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ASSESSMENT OF CRISIS DEVELOPMENT SCENARIOS AT INDUSTRIAL ENTERPRISES IN THE SYSTEM OF STRATEGIC PLANNING OF ANTI-CRISIS MANAGEMENT MEASURES

ABSTRACT

The article is devoted to assessing crisis development scenarios at industrial enterprises in the system of strategic planning of anti-crisis measures, building a cognitive model of relationships, and quantitatively reproducing the effects on intermediate results. The study is based on the basic factors, which were designated from X1 to X14, and intermediate indicators, which in turn were designated from O1 to O3 according to the data for the three enterprises selected by us for 2024. The indicators were normalized to dimensionless indices taking into account the direction of utility, then density matrices of relationships, cognitive maps, and separate equations for each enterprise were constructed, which reproduce the impact of the liquidity of the capital structure of interest payments of the revolving cycle of costs and market concentrations on the share of overdue obligations of capacity utilization and short-term solvency. A coordinated procedure for calibrating sensitivities and free terms was proposed, which provides traceability from expert and empirical information to calculation results and allows us to reproduce the recorded values for each of the enterprises selected by us. The paper forms a matrix of strategic alternatives at the intersection of two managed planes: access to financing for anti-crisis measures and the maturity of anti-crisis management and readiness for change. The cross-combination of high and low levels generates four scenarios: optimistic, conservative, moderately optimistic, and pessimistic. Based on four scenarios, specific proposals for anti-crisis management actions have been developed for each enterprise, which can be used by managers and financial managers of industrial enterprises, as well as anti-crisis management consultants.

Keywords: assessment of crisis development, strategic planning of anti-crisis measures, cognitive model, matrix of density of relationships, scenario analysis, industrial enterprises, liquidity, debt burden, solvency

JEL Classification: G32, L60, M11, O21, C61

INTRODUCTION

In the current stage of management development, anti-crisis management is conceptualized as a holistic system of decisions, procedures, and behavioral guidelines that prevent destructive developments and ensure business manageability under adverse internal and external conditions. The essence of this type of management lies in the continuous identification of weak threat signals, their timely assessment, the preparation of preventive actions, and the mobilization of resources even before signs of a crisis become apparent. This approach integrates strategic vision with the optimization of daily operations and is based on continuous monitoring of both the external environment and internal performance metrics. A system of vigilance and accountability is key, in which management decisions are based on transparent information, regular communication, and rapid coordination between departments. We believe that anti-crisis management should not be reduced to a so-called "firefighting". It establishes a system for the early detection of deviations, requires a clear division of roles, action plans, backup options, liquidity reserves, and updated security and compliance policies.

Effective anti-crisis management creates the necessary conditions for achieving and sustaining financial stability by proactively minimizing the risk of systemic failures and managerial errors. Consequently, a company that proactively monitors threats, diversifies sales and supply channels, maintains adequate liquid reserves, and hedges against key risks is much better positioned to withstand periods of turbulence. It is particularly true when the company also develops well-considered alternative logistics routes and energy supply solutions. This is particularly important in the current context of a full-scale armed invasion of Ukraine, where external shocks, fluctuations in demand and prices, as well as personnel and operational challenges, tend to emerge abruptly and may persist over time. Anti-crisis management in this environment not only ensures a rapid response in the event of an escalation but also helps prevent negative scenarios, maintain solvency, enhance partner and creditor confidence, protect reputation, support strategic investments, and consistently maintain its own financial security at the level accepted by management. As a result, the company not only survives but also develops manageable resilience and the ability to recover from shocks, transforming uncertainty into an opportunity for deliberate growth.

Thus, there is a need for anti-crisis management, especially with regard to early warning tools and individual financial ratios, but a comprehensive quantitative assessment of crisis development scenarios, specifically at industrial enterprises, has not been studied sufficiently. It is necessary to assess more comprehensively, focusing on those that directly reflect the share of overdue liabilities, capacity utilization, and short-term solvency. That is why the task of combining the cognitive model of crisis development with practical strategic alternatives for the system of strategic planning of anti-crisis measures at the level of specific enterprises remains unresolved, which determines the relevance of our article.

LITERATURE REVIEW

A review of scientific and practical findings reveals that anti-crisis management has evolved gradually from reactive approaches to preventive and systemic practices that integrate financial, organisational, and technological tools to facilitate the adoption of important and effective management decisions. In practical terms, the economic essence and key characteristics of crisis management are defined as a continuous process involving the identification of threats, assessment of their likelihood and impact, the formation of reserves and operational protocols, and the development of financial and managerial responses within a unified business policy framework. This approach ensures preparedness for recovery even before the onset of visible crisis symptoms, as clearly articulated by Kosarieva, Khokhlov, and Kobzar (2018). In this direction, Ilchuk, Viblyi, and Lashchyk (2018) break down the approach to the anti-crisis capacity of enterprises as a set of resources and early warning procedures, where the key ones are scenario planning, adaptive budgeting, and control indicators related to liquidity and platformability. In a similar conceptual vein, Yepifanova (2015) interprets anti-crisis management at the enterprise level as a special system of coordinated measures that combines diagnosis of crisis determinants, selection of appropriate financial responses, and alignment of managerial decisions with long-term development priorities, which reinforces the preventive and systemic understanding of this type of management.

Next, the focus shifts to preventive regulation tools that can be used until the disease becomes severe, as shown in the study by Maslak et al. (2020), which focuses on a methodical arsenal for the rapid adjustment of operations and finances, focusing on systems of early indicators, competition, and regulations of management decisions. In the current environment, digitalization has become an essential and unavoidable component of organizational development.

Thus, the digital aspect of current mechanisms is highlighted in detail by Gavkalova, Akimova and Akimov (2023), where a number of digital platforms have been established for monitoring risks in real time, data analytics for forecasting recovery and a flexible solution between the sub-units that changes the hourly lags between the signal and the control action and transfers the anti-crisis management to a permanent readiness mode.

Industry features of implementation are revealed in Pohrishchuk et al. (2023), the introduction of anti-crisis management practices was modeled, and the underlying effect of the technological complexity of production, the structure of expenditures, and market conditions was also identified.

An important aspect in this regard is the relationship between preventive anti-crisis management and financial stability, and research demonstrates the need for early response to weak signals and expansion of financial management tools. On the micro level, Mbatha and Ngibe (2017) demonstrate that the financial stability of small and medium-sized enterprises in emerging market economies is not primarily determined by access to financing or capital structure. Instead, it is strongly influenced by the quality of management practices, strategic foresight, liquidity policy, and income diversification, which directly support the preventive logic of the anti-crisis approach.

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On a strategic level, Vasechko (2021) systematizes the direct provision of financial stability, including optimization of the capital structure, liquidity reserves, receivables management and creditor debt, the institutionalization of risk management and the promotion of the management structure, which is avoided with the recommendations of Levkovych and Yakovenko (2024) of one hundred anti-crisis tools management, including restructuring of taxes, strict cash control and gradual adjustment of budgets. A comprehensive overview of strategy and capabilities is provided by Zaichko and Olifirov (2025), highlighting the integration of financial, organizational, and digital tools and the need to accommodate short-term stabilization solutions for long-term development goals.

The macro context is reinforced by the concepts of Remeikienė et al. (2023), which, based on the materials of pandemic shocks in Europe, show that business is being renewed more and more when preventive mechanisms are in place for business processes, when there is basic access to financial instruments, and management provides data for operational adjustments.

In summary, Figure 1 shows that the anti-crisis management system is currently considered in the context of diagnosis, prevention, response, and recovery, with various scholars and practitioners incorporating their own methods and data. In some studies, it serves as the basis for liquidity models, debt restructuring, bankruptcy risk assessments, and stress tests. In operations management, it is used to ensure business continuity, supply chain resilience, cost optimization, and production. HR management focuses on talent pooling, change planning, training, and mental health support, which enhances organisational resilience.

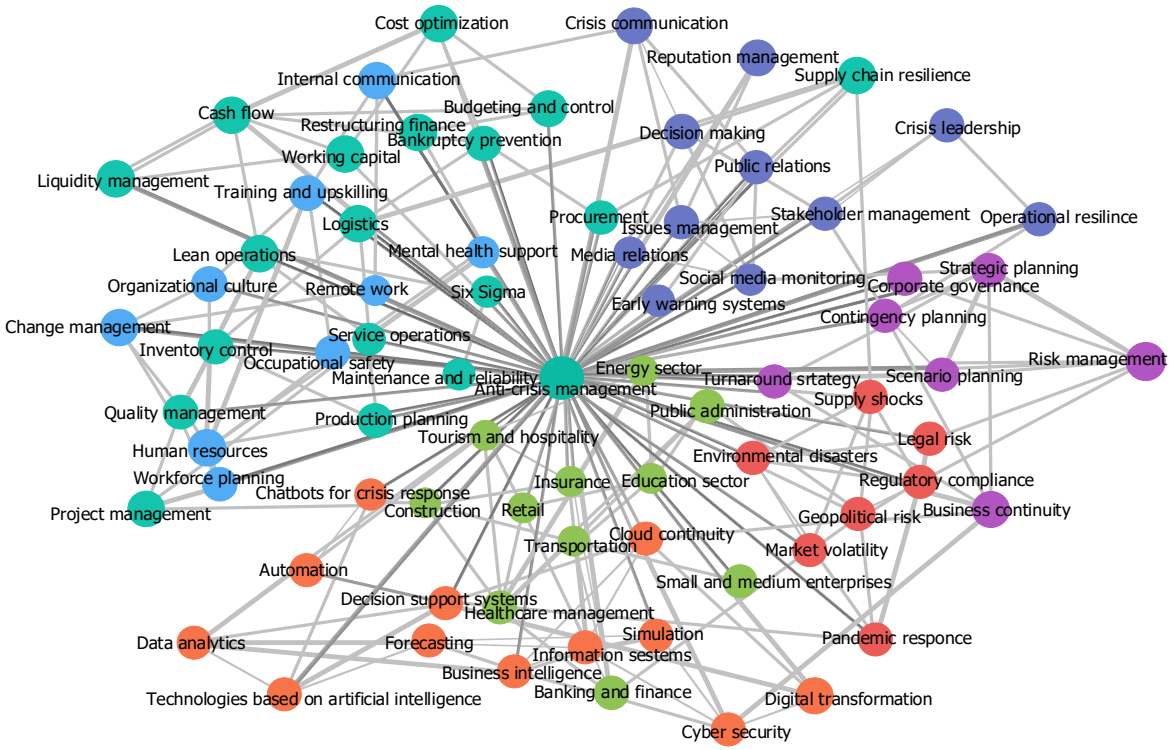

Figure 1. VOSviewer construction of scientific and practical research on the anti-crisis management system.

Thus, modern anti-crisis management is an integrative approach, combining financial, operational, human resources, communication, and technological tools, ensuring coordinated decision-making during shocks and uncertainty to restore the system as a whole.

AIMS AND OBJECTIVES

The aim of the study is to scientifically substantiate the approach to assessing crisis development scenarios at industrial enterprises in the system of strategic planning of anti-crisis measures. To this end, the task within the framework of our article is to build a transparent connection between the basic factors X1–X14 (denote a system of fourteen financial and operational indicators that reflect liquidity, debt load, intensity and quality of cash flows, cost and income structure, level

of diversification and other key parameters of the financial stability of the enterprise) and intermediate indicators O1–O3 (describe, respectively, the share of overdue financial liabilities in their total volume, the level of utilization of production capacities and the ratio of net operating cash flow to the company's short-term liabilities), transforming the obtained results into practical strategic alternatives for making appropriate anti-crisis management decisions.

METHODS

Our article uses a number of methods, which together constitute the methodology of our research. Therefore, first, the initial indicators are converted into dimensionless indices ranging from 0 to 1. For each indicator, lower and upper working limits are set, after which the value is linearly scaled within this interval. The direction of utility is coordinated according to the content of the indicator. That is, the indicator normalization method is used. It should be noted that the matrix method of achieving the density of relationships (Bakhtavar et al., 2021) is used. That is, a symmetric matrix is formed that reflects the strength and sign of the coordinated influence between all basic factors and intermediate indicators. The cognitive modeling method is also used. That is, the system is presented as a directed sign-weighted graph. Nodes correspond to factors and intermediate results. Edges are directed from causes to consequences, have the sign of influence and intensity. Visually, edges with a positive effect are indicated by solid lines, with a negative effect by dashed lines. The thickness of the line reflects the density of the relationship. Nodes are grouped by semantic blocks.

As a result, intermediate indicators are formed, which are created as weighted sums of normalized indices. The weights are taken from the density matrix, and the sign corresponds to the economic logic of the impact. Then, the dimensionless indices of the intermediate indicators are converted into understandable units, percentages, or "times". At the same time, the free terms are calibrated on the base year so that the model accurately reproduces the actual state.

The scenario analysis method is also applied (Lehr et al., 2017; Ramirez, 2014). Thus, the scenarios are formed according to a matrix of strategic alternatives that intersects two controllable planes: access to financing for anti-crisis measures and the maturity of anti-crisis management and readiness for change. Within each scenario, standardized changes, improvements, or deteriorations are applied to key factors.

RESULTS

The method of cognitive analysis is the most effective and progressive in the context of structuring problems for complex systems. Thus, the method itself allows describing qualitative and quantitative relationships between system elements using graphs in a single scheme. At the same time, it should be noted that the main elements of the cognitive map are basic factors, intermediate resulting indicators, and cause-and-effect relationships between them. Let us highlight the basic factors that influence the possibility of crisis development at industrial enterprises X1–X14:

- X1. The coefficient of general liquidity of the enterprise. The lower this indicator, the higher the likelihood of a crisis. However, the expected impact of an increase in this indicator reduces the risk.
- X2. The share of loan capital in the structure of liabilities. The increase in the share increases the debt load, and the expected impact increases the risk.
- X3. The coefficient of coverage of interest payments by earnings before interest, taxes, and depreciation. The higher the indicator, the better the stability, and the expected impact reduces the risk.
- X4. Share of overdue receivables in revenue. An increase in the indicator blocks cash inflows. The expected impact increases the risk.
- X5. Duration of the cash conversion cycle in days. An increase prolongs the liquidity deficit. The expected impact increases the risk.
- X6. Share of fixed costs in total cost. High fixed costs increase operating leverage. The expected impact increases the risk.
- X7. Depreciation rate of fixed assets. Old assets increase the probability of disruptions. The expected impact increases the risk.
- X8. Share of energy costs in the cost. High energy intensity makes the company vulnerable to price shocks. The expected impact increases the risk.
- X9. The concentration of the sales portfolio is the share of the five largest customers in revenue. Higher concentration increases dependence. The expected impact increases the risk.

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- X10. Supply concentration, share of the five largest suppliers in the value of purchases. Higher concentration threatens disruptions, and the expected impact increases risk.
- X11. Share of exports in sales revenue. When foreign markets are highly volatile, vulnerability increases, and the expected impact generally increases risk. In stable markets, the impact can be mitigated.
- X12. Volatility of demand for key products, standard deviation of sales volume per quarter. Higher variability complicates planning, and the expected impact increases risk.
- X13. Access to credit resources, confirmed credit lines to revenue. Better access mitigates liquidity shortages, and the expected impact reduces risk.
- X14. Crisis management maturity level is an index based on a questionnaire about the presence of policies, responsible persons, procedures, and plans. A higher level indicates greater preparedness, and the expected impact reduces risk.

Next, we will present the intermediate indicators that affect the crisis development, O1–O3:

- O1. The share of overdue financial liabilities in total financial liabilities. A higher ratio indicates financial stress;
- O2. Capacity utilization rate. A lower rate indicates underutilization, reduced revenue, and increased risk;
- O3. The ratio of net operating cash flow to short-term liabilities. A higher indicator reflects better solvency in the short term.

As part of the scenario modeling, we selected three industrial enterprises with different activities: LLC "SheMax"; JSC "Rivne-BTK"; LLC "Myasokombinat Myrhorodsky." As can be seen from the initial data (Table 1), the values of the liquidity ratio below 1 are considered low, values in the range from 1 to 1,5 are acceptable, and values close to 2 are high.

For the interest coverage ratio, values below 1.5 indicate weak coverage, values from 1 to 3 indicate medium coverage, and values above 3 indicate strong coverage. The share of overdue receivables less than 5 percent of income is considered a controlled level, from 5 to 8 percent as a moderate level, and above 8 percent as an increased level. Access to credit lines not exceeding 8 percent of annual revenue is interpreted as limited, from 8 to 12 percent as moderate, and above 12 percent as high.

An index of anti-crisis management maturity below 0,35 reflects a low level of maturity, the interval from 0,35 to 0,5 is an average level, and a value above 0,5 is a high level of maturity.

Thus, according to the selected basic factors from X1 to X14, we see, in particular, that LLC "SheMax" liquidity is below the desired level, interest payment coverage is weak, access to credit lines is limited, and anti-crisis management maturity is low. At the same time, overdue receivables in LLC "SheMax" are maintained within controlled limits, the cash cycle is shorter than typical for the industry, and the share of fixed costs is moderately low, which increases flexibility. At the same time, the liquidity of JSC "Rivne BTK" is near the lower limit of acceptable levels, the capital structure is balanced, and the coverage of interest payments is average.

Table 1. Values for baseline and intermediate indicators for selected industrial enterprises.

X/O	LLC "SheMax"	JSC "Rivne-BTK"	LLC "Myasokombinat Myrhorodsky"
X1	0.85	1.5	1.2
X2	38	45	48.3
X3	1	2	2.6
X4	4.5	6.8	5.2
X5	35	50	60
X6	24.3	28.7	31.3
X7	45.5	52.5	56.2
X8	12.1	16.3	19.6
X9	22.8	30.2	33.2
X10	28.4	35.7	37.9
X11	9.4	18.2	22.5
X12	5.5	7.5	8.8
X13	6.3	12.1	14.5
X14	0.3	0.45	0.52
O1	9.1	7.2	6.3
O2	81.5	79.5	77.6
O3	0.18	0.31	0.35

First, all X1…X14 are converted into dimensionless indices in the interval from zero to one. Min–max normalization is used, taking into account the direction of the utility of the indicator. Let L_k and U_k be the lower and upper threshold levels for the indicator X_k. First, we calculate the raw index (1):

$$r_k=\min\{1, \max\{0, (X_k-L_k)/U_k-L_k\}\} \quad (1)$$

Next, we form the "bigger is better" index (2):

$$zk=\begin{cases} rk \\ 1-rk \end{cases} \quad (2)$$

Let's consider one of the calculation examples for LLC "SheMax." So, for X1, we take the range 0.8 to 2.0. Having received the value X1=0.85, therefore r1=(0.85−0.8)/(2.0−0.8)=0.0417. For the cycle duration X5, we choose 30 days to 90 days. In this context X5=35, then r5=(35−30)/(90−30)=0.0833. Since a longer cycle is worse, we take z5=1−r5=0.9167. Similarly, for X3 with the range 0.5 to 6.0 and the value 1.0, we get z3=0.0909. The same is done for all the others. Thus, as we can see from Table 2, positive values mean a coordinated movement of indicators in one direction, and negative values mean the opposite movement. For example, for LLC "SheMax", the strongest negative relationships are observed between X1 and X5, X1 and O1, and X3 and X5, which is consistent with the expectation that a longer cash conversion cycle and lower solvency increase crisis pressure. The strongest positive relationships are observed between X1 and X3, X3 and X13, and X14 and X13, which is consistent with the fact that better access to credit lines and a more mature anti-crisis management system support liquidity and interest coverage.

Table 2. The density of relationships between factors that influence the formation of crisis development in the activities of LLC "SheMax."

X/O	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	O1	O2	O3
X1	1	-0.65	0.88	-0.6	-0.72	-0.4	-0.58	-0.45	-0.35	-0.3	-0.2	-0.55	0.62	0.66	-0.75	0.6	0.7
X2	-0.65	1	-0.7	0.55	0.5	0.58	0.52	0.45	0.48	0.46	0.64	0.66	-0.5	-0.56	0.58	-0.4	-0.55
X3	0.88	-0.7	1	-0.6	-0.65	-0.42	-0.56	-0.38	-0.66	-0.64	-0.62	-0.44	0.7	0.68	-0.72	0.58	0.68
X4	-0.6	0.55	-0.6	1	0.5	0.48	0.4	0.62	0.64	0.66	0.68	0.42	-0.66	-0.64	0.62	-0.65	-0.6
X5	-0.72	0.5	-0.65	0.5	1	0.62	0.54	0.58	0.66	0.68	0.7	0.5	-0.52	-0.4	0.65	-0.55	-0.62
X6	-0.4	0.58	-0.42	0.48	0.62	1	0.6	0.55	0.68	0.7	0.62	0.45	-0.4	-0.35	0.55	-0.42	-0.48
X7	-0.58	0.52	-0.56	0.4	0.54	0.6	1	0.52	0.7	0.62	0.64	0.48	-0.45	-0.38	0.6	-0.58	-0.52
X8	-0.45	0.45	-0.38	0.62	0.58	0.55	0.52	1	0.62	0.64	0.66	0.42	-0.35	-0.32	0.5	-0.45	-0.45
X9	-0.35	0.48	-0.66	0.64	0.66	0.68	0.7	0.62	1	0.7	0.4	0.36	-0.3	-0.28	0.38	-0.2	-0.35
X10	-0.3	0.46	-0.64	0.66	0.68	0.7	0.62	0.64	0.7	1	0.35	0.32	-0.25	-0.26	0.35	-0.22	-0.32
X11	-0.2	0.64	-0.62	0.68	0.7	0.62	0.64	0.66	0.4	0.35	1	0.25	-0.3	-0.2	0.3	0.25	-0.28
X12	-0.55	0.66	-0.44	0.42	0.5	0.45	0.48	0.42	0.36	0.32	0.25	1	-0.4	-0.36	0.5	-0.6	-0.58
X13	0.62	-0.5	0.7	-0.66	-0.52	-0.4	-0.45	-0.35	-0.3	-0.25	-0.3	-0.4	1	0.55	-0.62	0.42	0.65
X14	0.66	-0.56	0.68	-0.64	-0.4	-0.35	-0.38	-0.32	-0.28	-0.26	-0.2	-0.36	0.55	1	-0.7	0.5	0.6
O1	-0.75	0.58	-0.72	0.62	0.65	0.55	0.6	0.5	0.38	0.35	0.3	0.5	-0.62	-0.7	1	-0.5	-0.7
O2	0.6	-0.4	0.58	-0.65	-0.55	-0.42	-0.58	-0.45	-0.2	-0.22	0.25	-0.6	0.42	0.5	-0.5	1	0.6
O3	0.7	-0.55	0.68	-0.6	-0.62	-0.48	-0.52	-0.45	-0.35	-0.32	-0.28	-0.58	0.65	0.6	-0.7	0.6	1

Further, for JSC "Rivne-BTK", the normalization is the same. So, for example, for X1=1.05 in the range L1=0.8 and U1=2 we get the following value r1=(1.05−0.8)/(2.0−0.8)=0.2083 and z1=0.2083. For X5=50 days within 30…90, we get r5=(50−30)/60=0.3333, and considering that the longer the worse, we take z5=1−r5=0.6667. For X3=2.0 within 0.5…6.00 we have r3=1.5/5.5=0.2727. Compared to LLC "SheMax", in JSC "Rivne-BTK", the negative relationships leading to the growth of O1 became less sharp, primarily for pairs with X1, X3, X13, X14, and also for pairs with X5 and X6. The positive relationships between X1 and X3, X3 and X13, and X13 and X14 were preserved, but their magnitude decreased by approximately ten percent, which is consistent with a more even financial condition (Table 3).

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Table 3. The density of relationships between factors that influence the formation of crisis development in the activities of JSC "Rivne-BTK."

X/O	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	O1	O2	O3
X1	1	-0.60	0.84	-0.56	-0.64	-0.39	-0.52	-0.44	-0.32	-0.25	-0.19	-0.49	0.55	0.62	-0.72	0.55	0.67
X2	-0.63	1	-0.61	0.50	0.48	0.51	0.49	0.38	0.44	0.45	0.58	0.63	-0.48	-0.51	0.50	-0.37	-0.48
X3	0.78	-0.64	1	-0.56	-0.58	-0.41	-0.51	-0.38	-0.61	-0.56	-0.58	-0.38	0.62	0.64	-0.69	0.53	0.66
X4	-0.58	0.51	-0.52	1	0.48	0.42	0.38	0.54	0.59	0.64	0.62	0.41	-0.63	-0.58	0.54	-0.60	-0.52
X5	-0.69	0.46	-0.57	0.45	1	0.55	0.51	0.50	0.61	0.66	0.63	0.48	-0.50	-0.36	0.57	-0.51	-0.54
X6	-0.40	0.53	-0.36	0.43	0.59	1	0.56	0.48	0.63	0.67	0.56	0.43	-0.39	-0.31	0.48	-0.39	-0.41
X7	-0.56	0.48	-0.49	0.36	0.52	0.53	1	0.45	0.64	0.60	0.58	0.46	-0.43	-0.34	0.52	-0.53	-0.45
X8	-0.44	0.41	-0.32	0.56	0.55	0.49	0.49	1	0.57	0.62	0.60	0.41	-0.34	-0.28	0.43	-0.41	-0.38
X9	-0.35	0.44	-0.58	0.58	0.63	0.61	0.65	0.54	1	0.67	0.36	0.35	-0.30	-0.25	0.32	-0.18	-0.29
X10	-0.31	0.42	-0.56	0.60	0.65	0.62	0.58	0.56	0.64	1	0.31	0.31	-0.25	-0.23	0.29	-0.20	-0.26
X11	-0.21	0.59	-0.54	0.62	0.66	0.55	0.60	0.58	0.37	0.35	1	0.25	-0.30	-0.17	0.25	0.23	-0.23
X12	-0.54	0.61	-0.37	0.38	0.48	0.39	0.45	0.36	0.33	0.32	0.22	1	-0.39	-0.32	0.43	-0.55	-0.50
X13	0.54	-0.46	0.67	-0.62	-0.46	-0.39	-0.40	-0.35	-0.28	-0.20	-0.29	-0.35	1	0.52	-0.60	0.39	0.63
X14	0.58	-0.52	0.66	-0.60	-0.35	-0.34	-0.34	-0.32	-0.26	-0.21	-0.19	-0.31	0.49	1	-0.67	0.46	0.58
O1	-0.72	0.53	-0.63	0.56	0.62	0.49	0.56	0.43	0.35	0.35	0.27	0.48	-0.59	-0.63	1	-0.46	-0.61
O2	0.52	-0.37	0.56	-0.61	-0.49	-0.41	-0.52	-0.44	-0.18	-0.17	0.22	-0.53	0.37	0.47	-0.49	1	0.58
O3	0.61	-0.51	0.66	-0.56	-0.55	-0.46	-0.47	-0.44	-0.32	-0.26	-0.27	-0.51	0.58	0.56	-0.67	0.55	1

For LLC "Myasokombinat Myrhorodsky" X1=1.18 we get r1=(1.18−0.8)/1.2=0.3167 and z1=0.3167. For X5=60 days, we have r5=0, and z5=1−0.5=0.5. For X3=2.6, we get the following value r3=2.1/5.5=0.3818 and z3=0.3818. Compared to the enterprises LLC "SheMax" and JSC "Rivne-BTK", in LLC "Myasokombinat Myrhorodsky", the connections have become softer. Thus, this corresponds to a profile slightly below average. For example, the interaction with O1 is weaker. This means less direct pressure of debt and liquidity factors on the crisis contour. Positive connections between X1 and X3, as well as between X13 and X3, retain a system-forming role. They reflect a focus on maintaining liquidity and cash flow by improving interest coverage and access to credit lines (Table 4).

Table 4. The density of relationships between factors that influence the formation of crisis development in activities LLC "Myasokombinat Myrhorodsky."

X/O	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	O1	O2	O3
X1	1	-0.57	0.75	-0.49	-0.58	-0.36	-0.50	-0.37	-0.27	-0.29	-0.19	-0.47	0.54	0.59	-0.63	0.50	0.60
X2	-0.54	1	-0.63	0.45	0.43	0.51	0.47	0.36	0.40	0.40	0.57	0.53	-0.44	-0.48	0.48	-0.31	-0.49
X3	0.72	-0.60	1	-0.49	-0.58	-0.37	-0.48	-0.31	-0.53	-0.57	-0.54	-0.37	0.62	0.55	-0.60	0.49	0.59
X4	-0.49	0.50	-0.53	1	0.43	0.43	0.31	0.51	0.54	0.58	0.61	0.33	-0.57	-0.54	0.52	-0.58	-0.53
X5	-0.63	0.43	-0.54	0.46	1	0.52	0.47	0.52	0.53	0.56	0.60	0.44	-0.41	-0.36	0.52	-0.46	-0.50
X6	-0.32	0.46	-0.37	0.41	0.54	1	0.49	0.46	0.59	0.62	0.50	0.37	-0.34	-0.28	0.48	-0.38	-0.42
X7	-0.50	0.45	-0.45	0.31	0.44	0.51	1	0.47	0.57	0.52	0.55	0.43	-0.41	-0.34	0.48	-0.48	-0.41
X8	-0.35	0.36	-0.33	0.54	0.52	0.44	0.43	1	0.54	0.58	0.54	0.35	-0.29	-0.25	0.37	-0.40	-0.38
X9	-0.30	0.42	-0.53	0.52	0.55	0.59	0.62	0.50	1	0.60	0.36	0.34	-0.28	-0.25	0.31	-0.15	-0.33
X10	-0.29	0.38	-0.54	0.58	0.61	0.57	0.52	0.55	0.62	1	0.28	0.27	-0.20	-0.19	0.26	-0.20	-0.26
X11	-0.16	0.57	-0.56	0.56	0.60	0.54	0.58	0.54	0.33	0.31	1	0.18	-0.27	-0.17	0.26	0.24	-0.26
X12	-0.49	0.55	-0.37	0.38	0.39	0.37	0.41	0.37	0.34	0.25	0.20	1	-0.32	-0.34	0.39	-0.51	-0.48
X13	0.54	-0.39	0.57	-0.57	-0.43	-0.32	-0.41	-0.31	-0.26	-0.20	-0.22	-0.36	1	0.48	-0.48	0.33	0.54
X14	0.55	-0.48	0.59	-0.51	-0.36	-0.31	-0.32	-0.25	-0.27	-0.24	-0.17	-0.29	0.50	1	-0.57	0.43	0.53
O1	-0.58	0.44	-0.60	0.50	0.54	0.48	0.46	0.40	0.31	0.31	0.21	0.39	-0.50	-0.55	1	-0.43	-0.57
O2	0.50	-0.33	0.52	-0.58	-0.48	-0.36	-0.48	-0.35	-0.19	-0.20	0.22	-0.49	0.33	0.41	-0.40	1	0.54
O3	0.63	-0.49	0.57	-0.50	-0.50	-0.44	-0.46	-0.38	-0.28	-0.24	-0.26	-0.50	0.56	0.53	-0.60	0.49	1

The next step for all three selected industrial enterprises will be the formation of a system of linear equations. The coefficients are selected by the least squares method with fixed signs in accordance with the cognitive logic of modeling:

$$\text{LLC "SheMax"} = \begin{cases} O1 = 8.64 - 3.04 * X1 + 0.09 * X2 - 0.63 * X3 \\ O2 = 81.19 + 6.32 * X1 - 0{,}16 * X2 - 1{,}33 * X3 \\ O3 = 0.18 + 0.06 * X1 + 0{,}0019 * X2 + 0{,}00128 * X3 \end{cases}$$

$$\text{JSC "Rivne-BTK"} = \begin{cases} O1 = 7.51 - 3.18 * X1 + 0{,}094 * X2 - 0.609 * X3 \\ O2 = 77.99 + 5.98 * X1 - 0{,}16 * X2 + 1.409 * X3 \\ O3 = 0.29 + 0{,}057 * X1 + 0{,}001 * X2 + 0{,}0134 * X3 \end{cases}$$

$$\text{LLC "Myasokombinat Myrhorodsky"} = \begin{cases} O1 = 6.96 - 3.005 * X1 + 0.09003 * X2 - 0.672 * X3 \\ O2 = 74.53 + 6.19 * X1 - 0.163 * X2 + 1.3915 * X3 \\ O3 = 0.338 + 0.061 * X1 - 0.0019 * X2 + 0.012 * X3 \end{cases}$$

Next, based on the results of the assessment, we will build scenario matrices. Thus, such matrices of strategic alternatives for the anti-crisis management system have a number of combinations that reflect different basic scenarios S(I) (corresponds to a combination of high funding and high maturity), S(II) (reflects available funding with low maturity), S(III) (fixes high maturity with limited funding), S(IV) (combines a funding deficit and low maturity). The logic behind the division into four scenarios is based on two key, controllable, and independent dimensions of our cognitive model. These dimensions include the maturity of crisis management and readiness for change, as well as access to funding for anti-crisis measures. It is these two blocks that determine the direction and strength of influence on O1, O2, O3 through X1, X2, X3, and enablers X13, X14. In the density matrices for our selected industrial enterprises, the relationships of X13 and X14 with the target indicators were among the strongest, making them natural axes for scenario analysis, and they are also subject to management, not external shock. For example, for LLC "SheMax", in S(I) X1 and X3 are strengthened, while X2 is simultaneously reduced, which, according to our equations, reduces O1 and increases O2 and O3, which gives the best security profile. In S(II), there is funding, but weak readiness for change does not allow for realizing the potential; the indicators move according to the trend. In S(III) management maturity works, even with limited funding, the turnover cycle and cost discipline improve, which gives tangible but moderate progress. In S(IV), the simultaneous deficit of funding and management maturity strengthens X2 and weakens X1 and X3, which causes the deterioration of all three target indicators (Table 5).

Table 5. Description of crisis development scenarios for LLC "SheMax" and their impact on the level of financial security.

Scenario	Resulting indicators	Change in the resulting indicators	Impact on financial security
S(I) optimistic, high funding, and high maturity	O1 share of overdue liabilities, O2 capacity utilization, O3 short-term solvency	O1 significant reduction, the model gives a guideline of about 7% versus 9, O2 significant increase, about 85.4% versus 81.5, O3 significant increase, about 0.221 times versus 0.18	High positive effect, liquidity reserve is formed, debt pressure is reduced, and financial stability is increased
S(II) conservative, high funding, and low maturity	O1, O2, O3	On trend, minor changes from the base, guideline O1 about 9%, O2 about 81.5%, O3 about 0.18 times	Neutral or weakly positive effect, liquidity support without structural improvements, threat of accumulation of hidden problems
S(III) moderately optimistic, low funding, and high maturity	O1, O2, O3	O1 reduction, about 8.32%, O2 increase, about 82.8%, O3 increase, about 0.194 times	Positive effect due to management changes and cost system; however, lack of funding limits the scale of improvements
S(IV) pessimistic, low funding, and low maturity	O1, O2, O3	O1 significant increase, about 11%, O2 significant reduction, about 77.6%, O3 reduction, about 0.139 times	High negative effect, debt burden and arrears increase, utilization and solvency fall, and a crisis development spiral is launched

For JSC "Rivne-BTK", in a more favorable combination of high manageable capacity and sufficient resource provision, a noticeable decrease in debt stress, increased liquidity, stabilization of cash flows, and better capacity utilization are expected. If resources are available but there is a lack of willingness to change, the effect is limited to maintaining current solvency without making significant structural improvements. This will ultimately lead to the risk of inefficient use of funds. With limited resources and high managerial maturity, progress is achieved through cost discipline, short decision cycles, and local projects; sustainability is formed, but the scale of improvements is limited. With simultaneous resource shortage

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and immaturity, liquidity pressure increases, the cash cycle lengthens, delinquencies increase, and financial sustainability decreases (Table 6).

Table 6. Description of crisis development scenarios for JSC "Rivne-BTK" and their impact on the level of financial security.

Scenario	Resulting indicators	Change in the resulting indicators	Impact on financial security
S(I) optimistic, high funding, and high maturity	O1 4.6%, O2 84.5%, O3 0.352 times	O1 decreases from baseline 7.2 to 4.6. O2 increases to 84.5 from 79.5. O3 increases to 0.352 from 0.3	High positive effect. Debt pressure decreases. Liquidity and short-term solvency increase
S(II) conservative, high funding, and low maturity	O1 7.2%, O2 79.5%, O3 0.3 times	Indicators close to baseline	Neutral effect. Status quo maintained without significant structural change in risks
S(III) moderately optimistic, low funding, and high maturity	O1 6.3%, O2 81.2%, O3 0.317 times	O1 decreases to 6.3. O2 increases to 81.2. O3 increases to 0.317	Positive effect. Management maturity compensates for the funding deficit
S(IV) pessimistic, low funding, and low maturity	O1 8.1%, O2 77.8%, O3 0.283 times	O1 increases to 8.1. O2 decreases to 77.8. O3 decreases to 0.283	Significant negative effect. Share of overdue liabilities increases, and utilization falls

As for LLC "Myasokombinat Myrhorodsky", with a favorable combination of managed capacity and resources, a rapid increase in solvency, better turnover, and reduced risk of disruptions is manifested, and asset modernization gives an increase in productivity. In the presence of financing without managerial readiness, resources are absorbed by bottlenecks; the effect is short-term, and basic weaknesses are preserved. In conditions of limited resources and a high degree of maturity, moderate but sustainable results are achieved through cost optimization, maintenance, and targeted organizational decisions. With a combination of resource shortage and immaturity, vulnerability to demand fluctuations and supply disruptions increases, the risk of working capital shortage and deferred depreciation increases, which undermines financial security (Table 7).

Table 7. Description of crisis development scenarios for LLC "Myasokombinat Myrhorodsky" and their impact on the level of financial security.

Scenario	Resulting indicators	Change in the resulting indicators	Impact on financial security
S(I) optimistic, high funding, and high maturity	O1 3.12%, O2 83.24%, O3 0.409 times	O1 decreases to 3.12 vs. 6.0. O2 increases to 83.24 vs. 77.6. O3 increases to 0.409 vs. 0.35	High positive effect. Significant strengthening of solvency and utilization
S(II) conservative, high funding, and low maturity	O1 6%, O2 77.6%, O3 0.35 times	Indicators close to baseline	Neutral effect. Status quo with risk of deferred problems
S(III) moderately optimistic, low funding, and high maturity	O1 5.04%, O2 79.48%, O3 0.37 times	O1 decreases. O2 increases moderately. O3 increases	Positive effect. Management maturity partially compensates for the financing deficit
S(IV) pessimistic, low funding, and low maturity	O1 6.96%, O2 75.72%, O3 0.33 times	O1 increases. O2 decreases. O3 decreases	Significant negative effect. Strengthening of the debt and liquidity crisis contour

Thus, as a result, a cognitive model was developed, on the basis of which the main factors and subjects of influence on the development of the crisis were determined. Based on the combination of these factors, scenarios were determined. Also, based on the analysis, four different scenarios of the crisis were identified: optimistic, conservative, moderately optimistic, and pessimistic.

Summarizing the results of the scenario analysis for three industrial enterprises, we can conclude that for LLC "SheMax", in our opinion, the most realistic in the short term is the implementation of a moderately optimistic scenario with a gradual transition to a fully optimistic one, and the chances of a quick transition to it can be assessed as average due to the current resource constraints. However, for JSC "Rivne BTK", the basic profile is much more stable, so it is advisable to focus on a quick transition from a conservative model to an optimistic one with an emphasis on reducing the share of overdue liabilities, maintaining high-capacity utilization, and increasing short-term solvency. Thus, LLC "Myasokombinat Myrhorodsky" has the most favorable starting position in terms of access to financing and maturity of anti-crisis management, so the strategy for this enterprise should be based on the active use of available resources for the modernization of fixed assets.

DISCUSSION

Our results confirm that crisis development at industrial enterprises is systemic in nature, combining financial, operational, and other factors. At the same time, modern scientific works emphasize the need for a holistic vision of anti-crisis management and a clear definition of the crisis situation at the enterprise level, which is consistent with our cognitive model and matrix of the density of relationships.

At the same time, the generalization of approaches to the essence of anti-crisis management and the structuring of crisis phases, proposed in the works of Valackienė and Virbickaitė (2011), gives grounds to emphasize early warning and controllability of crisis processes, which we recreated through the allocation of X14 and its directed impact on O1, O2, and O3 in three enterprises. At the same time, the international experience of adapting anti-crisis management in transformation economies, which is highlighted by Khalatur, Kriuchko, and Sirko (2020), shows the importance of transferring proven mechanisms of financial stabilization and operational flexibility, taking into account the local context. The equations we obtained for each enterprise demonstrate that the effects of liquidity, debt burden, and interest coverage are significant, but not the same in scale, which confirms the thesis about the need for adaptive solutions, not universal recipes.

Modern developments in anti-crisis management in the Ukrainian economy, in particular Riabenko et al. (2024), strengthen the argument for prioritizing measures to stabilize cash flows, capital structure, and debt obligations. Thus, this is directly reflected in our matrix of strategic alternatives.

The results of Melnyk et al. (2020) emphasize that anti-crisis management is precisely a component of the economic security of the enterprise. In our models, this is reflected through the same factor X14, the level of maturity of anti-crisis management and readiness for change, which significantly affects O2 and O3, and determines the stability of capacity utilization and short-term solvency even with limited financing. It is additionally important to take into account the systemic nature of shocks, as emphasized by Askari et al. (2018) in their study of global trade networks. Thus, for industrial enterprises in Ukraine, this means that external disruptions in supply and sales can exacerbate internal imbalances (identified by us as X5, X9, X10, X11, X12), so scenario planning should include stress tests taking into account network effects.

The issues of bankruptcy risk diagnostics and warning systems, highlighted in Bivainis and Garškaitė (2010), support the use of early warning indicators and integral risk indicators. At the same time, our approach integrates these ideas through the normalization of basic factors and the construction of intermediate indicators O1, O2, O3 with subsequent quantitative connection in the equations, which provides transparent traceability from observed financial and operational metrics to the assessment of the crisis profile.

CONCLUSIONS

In our opinion, the results obtained by us are directly consistent with the set goal of scientifically substantiating the approach to assessing crisis development scenarios at industrial enterprises in the system of strategic planning of anti-crisis measures, since a consistent relationship has been built between the basic factors from X1 to X14, intermediate indicators O1, O2, O3 and a matrix of strategic alternatives for three real enterprises. Each of the tasks set in the article has been accomplished, since the indicators have been normalized, the density matrices of relationships have been formed, a cognitive model has been developed, equations for intermediate indicators have been identified, and a scenario analysis has been conducted.

The study demonstrates the practical suitability of an integrated approach to assessing crisis scenarios at industrial enterprises. Therefore, within the framework of this article, a clear and consistent chain of actions was developed, basic factors were standardized, relationship density matrices were formed, a cognitive model was developed, equations for intermediate indicators were identified, and a scenario analysis was conducted at the intersection of access to financing and anti-crisis management maturity. Reproducible equations and scenario benchmarks were obtained for three different enterprises, ensuring transparent traceability from factors to results and creating a basis for strategic planning of anti-crisis measures. Moreover, it should be noted that the key finding is that systemically important channels of influence are mediated by liquidity, interest coverage, and capital structure. However, their strength is significantly mitigated by the governance and financing systems. For example, at one of the companies we selected for modeling, the greatest sensitivity was found to increasing liquidity and access to credit lines. Therefore, management's anti-crisis actions quickly translate into reduced debt stress and increased operational resilience. The strategic alternatives matrix confirmed the expected trajectories. In the optimistic scenario, stress is reduced, and capacity utilisation and solvency improve. In the conservative scenario, the status quo is maintained. In the moderately optimistic scenario, management maturity compensates for the financing shortfall, and in the pessimistic scenario, the debt burden increases.

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The practical value lies in the list of priority actions, increasing the liquidity buffer, shortening the cash cycle, optimizing accounts receivable, balancing the capital structure, improving the effectiveness of the anti-crisis management system, diversifying customers and suppliers, implementing modernization and energy efficiency programs, and continuously monitoring triggering. The proposed toolkit allows for the establishment of clear links between management decisions and expected changes in debt stress, capacity utilization, and short-term solvency, facilitating the prioritization of activities and resource planning. The scientific contribution lies in the combination of cognitive modeling with relationship density and local linear equation identification, which ensures explainability and reproducibility. The limitations of the study include the use of a one-year data period and partial reliance on expert estimates for link density, as well as the linear approximation of effects, which does not account for possible nonlinearities and thresholds.

Prospects for further research include the development of industry benchmarks and sustainability ratings, and consideration of financial security during crisis development.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ОЦІНЮВАННЯ СЦЕНАРІЇВ КРИЗОВОГО РОЗВИТКУ НА ПРОМИСЛОВИХ ПІДПРИЄМСТВАХ У СИСТЕМІ СТРАТЕГІЧНОГО ПЛАНУВАННЯ АНТИКРИЗОВИХ УПРАВЛІНСЬКИХ ЗАХОДІВ

Стаття присвячена оцінюванню сценаріїв кризового розвитку на промислових підприємствах у системі стратегічного планування антикризових заходів, побудові когнітивної моделі взаємозв'язків і кількісному відтворенню впливів на проміжні результати. Дослідження спирається на базові чинники, які були позначенні від X1 до X14, та проміжні показники, які в свою чергу були позначені від O1 до O3, за даними трьох відібраних нами підприємств за 2024 рік. Показники нормовано до безрозмірних індексів з урахуванням напряму корисності, далі побудовано матриці щільності взаємозв'язків, когнітивні карти та окремі для кожного підприємства рівняння, що відтворюють вплив ліквідності структури капіталу покриття відсоткових платежів оборотного циклу витрат і ринкових концентрацій на частку прострочених зобов'язань завантаження потужностей і короткострокову платоспроможність. Запропоновано узгоджену процедуру калібрування чутливостей і вільних членів, яка забезпечує трасованість від експертної та емпіричної інформації до розрахункових результатів і дозволяє відтворити зафіксовані значення для кожного з відібраних підприємств. У роботі сформовано матрицю стратегічних альтернатив на перехресті двох керованих площин, доступу до фінансування антикризових заходів і зрілості антикризового управління й готовності до змін. Перехресне поєднання високого та низького рівнів породжує чотири сценарії: оптимістичний, консервативний, помірно оптимістичний, песимістичний. На основі чотирьох сценаріїв для кожного підприємства розроблено конкретні пропозиції щодо антикризових управлінських дій, які можуть бути використані керівниками та фінансовими менеджерами промислових підприємств, консультантами з антикризового управління.

Ключові слова: оцінювання кризового розвитку, стратегічне планування антикризових заходів, когнітивна модель, матриця щільності взаємозв'язків, сценарний аналіз, промислові підприємства, ліквідність, боргове навантаження, платоспроможність

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