання побудовані математичні моделі факторів, які визначають рівень

взаємодії стейкхолдерів. Розроблено схему формування методичного підходу до комплексної оцінки рівня взаємодії стейкхолдерів будівельних підприємств. Запропоновано узагальнюючий показник фінансового стану будівельних підприємств, побудовано математичну модель його визначення. У рамках економетричного моделювання запропоновані критерії, які підтверджують адекватність розроблених математичних моделей (*t*-тест Стьюдента та *F*-тест Фішера, які використовуються для визначення достовірності та повноти встановлених зв'язків; критерії перевірки залишків у математичній моделі на однорідність розподілу (гомоскедастичність) проводяться за критерієм ($\mu_{гозх}$); тест Дарбіна-Уотсона (*DW*) для перевірки на автокореляцію).

Результатом дослідження є застосування методів і моделей економетричного моделювання та побудова моделі впливу інтегрального показника рівня взаємодії стейкхолдерів будівельних підприємств на системний фактор їх фінансового стану. Це створило кількісну основу для застосування напрямків і механізмів підвищення ефективності взаємодії зі стейкхолдерами для зміцнення фінансового стану будівельних підприємств.

Ключові слова: будівельні підприємства; економетричне моделювання; стейкхолдери; рівень взаємодії зі стейкхолдерами.

Эконометрическое моделирование уровня взаимодействия заинтересованных сторон на строительных предприятиях

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Аннотация

Представлены направления и результаты эконометрического моделирования уровня взаимодействия стейкхолдеров строительных предприятий. Для реализации эконометрического моделирования построены математические модели факторов, которые определяют уровень взаимодействия стейкхолдеров. Разработана схема формирования методического подхода к комплексной оценке уровня взаимодействия стейкхолдеров строительных предприятий. Предложен обобщающий показатель финансового состояния строительных предприятий, построена математическая модель его определения. В рамках эконометрического моделирования предложены критерии, которые подтверждают адекватность разработанных математических моделей.

Результатом исследования является применение методов и моделей эконометрического моделирования и построение модели влияния интегрального показателя уровня взаимодействия стейкхолдеров строительных предприятий на системный фактор их финансового состояния. Это создало количественную основу для применения направлений и механизмов повышения эффективности взаимодействия со стейкхолдерами для укрепления финансового состояния строительных предприятий.

Ключевые слова: строительные предприятия; эконометрическое моделирование; стейкхолдеры; уровень взаимодействия со стейкхолдерами.

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