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# SYSTEM OF PREVENTIVE ACTION OF CONSTRUCTION ENTERPRISES ON THE BASIS OF IDENTIFICATION OF ANTICRISIS POTENTIAL

**Abstract:** Peculiarities of formation of anti-crisis potential of construction enterprises are considered. Construction companies are rapidly adapting to the requirements of the digital economy, transforming the management structure, business processes. To improve the system of preventive protection and protection of enterprises from loss of viability and subsequent self-liquidation or bankruptcy, a system of indicators is proposed, which allows to identify existing risks and threats at an early stage. In order to improve the mechanism of control of the stability of the system of anti-crisis potential of construction enterprises in the medium term, a cluster analysis was performed. The study was based on 53 enterprises of the type of activity «construction». This study allowed us to identify the most important, priority, leading indicators of the loss of economic security and to clarify the threshold values of these indicators and the degree of their «blurring» in the unstable conditions of the external economic environment. Indicators of crisis state of construction enterprises are determined by means of fuzzy sets, among which it is possible to allocate: level of capital consumption by owners, level of operating sales on retained earnings, return on working capital on retained earnings, cost of operating expenses on personnel costs, term of accounts payable. The main direct and indirect signs of deterioration of the anti-crisis potential of the enterprise are revealed. The model of

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information interaction of divisions of the enterprise is offered. All processes of information exchange with the help of IMS (Information Management System) have the ultimate goal of the maximum possible exclusion from the business practice of paper documents and the transition to direct paperless data exchange (in the practice of construction is an example of creating a BIM-model of objects).

**Keywords:** economic security, anti-crisis potential, digitalization, financial indicators, construction enterprise.

**Introduction**

A feature of the modern development of the economic system of all countries is the digital transformation of the functioning of the economy, strengthening internal and external information interaction of all parts of the economic system, including the information environment of enterprises [1]. The internal environment of the enterprise is gradually transformed from a number of separate functional units, centers of responsibility, and decision-making into a single information space. Within this space, each contractor can use information from a single database, see the progress of construction projects and their structure, the actions of other participants.

The market environment in Ukraine is characterized by instability and uncertainty, which further complicates the crisis management of enterprises. The destructive effect of adverse factors in the macro-environment is particularly acute for construction companies, as during their long operating cycle there are significant changes in prices, interest rates, the national currency, as well as the demand for residential, commercial and industrial real estate. Many construction companies, which have been operating relatively stably for 5 to 10 years, are therefore on the verge of bankruptcy or have already gone bankrupt.

Construction companies are rapidly adapting to the requirements of the digital economy, transforming the management structure, business processes. Currently, information systems, BIM modeling, are widely used in the organization and management of construction of facilities [2-3]. But in the context of digitalization, successful operations are impossible without an effective system of early detection of threats in the short and medium term. The main function of such a system is the ability to identify destabilizing factors, even when their negative impact is weak and has not yet affected the results of economic activity. This is especially relevant for the management of relatively successful enterprises, for which the probability of deterioration of financial condition, and even more bankruptcy, in the next 1-2 years remains low.

The key task is to form a system of preventive protection of enterprises as a component of economic security, able to accurately detect and neutralize threats, which determines the relevance of the study.

**Literature Review**

The problem of forming a system of preventive protection and economic safety of construction companies in economics on the example of various industries, countries, activities has been considered by many scientists, among whom are works Abidali, A.F., & Harris, F. [4], Chan, J. K.W., Tam, C.M., & Cheung, R.K.C.[5], Edum-Fotwe, F., Price, A., & Thorpe, A. [6], Kangari, R., Farid, F., & Elgharib, H.M.[7], Mason, R.J., & Harris, F.C. [8], Tserng, H., Lin, G., Tsai, L., & Chen, P. [9], Deakin, E.B. AndEdison, H. J. [10-11], Karas, M., & Režňáková, M. [12], Lin, F., Liang, D., & Chen, E. [13], Spicka, J. [14], Thomas Ng, S., Wong, J. M. W., & Zhang, J. [15] etc.

Despite the significant scientific achievements of these scientists, the system of prevention of threats to economic security of the enterprise in terms of digitalization of the economy, as well as the formation of systems of preventive protection of enterprises and the formation of its anti-crisis potential needs further consideration, improvement and development.

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**Aims**

Given the importance of solving the problem of forming the system of economic security of construction companies on the basis of sustainable development, the aim is to determine the theoretical prerequisites for the development and formation of preventive protection and selection of indicators of crisis development, as well as the development of digital interaction. which will help companies to adapt to the requirements of digitalization.

**Results and methods**

Presentation of the main research material and methods of realization of the set task. In order to improve the mechanism of control of the stability of the system of anti-crisis potential of construction enterprises in the medium term, a cluster analysis was performed. The study was based on 53 enterprises of the type of activity «construction». This study allowed us to identify the most important, priority, leading indicators of the loss of economic security and to clarify the threshold values of these indicators and the degree of their «blurring» in the unstable conditions of the external economic environment. To achieve the objectives of the study, in addition to cluster analysis, methods of data mining, fuzzy set theory - and fuzzy multicriteria analysis were used.

Cluster analysis allowed to determine the parameters of a «typical» enterprise, in which the anti-crisis potential is used at the average level, but the «representatives» of the cluster in the vast majority have other values of indicators. Therefore, we believe that the following rules-conditions for determining the level of activation of anti-crisis opportunities and, accordingly, the vulnerability of enterprises to threats to economic security are more correct:

- the level of consumption of owners' capital should be close to 37.3 percentage points;
- profitability of operating sales on retained earnings should not be lower than at least 5.5 percentage points;
- return on working capital on retained earnings must not be lower than at least 3.8 percentage points;
- the cost of operating costs for personnel costs must be under any circumstances not higher than 14.6 times;
- the term of turnover of accounts payable must under any circumstances not exceed 38.3 days.

The conditions of the rules in the form of phrases highlighted in italics, ie «must be close», «not lower, at least», «under no circumstances exceed» can be quantified, if we use the provisions of the theory of fuzzy sets. This section of information intelligence is the basis of automatic control systems for artificial intelligence. Concepts familiar to human language, which are characterized by incomplete certainty, uncertainty in the result, are presented in the form of fuzzy sets, which are also known as «fuzzy terms». Fuzzy sets, in contrast to traditional, clear ones, contain not only a list of elements, but also determine the degree to which each element of a universal set belongs to a fuzzy term. A universal set is the set of all values that can be acquired by a fuzzy variable, in other words, all possible values of profitability, which can be indefinitely negative or positive, or all possible options for the duration of debt turnover: from zero to an unlimited number of days. Both of these examples, as well as other indicators of the use of anti-crisis potential, are continuous variables, and to formulate fuzzy terms based on them use special formulas - membership functions. These functions make it possible to quantify the degree to which a particular value from the universe corresponds to a fuzzy term. There are certain types of membership functions, and their parameters are determined either on the basis of expert methods or by the results of statistical analysis.

In particular, for terms of the type «should be close to» use U-shaped membership functions, such as bell, or Gaussian, which we have performed on the level of consumption of capital of

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owners. For terms of the type «must be not less than», this applies to all types of profitability, use the s-shaped function, while the term of the type «not more than» corresponds to the z-like function, and it is used for the structure of operating costs and debt turnover. S-shaped and z-shaped functions can be piecewise linear or piecewise nonlinear, for example, obtained by combining a Gaussian function with constant acceptance levels. The latter option is used in the method of identifying the level of anti-crisis potential, which are based on fuzzy sets.

The Gaussian-type membership function is developed on the basis of the provisions of probability theory, the fundamental postulate of which is the density function of the normal distribution or the Gaussian curve. However, the Gaussian function is somewhat simplified $\sqrt{2 \cdot \pi \cdot \varsigma} = 1$, and therefore it has the form:

$$\mu(x) = e^{-\frac{1}{2} \cdot \left( \frac{x - c}{\sigma} \right)^2}, \quad (1)$$

where ς – the parameter of the law of normal distribution, which corresponds to the standard deviation of the feature in the general population;

σ and $c$ – numerical parameters, with c, the coordinate of the maximum – coincides with the mathematical expectation of the value of the feature in the general population σ; and, ie the coefficient of concentration, or stretching, is determined based on the distribution of the feature in the general population. However, a relatively small sample was studied – only 33 cases of construction companies operating, which is much less than 120 – the sample limit for data mining. Therefore, it is difficult to reliably determine the standard deviations of the analyzed indicators in the general population. In this regard, the concentration coefficient of all membership functions of all indicators is taken to be equal to half of the average cluster value:

$$\sigma = 0{,}5 \cdot c, \quad (2)$$

The graph (Fig. 1) shows the Gaussian membership function for the term «average level of consumption of owners' capital», as can be seen from Fig. 1, the maximum level of confidence in the level of consumption of owners' capital is 0.373, or 37.3 percentage points, because the parameter $c_1 = 0.373$.

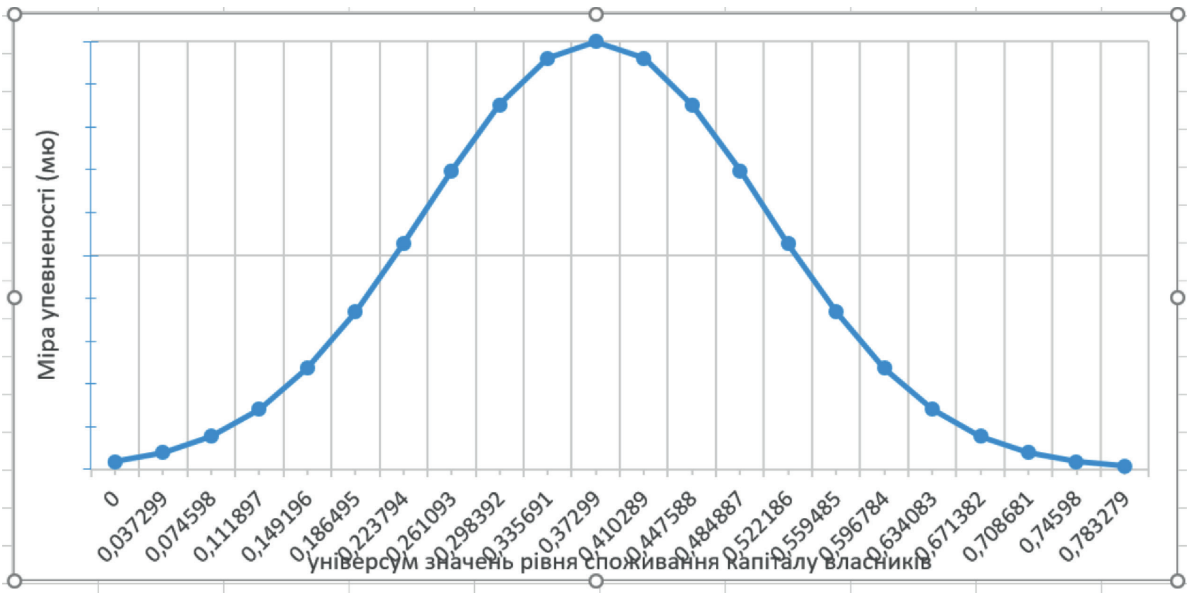


Fig. 1. Function of belonging to the term «average level of consumption of owners' capital»

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The concentration factor affects the «transition point» – a value of the universe for which the degree of confidence will be equal to 0.5, which reflects the maximum uncertainty. The coefficient of concentration of the function on the graph 1 for (2)

$$\sigma_1 = 0{,}5 \bullet c_1 = 0{,}187$$

Thus, to determine the extent to which a certain value of the level of consumption of capital of owners (x1) can be recognized as «average», should be based on the formula:

$$\mu(x_1) = e^{-\frac{1}{2}\cdot\left(\frac{x_1 - 0{,}373}{0{,}187}\right)^2} \quad (3)$$

The situation with profitability indicators is somewhat different. In our opinion, the determination of the conditions under which threats to economic security increase is not based on the parameters of the average level of return on sales or current assets, but takes into account a certain margin of safety. That is, the horizontal part of the s-shaped membership function, on which the measure of acceptance is single, should begin not with the average level of profitability per cluster, but with some value of the universe that is higher than this average level. It is substantiated by «extrapolation», ie by moving the ascending section of the Gaussian membership function of profitability indicators while maintaining the tensile parameter. Determination of the parameters of membership functions of terms such as «profitability necessary for economic security» was carried out based on the recommendations for the construction of fuzzy rules given in [22]. In particular, the authors recommend defining the membership functions of related terms as follows:

- first, the vertex of the membership function of one of the terms must correspond to the zero values of the membership function of neighboring terms;
- secondly, at the point of intersection of the graphs of neighboring terms must correspond to a degree of confidence of 0.5.

The latter confirms the analogy between the theory of fuzzy sets and the theory of probabilities: at the transition point there is the greatest uncertainty as to which of the terms to attribute such a meaning of the universe. In other words, for some level of profitability, it can be equally asserted either that it is average profitability or that it is high profitability. Gaussian membership functions of the term «average» for each of the indicators of profitability are:

- for profitability of sales on retained earnings ($x_2$):

$$\mu(x_2) = e^{-\frac{1}{2}\cdot\left(\frac{x_2 - 0{,}055}{0{,}028}\right)^2} \quad (4)$$

- for the return on current assets at retained earnings ($x_3$):

$$\mu(x_3) = e^{-\frac{1}{2}\left(\frac{x_3 - 0{,}038}{0{,}019}\right)^2} \quad (5)$$

To determine the parameters of the term «profitability necessary for economic security», you must first calculate the coordinates of the transition point ($x_{0,5}$), using the membership functions of the terms «average» of both types of profitability with parameters ($c_{\text{серед}}$ $ma$ $^{\sigma}{}_{серед}$).

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$$\mu(x_{0,5}) = e^{-\frac{1}{2}\left(\frac{x_{0,5}-c_{необх}}{\sigma_{серед}}\right)^2} = 0,5 \Rightarrow$$
$$x_{0,5} = c_{середн} + \sigma_{серед} \cdot \sqrt{(-2)\cdot \ln 0,5} \quad (6)$$

In the future, it is necessary to solve the inverse problem, when the values of the universe are known ($x_{0,5}$), concentration factor ($^{\sigma}_{серед}$) and confidence measures at the level of 0.5, the coordinates of the maximum of the term «necessary for economic security...» are calculated ($c_{необх}$)

$$\mu(x_{0,5}) = e^{-\frac{1}{2}\left(\frac{x_{0,5}-c_{необх}}{\sigma_{серед}}\right)^2} = 0,5 \Rightarrow$$
$$c_{необх} = x_{0,5} + \sigma_{серед} \cdot \left(-\sqrt{(-2)\cdot \ln 0,5}\right) \quad (7)$$

As a result of substituting the values of the parameters of membership functions (4, 5) in the formula (6, 7) defines the limit of profitability on retained earnings, which should be recognized as the threshold of economic security: for profitability of operating sales on retained earnings – 12% ($c_{необх} = 0,12$):

$$x_{0,5} = 0,055 + 0,028 \cdot \sqrt{(-2)\cdot \ln 0,5} \approx 0,087,\ c_{необх} = 0,087 + 0,028 \cdot \left(-\sqrt{(-2)\cdot \ln 0,5}\right) \approx 0,12$$

Thus profitability at the level of 8,74% with the same degree of confidence can be defined both as average, and as necessary for economic safety.

Similarly, for the profitability of current assets on retained earnings, its required level for economic security was set at 8.3%. Instead, the 6.06% return on current assets is equally consistent with the terms «average» and «necessary for economic security.»

Thresholds for the cost of personnel costs and turnover of accounts payable, the achievement of which is necessary for the economic security of the construction company is taken at the level of average cluster values.

Finally, the membership functions of all five indicators that characterize the terms of the type «necessary for economic security» are systematized in Table 1. In Fig. 2 shows the graphs of membership functions for two terms of the level of profitability of retained earnings: «average» and «necessary for economic security»: at the point ofintersection of the respective lines, the degree of confidence is equal to 0.5.

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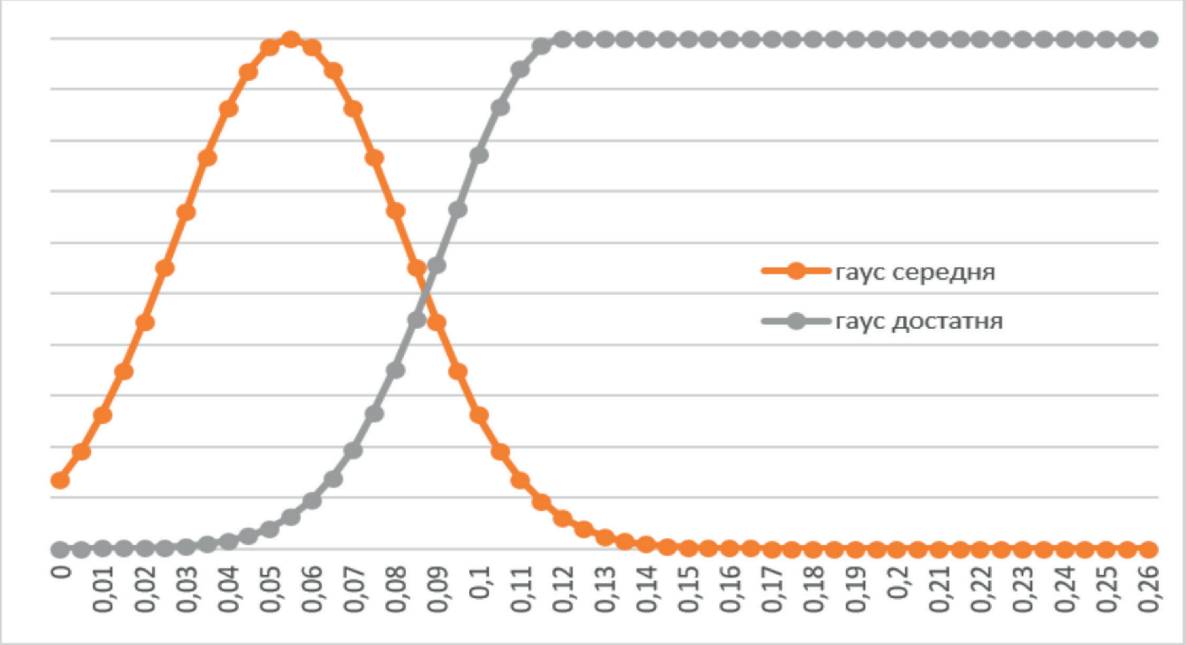


Fig. 2. Functions of belonging of the terms «average» and «necessary for economic security» the level of profitability of sales on retained earnings distribution.

Table 1. Functions of belonging of all indicators for the terms «level necessary for economic security»

| Indicator | Belonging function |
|---|---|
| The level of capital consumption of owners | $\mu(x_1) = e^{-\frac{1}{2}\cdot\left(\frac{x_1 - 0{,}373}{0{,}187}\right)^2}$ |
| Profitability of operating sales on retained earnings | $\mu_{необх}(x_2) = \begin{cases} e^{-\frac{1}{2}\cdot\left(\frac{x_2 - 0{,}12}{0{,}028}\right)^2}, & if\ x_2 < 0{,}12 \\ 1, & if\ x_2 \geq 0{,}12 \end{cases}$ |
| Return on working capital by retained earnings | $\mu_{необх}(x_3) = \begin{cases} e^{-\frac{1}{2}\cdot\left(\frac{x_3 - 0{,}083}{0{,}019}\right)^2}, & if\ x_3 < 0{,}083 \\ 1, & if\ x_3 \geq 0{,}083 \end{cases}$ |
| Cost of operating costs by personnel costs | $\mu_{необх}(x_4) = \begin{cases} 1, & if\ x_4 < 14{,}611 \\ e^{-\frac{1}{2}\cdot\left(\frac{x_4 - 14{,}611}{7{,}306}\right)^2}, & if\ x_4 \geq 14{,}611 \end{cases}$ |
| Term of turnover of accounts payable | $\mu_{необх}(x_5) = \begin{cases} 1, & if\ x_5 < 38{,}3 \\ e^{-\frac{1}{2}\cdot\left(\frac{x_5 - 38{,}3}{19{,}15}\right)^2}, & if\ x_5 \geq 38{,}3 \end{cases}$ |

Achieving economic security is possible only if all five conditions are met, which are, however, unequal. In fuzzy set theory, the simultaneous satisfaction of the preconditions of several rules of fuzzy products is determined by the operation of the minimum. The significance of individual conditions is taken into account by means of their concentration, which is achieved by raising the functions of belonging to a degree equal to the weight of the rule-condition ($w_j$). That is, the minimum value of all five membership functions, given in table 1, determines the extent to which the current state of the enterprise corresponds to its economic security:

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$$\mu_{\text{екон.безп}} = \left(\mu\ \ (x_1)\right)^{\omega_1} \wedge \left(\mu_{\text{необх}}(x_2)\right)^{\omega_2} \wedge \left(\mu_{\text{необх}}(x_3)\right)^{\omega_3} \wedge \left(\mu_{\text{необх}}(x_4)\right)^{\omega_4} \wedge \left(\mu_{\text{необх}}(x_5)\right)^{\omega_5}$$
$$\Updownarrow \qquad (8)$$
$$\mu_{\text{екон.безп}} = min\left(\left(\mu\ \ (x_1)\right)^{\omega_1}; \left(\mu_{\text{необх}}(x_2)\right)^{\omega_2}; \left(\mu_{\text{необх}}(x_3)\right)^{\omega_3}; \left(\mu_{\text{необх}}(x_4)\right)^{\omega_4}; \left(\mu_{\text{необх}}(x_5)\right)^{\omega_5}\right)$$

To substantiate the weights that simultaneously act as «concentrators» of fuzzy sets of rules, we used the formula of Fishburne weights

$$\omega_j = \frac{2\bullet(m-\bar{j}+1)}{m\bullet(m+1)}, \qquad (9)$$

Where $m$ – the number of rules, $m = 5$;

$\bar{J}$ is the rank of the $j$-th indicator – fuzzy set, which we determined by the results of the following ordering:

previous studies have repeatedly proven the priority of profitability indicators as anti-crisis indicators. Therefore, the highest ranks are given to indicators of profitability of operating sales and current assets on retained earnings. That is, two related ranks $j_2 = j_3 = 31{,}5$ are obtained, since both profitability ratios are, in our opinion, equivalent;

Given the significant role of human, managerial, intellectual potential in the formation of anti-crisis potential, the next rank is given to the cost of operating costs for personnel costs, and therefore $j_4 = 3$;

since the indicator «consumption of owners' capital» turned out to be insignificant during the cluster analysis (Table 2), the corresponding fuzzy rule received a minimum rank, and therefore $j_1 = 5$;

the duration of the turnover of accounts payable, thus, received the penultimate rank: $j_5 = 4$.

The values of the weights of each of the conditions necessary to achieve economic security are calculated by (9). Summarized in table.2.

Table 2. The weight of indicators to determine the state of economic security using the resulting fuzzy set

| **The indicator for which the term is defined "Level necessary for economic security"** | **Weighting factor – "concentrator" of fuzzy set-rules** |
|---|---|
| The level of capital consumption of owners | $\omega_1 = \frac{2 \bullet (5 - 5 + 1)}{5 \bullet (5 + 1)} = 0{,}07$ |
| Profitability of operating sales on retained earnings | $\omega_2 = \frac{2 \bullet (5 - 1{,}5 + 1)}{5 \bullet (5 + 1)} = 0{,}30$ |
| Return on working capital by retained earnings | $\omega_2 = \frac{2 \bullet (5 - 1{,}5 + 1)}{5 \bullet (5 + 1)} = 0{,}30$ |
| Cost of operating costs by personnel costs | $\omega_4 = \frac{2 \bullet (5 - 3 + 1)}{5 \bullet (5 + 1)} = 0{,}20$ |
| Term of turnover of accounts payable | $\omega_5 = \frac{2 \bullet (5 - 4 + 1)}{5 \bullet (5 + 1)} = 0{,}13$ |
| The sum of weights | $1 = (0{,}07 + 0{,}30 + 0{,}30 + 0{,}20 + 0{,}13)$ |

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Thus, it becomes possible to quantify the compliance of the current level of activation of anti-crisis potential with the conditions necessary to achieve economic security. This is achieved by calculating the degree of acceptance of the current state as economically safe by substituting the data of each individual enterprise in the formula:

$$\mu_{\text{екон.безп}} = min\left(\left(\mu\ \ (\text{x}_1)\right)^{0,07}; \left(\mu_{\text{необх}}(\text{x}_2)\right)^{0,3}; \left(\mu_{\text{необх}}(\text{x}_3)\right)^{0,3}; \left(\mu_{\text{необх}}(\text{x}_4)\right)^{0,2}; \left(\mu_{\text{необх}}(\text{x}_5)\right)^{0,13}\right) \quad (10)$$

Of course, to (10) should enter the results of calculations according to the formulas given in table. 3.

In fuzzy set theory, negation is also determined using the measure of belonging. The membership function to deny a particular term is the difference between the unit and the membership function of the term being denied. That is, the degree of acceptance of the lack of economic security is proposed to be calculated as follows:

$$\mu_{\text{відс екон безп}} = 1 — \mu_{\text{екон безп}} \quad (11)$$

Formula (11) thus allows to quantify the level of threats to the economic security of the enterprise caused by insufficient use of anti-crisis potential.

The results of researches presented in this subdivision allowed to form scientific and methodical tools of identification and control of level of anti-crisis potential of the building enterprise in the conditions of digital transformation (fig. 3).

mplementation of the proposed in Fig. 3 tools in the context of digital transformation involves the use of online forms that are easy to develop in a spreadsheet environment.

The relationship between these subsystems is proposed to be created on the basis of information technology, which is widely used in product life cycle management in science-intensive industries. The paper proposes to use this model as a basis for the development of a system of continuous information support of the enterprise life cycle and the formation of anti-crisis potential at each stage of its development.

The variety of processes in the course of operational, financial and investment activities of the enterprise and the need to prevent threats require active information interaction of all divisions of the enterprise, as well as key stakeholders who have the greatest impact on economic security. Due to the fact that every year the amount of information used and transmitted, the need to create an integrated system to support anti-crisis potential at different stages of the life cycle, systematization of information interaction of system components leads to the need to create an integrated information system. Such a system should provide the possibility of interaction of different subsystems of the enterprise and analysis of threats from interaction with different stakeholders (suppliers, customers, competitors, state and local authorities, financial institutions, etc.) in order to prevent crisis development. All information in the IBC is stored digitally.

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<table>
<tr><th colspan="5">Login: financial statement data</th></tr>
<tr><td colspan="2">Balance sheet (Statement of financial position)</td><td colspan="3">Statement of financial performance (Statement of comprehensive income)</td></tr>
<tr><th colspan="5">Stage 1<br>Calculation of financial indicators</th></tr>
<tr><td>The level of capital consumption of owners ($x_1$)</td><td>Profitability of sales on retained earnings ($x_2$)</td><td>Return on current assets on retained earnings($x_3$)</td><td>Cost of operating costs by personnel costs ($x_4$)</td><td>Term of turnover of accounts payable ($x_5$)</td></tr>
<tr><th colspan="5">Stage 2<br>Determining the degree of acceptance of the current situation as "necessary for economic security" for each individual indicator</th></tr>
<tr><td colspan="5">Each of the five rules defines a membership function</td></tr>
<tr><td>The level of capital consumption of owners ($x_1$)<br>$\mu(x_1) = e^{-\frac{1}{2}\left(\frac{x_1 - 0{,}373}{0{,}187}\right)^2}$</td><td>Profitability of sales on retained earnings ($x_2$)<br>$\mu_{необх}(x_2) = \begin{cases} e^{-\frac{1}{2}\left(\frac{x_2 - 0{,}12}{0{,}028}\right)^2}, & if\ x_2 < 0{,}12 \\ 1, & if\ x_2 \geq 0{,}12 \end{cases}$</td><td>Return on current assets on retained earnings ($x_3$)<br>$\mu_{необх}(x_3) = \begin{cases} e^{-\frac{1}{2}\left(\frac{x_3 - 0{,}083}{0{,}019}\right)^2}, & if\ x_3 < 0{,}083 \\ 1, & if\ x_3 \geq 0{,}083 \end{cases}$</td><td>Cost of operating costs by personnel costs ($x_4$)<br>$\mu_{необх}(x_4) = \begin{cases} 1, & if\ x_4 < 14{,}611 \\ e^{-\frac{1}{2}\left(\frac{x_4 - 14{,}611}{7{,}306}\right)^2}, & if\ x_4 \geq 14{,}611 \end{cases}$</td><td>The term of the accounts payable is owed ($x_5$)<br>$\mu_{необх}(x_5) = \begin{cases} 1, & if\ x_5 < 38{,}3 \\ e^{-\frac{1}{2}\left(\frac{x_5 - 38{,}3}{19{,}15}\right)^2}, & if\ x_5 \geq 38{,}3 \end{cases}$</td></tr>
<tr><th colspan="5">Stage 3<br>Establishing the degree of acceptance of the current situation as economically safe by a set of indicators</th></tr>
<tr><td colspan="5">$\mu_{\text{екон.безп}} = \min\left((\mu\ (x_1))^{0,07}; (\mu_{\text{необх}}(x_2))^{0,3}; (\mu_{\text{необх}}(x_3))^{0,3}; (\mu_{\text{необх}}(x_4))^{0,2}; (\mu_{\text{необх}}(x_5))^{0,13}\right)$</td></tr>
<tr><th colspan="5">Stage 4<br>Calculation of the level of threats to the economic security of the enterprise caused by insufficient use of anti-crisis potential</th></tr>
<tr><td colspan="5">$\mu_{\text{відс.екон.безп}} = 1 - \mu_{\text{екон.безп}}$</td></tr>
<tr><th colspan="5">Stage 5<br>Decision-making on the effectiveness of crisis management measures and their compliance with the stages of the life cycle of the enterprise</th></tr>
<tr><td colspan="5">$\mu_{\text{екон.безп}} \geq 0{,}85$ – anticrisis management is effective;<br>$\mu_{\text{екон.безп}} < 0{,}85$ – crisis management is ineffective;</td></tr>
</table>

Fig. 3. Methodical tools for identification and control of the level of anti-crisis potential of the construction company in terms of digital transformation

All processes of information exchange with the help of IMS have the ultimate goal of the maximum possible exclusion from the business practice of paper documents and the transition to direct paperless data exchange (in the practice of construction is an example of creating a BIM-model of objects).

Integrated information system, which is the basis for the formation of economic immunity of construction companies can be considered as a set of distributed databases that contain information about the financial and economic, production environment, resources and processes of the enterprise, changing its state at any time, provides accuracy, relevance, storage and availability of data to those entities who need and allow it. All data in the IBC should be

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stored in the form of information objects, but it should be possible if necessary to display each block of data on the screen or on paper.

The principal basis for the implementation of CALS – technologies is a functional and structural analysis of life cycle management processes of the enterprise (LCP). On the basis of the analysis and classification of functions of management of ZhTSP the conceptual model as bases of formation of economic immunity of the building enterprise is offered.

Since we are talking about the formation of economic immunity throughout the LRU, and this is a fairly long period of time, there is a need to integrate information flows and databases of all departments of the enterprise into a single information space (accounting information systems, financial and economic, material movement data). technical and labor resources, financial flows, engineering and technological documentation and other enterprise management systems.To solve this problem it is necessary to implement a single system of classification of operations, resources, financial and economic indicators, indicators of financial condition, a single system of classification of threats It is also necessary to be able to track threats at the level of an individual event or transaction (for example, tracking the period and amount of receivables under a separate contract / supplementary agreement or tracking the period of delivery of materials to the facility, etc.). incip - information about threats and risks that have arisen at any stage of operational, investment and financial activities of the enterprise is stored and should be available to all responsible performers in accordance with their access rights.

The implementation of the system on an enterprise scale (Fig. 4) requires the provision of different levels of access for different groups of employees.

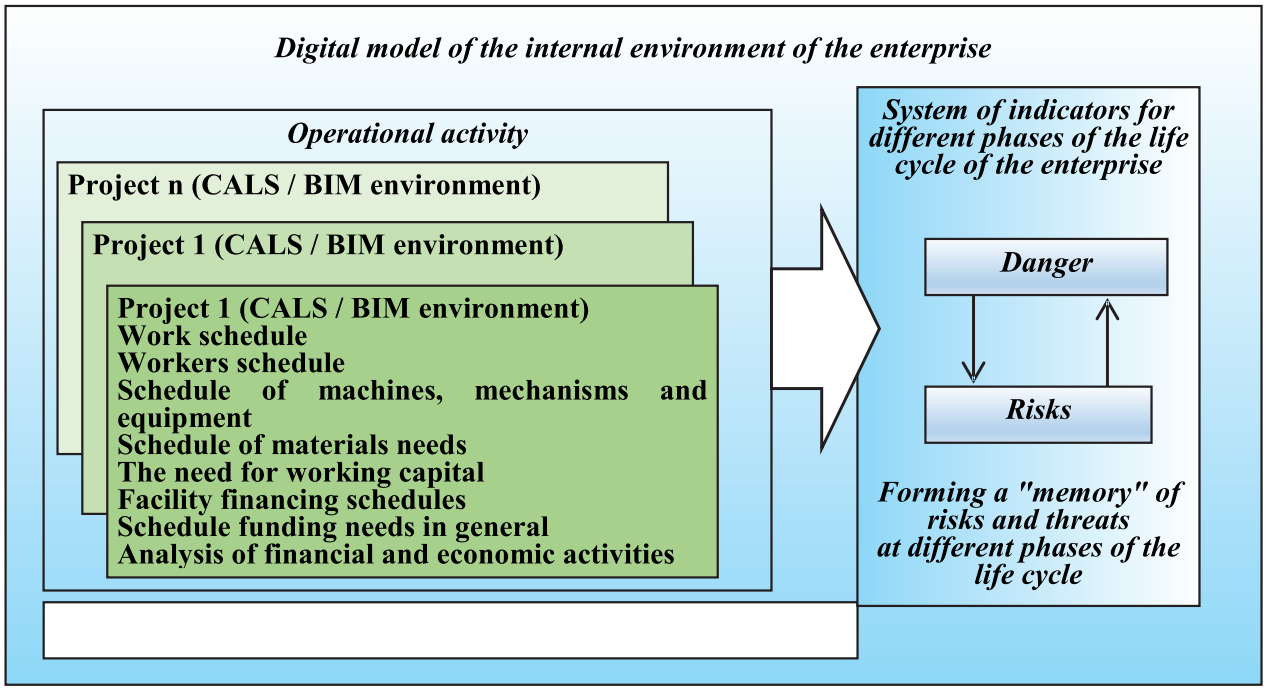


Fig. 4. Digital enterprise model

Integration within a single system of financial and economic, accounting, legal, design, technological and management data inevitably leads to the need to protect data confidentiality on the one hand, on the other – to ensure the openness necessary to form an effective system of preventive protection. In addition, when implementing information support systems for economic immunity, companies need to implement their own standards, methods and

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instructions for working with data, as copying the experience of other firms for a number of reasons is almost impossible due to differences in organizational structure, operational activities, accounting systems, business processes.

**Conclusion**

The digital technologies are being implemented in the construction industryand in the activities of enterprises. This will help speed up the decision-making process. At the same time, even small construction companies today have the technological ability to build a system of preventive protection and forecasting. This should have a positive impact on the formation of anti-crisis potential of enterprises and the system of economic security.

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