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PROCESS AND ECONOMIC-MATHEMATICAL FORMALIZATION OF CONSTRUCTION ENTERPRISES' ADMINISTRATION INDICATORS

ABSTRACT

The article considers the main approaches to the rehabilitation ability of construction companies, which should be identified based on a set of individual aspects of the construction company as a participant in investment and construction project and identification of synergetic properties to restore financial stability based on a holistic approach to such assessment. The purpose of this article is to identify the factors that should ensure the rehabilitation ability of the enterprise in the long run. Four groups of indicators can signal in advance the rehabilitation ability state of the construction company. These are indicators that characterize: rehabilitation ability of staff (rehabilitation ability of the project team, rehabilitation potential of staff) *(K_1);* rehabilitation ability of the existing business model for the period of evaluation of the construction company (K_2); rehabilitation favorability of environment of the investment and construction project (K_3)*;* rehabilitation potential of the construction company *(K_4)*. Identification of construction companies rehabilitation ability level is proposed to be carried out based on the calculation of the cumulative indicator, which is determined in six stages: 1) analysis of the dynamics of individual indicators of enterprise activity; 2) calculation and analysis of pairwise correlation coefficients between each of the cumulative indicators of rehabilitation ability and a set of indicators; 3) forming of four local correlation-regression models of the cumulative indicators' dependence on the most influential explanatory factors from the set formed at the previous step; 4) creating a comprehensive cumulative indicator of the rehabilitation ability of the construction company I; 5) calculation and analysis of pairwise correlation coefficients between each of the cumulative indicators of rehabilitation ability as an explanatory factor and the cumulative indicator of rehabilitation ability I; 6) construction of a correlation-regression model of dependence of I on indicators from the set. Then all created models are combined into a single tool that can detect the threat of bankruptcy of the construction company, taking into account the functional-informational, financial, operational links between the participants of the construction in investment and construction projects. Assessing the rehabilitation ability of construction companies based on four aspects of development success (staff, business model, development project environment, and competitiveness factors) not only identify the strengths and weaknesses of participants of construction project but also identify areas of priority for control, correction and other rehabilitation actions for participants in development projects.

Keywords: rehabilitation ability, risk criteria, construction companies, development project, operating system, economic and mathematical model

JEL Classification: A12, C10, D81, M19

INTRODUCTION

The development company should be responsible for the project implementation, its success and profitability over a long period. In the changing economic situation, it is especially important to assess the risks of project implementation, one of which is the low financial stability of construction participants. The influence of these factors can lead to a significant increase in the construction time of the facility or even to the cessation of construction. This is due to the fact that the development project participants interact closely through the flow of financial, informational, logistical, labor resources.

Such interaction during the execution of the construction stages should be mutually agreed upon not only in the framework of certain types of work but also by organization of design, construction, logistics, facility commissioning. Therefore, the implementation of such complex projects requires involving a significant number of specialists from different industries, in particular marketing, budget planning of cash flows, architectural design, construction, engineering, real estate sales, analysis of the economic efficiency of the project and financial sustainability and the use of new and well-known methods of assessment and administration of investment and construction process.

Successful implementation of a development project can be achieved can be achieved by ensuring the financial solvency of all participants in the construction, preventing bankruptcy and increasing the financial rehabilitation potential at each stage of the project implementation. Crisis phenomena of one or more contractors, transport, design or engineering companies, suppliers, financial institutions, etc. can cause the bankruptcy of not a single business entity, but of a number of them, thereby significantly undermining the ability of the developer to implement the project. The bankruptcy of a development company in its turn can further undermine the financial stability of all interconnected construction participants. Thus, determining the tendency to bankruptcy and ensuring the financial rehabilitation potential of enterprises that are development projects participants is a key to successful project implementation.

Therefore, it is very important to identify the financial rehabilitation potential of development companies in the long run.

LITERATURE REVIEW

Financial rehabilitation potential of construction companies should be determined based on a set of individual aspects of a construction company as a participant of an investment and construction project and identification of synergetic properties to restore financial stability based on a holistic approach to such assessment.

The operating system is a central part of any business system covering more functions than a production system, as it includes, in addition to production backward linkages, consumers and other stakeholders of the construction company, additional services, warranty service and more. This (operating) system includes internal and external functions, subsystems of project management, management and transmission of information. This ensures a high level of competitiveness of the developer in the long run.

Operating system of the enterprise converts input resources (raw materials, products and structures, labor, information, capital) to output (finished products, results of the enterprise, etc.), so the evaluation of features and characteristics specific to each enterprise should identify its merits and flaws in ensuring financial rehabilitation, and therefore should be the basis for the resumption of the relevant entity and the bankruptcy avoidance in case of need.

To identify the potential to restore financial stability or the feasibility of such restoration from the standpoint of financial rehabilitation and object-target construction enterprise operating system management as a cumulative part of the construction enterprises administration within the single framework for identifying, preventing, neutralizing or mitigating threats, a system of indicators has been proposed that covers various aspects of a construction company's activity and allow to identify strengths of the company investigated, the so-called «platforms for financial recovery», «development islands», etc. Since the operating system covers various functional tasks – from human resource management to construction preparation, cash flow management, construction production management, etc. and is the basis of the enterprise, its assessment in terms of financial rehabilitation potential of the enterprise should be the basis of financial recovery and the creation of a group of indicators or a single cumulative feasibility indicator financial rehabilitation of a construction company.

To identify the construction companies' anti-crisis capacity, a number of scientists study the industry features concerning bankruptcy, crisis management, financial rehabilitation, solvency recovery, forecasting, and threat monitoring and detection, economic and financial security issues. The authors propose the following sets of indicators that can signal the capability of a construction company to restore its solvency, namely:

1) Stetsenko S. P. and Bolila N. V. emphasize the importance of balancing the system of indicators for assessing receivables and payables and their structure to create a system monitoring antirecession capability in construction and evaluation of crisis management of construction enterprises [1; 2];

2) to identify the antirecession capability of construction companies Izmailova K., Ryzhakova G., Prikhodko D. and other authors [3–5] used indicators of financial condition, supplemented by indicators of business activity, cash flow and others;

3) Skupsky R., Vakhovych I., Bolila N., Antropov Y. and other scientists [6–9] proposed to use cumulative indicators for assessing financial stability to identify bankruptcy threats for small construction companies having condensed financial statements, and therefore the amount of statistical information on their activities is significantly limited;

4) Sorokina L., Goiko A., Skakun V. and other authors [10–13] chose the method of fuzzy sets to solve problems of assessing the anti-crisis ability of the construction company, and selected coefficients of financial and market stability, profitability, development stability, etc. as factors;

5) Interesting is the proposed approach [14–16] of assessing long-term behavior of construction enterprises to identify the causes of financial stability loss and identifying the impact on long-term financial stability along with other factors of «economic cycle phase» or «seasonality» criteria and macroeconomic features. The disadvantage of this approach is the lack of long-term observations and initial data for newly established enterprises;

6) Diana Elena Vasiua and Iulian Gheorghe offer beyond the financial performance assessed on the basis of profit and loss account, evaluating a company is made from the perspective of its ability to cope with due debts [17];

7) Jieh-Haur Chen, Li-Ren Yang, Mu-Chun Su, Jia-Zheng Lin [18] offer to develop an automatic expert model using the Hyper Rectangular Composite Neural Networks (HRCNNs). With these 16 financial ratios and the proposed model, derivative use to hedge financial risk can be established for the benefit of the construction practitioners);

8) authors [19] propose a new model to predict company failure in the construction industry. The model includes three major innovative aspects. The use of strategic variables reflecting the key specificities of construction companies, which are critical to explaining company failure. The use of data mining techniques, i.e. support vector machine to predict company failure. It is concluded that support vector machine, with random oversampling and including strategic variables, is a very robust tool to predict company failure in the context of the construction industry. In particular, this model outperforms the results obtained with logistic regression;

9) In the article [20–22] authors review two models for testing the financial security of construction companies. It discusses the utility of the ratio analysis technique and the Z model in predicting whether companies are heading for insolvency;

10) Scientists [23–25] develop a prediction model that can be effectively used in practice to analyze and signal the risk of insolvency and bankruptcy of a construction firm. Their research must identify the key factors that would allow for early identification of the symptoms of the upcoming financial failure of companies from the construction sector. To reach the goal of the study discriminant analysis, logistic or multiple regression and classification trees were used. The final estimated models included nine variables related to profitability; revenues; liquidity; asset's structure; and owner's and foreign equity, some referred to the industry and market situation in a construction sector. What are more, results show that the method chosen to estimate the insolvency prediction model may have an impact on both partial and general effectiveness in the process of creditworthiness assessment.

All the analyzed methods take into account the general state of construction enterprises. Some determine the possibility of bankruptcy in the organization. At the same time, none of the studied evaluation methods considers special indicators that may signal the financial rehabilitation potential of construction enterprises. So, the purpose of this article is to identify the factors that should ensure the financial rehabilitation potential of the enterprise in the long run. Construction companies operating in the domestic market during 2008–2020 were selected as representative companies.

RESULTS

From the analysis and aggregation of theoretical and methodological approaches, applicable tools to choose proper indicators for construction companies' insolvency, gaining financial rehabilitation potential and economic security, a preliminary list of indicators that can signal the financial rehabilitation potential of a construction enterprise has been determined and divided into groups:

- K_1 – indicators that characterize the financial rehabilitation potential of staff (financial rehabilitation potential of the project team, the financial rehabilitation potential of staff), which is defined as the ratio of the average wage at the enterprise to the average wage in the industry for the year. This ratio is an integral indicator depending on a number of factors, namely: annual labor productivity, thousand UAH/person; the share of administrative costs of the enterprise in relation to wages in operating expenses, the share of units; share of wages in the operating expenses of the enterprise, share of units; share of employees with higher education among a construction company administrative staff, share of units; average work experience of management personnel, years; ratio of wage obligations to the total

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wage bill, share of units. Given factors are calculated according to the data of forms № 1 «Balance (Statement of financial position)» and № 2 «Statement of financial results (Consolidated income statement) «, Information on the education and work experience of the emitent's officials and other regular information about emitent available on the Stock market infrastructure development agency of Ukraine (SMIDA) website.

- K_2 – indicators that characterize the financial rehabilitation potential of the existing business model for the period of evaluation of the construction company, which is determined based on an indicator of autonomy that characterizes the financial stability of the enterprise in the long term and depends on the following factors: the ratio of revenue to cost; depreciation level of the company's fixed assets, share of units; capital productivity; number of activities; working capital turnover ratio; developmental stability coefficient. Given factors are calculated according to the data of forms № 1 Balance (Statement of financial position) and № 2 Statement of financial results (Consolidated income statement), Information on obtained licenses for certain activities and other regular information about emitent available on the Stock market infrastructure development agency of Ukraine (SMIDA) website.
- K_3 – indicators that characterize the suitability of the investment and construction project environment for financial rehabilitation. This group of indicators is calculated to determine the degree of external influence on the company, stakeholders' engagement in construction projects, which can be both constructive and destructive factors given the financial rehabilitation potential of such companies. It is suggested to measure environment suitability based on the financing stability coefficient (the share of timely paid volumes of work performed in accordance with forms № KB-2 «Act of completed construction work» and № KB-3 «Certificate of the cost of completed construction work and expenses» in the total number of submitted acts. This ratio is an integral indicator that depends on a number of factors, namely: the ratio of the average level of accounts payable to the production cost; the ratio of the average level of accounts receivable to the production cost; coverage ratio; the ratio of net income to the average annual amount of receivables; share of accounts payable in liabilities, calculated according to the data of forms № 1 Balance (Statement of financial position) and № 2 Statement of financial results (Consolidated income statement).
- K_4 – financial rehabilitation potential of the construction enterprise, which reflects organization competitiveness level to the resumption of further activities; its market position characterized by the quality of products, goods, works, services, schedule overrun due to the contractor's fault, etc., length of business experience, the percentage of tenders won to submitted proposals. This indicator is determined depending on the ratio of the increase (fall) in production volumes to the industry average values for the reduction or increase in construction volumes; exceeding the planned deadlines for the performance of work under contracts, months; sales costs to the operating expenses of the enterprise in the period under review; average term of work of managerial staff at the enterprise, years. Given factors are calculated according to the data of forms № 1 Balance (Statement of financial position) and № 2 Statement of financial results (Consolidated income statement), Information on the education and work experience of the emitent's officials and other regular information about emitent available on the Stock market infrastructure development agency of Ukraine (SMIDA) website as well as data on the planned and actual dates commissioning dates for the developer's facilities.

While analyzing the theoretical and applied, methodological principles to evaluating construction companies' financial rehabilitation potential it is important to esteem the incremental advance of an enterprise over several years to identify financial status downtrend and identify groups of factors posing threats to the enterprise activity and vice versa can be the basis for financial rehabilitation [4; 8; 17]. Evaluation of financial rehabilitation potential through a group of factors has significant shortcomings such as considerable time and volume needed for information collection and processing, the diversity of factors that can simultaneously indicate both improvement and slowdown in financial rehabilitation potential of a construction company. At the same time, it is difficult to implement a single overall assessment, which requires a high level of qualification and labor inputs of the analyst. Therefore, to identify construction companies' financial rehabilitation potential, it is proposed to calculate a cumulative indicator, which is carried out in several stages.

Stage 1. Enterprise individual indicators dynamics analysis by 4 abovementioned dimensions: financial rehabilitation potential of the team (K_1), financial rehabilitation potential of the business model (K_2), financial rehabilitation suitability of the multi-project investment and construction environment (K_3), competitiveness level of a construction company (K_4).

Creating a set of factors $\{x_{ij}^n\}$, that affect each aspect of the enterprise $\{K_1^m\}$,

where $m \in [1,4]$ – number of parameters evaluated; K – cumulative indicator; x – influencing factors.

Based on a set of factors for j supervision for i enterprises the most problematic and the most favorable directions of activity in view of the feasibility of future financial rehabilitation are preliminarily defined.

Stage 2. Calculation and analysis of pairwise correlation coefficients between each of the cumulative indicators of financial rehabilitation potential $\{K_{1j}^4\}$ and a set of indicators $\{x_{ij}^n\}$. Determining the indicators impacting the most significantly on every resulting factor and testing each of the four models for multicollinearity. Verification is proposed to be performed by analyzing the correlation matrix between the independent variables of each model and establishing the determinant of each matrix.

Since paired correlation coefficients of independent variables often include indicators with the value close or equal to the multiple correlation coefficient, it may indicate the possibility of multicollinearity. Data on pairwise correlation is provided by a matrix of pairwise correlation coefficients:

$$r = \begin{pmatrix} r_{X_1X_1} & r_{X_1X_2} & r_{X_1X_3} & \cdots & r_{X_1X_K} \\ r_{X_2X_1} & r_{X_2X_2} & r_{X_2X_3} & \cdots & r_{X_2X_K} \\ r_{X_3X_1} & r_{X_3X_2} & r_{X_3X_3} & \cdots & r_{X_3X_K} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{X_KX_1} & r_{X_KX_2} & r_{X_KX_3} & \cdots & r_{X_KX_K} \end{pmatrix}$$

Verification of multicollinearity, if the model uses more than one influencing factor, assumes D matrix determinant definition. Numerical values of the determinant are on the set: $D \in [0,1]$. The closer the value of the determinant D is to zero, the more certain there is multicollinearity between the explanatory variables. If $D = 0$ – there is complete multicollinearity, if $D = 1$ – there is no multicollinearity.

If multicollinearity appears in the model, it may have large error margins and, thus, be unusable. Multicollinearity of independent factors leads to a significant shift in the parameters of the model, calculated using the least-squares method, which leads to the incapability to find out actual relationship and impact. Based on these estimates, it is impossible to draw specific conclusions about the interrelation outcome between the resulting indicator and the influencing variables.

Stage 3. Creation of four local correlation-regression models with a dependency of each of the cumulative indicators $\{K_{1j}^4\}$ to the most impacting explanatory factors from the set formed in the previous step $\{x_{ij}^n\}$. Each of the created models explains and describes in-depth the financial rehabilitation potential of the staff, the existing business model, multi-project environment favorability and competitiveness of construction companies.

Stage 4. Creating a comprehensive cumulative indicator of the financial rehabilitation potential for the construction company I, determining the impact of the above four aspects of activity (staff, business model, environment, competitive advantages and disadvantages), identifying the dynamics of cumulative indicators $\{K_{1j}^4\}$, which in this model act as influencing factors and the calculation of their critical values.

Stage 5. Calculation and analysis of pairwise correlation coefficients between each of the cumulative indicators of financial rehabilitation potential $\{K_{1j}^4\}$ as an explanatory factor and a cumulative indicator of financial rehabilitation potential I. Identification of indicators that have the most significant impact on each of the resulting factors and verification of each of the four constructed models for the presence of multicollinearity.

Stage 6. Creation of a correlation-regression model with a dependency of I on indicators from the set $\{K_{1j}^4\}$. The next stage of the study is to create a cumulative indicator of construction participants financial rehabilitation potential based on a combination of the above four cumulative indicators, which in this case are factors influencing the cumulative indicator for development project participants (*Tables 1–4*).

To determine the significance and level of influence of coefficients K_1 – K_4 on the cumulative indicator of construction companies' financial rehabilitation potential, we will conduct a regression analysis, the first stage of which should be to check the factors for the presence of a pair (see *Table 1*).

Table 1. Pairwise correlation coefficients for the factor «internal financial rehabilitation potential.

	K_1	K_2	K_3	K_4	I
K_1	1				
K_2	-0.15472651	1			
K_3	0.561872675	-0.24316	1		
K_4	-0.021478731	-0.28918	0.35084	1	
I	0.170507967	0.380762	0.299819	0.141705	1

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Table 2. Determination of multiple correlation coefficient.

Multiple *R*	0.577902685
R-square	0.333971514
Rationed *R*-square	0.259968349
Standard deviation	4.080854576
Observation	41

Table 3. The results of variance analysis.

	df	***SS***	***MS***	***F***	***Significance F***
Regression	4	300.6224146	75.15560365	4.512935536	0.004663163
Remainder	36	599.5214666	16.65337407		
Total	40	900.1438812			

The parameters of the coefficients of the obtained dependence (a cumulative indicator of the financial rehabilitation potential of the project team) are presented in *Table 4*.

Table 4. Parameters of the coefficients of the obtained equation.

	Coefficients	**Standard deviation**	***t*-statistics**	***P*-value**	**Bottom 95%**	**Top 95%**	**Bottom 95%**	**Top 95%**
I	-16.839	12.790	-1.3165	0.19632	-42.779	9.1017	-42.779	9.1017
K_1	1.0499	2.4113	0.43543	0.6658	-3.8404	5.9404	-3.8404	5.9404
K_2	2.7373	0.75629	3.6194	0.0009	1.2034	4.2711	1.2034	4.27117
K_3	5.0073	2.86114	1.7501	0.08861	-0.7953	10.810	-0.7953	10.810
K_4	15.7708	13.5224	1.16626	0.25117	-11.6540	43.1957	-11.654	43.1957

The model has sufficient accuracy and explains the variability of the resultant factor *I* depending on the explanatory factors of almost 33%. The multiple correlation coefficient *R* is 0.577 or 50.7%, so the relationship between the dependent variable and the influencing factors is quite close. The value of R^2 indicates that the financial rehabilitation potential of the project team by 33.4% is due to variables in the resulting modeling of the cumulative indicator. Therefore, the model has sufficient accuracy and statistical significance.

According to the *Table 4* linear equation parameters have values: a_0 = -16,839; a_1 = 1,0499; a_2 = 2,7373; a_3 = 5,0073; a_4 =15,770. Since the Fisher test for the model is greater than the critical value at the significance level α = 0.05, the null hypothesis is rejected, which means the statistical significance of the regression.

As a result, linear regression model of a construction company's financial rehabilitation potential is as follows:

$$I = -16{,}839 + 1{,}0499K_1 + 2{,}7373K_2 + 5{,}0073\ K_3 + 15{,}7708\ K_4, \quad (1)$$

where K_1–K_4 – indicators of financial rehabilitation potential of the construction company.

As a result, all the models created at the previous stage are combined into a single tool that can detect the threat of bankruptcy of the construction company, taking into account the functional-informational, financial, operational links between construction participants in investment and construction projects (*Fig. 1*).

The presented scientific and methodological tools for identifying and controlling the level of financial rehabilitation potential allows the development company to carry out a multi-parameter assessment of future project executors in terms of approximation of the current state to the target or control values necessary for timely and successful implementation of contracts within the project.

Assessing the financial rehabilitation potential of construction companies based on four aspects of development success (staff, business model, development project environment, and competitiveness factors) will not only identify the strengths and weaknesses of individual participants in construction but also identify areas of priority control, corrective and other financial rehabilitation activities of participants in development projects.

№	Name of the indicator	Formula
1	K_1 - rehabilitation ability of the project team	$K_1 = 0,095 + 0,0000IX_1 + 0,309X_2 - 0,306 X_3 - 0,004 X_4 - 0,003 X_5 - 0,465 X_6$
X_1 - annual labor productivity, thousand UAH / person; X_2 - the share of administrative costs of the enterprise in relation to wages in operating expenses, the share o f units; X_3 - the share o f wages in the operating costs of the enterprise, the share o f units; X_4 - the share of employees with higher education among the management staff of the construction company, the share of units; X_5 - average work experience o f management staff years; X_6 - the ratio of payroll obligations to the general wage fund, the share o f units.		
2	K_2 - rehabilitation capacity of the business model of a construction company	$K_2 = 0,349 - 0,003X_7 - 0,0001X_8 - 0,057 X_9 - O,O23X_{10} + 0,053X_{11} + 0,0026 X_{12}$
X_7 - revenue to cost ratio; X_8 - level o f depreciation of fixed assets o f the enterprise, share of units; X_9 - return on assets; X_{10} - the number o f licenses obtained; X_{11} - working capital turnover ratio; X_{12} - development stability coefficient.		
3	K_3 - rehabilitation of the investment and construction project environment	$K_3 = 0,6365- 0,0587X_{13} - 0,1203X_{14} + 0,025 X_{15} + 0,0009X_{16} + 0,1479X_{17}$
X_{13} - the ratio o f the average level o f accounts payable to production costs; X_{14} - the ratio of the average level of receivables to production costs; X_{15} - coverage ratio; X_{16} - the ratio o f net income to the average annual amount o f receivables; X_{17} - share o f accounts payable in liabilities		
4	K_4 - internal competitive potential of the construction company	$K_4 = 1,0141 - 0,01015X_{18} - 0,0032X_{19} + 0,219 X_{20} - 0 ,0022X_{21}$
X_{18} - the ratio of increase (decrease) in production to the average industry values of reduction or increase in construction; X_{19} - exceeding the planned terms of performance o f works under contracts, months; X_{20} - sales costs in relation to the operating costs o f the enterprise in the analyzed period; X_{21} - average term o f work of the personnel at the enterprise, years.		
I = -16,839 + 1,0499 K_1 + 2,7373 K_2 + 5,0073 K_3 +15,7708 K_4		

Figure 1. Tools for assessing the financial rehabilitation potential of development project participants.

Data from Ukrainian construction companies were used to evaluate the financial rehabilitation potential of a group of companies during four years in a row, divided into two groups:

a) enterprises subjected to financial rehabilitation procedure in 2008–2020, namely: BC «Domobudivnyk», «Vinnytsia Bridge Construction Department № 4», «Genicheskagrobud», «Azovstalbud» and enterprises that are currently successfully operating in the construction market and real estate sales «Kyivmiskbud-2», «Kyivmiskbud-6».

b) enterprises subjected to bankruptcy proceedings in different years or closed down at the request of the owners. Such enterprises include «Dzhankoysky Budivel'nyk», «Trust Kyivmiskbud-1», «Kyivmiskbud-3», «Kyivmiskbud-1 named by P. Zavgorodny», BC «Budivel'nyk».

For these enterprises, an analysis of the financial rehabilitation potential was carried out within four years and the level of change in indicators that determine different aspects of activities was determined.

The cumulative financial rehabilitation potential of the studied construction enterprises group is determined based on indicators K_1–K_4 values and dynamics (*Table 5*).

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Table 5. Determining financial rehabilitation potential of construction companies.

Name of Company	Years			
	$t-3$	$t-2$	$t-1$	t (liquidation or financial rehabilitation)
«Domobudivnyk»	5.9136	5.5590	5.1080	6.3307
«Vinnytsia Bridge Construction Department №4»	0.4676	3.8748	3.4209	2.8986
«Genicheskagrobud»	7.6987	6.6192	7.1031	6.9189
«Azovstalbud»	3.1701	-1.9570	0.5581	1.2923
«Kyivmiskbud-2»	4.6481	3.7772	2.2388	4.6481
«Kyivmiskbud-6»	2.3785	-1.3099	0.5910	0.9832
«Dzhankoysky Budivel'nyk»	2.7532	1.0579	0.5481	-2.5858
«Trust Kyivmiskbud-1»	1.4917	1.7799	0.3411	- 0.1844
«Kyivmiskbud-3»	4.0095	1.1560	-2.6655	-3.3229
«Kyivmiskbud-1 named by P. Zavgorodny»	2.9182	1.4482	0.5307	0.5618
BC «Budivel'nyk»	0.5604	1.5008	-0.2562	0.1604

The lower limit of normal values of the construction company financial rehabilitation potential cumulative indicator is determined as 0.56.

According to the calculation results, it can be seen that most companies in the group of high financial stability (enterprises of the first group) have an indicator of financial rehabilitation potential (I) greater than 0.56, while enterprises of the second group (low level of financial stability, close-down due to bankruptcy or owners) have a cumulative score less than or close to critical.

The dynamics of the indicator I for the enterprises in the first group is quite strong and diverse. Thus, for the company «Vinnytsia Bridge Construction Department № 4» the indicators of cumulative financial rehabilitation potential gradually decreased within the studied period, while for the enterprises «Domobudivnyk», «Genicheskagrobud», «Kyivmiskbud-2» – fluctuated but remained high, and for the companies «Kyivmiskbud-6», «Genicheskagrobud» – decreased below the minimum values, but in the last year returned to the range that is inherent in enterprises with high financial rehabilitation potential.

Among the majority of enterprises belonging to the second group, cumulative indicators of financial rehabilitation potential tend to decrease, except for «Kyivmiskbud-1 named by P. Zavgorodny», which had a cumulative within normal values for the past year.

It can be concluded that the enterprises belonging to the first group have a fairly high level of financial rehabilitation potential, while the enterprises of the second group have a low level of financial stability, prone to bankruptcy while having a low level of financial rehabilitation potential.

To identify the impact of managerial decisions made by development project participants on the financial stability of individual construction companies involved in the construction, it is proposed to use simulation method, which will let to replace real interrelation between managerial decisions and the resulting financial rehabilitation potential indicators, as well as model different process scenarios over time, and choose the best scenario for the company, or identify threats that arise as a result of certain managerial decisions, as a result of project administration by the developer and independent external and internal factors.

CONCLUSIONS

A cumulative indicators system has been developed to evaluate investment and construction projects participants' financial rehabilitation potential. The system combines indicators evaluating financial rehabilitation potential of the project team (staff), financial rehabilitation potential of the business model, development project environment favorability for financial rehabilitation and competitiveness potential of an enterprise to determine bankruptcy resistance of a certain company but also to identify threat factors in abovementioned indicators of a construction company as a development project participant, detect «growth points», «rehabilitation points», which can serve as a basis for financial and bankruptcy prevention activities. Suggested logical-mathematical or schematic description of the object can be used for computer «playback» of different scenarios and create an appropriate model to analyze, predict, monitor and evaluate the dynamics and trends of

the development project environment in terms of financial rehabilitation potential of its participants, and easily maintain the operating system of construction companies in a multi-project environment, anticipating future consequences for individual project participants and for the entire operating environment of the project in context of combating bankruptcy and maintaining financial stability in the long run.

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ПРОЦЕСНА ТА ЕКОНОМІКО-МАТЕМАТИЧНА ФОРМАЛІЗАЦІЯ ІНДИКАТОРІВ АДМІНІСТРУВАННЯ БУДІВЕЛЬНИМИ ПІДПРИЄМСТВАМИ

Розглянуто основні підходи до санаційної спроможності будівельних підприємств, яка має виявлятись на основі сукупності окремих аспектів діяльності будівельного підприємства як учасник інвестиційно-будівельного проєкту та ідентифікації синергетичних властивостей щодо відновлення фінансової стійкості на базі цілісного підходу до такого оцінювання. Метою статті є виявлення чинників, які мають забезпечити санаційну спроможність підприємства в довгостроковій перспективі. Визначено чотири групи показників, які заздалегідь можуть сигналізувати про санаційну спроможність будівельного підприємства. Це показники, які характеризують: санаційну спроможність персоналу (санаційна спроможність проєктної команди, санаційний потенціал персоналу) (K_1); санаційну спроможність наявної бізнес-моделі на період оцінювання будівельного підприємства (K_2); санаційну сприятливість середовища інвестиційно-будівельного проєкту (K_3); санаційний потенціал будівельного підприємства (K_4). Виявлення рівня санаційної спроможності будівельних підприємств запропоновано здійснювати на основі розрахунку інтегрального

показника, визначати який потрібно в шість етапів: 1) аналіз динаміки окремих показників діяльності підприємства; 2) розрахунок та аналіз коефіцієнтів парної кореляції між кожним із інтегральних показників санаційної спроможності та множиною показників; 3) побудова чотирьох локальних кореляційно-регресійних моделей залежності кожного із інтегральних показників від найбільш впливових пояснювальних чинників зі сформованої на попередньому кроці множини; 4) створення комплексного інтегрального показника санаційної спроможності будівельного підприємства I; 5) розрахунок та аналіз коефіцієнтів парної кореляції між кожним із інтегральних показників санаційної спроможності як пояснювальний чинник та інтегральний показник санаційної спроможності I; 6) побудова кореляційно-регресійної моделі залежності I від показників із множини. Далі усі створені моделі об'єднано у єдиний інструментарій, здатний виявити загрози настання банкрутства будівельного підприємства, враховуючи при цьому функціонально-інформаційні, фінансові, операційні зв'язки між учасниками будівництва в рамках інвестиційно-будівельних проєктів. Оцінювання санаційної спроможності будівельних підприємств, виходячи із чотирьох аспектів успішності розвитку (персонал, бізнес-модель, середовище девелоперського проєкту, чинники конкурентоспроможності), дозволить не тільки виявити сильні і слабкі сторони окремих учасників будівництва, а й визначити сфери першочергового проведення контрольних, корегувальних та інших санаційних заходів учасників девелоперських проєктів.

Ключові слова: санаційна спроможність, критерії ризику, будівельні підприємства, девелоперський проєкт, операційна система, економіко-математична модель

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