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DEVELOPING A MONITORING SYSTEM OF AGRICULTURAL ENTERPRISES' PROPENSION TO BANKRUPTCY

Iryna KONOVALYUK[1], Svyatoslav KNYAZ[1], Lesia KUCHER[2], Olena PAVLENKO[3], Oxana SHAUDA[1], Vira KOSOVSKA[1], Yaroslava MOSKVYAK[1]

[1]Lviv Polytechnic National University, Bandery, 12, Lviv 79000, Ukraine;
E-mails: iryna.v.konovaliuk@lpnu.ua, sviatoslav.v.kniaz@lpnu.ua, oksana.y.shaida@lpnu.ua, vira.v.kosovska@lpnu.ua, slavakohanec1201@gmail.com
[2]State Biotechnological University, Alchevskykh, 44, Kharkiv, 61002, Ukraine;
E-mail: kucher@btu.kharkov.ua
[3]Odesa State Environmental University, Lvivska, 15, Odesa, 65016, Ukraine;
E-mail: pavlenkoep@ukr.net

Corresponding author: kucher@btu.kharkov.ua

Abstract

Methodological tools for developing a system for monitoring agricultural enterprises' activities based on forecasting their resilience to bankruptcy have been improved. In contrast to the existing methodological tools, the author's proposals are based on decomposing the priority of monitoring objects, clarifying the logic of relationships between indicators that characterize these objects, and applying probit-analysis to identify changes in the values of factors that cause a decrease in agricultural enterprise resilience to bankruptcy. The practical value of the improved methodological tools is in the possibility of its application by managers of agricultural enterprises to predict their resilience to bankruptcy. Considering the forecast is based on grading integrated monitoring objects because of their priority, the proposed tools allow identifying causal links in judgments about expectations of changing management rationality in an enterprise and an enterprise's compliance with sustainable development values under the influence of enterprise resilience to bankruptcy.

Key words**:** *enterprise management, resilience, bankruptcy, development, monitoring.*

INTRODUCTION

In recent years, the agricultural business has been characterized by positive dynamics of development. This is expressed in: (i) growing exports (in 2019, compared to 2017, the export of agricultural products increased by 4.34 billion dollars, in 2020, the exports were already 22.199 billion dollars [22], [20]). In 2017-2020, the share of agricultural products in the total volume of Ukrainian exports grew steadily and was at average 42% [22]; (ii) diversifying the export structure of agricultural products (the list of marketable products produced in the agricultural sector exceeds two dozen. The greatest demand is observed for fats and butter, milk and dairy products, poultry eggs, natural honey, products of processing vegetables, fruits or other parts of plants); (iii) growing budget expenditures to support the agricultural market (in 2017-2019 – 38.8 billion UAH, the annual growth is 1 billion UAH [26]. In the budget for 2020, 5 billion UAH were allocated to support the agro-industrial complex activities [32], [31]).

Despite this, it should be recognized that the conditions for carrying out business activities in the agricultural sector are quite difficult. Firstly, price competition is high in both domestic and foreign markets. It is aggravated by the influence of the weather factor, fluctuations in fuel prices, changes in export quotas, the breadth of supply of agricultural products, and so on. Secondly, the demand for agricultural products that meet international quality standards, in particular regarding their safety and environmental friendliness, is constantly growing in the markets.

As a result, for agricultural enterprises, in the context of the need to increase the cost of ensuring environmental friendliness and

environmental safety of agricultural products, the need to develop a monitoring system, which would allow identifying, analyzing and predicting phenomena and trends that are critical for avoiding bankruptcy, including ensuring financial resilience and profitability is being updated.

Meeting this need is quite problematic since forming such multifunctional monitoring systems requires the application of software adapted to a specific enterprise. Developing such software is associated with significant costs, which will inevitably affect the cost of finished products. In addition, rational applying such software requires well-trained analysts on an agricultural enterprise staff. There is no doubt that only major players in the agricultural business will be able to overcome these difficulties. As for small and medium-sized agricultural enterprises, they need to have multifunctional monitoring algorithms that reflect the values of sustainable development and allow them to make timely reasoned decisions that will contribute to their resilience to bankruptcy.

Thus, the problem is to improve the methodological tools for developing a system for monitoring agricultural enterprises' activities based on predicting their resilience to bankruptcy in the context of professing the values of sustainable development.

The results of the analysis of the dynamics of the number of documents indexed in the Scopus, containing the term “bankruptcy” in the title over the past 30 years (Fig. 1), indicate a high level of publishing activity in the world, which is increasing over time. In total, 3,682 documents were indexed in Scopus, 28.6% of which were published over the past five years, which indicates the urgency of the problem.

In the scientific literature, much attention is paid to various aspects of monitoring enterprises' activities. In general, the author's works are devoted to clarifying the concept of “activity monitoring” [7], [10], [25], indicators, methods and technologies of monitoring [21], [23], as well as its functionality and information content for making managerial decisions [5].

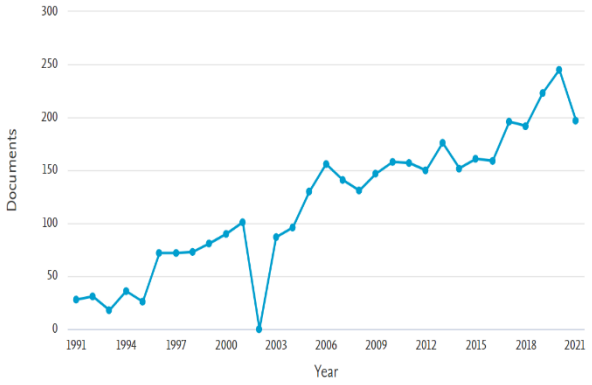

Fig. 1. Dynamics of the number of documents indexed in the Scopus, containing the term “bankruptcy” in the title, 1991-2021
Source: built on the basis of Scopus.

Based on the scientific literature critical analysis, it is revealed that the choice of indicators and monitoring methods depends on the enterprise managers’ information needs. These needs are formed under the influence of many factors, among which the most important are: types of economic activity of the enterprise, priority goals of the enterprise, problems of a managerial and engineering-technological nature that arise at the enterprise, the level of development of the management system and corporate culture. Taking into account these factors, each enterprise should build an individual system of indicators, according to the values of which it is possible to make managerial and other decisions. Many authors, the experts in the field of agribusiness such as J. Grabara et al. [9], N. Bulavinova et al. [6], O. Kravchenko et al. [14], L. Pronko et al. [27] note that in the current conditions, the systems for monitoring agricultural enterprises’ activities should be based on the sustainable development values. Another group of the researchers is V. Kuzoma and S. Pavliuk [17], R. Hyde et al. [13], E. Domenech et al. [8], M. J. Ramos Fraqueza et al. [28], X. Li [36], L. Kucher et al. [16], [15], A. Sumets et al. [33] notes that it is necessary to take into account the principles that underlie the HACCP system, which is especially important to the exporters of agricultural products. The same opinion, but slightly broader, is supported by A. Honcharov and S. Honcharova [12]. The authors argue that

monitoring a company's activities should go beyond the factors of the internal environment. They claim that the quality characteristics of the products offered to the market are directly related to the consumers' market needs. This indicates the need of monitoring changes in market preferences, including new trends in the field of food and raw material safety. It should be recognized that enterprise security is an end-to-end monitoring object for most business entities. In the context of security monitoring, the scientific literature also pays considerable attention to risks. For example, S. V. Selishchev [29], investigating the possibilities of optimizing internal audit procedures of enterprises, proposed an applied approach to monitoring continuity risk assessment. Also dealt with a similar topic is I. Sysoieva et al. [35] who brilliantly described the technology of audit actions in the context of identifying risks associated with economic crimes and fraud. D. Zatonatsky [37] investigated the nature of insider risks and proposed a system for monitoring them that can be easily automated. In fact, one of any monitoring system purposes is timely detection of threats and risk assessment. In many modern scientific papers, the technologies of automated threat monitoring and risk assessment are carefully described. In this direction, the scientific heritage of such researchers such as A. Syrotynska et al. [34], E. Asnina [3], A. Shamsuzzoha [30], E. S. Borges [5], I. M. Gavrilko [11], O. Bogma et al. [4]

One of the trends in forming a system for monitoring enterprises' activities is the gender factor consideration. For example, K. Andriushchenko et al. note: "for each business entity there are individual combinations of resources forming the asymmetry of resources and increase the level of enterprise competitiveness..." [2]. These authors argue that the gender factor can significantly affect enterprise competitiveness, and therefore, if necessary, it should be monitored and adjusted.

Thus, the conclusion is that the objects of monitoring systems are multi-vector. In general, the indicators that characterize these objects are designed to inform management entities, on the one hand, about possible threats and associated risks, and, on the other hand, about the opportunities (potential) for obtaining additional benefits. Implementing this purpose by monitoring systems requires taking into account the provisions of the sustainable development concept, which generally reduces the selfish interests of agribusiness and the consumer interests of a society to a common denominator.

MATERIALS AND METHODS

The purpose of the study is to improve the methodological tools for developing a system for monitoring agricultural enterprises' activities based on forecasting their resilience to bankruptcy. To achieve this purpose, it is necessary to:

- clarify the structure of monitoring systems for agricultural enterprise activity and specify its development directions;
- justify the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy;
- reveal the essence of methodological and applied tools for monitoring an agricultural enterprise propensity to bankruptcy.

During the research, systematic, structural and integration methodological approaches were applied, as well as general scientific principles of cognition of reality, namely consistency, functionality, and casualty. This allowed clarifying the structure of monitoring systems of agricultural enterprises' activities, specify the directions of its development, and justify the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy. To reveal the essence of the methodological and applied tools for monitoring an agricultural enterprise propensity to bankruptcy, the methodological tools of set theory, as well as the method of probit analysis were used.

RESULTS AND DISCUSSIONS

The structure of a monitoring system for agricultural enterprise activity and its development directions. Based on the review

of scientific literature and empirical data of agricultural enterprises, there are grounds to assert that enterprise monitoring systems have the following structure:

- components of a monitoring system, that is, goals and criteria for identifying their achievement; monitoring objects; indicators with whose values monitoring is carried out; monitoring methods; information sources; monitoring subjects;
- monitoring system functions, namely, analytical, informative, predictive;
- monitoring system levels, namely, strategic, tactical, and operational.

From a structural approach view, the monitoring system subjects are the drivers of identifying promising directions for developing the monitoring system of an agricultural enterprise. This is because, in a dynamic competitive environment, the information needs of management entities are constantly changing. As a result, under the influence of accumulated experience and as new methods of processing and interpreting management information are mastered, the demand for its significance and speed of obtaining objectively increases. This indicates that the priority areas for developing the monitoring system of an agricultural enterprise are monitoring subjects and methods of obtaining and processing information related to them. The subject of monitoring is within the object. It characterizes a specific side of the object, for example, if the object of monitoring is economic efficiency, then the subject may be its balance over time, resilience, the sufficiency of the efficiency level in comparison with competitors, etc.

Taking into account the above-mentioned it should be recognized that within a particular enterprise, objects and monitoring objects constitute a certain set of components, in which there are both independent and common elements. To prove this thesis, it is necessary to formalize the types of objects and their subjects to a certain extent. Thus, according to the research results, it was revealed that the integral objects of monitoring systems of agricultural enterprises are the following:

- economic efficiency of an enterprise's activities;
- managerial rationality in an enterprise;
- compliance of an enterprise's activities with the sustainable development values.

In turn, local objects are divisions of the enterprise, types of its activities, projects being implemented, and individual operations. Timeliness, sustainability, safety, quality, and balance should be highlighted among the monitoring subjects.

Justifying the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy. Among the selected objects and subjects, there are ones that are priority and secondary, or causal and consequential. Thus, any agricultural enterprise is a business entity that carries out business activities at its own risk to make a profit. Profit maximization is a selfish purpose of the enterprise, its main, primary priority. In turn, in order to get its growth constantly and avoid managed and unmanageable threats of an internal and external nature, the enterprise is forced to rationalize management processes permanently and coordinate its own goals with the goals of a society, in particular, regarding the quality and safety of the created product offer. That is, enterprise economic efficiency is the primary object of monitoring, and other integral objects are secondary, those that serve to ensure the implementation of the main purpose by the enterprise, namely, profit maximization.

Given this, it makes sense to prioritize and monitor items. Performing this task requires taking into account the fact that two indisputable criteria for the economic efficiency of an enterprise's functioning are its profitability and financial stability. The proper level of financial stability and profitability values of an enterprise characterizes its resilience to bankruptcy. Consequently, an enterprise that is not resilient to bankruptcy is economically inefficient. Logically, it follows that monitoring an enterprise for enterprise resilience to bankruptcy is extremely important since it reflects information the state of primary and secondary integral monitoring objects depends on.

Methodological and applied tools for

monitoring an agricultural enterprise propensity to bankruptcy. In accordance with the code of Ukraine on bankruptcy procedures No. 2597-VIII of 14.08.2021, bankruptcy is the debtor's inability recognized by an economic Court to restore its solvency through rehabilitating and restructuring procedure and to repay creditors' monetary claims not otherwise than through applying the liquidation procedure. In turn, insolvency is the inability of the debtor to fulfill monetary obligations to creditors after the due date, not otherwise than through applying the procedures provided for in the above–mentioned Code. As you can see, the key indicator of the enterprise monitoring system that characterizes its resilience to bankruptcy is the solvency coefficient. Mostly, it is calculated as the ratio of the enterprise's equity to total liabilities. Ideally, equity should be greater or equal to total liabilities. Identification by the monitoring system of the critical value of the solvency coefficient is direct evidence that the enterprise is on the verge of bankruptcy. The task of the monitoring system is to identify signs of a decrease in the enterprise resilience to bankruptcy. This task can be performed because of monitoring those indicators that characterize the enterprise financial stability and profitability. For example, in addition to the solvency ratio, the total coverage ratio and profitability of production should also be monitored, as well as their variables, i.e. factor indicators that affect solvency, liquidity, and profitability. The logic of relationships is as follows:

$$\left.\begin{array}{l} K_v \wedge Z_s \Rightarrow \bigcup_{x=1}^{2} P_x; A_p \wedge Z_p \Rightarrow \bigcup_{y=1}^{2} L_y; P_o \wedge V_v \Rightarrow \bigcup_{z=1}^{2} R_z; \\ \because \bigcup_{x=1}^{2} P_x \cap \bigcup_{y=1}^{2} L_y = \left\{ Z_p \mid Z_p \in \bigcup_{x=1}^{2} P_x \wedge Z_p \in \bigcup_{y=1}^{2} L_y \right\} \therefore \left(\bigcup_{x=1}^{2} P_x \cap \bigcup_{y=1}^{2} L_y \right) \wedge \bigcup_{z=1}^{2} R_z \Leftrightarrow \bigcup_{\Omega=1}^{6} S_\Omega; \\ K_v \wedge Z_s \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{x=1}^{2} P_x \in \bigcup_{\Omega=1}^{6} S_\Omega, K_v \wedge Z_s \in \bigcup_{x=1}^{2} P_x; \\ A_p \wedge Z_p \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{y=1}^{2} L_y \in \bigcup_{\Omega=1}^{6} S_\Omega, A_p \wedge Z_p \in \bigcup_{y=1}^{2} L_y; \\ P_o \wedge V_v \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{z=1}^{2} R_z; \in \bigcup_{\Omega=1}^{6} S_\Omega, P_o \wedge V_v \in \bigcup_{z=1}^{2} R_z, \end{array}\right\} \quad (1)$$

where K_v – the volume of the enterprise's own capital; Z_s – the volume of an enterprise's total liabilities; $\bigcup_{x=1}^{2} P_x$ – a set of the indicators that characterize an enterprise's solvency; A_p – the volume of an enterprise's current assets; Z_p – the volume of an enterprise's current liabilities; $\bigcup_{y=1}^{2} L_y$ – a set of indicators that characterize an enterprise's liquidity; P_o – the volume of profit after tax; V_v – the volume of production costs; $\bigcup_{z=1}^{2} R_z$ – a set of indicators that characterize an enterprise's production profitability; $\bigcup_{\Omega=1}^{6} S_\Omega$ – a set of indicators that characterize an enterprise's resilience to bankruptcy.

Thus, the set $\bigcup_{\Omega=1}^{6} S_\Omega$ depends on a set of factor indicators $\bigcup_{x=1}^{2} P_x$, $\bigcup_{y=1}^{2} L_y$ and $\bigcup_{z=1}^{2} R_z$.

Identifying the deterioration of their values may in the future worsen the value of the solvency, liquidity, and profitability coefficients and, as a result, reduce the enterprise's resilience to bankruptcy.

Due to the individual work specifics of each agricultural enterprise, its resilience to bankruptcy formed under the influence of the above factors, differ from each other. Given this, it is necessary to determine the value of the average values of factor indicators and their standard error. The established variation series of minimum values of factor indicators that cause changes in enterprises' resilience to bankruptcy reflect the individual enterprises' sensitivity to these factors. The performed studies allow stating that in the variation series the particle distribution of minimal changes in factor indicators is close to normal. The area above the abscissa axis is bounded by the normal distribution curve. It reflects the number of enterprises that have detected a change in their resilience to bankruptcy under the influence of a minimum change in the values of factor indicators. The normal distribution curve is symmetric to a straight line perpendicular to the abscissa axis and passes through a point $\bar{x}$ (the value of the average value of a particular factor indicator). Given this, this straight line divides the entire area bounded by the normal distribution curve into two equal parts. As a result, the average

values of changes in all factor indicators that affect the enterprises' resilience to bankruptcy occur in 50% of the studied agricultural enterprises. Those average values that cause an increase in resilience to bankruptcy are denoted as P_{50}, and those values that cause the reverse reaction are denoted as Z_{50} [18].

Based on the methodological tools presented in the works [18], [1], [19] note that when $x=-1$ the perpendicular set from this point to the left of it is an area equal to approximately 16% of the total area bounded by the normal distribution curve, and with $x=+1$ to the right of the perpendicular is an area of approximately 84%. That is, a change in the values of factor indicators, which is less than one standard deviation from P50, causes a change in resilience to bankruptcy in 16% of agricultural enterprises, and a change in the values of factor indicators, which is more than one standard deviation from P50, causes a change in resilience to bankruptcy by 84% agricultural enterprises. Let's denote these changes as P_{16} and P_{84} or, respectively, Z_{16} and Z_{84}.

Taking into account the above-mentioned it is possible to predict enterprise resilience to bankruptcy based on probit analysis in Excel-97, in particular using the Accute_LD_Calc specification. In this case, probit analysis is a quantitative analysis of experimental data based on studying the relationship between the logarithms of the number of factor indicators studied in the experiment and probits corresponding to the observed effects-changes in enterprises' resilience to bankruptcy. A probit is a probabilistic unit calculated by the formula [18], [24]:

$$Y=\frac{x-P_{50}}{\sigma}+5, \qquad (2)$$

where: Y – probit; X – any number of factor indicators studied in the experiment; P_{50} – the value of an unambiguous resilience of an agricultural enterprise before bankruptcy for 50% of the studied enterprises; σ is the standard deviation.

In Formula (2) $\frac{x-P_{50}}{\sigma}\sim n$ and $n=b_0+b_1x$,

In case of replacement n for the right side of formula (2) $\frac{x-P_{50}}{\sigma}+5$, P_{50} can be defined [18], [1]:

$$P_{50}=\frac{5-b_0}{b_1}. \qquad (3)$$

In this case, the standard deviation will be expressed as the ratio $1/b_1$.

Based on formula (2) for P_{50} (Z_{50})-Y=5, P_{16} (Z_{16})-Y=4, P_{84} (Z_{84})-Y=6.

Since the dependence between factor indicators and probits is linear, it is written as follows:

$Y=b_0+b_1x$, accordingly, $x=\frac{Y-b_0}{b_1}$,

where

$$b_1=\frac{\sum_{i=1}^{N}x_iy_iz_i\cdot\sum_{i=1}^{N}z_i-\sum_{i=1}^{N}x_iz_i\cdot\sum_{i=1}^{N}y_iz_i}{\sum_{i=1}^{N}z_i\cdot\sum_{i=1}^{N}x_i^2z_i-(\sum_{i=1}^{N}x_iz_i)^2},\ b_0=\frac{\sum_{i=1}^{N}y_iz_i-b_1(\sum_{i=1}^{N}x_iz_i)}{\sum_{i=1}^{N}z_i\cdot},$$

where: x_i – *and*- the value of the number of factor indicators; y_i – *and*- the value of the probit effect (state of the agricultural enterprise) that corresponds to the corresponding number of factor indicators; z_i – *and*- the value of the probit weight coefficient corresponding to y_i; N – number of experiments.

Monitoring with probit analysis allows identifying the relationships between the values of factor indicators that affect the solvency, liquidity, and profitability and the enterprise's resilience to bankruptcy. Performing this task requires a certain formalization of the state of an agricultural enterprise, that is, the gradation of these states by the levels of resilience to bankruptcy. Probit analysis assumes unambiguous characteristics of the resulting parameters, so they can be exclusively positive or negative, which corresponds to 1, or 0. Using the method of chain substitutions and the principle of constructing the Harrington scale, the following gradation of an agricultural enterprise's state by the levels of resilience to bankruptcy is performed (Table 1).

Table 1. The gradation of an agricultural enterprise's state by levels of resilience to bankruptcy

States	State symbols	State gradation levels
Illiquid (0), solvent (1), profitable (1)	1	Bad
Liquid (1), insolvent (0), profitable (1)	2	
Liquid (1), solvent (1), non-profit (0)	3	
Liquid (1), insolvent (0), non-profit (0)	4	Very bad
Illiquid (0), solvent (1), non-profit (0)	5	
Illiquid (0), insolvent (0), profitable (1)	6	
Illiquid (0), insolvent (0), non-profit (0)	7	Critical

Source: own calculations.

Let's apply probit analysis using empirical data of a number of small agricultural enterprises MP "Supiy", FG "Vayak", FG "Ranok", FG "Galagropolis", LLC "Farm "Losfort", LLC "Farm "Razdolnoye", LLC "Farm "Obriy", LLC "Farm "LLC-temp", LLC "Farm "Kolos", LLC "Farm "Norma", SGP LLC "Kalina", SGP LLC "Ukraine-sich" (Table 2).

Using the Accute_LD_Calc specification in Excel-97, the number of facts for identifying factor indicators that caused negative values of the resulting indicators was calculated. Thus, the average value of changes in factor indicators, which leads to a decrease in the enterprises' resilience to bankruptcy, is Z50 = 8.7763≈9. When changing the factor values to the left relative to equal to Z16 = 5.5643≈6, and when changing to the right – Z84 = 11.9883≈12.

Table 2. Average results of identifying the effect values in probits and weight coefficients of probits

The ordinal numbers of the experi-ments	The number of factor indicators that caused the identification of negative (0) characteristics of the resulting indicators	Research results		Effect value in probits	Weighting factor of probits
		The number of businesses with the detected effect	The total number of businesses in the group		
1	1	0	12	2.97	1
2	2	0	12	2.97	1
4	3	0	12	2.97	1
4	4	0	12	2.97	1
5	5	1	12	3.61	2.3
6	6	3	12	4.33	4.1

Source: own calculations.

CONCLUSIONS

Monitoring systems for agricultural enterprises are multifunctional and have a decomposition structure, in particular in terms of monitoring objects. This is due to the large number of monitoring objects, which are divided into integral and local. In addition, it is argued that among the integral monitoring objects there are primary and secondary ones, which are correlated as causal and consequential. It is proved that the economic efficiency of the enterprise's activities is primary among the integral objects of monitoring. Despite the fact that economic efficiency can be monitored for various subjects, the information about the enterprise's resilience to bankruptcy is still the most informative. This resilience is directly dependent on the indicators of an enterprise's liquidity, solvency, and profitability. Because of that, the identification of signs that indicate a change in an enterprise's resilience to bankruptcy is a sufficient basis for forming sound judgments about the expected changes of management rationality in the enterprise and an enterprise's activities' compliance with the values of sustainable development.

It is argued that it is advisable to develop monitoring systems for agricultural enterprises in the direction of expanding monitoring subjects and methods of processing and interpreting management

information. On the example of empirical data of agricultural enterprises, using probit analysis, it is proved that the monitoring of factor indicators affecting primary monitoring objects allows predicting future changes in these primary objects and, thus, forming reasonable judgments about the expected changes in secondary monitoring objects.

Further research should be carried out in the direction of deepening the parameterization of integral monitoring objects, namely, creating conditions to measure isotonic distances between parameters characterizing these objects. This will allow clustering parameters and making predictive dendrites.

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