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THE USE OF FUZZY COGNITIVE MODELS FOR DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

The article researches theoretical and methodical foundations of cognitive analysis and semistructured economic systems' modeling, problems of improving of existing methodical approaches to diagnostics of probability of enterprises' bankruptcy through the use of fuzzy cognitive model. Cognitive diagnostic of probability of bankruptcy is aimed to obtaining knowledge of processes of business entity's activities based on a study of quantitative and qualitative indicators with a purpose to assess both current and future state of an enterprise base on accounting and reporting data as well as expert appraisal.

The result of cognitive diagnosis is to determine the probability of enterprises' bankruptcy based on integral indicator of probability of bankruptcy, which reflects the management level in five directions, namely: the management level of fixed and circulating assets, personnel, financial resources and level of culture of enterprise. Is proposed to conduct cognitive diagnostics of probability of enterprises' bankruptcy in two directions, namely: Q-diagnostics, based on an assessment of financial performance, and V-diagnostics, based on the research of non-financial verbal indicators.

Cognitive modeling makes it possible to solve problems of a conceptual nature, to make managerial decisions that will provide the business entity with competitive advantages in future. A characteristic feature of the model of cognitive diagnostics of probability of enterprises' bankruptcy is that it is based on anticipative management concept, it can help to not only to determine the probability of bankruptcy of a business entity, but also to investigate the main factor of bankruptcy in the perspective and identify ways to improve the level of this factor. Using this model, enterprises will not only assess the probability of bankruptcy today, but also to prevent the bankruptcy of economic entities in the future.

Keywords: fuzzy cognitive models, bankruptcy, an enterprise, diagnostics of probability

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1. INTRODUCTION

The current stage of development of Ukraine's economy is characterized by a crisis phenomena in the economic system at its different levels. The largest number of crisis situations observed precisely at the microeconomic level. Today particularly noticeable significant deterioration in financial condition of enterprises, increase in the number of loss-making business entities. In Ukraine crisis state of many enterprises due to the mismatch of their financial and economic parameters of the current situation, which, in turn, is caused by the wrong strategy, inadequate organization of business and, as a consequence, a weak adaptation to the demands of the market.

Under such conditions the problem of developing methodical bases of diagnostics probability of bankruptcy of economic entities acquires nationwide character. This is due to fact that bankruptcy of the enterprise has negative consequences not only for its owners, but also for business partners, employees and the state as a whole in connection with a further imbalance of macroeconomic system. In addition, from the objective assessment of the probability of bankruptcy depends the cost of the enterprise, its investment attractiveness, effectiveness of sanation or restructuring.

Given that the occurrence of crisis phenomena in the enterprise is a threat to the very existence the enterprise and is associated with tangible capital losses of its owners, the probability of occurrence of crisis situations should be diagnosed at the earliest stages with a view to timely opportunities to neutralize them. Therefore the development of methodical approaches to the early diagnostics and overcome the crisis phenomena in the enterprise deserves of great attention both for the purpose the theoretical research and the practical use. Awareness of crisis situation on the earliest stages of its development will enable timely and purposefully to respond to threats by appropriate measures.

Today for Ukraine the problem of sustainable development of enterprises in a global economic crisis continues to be extremely urgent, because in terms of the economic crisis generally majority enterprises running at a loss, as well as there is a large part of the companies that are on the edge of bankruptcy or on the stage of initiation of bankruptcy cases [1]. Namely accurate and timely identification of negative factors of influence on the financial and economic activities using the tools of crisis management the enterprise is a guarantee emerge from the financial crisis. In foreign practice has developed various techniques of management the crisis phenomena at the microeconomic level, but they cannot be completely transferred to the national scientific and practical activities, as thus not taken into account sectoral specification functioning of domestic enterprises, conditions of the economic and the tax legislation, the development trend of the economy of Ukraine as a whole.

2. THE RESEARCH METHODICAL BASES OF COGNITIVE DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

In order to diagnose the probability of enterprise's bankruptcy, mainly financial indicators are used nowadays. However, this information is not always unbiased and sufficient for effective diagnostics. In the process of managerial decision making there often appears a requirement in obtaining non-financial information, importance of which is increasing in competitive environment. Beside profit making and capitalization increasing today it is important, in particular, to conquest the market and to obtain

competitive advantages. Therefore, along with financial indicators, non-financial indicators of probability of enterprise's bankruptcy shall be considered in diagnostics.

Financial indicators taking source in the accounting system show only the results of previous financial activity of an enterprise and can not be used for appraisal of its future financial opportunities. Making focus on the financial indicators often results into the fact that business processes, development processes and staff training area of an enterprise are not being studied. There emerged a necessity of development of more complete and effective methods to diagnose the probability of enterprise's bankruptcy.

Due to the need for comprehensive study of enterprise's activities, it would be substantiate to consider the diagnostics of probability of the enterprise's bankruptcy as cognitive diagnostics. Cognitive diagnostic of probability of bankruptcy is aimed to obtaining knowledge of processes of business entity's activities base on a study of quantitative and qualitative indicators with a purpose to assess both current and future state of an enterprise base on accounting and reporting data as well as expert appraisal. The system of cognitive diagnostics of probability of enterprise's bankruptcy is based on the cognitive structuring of knowledge about the object; it is used in case of incomplete statistical information, and widely applies to expert polls [2].

Given the above, it is proposed to use cognitive diagnostics of probability of enterprise's bankruptcy in two ways, namely:

– quantitative diagnostics (Q-diagnostics) of the probability of bankruptcy basing on an appraisal of financial indicators;

– qualitative diagnosis (V-diagnostics) of the probability of bankruptcy basing on the study of non-financial verbal indicators.

Today it is important to work out the issue of financial and non-financial indicators' combination in the bankruptcy diagnostics of enterprises, taking into account cause-and-effect relations between performance indicators and key factors. Indicators that measure the goals achieved, and indicators showing processes required to achieve these goals shall be consistent, because in order to achieve the goals, for example, increase net income from product sales, it is necessary to implement the indicators describing ways to reach these goals, i.e. to achieve greater loyalty from the existing customers and to increase their number.

For countries with transitional economy there is a common situation where business records show that a company with such level of performance cannot perform its activities at all, though the enterprise has been effectively functioned and developed for years. Sometimes it is the opposite situation, when a business entity has standard performance indicators, but after a short period of time it is eliminated.

Thus, in Ukraine it is substantiated to perform diagnostic analysis of the probability of enterprise bankruptcy in combination with economic and financial indicators with a number of subsidiary factors, e.g. along with the quantitative indicators and qualitative information it is important to consider financial indicators and indicators describing the level of management in the enterprise as well.

Moreover, the process of managerial decisions making at micro level shall be based on the results of modeling of complex systems using the methods of program-oriented, cognitive, systemic approaches, methods of situations modeling and decision-making, as well as cognitive information technologies. Today, the system analysis is quite effective in the study of social and economic systems.

3. THE USE OF COGNITIVE APPROACH FOR SEMISTRUCTURED ECONOMIC SYSTEMS MODELING

Complexity and interrelatedness of problem situations in enterprises necessitates the development of complex, multi-level models, development of which is quite time-consuming process. The effective method of overcoming these difficulties is using cognitive models.

Thus, the pre-condition to apply the cognitive approach in enterprise management is the complexity of analysis of processes and managerial decisions' making [3]. In management performance it is required to use the methodology considering the variability of the environment and enabling forecasts of problem situation's occurrence, taking measures to reduce the level of risk and uncertainty. In cognitive analysis and modeling technologies' basis there are methods of cognitive (cognitive task) structuring of knowledge about the subject.

The analysis of the complex social and economic systems' functioning, development of strategies for their sustainable improvement and assessment of the impact of managerial decisions it is reasonable to perform using methods, models and mechanisms of economic diagnostics such as cognitive technology, which involves modern technologies of system analysis enabling experts' knowledge structuring, formalizing the processes of qualitative and quantitative modeling of complex systems' (e. g. social and economic system) behavior. Cognitive modeling's technology is a modern informational technology of system analysis including methods of expert assessment, methods of set-theoretic and statistical description of the object, methods of graph theory, decision making theory, stability theory and methods of scenario modeling on cognitive charts [4].

It should be noted that most of the social and economic systems are semistructured. This system type includes systems, which parameters and laws of behavior are described mainly on a qualitative level, and changes of system parameters may result into unpredictable changes in its structure. Thus, modeling of such systems and their management using traditional approaches based on analytical description or statistical surveying of dependencies between the input and output parameters is complicated and often impossible. Therefore it is necessary to access the subjective models based on information obtained from experts and processed base on thinking, intuition and heuristics.

It shall be noted that the economic system are featured with a large number of elements, relations between them and the external environment, presence of various uncertainties including the deficit of complete information on the mechanism of their functioning, inaccuracy of quantitative and qualitative appraisals, uneven development. Therefore, considering the problem of forecasting of complex systems' development and their management these systems are usually defined as semistructured. Simultaneously the need to study processes in complex systems requires clear scientific and research methodology. Integration processes in science and up-to date tendency of interdisciplinary approach determine necessity of integral methodological system's development. In recent years there appeared a number of theoretical and practical studies based on the cognitive approach [5].

Both cognitive approach to subjects of study and cognitive technologies are promising for the development of managerial decisions development in the area of ensuring the economic security of a complex system. Cognitive analysis and modeling are essentially

new elements in the structure of systems supporting decision making. Today there is sufficient number of projects developed in different operating areas based on cognitive technologies. Using cognitive technologies in the economic area enables prompt development and justifying of economic development strategy for a company considering changes of the external environment. Using cognitive modeling technology allows feed-forward control, preventing potentially dangerous situations' transformation into threatening and conflict, and when they occur, to make substantiated decisions.

For semistructured economic systems modeling it is appropriate to apply to the cognitive approach aimed to enhance the intellectual processes of a person, who makes decisions, and support him/her in fixing his/her vision of the problem situation in a formal model. Cognitive chart of situation is such a formal model. Multifaceted process, their interrelationship disabling detailed study of certain issues and requiring their analysis in the aggregate, lack of sufficient quantitative information about the dynamics of processes resulting in switching to qualitative analysis, and variability of the processes' nature in the course of time are the preconditions for cognitive approach application to complex economic systems.

In the study of semistructured systems it is complicated to apply traditional econometric approach to analysis of processes supporting development of integrated management solutions. Reasonable alternative to the traditional approach in this situation may be cognitive modeling as a set of methods for obtaining, analyzing subjective expert judgments of the processes of semistructured situations' functioning and methods of management strategies for such situations [6].

Technology of cognitive analysis of economic systems enables direct including of cognitive theory models and methods into the process of development and decision making on system's management; it provides new opportunities for studying the processes in the given system in case of uncertainty and risk inhering in the system's functioning. Using the technology of cognitive modeling in the study of economic systems requires the following conditions:

– ensure the collection of data necessary and sufficient for development of the structure of cognitive model, with experts involved;

– selection of key concepts (parameters), both quantitatively and qualitatively specifying the subject of a study in the subject area;

– definition of relations and connections between the defined key concepts, as well as vectors of parameters specifying the subject of a study;

– ensuring the development of the structure of the cognitive model based on one of the formal (informal) data and knowledge specifying models;

– analysis of relations and correlation dependencies between the selected concepts (parameters);

– sets of parameters should not be contradictory, and the resulting structure of the cognitive model shall meet the purposes, requirements and restrictions developed with respect to the subject of a study;

– implementation of the practical use of the cognitive model, filling the resulting structure with the parameter values;

– accumulation of information about the subject of research as an integrated system and its elements, the analysis of the adequacy and interaction parameters describing dynamics of the subject's functioning;

– processing of aposterior statistical data of modeling and developing conclusions about the effectiveness of the subject of a study generally and particularly;

– formulation of objective conclusions based on data obtained from various subject areas' perspective;

– definition of tasks on cognitive model's structure improvement considering the results of subject interpretation and study of dynamics of researched situation.

In the process of the cognitive model's structuring it is necessary to identify a set of properties specifying the subject of a study from the prospect of particular aspect; represent each feature type as a set of elementary features and each elementary feature of the subject of a study to be defined as a vector of parameters. Thereafter elementary parameters constituent the basis of each vector of parameters are defined.

4. DEVELOPMENT OF THE MODEL OF COGNITIVE DIAGNOSTICS OF PROBABILITY OF ENTERPRISES' BANKRUPTCY

Considering semistructured, multidimensional and interrelationed nature, deficit of sufficient quantitative information on a process dynamics typical for managerial decisions making in enterprises, the most appropriate method of a study and decision making would be the method of cognitive charts and methods of cognitive modeling. Cognitive structuring of information is a useful tool for semistructured problems studying, providing their better understanding, and supporting in identification of contradictions and qualitative analysis of economic systems. The main advantage of the cognitive approach is the possibility of cognitive modeling methods improvement with other methods on any stage of a study of the social and economic systems.

Cognitive model of information analysis enables studying the interrelations of quantitative (measurable) and qualitative (immeasurable) factors that influence the stable development of enterprise. This analysis is based on the graphic and the set-theoretic description of economic systems by means of cognitive structuring of the subject and its external environment, when the subject and the external environment are not clearly differentiated.

The source concept of the cognitive modeling of complex situations is the concept of cognitive chart of the situation. Cognitive chart of the situation is a weighted directed graph; nodes of the graph stand for the basic factors of the situation, in the terms of which the situation processes are described; the graph includes definition of direct relations between the factors through the review of cause-and-effects chains describing the influence spread of one factor upon the other factors.

Cognitive chart represents only the fact of the influence of factors upon each other. It does not provide neither detailed description of its nature, nor the influence dynamics depending on the situation changing, or the temporal changes of the factors. In order to consider all the circumstances above, it is required to apply the lower detail level of structuring of the information presented in the cognitive chart, i.e. the cognitive model. On this level each relation between the cognitive chart factors is described in respective formula, which may include both quantitative and qualitative variables. Whereby the quantitative variables are presented as numeric values. Each qualitative variable is assigned to a set of linguistic variables reflecting various states of the qualitative variable, and each linguistic variable corresponds to a specific numerical equivalent in the scale [0, 1]. Accumulation of knowledge about the processes occurring in the given situation

enables further detailed studying of the nature of relationships between factors. Technically, cognitive model of the situation may be, as well as a cognitive chart, represented by a graph, but each arc in this graph represents particular functional relationship between the basic factors, i.e. the cognitive model of the situation is described with a functional graph.

The following sequence is used to develop a cognitive model of the problem situation:

– selection of the factors defying the problem situation: definition of the basic factors describing the nature of a problem; identification of factors influencing the target factors and definition of factors-indicators describing the process development in a problem situation;

– by blocks grouping of factors: selection of integral indicators in the block, changing of which enables conclusion making on general trends in this area; identification of factors within the block providing detailed description of trends and processes in this area;

– determination of relationships between the factors: identification of links between blocks of factors, definition of the direct links within a block of factors;

– checking of the adequacy of the model, i.e. comparing obtained results with the system characteristics defined in the past with similar initial conditions.

Thus, the main stages of development of a cognitive model for problem situations are the following: identifying the most essential factors that provide sufficient description of a problem situation, definition of cause-and-effect relations between identified factors; base on expert conclusion of development of weight matrix for relations' definition; direct development of studied situation's cognitive model as a relations' weighted directed graph [7].

The basis of cognitive analysis and cognitive modeling is a cognitive structuring of knowledge about the subject and its external environment, where the subject and the external environment are not clearly differentiated. The purpose of this structuring is to identify the most significant (baseline) factors and to define qualitative (cause-and-effect) relations between them. Interrelations between the factors is presented as cognitive chart (model), which is a sign (weighted) directed graph [8]. Thus, the cognitive chart is a tool of structuring and supporting of managerial decision making in case of the absence of sufficient statistical information requiring expert appraisal to use standard methods, and it is a group of directed factors showing and explaining the development of processes in the studied area and their influence on the various elements of the cognitive chart.

Analysis of different mathematical models proves that in order to develop a model, it is reasonable to use the apparatus of directed graphs (digraph) to utilize the expert knowledge. Directed graph $G = \{X, U\}$ is an ordered pair (X, U), where X is – an empty set of objects – nodes (concepts) of the graph with the most essential factors assigned as the graph's nodes; U is a set of ordered pairs of elements of X, $U = \{x, y\} \subseteq X \times X$ called the arcs of the digraph, i.e. an arch is lined from the node X_i to the node X_j, if changing of X_i directly influences X_j. One of the most important aspects of the modeling process is to identify relations between subjects, their direction and influence. Digraphs' visuality and simplicity make it appropriate to use this type of modeling for multicomponent systems. Moreover, this apparatus enables manipulating both qualitative and quantitative types of data.

Using cognitive analysis for diagnostics of a probability of bankruptcy is substantiated due to the large number of interrelated factors affecting the financial state of an enterprise to be considered, as well as the insufficiency of complete information about these factors,

or relations between them. Cognitive modeling enables detailed high-quality prompt evaluation of a problem situation; analysis of the mutual influence of operating factors that determine possible scenarios of development of a given situation; identification of trends of its development; definition of possible methods of business entities' cooperation in the economic system for its directed improvement; developing and proving of problem situation's management direction; select available ways of influence upon the situation considering the results of managerial decision making. Cognitive modeling is performed on a stage basis. Initial stages require approval of a concepts' list, causality relation between them and causality relation's values. In order to develop a cognitive model of a subject, expert methods, statistical analysis methods, provisions of economic theory can be used. Upon development of a cognitive model there is a model analysis stage involving its structure research and scenario analysis. Research of a structure consists of definition of routs, ways and cycles of a graph model enabling analysis of cause-and-effect relations. It shall be mentioned that semistructured nature of the economic systems results into the complexity of cause and effect chains' analysis.

The advantage of the cognitive model is the fact that using graphs enables combining various indicators into a whole, and the indicators can be both quantitative and qualitative. It is possible to analyze the system improvement trends in any direction and to select the most efficient method. It shall be also noticed that digraphs' apparatus is the most effective for hardly formalizing factors [9].

Classic cognitive models are developed into fuzzy cognitive models considering the fact that interinfluences between the factors resulted from the cause-and-effect relations may be of different intensity, while the intensity of any influence may change in the course of time. Thus, the concept of fuzzy cognitive chart is put in, which can be represented as a weighted directed graph. The nodes of the graph correspond to the factors, and the arcs are the cause and effect relations between them, while the weight of each arc corresponds with the intensity of respective influence.

Given the availability the urgent need for an adequate assessment of the subjects of business activity, model of cognitive diagnostics of probability of enterprises' bankruptcy was developed, which is presented in a general form in Fig. 1. According to this model, the process Q-diagnostics of probability of bankruptcy of economic entities comprises the following three successive stages:

I. Determination of the probability bankruptcy of the enterprise.

II. The research by experts of the main factor of bankruptcy in perspective.

III. Identifying ways to improve the level of the main factor of bankruptcy in perspective.

V-diagnosis performed on the basis evaluation of integral indicator the probability bankruptcy of the enterprise, which includes the formation of nonfinancial verbal indicators, computation of aggregated indicators, the calculation of integral indicator, implementation the procedure for its recognition, and building a fuzzy cognitive model of diagnostics of probability of bankruptcy based on the identified cause-and-effect relationships between factors of bankruptcy and a certain intensity of the impact of these factors, which is served compiled as a weighted directed graph (Fig. 2) [10, 11].

In order to develop a fuzzy cognitive model experts use methods of analytical processing directed to the system's structure studying and obtaining forecasts of its development considering various influences with the purpose of effective management strategies' synthesis. At the stage of constructing fuzzy cognitive model is necessary to

specify the interconnections and mutual influences of extracted factors of the problem situation. Interconnections of factors that are not supported by objective reasons, are concretized with the involvement of experts on the subject area. Using fuzzy cognitive models enables resolving of a range of hardly formalizing tasks emerging on various stages of managerial decision preparing and making process currently solved on a qualitative level using intuition and vague judgments.

Cognitive approach to the modeling in process of enterprise management is used, when there is deficit of statistical information, or it is impossible to describe problem situation features using metric scales, which reduces the effectiveness of, or disables the application of statistical analysis methods for the activities of business entities. At the same time the fuzzy cognitive modeling even in case of availability of statistical estimation of enterprise activities enables visualization of all the elements of a problem situation and relations between them, which certainly provides better understanding of the internal and external processes in the enterprise. In addition, cognitive modeling makes it possible to solve problems of a conceptual nature, to make managerial decisions that will provide the business entity with competitive advantages in future.

In order to obtain non-financial information in the process of cognitive diagnostics of the probability of enterprise bankruptcy, it is sustained to use the expert poll method, which is one of the expert appraisal's stages. The purpose of the expert poll is to obtain the expertise and encode it into the proper shape interpreted using the developed mathematical apparatus. It is believed that the opinion of the expert group is more reliable than the opinion of an individual, which explains the popularity of group interviewing techniques. The main advantage of these methods is the possibility of comprehensive analysis of quantitative and qualitative aspects of the problem, and the disadvantage is that even opinions of experts of similar area may differ. Data obtained within the poll is no always available in written form or opened for the direct observing. Verbal information obtained through this method is much richer than the non-verbal one; it is more sufficient for the quantify processing and analysis enabling using of computer technologies for these purposes.

It should be noted that the advantage of fuzzy cognitive model is the fact that using graphs enables combining various indicators into a whole, and the indicators can be estimated both quantitative and qualitative. Digraphs' apparatus is the most effective for hardly formalizing factors. Specific feature of fuzzy cognitive models is their visibility; in addition, fuzzy cognitive models contain a small number of basic factors and the relations between them showing main rules and laws of the situation development. Fuzzy cognitive models including a large number of factors lose their visibility that result into decreasing of the efficiency of this analysis. In a broad sense, fuzzy cognitive model is a problem model describing its main factors.

A characteristic feature of the model of cognitive diagnostics of probability of enterprises' bankruptcy is that it is based on anticipative management concept, it can help to not only to determine the probability of bankruptcy of a business entity, but also to investigate the main factor of bankruptcy in the perspective and identify ways to improve the level of this factor [12]. Using this model, enterprises will not only assess the probability of bankruptcy today, but also to prevent the bankruptcy of economic entities in the future.
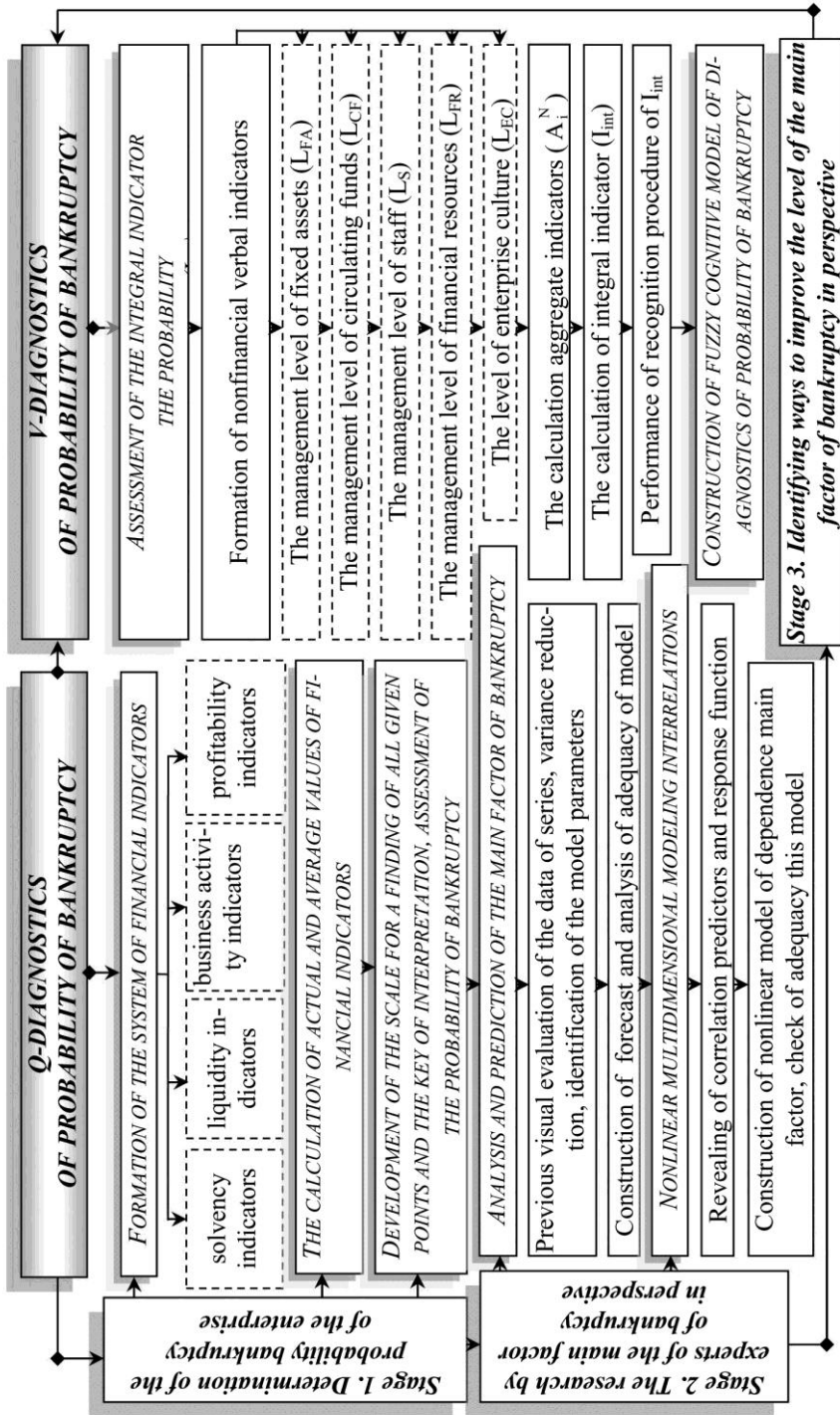
Fig. 1. Model of cognitive diagnostics of probability of enterprises' bankruptcy
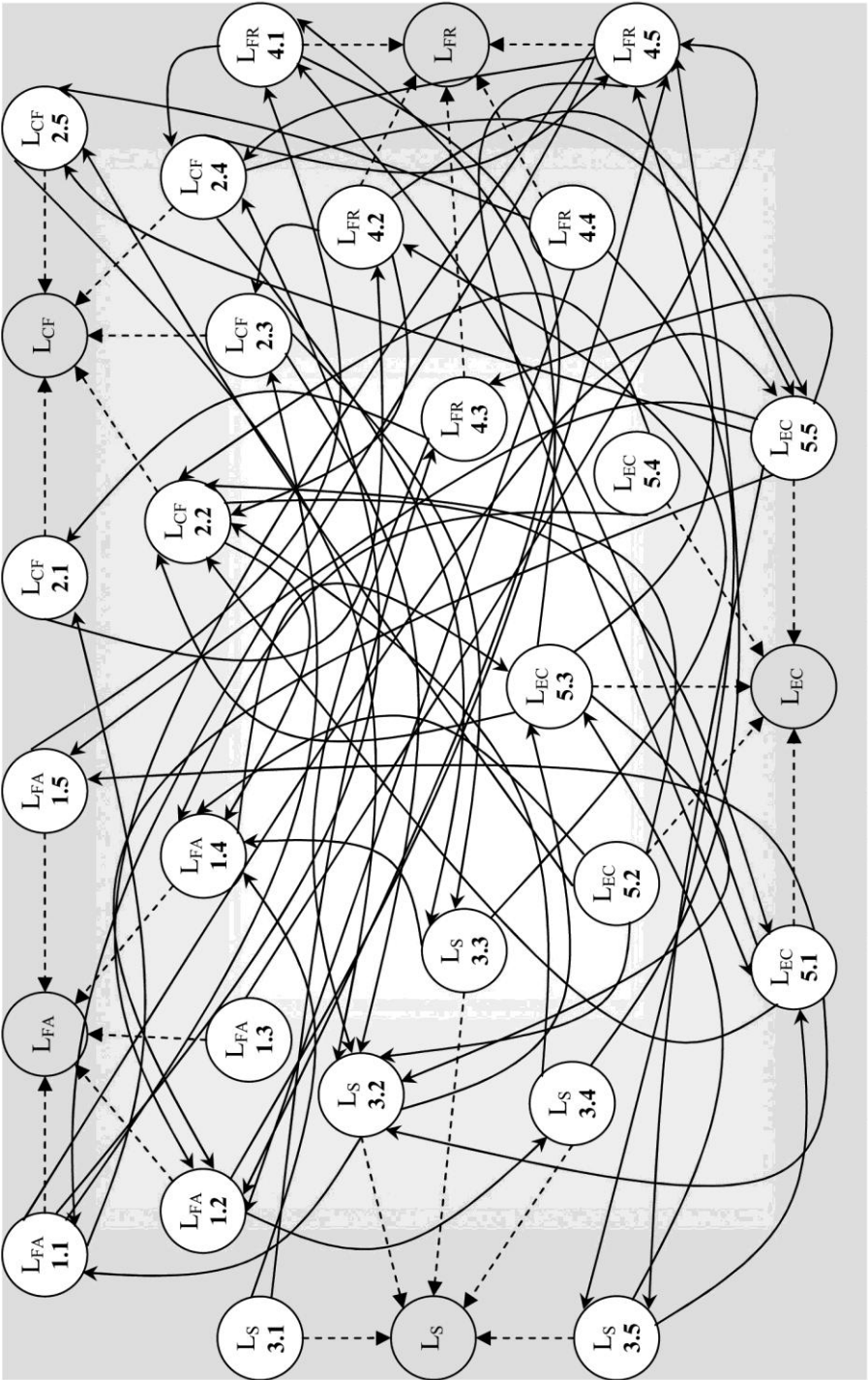
Fig. 2. Fuzzy cognitive model of diagnostics of probability of enterprises' bankruptcy

5. CONCLUSIONS

Thus, for hard formulating processes, their forecasting and support of decision making it is advisable to use fuzzy cognitive model. Its undeniable advantage over other methods is the formalization of quantitatively immeasurable factors, ability to operate with incomplete, unclear and even contradictory information. The apparatus of fuzzy cognitive model that is based on a combination of cognitive modeling and fuzzy set theory can adequately analyze the systems and processes, taking into account uncertainties, inaccuracies and incompleteness of the source data. Application of the theory of fuzzy sets in the diagnostics of the probability of bankruptcy enables involvement the statistical uncertainty, as well as ones of linguistic nature, to make scientific conclusion in the language of mathematics base on obtained unclear descriptions.

It should be noted that the application of the proposed model of cognitive diagnostics of probability of enterprises' bankruptcy will allow for the effective evaluation of the internal environment of the company, will contribute to the timely identification of actual and potential threats in the process of developing an economic strategy, prevention of the emergence crisis phenomena, support the sustainable enterprise financial condition, stable operation and development in the future.

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ZASTOSOWANIE ROZMYTYCH MODELI KOGNITYWNYCH DO DIAGNOSTYKI PRAWDOPODOBIEŃSTWA UPADŁOŚCI PRZEDSIĘBIORSTW

Artykuł analizuje teoretyczne i metodyczne podstawy poznawczej analizy i modelowanie systemów ekonomicznych, problem poprawy istniejących podejść metodycznych do diagnostyki prawdopodobieństwa upadłości przedsiębiorstw na podstawie rozmytych modeli kognitywnych. Diagnostyka ta ma na celu uzyskanie wiedzy o działalności przedsiębiorstwa opartej na badaniach wskaźników ilościowych i jakościowych oraz danych ze sprawozdawczości oraz oceny ekspertów. Wynikiem poznawczej diagnostyki jest określenie prawdopodobieństwa upadłości przedsiębiorstw, który opiera się na wskaźniku prawdopodobieństwa upadłości, który odzwierciedla poziom zarządzania w pięciu obszarach, a mianowicie: poziom kierownictwo środki trwałe i kapitał obrotowy, zasoby ludzkie, zasoby finansowe i poziom kultury przedsiębiorczości. W artykule zaproponowano przeprowadzenie poznawczej diagnostyki prawdopodobieństwa upadłości przedsiębiorstw w dwóch kierunek, a mianowicie: Q-diagnostykę w oparciu o ocenę wyników finansowych i V-diagnostykę w oparciu o badania wskaźników niefinansowych werbalnych. Modelowanie poznawcze pozwala na rozwiązanie problemów o charakterze konceptualnym, służy do podejmowania decyzji zarządczych, które zapewnią podmiotowi gospodarczemu przewagę konkurencyjną w przyszłości. Charakterystyczną cechą modelu diagnostyki prawdopodobieństwa upadłości przedsiębiorstw jest to, że opiera się ona na antycypacyjnej koncepcji zarządzania, może pomóc nie tylko w celu określenia prawdopodobieństwa upadłości jednostki gospodarczej, ale także w celu zbadania głównego czynnika upadłości w perspektywie i identyfikacji sposobów poprawy poziomu tego czynnika. Wykorzystując ten model przedsiębiorstwa będą oceniać nie tylko prawdopodobieństwo bankructwa dziś, ale także aby zapobiec upadłości podmiotów gospodarczych w przyszłości.

Słowa kluczowe: rozmyte modele kognitywne, upadłość, przedsiębiorstwo, diagnostyka prawdopodobieństwa