The Diagnostic Model For Assessing The State Of Stability Of An Industrial Enterprise

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Abstract. At the present stage, Ukraine is in a state of market transformation which is accompanied by the spread of global integration processes, digitalization of social and economic processes, open national economies and, consequently, the intensification of crises. In these conditions, the formation of effective tools for diagnosing the state of industrial enterprises will identify timely latent threats to its sustainable behaviour, overcome the crisis if it occurs, and ensure its revival at the same or higher level of organization and efficiency. The violation of cyclicality (failure to overcome the crisis) leads to the termination of its activities as a business entity. The article presents an algorithmic model for diagnosing the class of resilience / crises of industrial enterprises and develops the diagnostic scales that serve as a tool for recognizing the current and future state of the enterprise. It is proposed to study the activity of the enterprise as a set of its system-forming spheres - production, financial and labour. The diagnostic scales are developed on the basis of processing of the information on the allocated spheres for 24 enterprises of the industry of Ukraine for 10 years with application of information and computer technologies. They serve as a basis for the formation of adequate management impulses and the construction of achievable scenarios for crisis management in the enterprise, taking into account its resource capabilities. The methods of correlation, taxonomic and cluster analyzes are mathematical tools for constructing scales. The proposed scales are universal and can be used as an analogue of industry standards.

Keywords: crisis situation, enterprise, diagnostic model, scale, sphere of enterprise's life.

1 Introduction

The development of the modern economy of Ukraine is characterized by a

rapid pace of economic and technological transformations, which is intensified by the competition in its industries in accordance with the dynamic changes in consumer needs. However, the domestic business sphere shows the signs of prolonged stagnation, to overcome which is a critical task for the development of the Ukrainian economy at both the macro and micro levels.

According to the liberal concept of economics, there are special conditions for business entities. However, it should be noted that industrial enterprises are one of the subjects of the economy, which is strongly influenced by economic cycles and competition in the markets. This is especially true of business development in the context of digital transformation, which is a new dimension of reality with the definition of digital leadership.

In today's world, digital technologies create fundamentally new opportunities for building interaction between government, business and the public, eliminating long chains of intermediaries and accelerating the conduct of various transactions and operations. Such factors come to the fore due to the rapid development of information technology and globalization of the economy. They offer fundamentally new concepts of consumption and open up additional potential for the development of new markets and access to them. In such conditions, organizations need to intensify their development to be innovative, so as not to lose competitiveness and communication with consumers.

The solution of this problem belongs to the type of complex multicriteria tasks, which actualizes scientific and economic research in diagnosing the trajectory of enterprise development, its resource capabilities, business management system. These issues become especially relevant in conditions of force majeure, particularly in the context of the COVID-19 pandemic. Due to the crisis caused by the COVID-19 pandemic, Ukrainian business in 2020 is on the verge of survival. The economic downturn, declining purchasing power and changing behaviour of citizens, weak support (or inefficiency) by the state, have led to the reduction in production and the creation of social tensions in society. All this necessitates the constant search for effective approaches, tools, tools for monitoring and diagnosing the state of business.

The article's purpose is to develop a diagnostic model for assessing the state of sustainability of an industrial enterprise in the crusial spheres of its life. This model is aimed at recognizing trends in the development of an enterprise in accordance with the changes in the external and internal environment.

To achive the goal of the article, the following tasks are solved:

1) Formation of the information space of recognition of a class of stability / crisis at the enterprise.

2) Development of a criteria for recognizing enterprises that are in a state of resilience / crisis

3) Forming the rule of recognition of stable / crisis enterprises

4) Grouping of industrial enterprises of Kharkiv region.

5) Developing the ranges of values of indicative indicators of recognition of a class of stability / crisis at the enterprise

2 Literature Review

Today, there is a large number of scientific papers, which at the theoretical,

methodological and practical levels explored a wide range of issues related to the diagnosis of enterprises. Diagnosis is often associated with diagnosing only the financial condition of the company.

V. Ponomarenko, O.Tridid (Ponomarenko, 2002), E. Utkin (Utkin, 1997) and others made a significant contribution to the study of enterprise economics in crisis conditions and to the theory of crisis management. In the works of these authors, considerable attention is paid to the efficiency and safety of the enterprise, the development of theory and practice of diagnosing the crisis and the threat of bankruptcy.A significant number of factors, which affect the financial sustainability of the enterprise, cause the lack of a single approach to its definition and assessment in the economic literature (Yalovy &Bakerenko, 2011).

Khrystynko and Butkova (2011) considered sustainable economic development, mainly at the level of the country or region. One of the elements of economic sustainability of the enterprise is the personnel sustainability. The value of this is that the level of qualification and competence of employees determines the enterprise competitiveness in the labour market. Therefore, it determines its ability to attract staff on time, to form a team with the necessary characteristics for the enterprise, to update the staff.

Galyna Azarenkova, Olena Golovko and Kateryna Abrosimova (2018) believed that a financial sustainability of the enterprise is a key feature of its financial status, its strategic development. Timely analysis of financial sustainability creates new opportunities for the enterprise to identify reserves in order to enhance its competitive position, increase market share and fulfill other tactical and strategic goals.

Monetary and financial stability of the enterprise in the coronavirus outbreak became Tobias' research subject (2020). The assumption was made that if economic and financial conditions were to deteriorate further, policymakers could revert to the broader toolkit developed during the financial crisis.

Iryna Trunina, Denys Zagirniak and other authors (2020) study the sustainability in different contexts. Some identify the indicators and predictors of the sustainability, and others identify the need to ensure personnel sustainability as a competitive advantage of the enterprise.

The traditional methods of financial sustainability assessment can be divided into three groups. The first group includes the qualitative assessment of financial stability, the second one contains the quantitative assessment of financial stability, and the third group includes the assessment of financial insolvency of enterprises. Among the methods of enterprise`s financial state analysis and its` financial sustainability the following methods can be outlined: time series models, regression models, models of the systems of interrelated variables, recursive systems, etc. (Zakharova, 2013).

In the work of V.Savchuk (Savchuk, 2020) it is presented a set of issues of financial diagnostics and monitoring of the enterprise from the standpoint of making sound management decisions. The issues of financial analysis are considered in their organic relationship with strategy and marketing, as well as with internal business processes of the enterprise.

A number of researches are devoted to the development of conceptual and methodical bases of diagnostics of various kinds of activity of the enterprise

separately. For example, in Ruslan Skrynkovskyy & Oksana Klyuvak's work (2016), the authors pay attention to the diagnosis of the export potential of the enterprise. They determine that to analyze and assess the level of potential and readiness of the enterprise to export activities, it is necessary to form a system of business indicators. These combine indicators of overall competitiveness in international and national markets, the level of product competitiveness based on its resource capabilities.

Bilal Bin Saeed and Wenbin Wang (2013) focus on the organizational diagnostics. Based on a critical analysis of existing models, the authors proposed a new model of organizational diagnostics based on three criteria - the model should be clear and not very complex, it should meet the specifics of the organization, the diagnostic model should collect data in the diagnostic process.

The research of Kumar, Maneesh and Harris, Irina (2020) is devoted to the improvement of diagnostic methodology in the enterprise as a whole. It is proved that total diagnostics increases the efficiency of integration between the levels of organization and departments, and requires the development of information model basis.

The issues of improving the methods of analysis and diagnosis in the process of enterprise management are also relevant in the research of scientists. So, O. Rayevnyeva and other authors (2020) think that a diagnostic is an effective tool for managing enterprise behaviour taking into account the stage of its business cycle. The resource capabilities of the enterprise correspond to the stages of the cycle, the cognitive relationship of the main system-forming areas of the enterprise. By analyzing and evaluating these capabilities, the opportunity of crisis management is determined - the possibility of provoking occurrence of artificial, positive crises or elimination of the natural, negative crises.

Zachosova and Babina (2018) simulate the behaviour of Ukrainian financial institutions' economic security in 2018 on the conjuncture of the financial market and the state financial security.

The influence of industry on the economic development of Ukraine is studied by the authors N. Marynenko (2016), M. Sushko (2017), O. Bilska (2020), V. Gurochkina (2020). Their works reveal the reasons for the low level of profitability, business activity, insolvency of industrial enterprises, the wave-like nature of the dynamics of profitability.

L. Deineko, V. Zymovets, N. Sheludko and others (2018) argue that industry is the main driver of economic growth of the Ukrainian economy. Thus, statistical studies of the industrial production index and the gross domestic product index show a one-way trend of change in these indicators. They also prove the conclusion of a significant contribution of the Ukrainian industrial enterprises to general economic development.

However, the studies have shown that the scientific literature reveals only some aspects of the diagnosis, and often diagnosis is defined as a direction of economic analysis which significantly narrows the focus and scope of its action.

Developing the existing approaches to diagnostics of functioning of the enterprise, diagnostic scales of a condition of development of the industrial enterprise are offered in work. They are based on the basic system-forming spheres of its vital activity - industrial, financial and labour. This allows to determine the current and future trajectory of the enterprise, as well as to form a general direction of managerial

influences to adjust the future behaviour of the enterprise taking into account its resource capabilities. This position of the authors is justified by the following considerations. The activity of an industrial enterprise is a set of various spheres of its life activity, starting from a purely production and ending with marketing and sales activities and the formation of the image of the enterprise. All these areas are important for a stable enterprise in its synergetic combination. But if the company operates for a long period of time in the conditions of severe financial constraints caused by constant political and economic destruction, the key areas of its activities are production, labour and financial spheres. They allow all other spheres of life to function effectively.

3 Problem Description and Basic Assumptions

This section introduces the research problem in this study and presents the assumptions of the scientific research.

3.1 Problem Description

Modern complex open socio-economic systems, enterprises are not isolated. They operate under the conditions of active influence of the external environment and are forced to adapt accordingly to its changes based on their resource capabilities. In this regard, the diagnosis of the main trends of changes in the functioning of enterprises in market conditions is becoming more relevant, which is strategically important for both specific regions and for the whole country. There is an urgent need to manage crisis situations of industrial enterprises through the formation of balanced, adequate to these changes trajectories of the further development of enterprises.

Over the past few years, most businesses have been in crisis (Fig. 1).
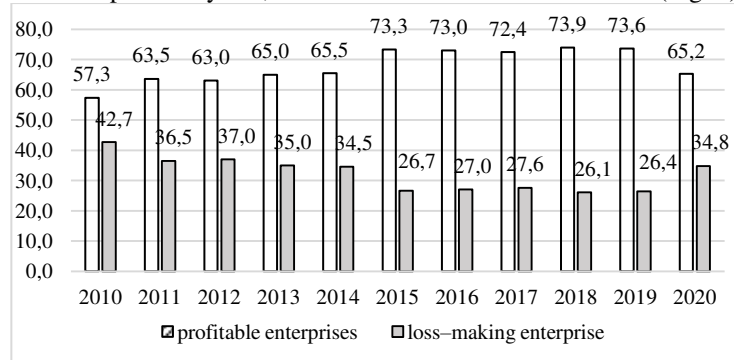
Fig. 1 The number of enterprises that made a profit / loss (% to the total number of enterprises / % to the total) (Sourse: State Statistics of Ukraine)

Presented in Fig. 1 data show that the number of unprofitable enterprises in Ukraine is gradually increasing every year. The graph shows that there is a tendency to increase the share of unprofitable enterprises in the period from 2018 to 2020. In 2020, compared to 2019, the number of enterprises that suffered a loss increased by

1.32%. This is due to the introduction of quarantine restrictions, slowing down production volumes, reduction of the demand for products / services.

Since industrial enterprises are subjects of the economy and are strongly exposed to the economic cycles and competition in the markets, so these enterprises are sensitive to crises. Figure 2 shows the dynamics of profit / loss of industrial enterprises for the period 2010-2019.
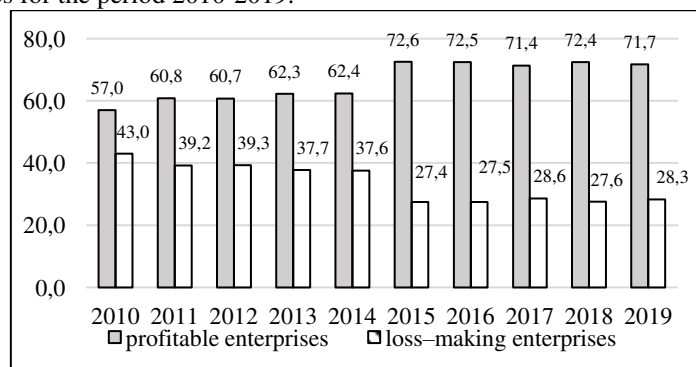

Fig. 2 The number of industrial enterprises that made a profit / loss (% to the total) (Sourse: State Statistics of Ukraine)

Such crisis phenomena have not only a negative economic but also a social effect, which provokes increasing tensions in society. Thus, during the period 2010-2020, the number of employees in business entities decreased by 17%.

In this regard, the diagnosis of major trends in industrial development in an unstable environment is one of the urgent tasks of the enterprise management. It requires a constant search for the effective forms and means of processing and monitoring large amounts of information by means of economic and mathematical modeling and information technology.

In addition, the result of an effective diagnostic system is the development of management solutions to adjust the trajectory of the enterprise, localization of crises, taking into account its resources and bankruptcy. This is a strong signal to actively interact with its stakeholders - owners, workers, financial institutions, investors, contractors.

3.2 Basic Assumptions

Assumption 1. The stability of the behaviour of enterprises in the market environment depends on the effective approaches, diagnostic tools of its enterprise, based on the processing of large arrays of information by means of information and communication technologies.

Assumption 2. The state of the enterprise is a set of spheres of its system-forming spheres of life, namely financial, labour, production, which interact with each other and determine its market development in accordance with its resource capabilities.

Assumption 3. The quality of the diagnostics system of the internal and

external environment of the enterprise should be based on the use of adequate economic and mathematical methods, approximation of trends in system-forming spheres of its life and serve as a basis for effective management decisions to adjust market behaviour.

4 Model Formulation

This section presents an algorithmic model for diagnosing the behaviour of industrial enterprises and a description of a set of economics-mathematical methods and models that act as diagnostic tools.

4.1 Notation

Diagnosis is an integral part of the management system of each enterprise, as it aims to identify retrospective, current and future status, as well as the development of preventive, remedial and reactive management solutions. These are aimed at eliminating problems and using the chances of the operating environment.

The proposed algorithm for recognizing the class of stability / crisis of the industrial enterprises and the formation of indicative values of indicators that characterize this phenomenon is presented in Fig.3.

To build diagnostic scales for recognizing the types of enterprises (Fig. 3, stage 5), the use of the following classes is proposed:

1. For the type of sustainable enterprises:

the class of absolute stability of the enterprise, when stocks and costs are less than the amount of working capital and bank loans for inventory. Indicators that characterize the provision of production assets and labour productivity, show a stable tendency to increase. The structure and number of production staff is stable. The share of highly skilled workers and average wages are growing;

the class of normal stability, when the solvency of the enterprise is guaranteed, capital adequacy and capital efficiency are at a high level, the share of material costs in the cost of production increases, and profitability tends to decrease. There is a stable share of employees with higher and secondary special education, increase in the minimum wage in the country;

the class of unstable (pre-crisis) state, when there is a violation of solvency, but the possibility of reproducing the balance of means of payment and payment obligations by attracting temporarily free sources of funds in the turnover of the enterprise. There is a slowdown in fixed assets growth and a predominant increase in material costs, the growth rate of the average wage slows down. The turnover ratio for hiring employees decreases and the turnover ratio for retirement increases.

2. For crisis enterprises:

the class of slight crisis, when there are significant stocks of finished products in the warehouse. There is reducing turnover from sales, rising costs, slowing down the dynamics of fixed assets and their turnover. The share of material costs in total continues to increase, the staff structure changes to increase the share of less skilled workers. There is a tendency to reduce productivity;
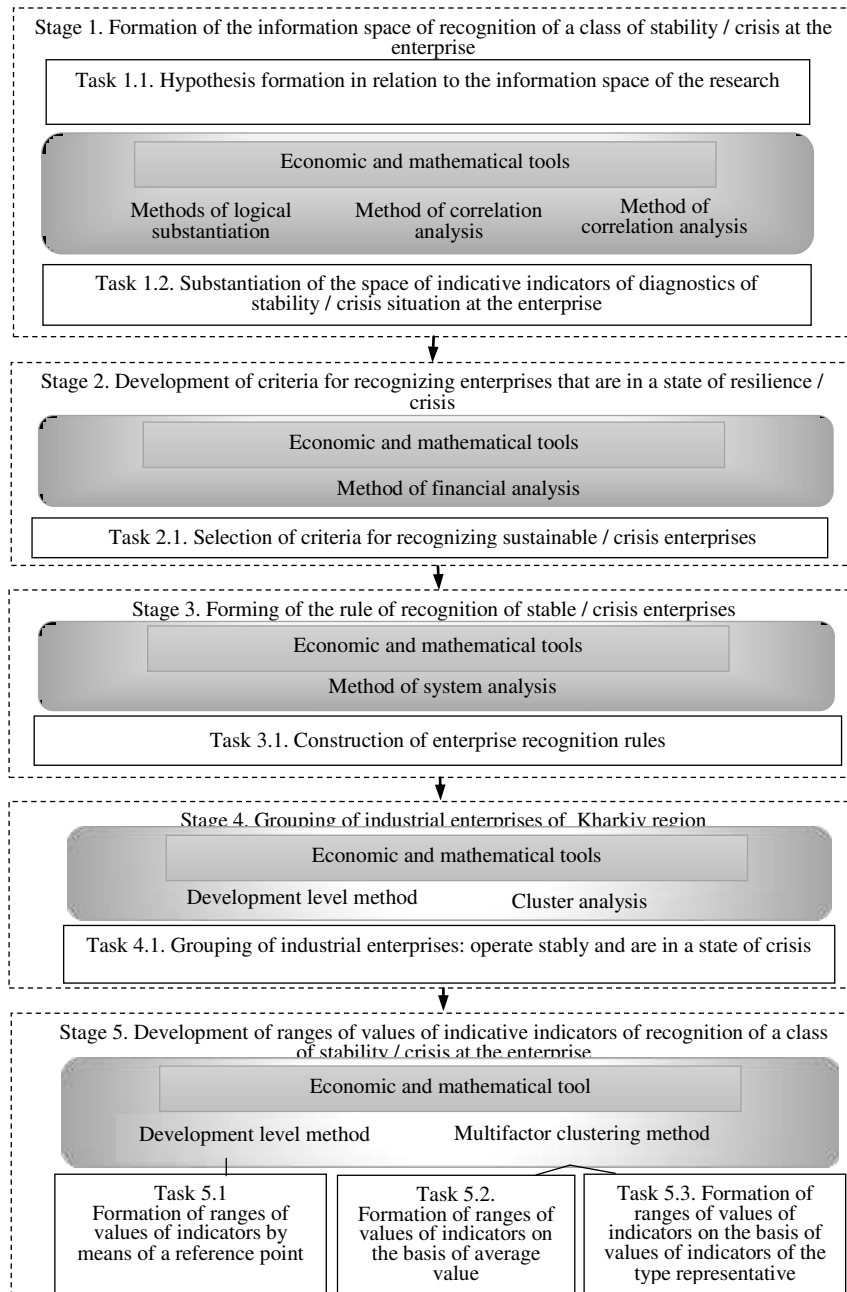
Stage 1. Formation of the information space of recognition of a class of stability / crisis at the enterprise

Task 1.1. Hypothesis formation in relation to the information space of the research

Economic and mathematical tools

| Methods of logical substantiation | Method of correlation analysis | Method of correlation analysis |

Task 1.2. Substantiation of the space of indicative indicators of diagnostics of stability / crisis situation at the enterprise

Stage 2. Development of criteria for recognizing enterprises that are in a state of resilience / crisis

Economic and mathematical tools

Method of financial analysis

Task 2.1. Selection of criteria for recognizing sustainable / crisis enterprises

Stage 3. Forming of the rule of recognition of stable / crisis enterprises

Economic and mathematical tools

Method of system analysis

Task 3.1. Construction of enterprise recognition rules

Stage 4. Grouping of industrial enterprises of Kharkiv region

Economic and mathematical tools

| Development level method | Cluster analysis |

Task 4.1. Grouping of industrial enterprises: operate stably and are in a state of crisis

Stage 5. Development of ranges of values of indicative indicators of recognition of a class of stability / crisis at the enterprise

Economic and mathematical tool

| Development level method | Multifactor clustering method |

| Task 5.1 Formation of ranges of values of indicators by means of a reference point | Task 5.2. Formation of ranges of values of indicators on the basis of average value | Task 5.3. Formation of ranges of values of indicators on the basis of values of indicators of the type representative |

Fig. 3 The algorithm for diagnosing the state of development of an industrial enterprise (Sourse: made by the authors)

the middle crisis class, when there is the absence or insignificant level of insurance (reserve) funds, a high level of accounts payable, large amounts of low-

liquid current assets and a large amount of investment with a long payback period. The capital adequacy and return on assets is low, the return on fixed assets is close to zero. The average wage is constantly decreasing, the turnover ratio of retirement of employees is significantly higher than the turnover ratio of the reception of employees;

the class of severe crisis, when the share of equity is less than the share of borrowed capital. There is a lack of equity for further investment in production, material consumption exceeds one, and the return on fixed assets may become negative. There is a significant decline in productivity and average wages, and debt to staff accumulates.

In order to eliminate the zones of uncertainty in the scales between the criteria values of indicators of certain classes, the following procedure is proposed:

1. Determining the interval of uncertainty between adjacent classes by the formula:

$$N = X_{min}^{B} - X_{max}^{H} \tag{1}$$

where X_{min}^{B} - the lower value of the indicator of the highest class of the scale; X_{max}^{H} - the upper value of the indicator of the lower class of the scale.

2. Determining the average value of the uncertainty zone:

$$\bar{x} = \frac{N}{2} \tag{2}$$

3. Formation of criterion values of indicative indicators for middle classes:
a) for indicators of stimulants:

$$x_{B}^{H} = X_{min}^{B} - \overline{X} ; \quad x_{B}^{H} = X_{max}^{H} + \overline{X} \tag{3}$$

b) for indicators of destimulators:

$$x_{H}^{B} = X_{min}^{B} + \overline{X} ; \quad x_{B}^{H} = X_{max}^{H} - \overline{X} \tag{4}$$

where x_{H}^{B} - the lower limit of the highest class of the scale;

x_{B}^{H} - the upper limit of the lower class of the scale.

5 Solution Method

Within the limits of this section the complex of economic and mathematical tools, which is used for construction of diagnostic scales of recognition of a class of stability / crisis of the industrial enterprise, is presented.

5.1 Basis for Method Selection

Let's consider the economic and mathematical tools used to solve each problem.

Task 1.2. Substantiation of the space of indicative indicators of diagnostics of stability / crisis situation at the enterprise. In solving this problem such methods were used:

a) the method of logical substantiation, monographic, comparative, content analysis for the formation of the primary list of indicators of the indicative space of the study of the industrial enterprise as a whole and its system-forming spheres of life;

b) the method of correlation analysis to eliminate duplication of information on the basis of determining the correlations between the indicators of the primary indicative space of the study of the internal environment of the enterprise as a whole and by areas of life. The pairwise correlation coefficient was used for this:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad (5)$$

where x_i, y_i – the value of the levels of factor and performance indicators;

$\bar{x}, \bar{y}$ – average values of the levels of indicators.

Task 2.1. Selection of criteria for recognizing sustainable / crisis enterprises. Mathematical tools for solving the problem are the methods of financial analysis. They allow you to assess the current and future financial condition of the enterprise; determine the possible appropriate pace of the development of enterprise from the standpoint of financial security; identify available sources of funds and assess the possibility and feasibility of their mobilization, forecast the company's position in the capital market.

The primary external manifestation of the crisis is the formation of a steady trend of increasing current costs, as well as reducing the volume of activity, income and profits. Further deepening of the crisis is characterized by a catastrophic deterioration of all the indicators of its condition (both quantitative and qualitative), which leads to a gradual loss of equity (net assets) and a shortage of financial resources to settle liabilities. Based on the following judgments, it is proposed to choose the criteria of net profit / loss (CPR) and the ratio of own funds (Kz.v.z) as a criteria for recognizing the crisis.

Task 3.1. Construction of the enterprise recognition rules. The solution of the problem is aimed at forming a motorcade of the above indicators of financial activity of the enterprise, namely:

$$S_{enterprise} = < CPR; Kz.v.z >, \quad (6)$$

where CPR = 1, if there is a tendency to increase net income; CPR =0, if there is a tendency to reduce net income;

Kz.v.z = 1, if the value of the coefficient is observed $\geq 0,1$; Kz.v.z = 0, if the value of the coefficient is observed $< 0,1$.

The rules for recognizing the level of stability of the enterprise are as follows:

1. $S_{enterprise} = \{1; 1\}$ provided that the state is maintained for at least 2/3 of the time of the analyzed period - the company is stable.

2. $S_{enterprise} = \{1; 1\}$ 2/3 of the time of the analyzed period - the company is stable.

3. $S_{enterprise} = \{0; 1\}$ provided that the state is maintained for at least 1/3 of the

time of the analyzed period - a crisis enterprise.

4. $S_{enterprise} = \{1; 0\}$ provided that the state is maintained for less than 1/3 of the time of the analyzed period - a crisis enterprise.

To solve task 4.1, the taxonomic method of the level of development and cluster analysis are used, the combination of which allows to form 2 clusters of enterprises: enterprises that function stably in a market economy and enterprises in crisis. The integrated indicator of the stability of the enterprise is proposed to be calculated on the basis of the method of the level of development - the method of taxonomic analysis developed by Z. Helwig (Pluta, 1980). The choice of this method is justified by the fact that the integrated indicator accumulates the influence of various indicators in the financial, labour and production spheres. It allows to give an economic description of the behaviour of the enterprise from a systemic standpoint. The values of the indicator are normalized and range from 0 to 1. The economic interpretation of the values of the integrated indicator is as follows: the closer the value is to 1, the more stable the company operates.

The calculation of the integrated indicator (Di) is as follows:

$$D_i = 1 - \frac{C_{i0}}{C_0} \tag{7}$$

$$C_0 = \overline{C}_0 + 2 * S_0 \, ; \qquad S_0 = \sqrt{\frac{\sum\limits_{i=1}^{w}(C_{i0} - \overline{C}_0)^2}{w}} \, ; \qquad \overline{C}_0 = \frac{\sum\limits_{i=1}^{w} C_{i0}}{w}$$

where D_i – an indicator of enterprise / sphere of life development;

To solve tasks 4.2 and 5.2-5.3, the paper proposes the use of cluster analysis, namely the method of k-means. This method should be used when there are certain a-priori hypotheses about the number of clusters. The advantage of this method is to obtain disparate cluster groups with unambiguous economic interpretation.

6 Computational Case

The approbation of the proposed algorithmic model was carried out on the example of 24 industrial enterprises of Ukraine for 10 years.

The result of stage 1 is an economically sound system of indicators that reflects the development of the enterprise as a whole and in the spheres of its life (Fig. 4).

The obtained system of indicators is the basis for the development of diagnostic scales for recognizing the class of resilience / crisis of an industrial enterprise.

As a result of solving the tasks of stage 2 (Fig. 2), the indicators of net profit / loss and the ratio of own funds were selected as criteria for recognizing the crisis. The choice of these criteria is justified by the fact that:

1) the amount of net profit / loss provides users, primarily investors and creditors, important financial information to assess the past performance of the enterprise, as well as the risk of not achieving the expected results;

2) the ratio of own funds is considered as a criterion for determining the insolvency (bankruptcy) of the enterprise and characterizes the availability of working

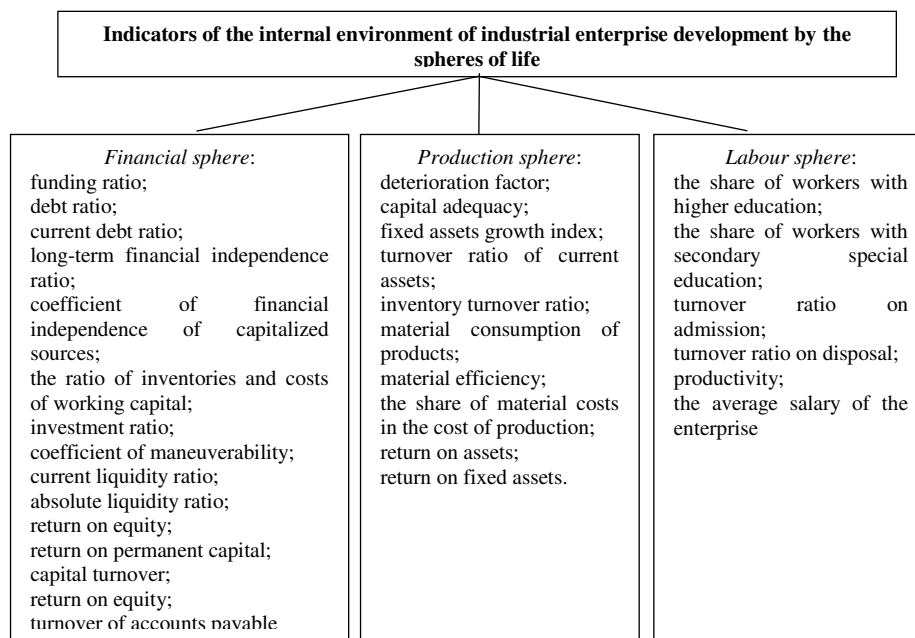capital of the enterprise, necessary for its financial stability.

Indicators of the internal environment of industrial enterprise development by the spheres of life

Financial sphere:
funding ratio;
debt ratio;
current debt ratio;
long-term financial independence ratio;
coefficient of financial independence of capitalized sources;
the ratio of inventories and costs of working capital;
investment ratio;
coefficient of maneuverability;
current liquidity ratio;
absolute liquidity ratio;
return on equity;
return on permanent capital;
capital turnover;
return on equity;
turnover of accounts payable

Production sphere:
deterioration factor;
capital adequacy;
fixed assets growth index;
turnover ratio of current assets;
inventory turnover ratio;
material consumption of products;
material efficiency;
the share of material costs in the cost of production;
return on assets;
return on fixed assets.

Labour sphere:
the share of workers with higher education;
the share of workers with secondary special education;
turnover ratio on admission;
turnover ratio on disposal;
productivity;
the average salary of the enterprise

Fig. 4 Indicators of industrial enterprise development by the spheres of life

By using the proposed rules for the recognition of industrial enterprises (Fig. 3, stage 3), the division of 24 industrial enterprises of Ukraine for 10 years on an annual basis was conducted. The analysis showed that half of the enterprises are in a state of crisis, and the others are stable (Table 1).

Table 1. The result of grouping industrial enterprises of Ukraine

№	Sustainable industrial enterprises	Industrial enterprises in crisis
1	OJSC "Experimental Electrical Plant"	OJSC Electrotechnical Plant "Ukrelektromash"
2	OJSC Kharkiv Machine-Building Plant "Light of Shakhtar"	OJSC "Electromashina"
3	State Enterprise Electrovazhmash Plant	OJSC "Kharkiv Plant of Aggregate Machines"
4	OJSC "Kharkiv Plant of Aggregate Machines"	OJSC "Kharkiv Plant of Aggregate Machines"
5	OJSC "Frunze Plant"	OJSC "Avtramat"
6	CJSC Lozovsky plant "Traktorodetal"	OJSC "Izium Locomotive Repair Plant"
7	CJSC Kharkiv Order "Badge of Honor" Machine-Building Plant "Red October"	CJSC "Kharkiv plant of electrical products №1"
8	OJSC Kharkiv plant "Tochmedprilad"	OJSC "Ordzhonikidze Kharkiv Tractor Plant"
9	OJSC Kharkiv Electrotechnical Plant "Transvyaz"	OJSC Kharkiv Bearing Plant
10	OJSC Kharkiv Electric Equipment	CJSC Joint Venture "HEMZ-IRES"

	Plant	
11	CJSC "ELOX"	CJSC "Interconditioner"
12	PJSC "Finprofil"	DNVP "System"

The result of solving task 4.1 is the construction of an indicator of the enterprise development in the spheres of its life in table. 2.

Table 2. The integral indicator of the development of sustainable industrial enterprises by spheres of life (fragment)

Pe-riod	Integral in the financial sector	Integral in the manufacturing sector	Integral in the labor sphere	Pe-riod	Integral in the financial sector	Integral in the manufacturing sector	Integral in the labor sphere
1	0.116	0.169	0.117	10	0.222	0.210	0.364
	0.202	0.171	0.215		0.232	0.092	0.285
	0.131	0.174	0.201		0.137	0.176	0.352
	0.216	0.223	0.314		0.194	0.193	0.349
	0.189	0.213	0.292		0.194	0.268	0.314
	0.225	0.204	0.216		0.170	0.173	0.202
	0.168	0.182	0.209		0.229	0.177	0.314
	0.186	0.187	0.233		0.163	0.281	0.253
	0.138	0.174	0.194		0.170	0.193	0.104
	0.147	0.156	0.192		0.234	0.207	0.286
	0.268	0.262	0.285		0.243	0.293	0.361
	0.213	0.152	0.204		0.178	0.190	0.247

The obtained values of the integrated indicator for each sphere of life of the enterprise served as an information basis for the construction of diagnostic scales for recognizing the class of stability / crisis of the industrial enterprise.

The result of stage 4 (Fig. 3) is the grouping of industrial enterprises that are in a state of stability into 3 clusters. Out of 120 situations of functioning of the industrial enterprises, 38 situations are referred to the first cluster; 70 situations - to the second cluster; 12 situations - to the third class .

According to the results of multifactor clustering, out of 120 situations of functioning of the enterprises that are in a state of crisis, 6 situations are referred to the first class;18 situations - to the second class ; 96 situations - to the third class .

The construction of diagnostic scales for recognizing the class of stability / crisis of an industrial enterprise in the financial, industrial and labour spheres is the result of solving the 5th stage (Fig. 3). Table 4 shows a fragment of diagnostic scales (criterion values of indicators) for recognizing the level of stability / crisis of the enterprise in the labour sphere.

Similar scales that include a complex of indicators have also been developed for the production and financial spheres of life of the industrial enterprises.

The obtained scales are an effective tool for recognizing latent and obvious problems in each area of life of the enterprise and the development of managerial influences for their elimination or localization.

Table 3. The diagnostic scale for recognizing the class of resilience / crisis for the labour sphere of industrial enterprises

Stability / crisis class of the enterprise	The name of the indicator					
	HE (share of workers)	SSE (share of workers)	TOA	TOD	Prod	AS
Sustainable industrial enterprises						
absolute stability	0,562-0,380	0,225-0,315	0,296-0,231	0,198-0,249	4368,474-2038,666	4,137-3,210
normal stability	0,379-0,333	0,316-0,412	0,230-0,183	0,250-0,280	2038,665-738,666	3,209-1,896
unstable (pre-crisis)	0,332-0,261	0,413-0,444	0,182-0,150	0,281-0,350	738,665-263,782	1,895-1,174
Crisis industrial enterprises						
A slight crisis	0,447-0,352	0,190-0,239	0,588-0,280	0,206-0,438	2530,937-904,373	2,926-1,575
Medium crisis	0,351-0,272	0,240-0,282	0,279-0,220	0,439-0,648	904,372-425,873	1,574-1,249
Severe crisis	0,271-0,203	0,281-0,294	0,219-0,127	0,649-0,816	425,872-207,139	1,248-0,829

The expediency of their practical application lies in the possibility of adjusting the trajectory of the enterprise as a whole on the basis of establishing specific values of the proposed indicators for the production, financial and labour spheres as planned quantitative benchmarks in accordance with the real resource capabilities of the enterprise.

7 Conclusion

A characteristic feature of the current stage of development of the Ukrainian economy is, on the one hand, the recognition of the key role of industry, and, on the other hand, the existence of a deep systemic crisis of industrial enterprises. Therefore, one of the urgent tasks of the management of industrial enterprises is to create an effective and efficient system for recognizing the state of their stability. All this necessitates the improvement of existing tools, diagnostic tools.

Based on the studies of the functioning of 24 industrial enterprises of Ukraine, an algorithm for determining the general indicative values of financial, production and labour indicators of enterprises operating in conditions of stability and different depths of crisis phenomena, has been developed. Under the conditions that the developed ranges of value change of these indicators are defined on the basis of the analysis of the enterprises of mechanical engineering, they can be considered as the most characteristic values reflecting a certain class of stability / crisis at the enterprise. These values form the basis of the system of monitoring the activities of industrial enterprises. They can also be used as an information basis for the formation

of effective management influences to adjust the trajectory of future behaviour of the enterprise. The future trajectory can be formed by provoking an artificial crisis to strengthen the upward trajectory of the enterprise development or natural crisis management in order to localize negative phenomena and create the preconditions for changing the general vector of the development from descending and ascending.

On the basis of the conducted researches, the algorithm of definition the general indicative values of the financial, industrial and labour indicators of the enterprises operating in the conditions of stability and various depth of display of the crisis phenomena is developed. Under the conditions that the developed ranges of change of the value of these indicators are defined on the basis of the analysis of the enterprises of mechanical engineering, they can be considered as the most characteristic values reflecting a certain class of stability / crisis at the enterprise. These values form the basis of the monitoring system of industrial enterprises. They can also be used as an information basis for the formation of the effective management influences to adjust the future behaviour of the enterprise, namely the formation of an artificial crisis to strengthen the upward trajectory of the enterprise development or natural crisis management changes in the general vector of development from descending and ascending.

The use of modern economic and mathematical tools for analyzing the behaviour of the enterprise as a whole and the main system-forming areas of its life significantly improves the quality of management decisions. These decisions are aimed at maintaining an upward or changing downward trajectory of the development by ascending a set of appropriate management responses to artificial or natural crisis. To this end, the study substantiates the use of the taxonomic method of the development level, cluster, correlation, financial and system analysis.

Further researches on the diagnosis of market behaviour of the industrial enterprises should be aimed at developing economic and mathematical tools for identifying promising trends in system-forming areas of the enterprise, creating cognitive models of interaction of certain indicators, developing a system to support management decisions to adapt to fluctuating the market environment.

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