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Cognitive Modeling and Formation of the Knowledge Base of the Information System for Assessing the Rating of Enterprises

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***Abstract*—A mathematical model is proposed that makes it possible to describe in a conceptual and functional aspect the formation and application of a knowledge base (KB) for an intelligent information system (IIS). This IIS is developed to assess the financial condition (FC) of the company. Moreover, for circumstances related to the identification of individual weakly structured factors (signs). The proposed model makes it possible to increase the understanding of the analyzed economic processes related to the company's financial system. An iterative algorithm for IIS has been developed that implements a model of cognitive modeling. The scientific novelty of the proposed approach lies in the fact that, unlike existing solutions, it is possible to adjust the structure of the algorithm depending on the characteristics of a particular company, as well as form the information basis for the process of assessing the company's FC and the parameters of the cognitive model.**

***Keywords*—information security; audit; Bayesian network; artificial neural networks**

I. Introduction

THE problem of obtaining a reliable predictive estimate in the process of analyzing the solvency of any company (or enterprise, hereinafter we will use the term "company") remains relevant to this day. Moreover, this is also relevant for practicing economists of companies and for theorists involved in the study of the theoretical aspects of the functioning of companies. Note that this kind of forecasting and analysis of the results obtained allow specialists to talk about the stability or instability of companies. And this, in turn, can be important when evaluating, for example, the investment attractiveness of the object of analysis and evaluating it in terms of financial condition (FC). In the scientific literature, one can find hundreds of publications about forecasting and evaluating the FC of companies. Moreover, the methodological tools used in the process of solving such a problem are quite wide, ranging from regression models [1, 2] to the use of artificial neural networks (ANN) [3, 4]. All this only emphasizes the relevance of new research in this direction. Moreover, given the rapid development of information technology (IT), interest in such an aspect of the general task of assessing the company's FC as studying the possibility of using new cognitive systems and technologies in the process of assessing the FC and predicting the stable operation of the object of analysis. The latter predetermined our interest in research in this direction.

II. Literature Review

As noted above, the methods and models used in the process of analyzing the FC of companies are very diverse.

Moreover, several authors [5,6] agree that not only the assessment of the FC itself is of paramount importance, but also to what extent certain models used in the assessment of the FC reflect the actual processes.

Another problem noted in the publications of a few authors, for example, in [7,8], is the difficulty associated with understanding whether the information provided for the analysis of the FC is reliable. There may also be additional problems associated with the difficulties of obtaining such reliable information [9]. It should also be considered that a detailed analysis and forecasting of the company's FC is usually performed either by specialists of the object of assessment itself or by an audit company. This has become especially noticeable in recent years when many companies began to pay more attention to the protection of their information assets [10-12].

If we ignore the general problems of this task, then speaking of previous studies on the development of models for assessing the FC of enterprises, we should mention the simplest models in which the coverage factor is applied [1]. Such models operate with liquidity characteristics, and in addition, they use other coefficients, for example, financial dependence, etc. Such models are based on accounting information that reflects the current state of the enterprise. But if we talk about predicting FC in the future, then such models, as shown in [1,2], are not consistent. Expert methods should also be mentioned [2, 4]. In expert methods, a multi-stage survey of experts is provided. During such a survey, work with interviewees is carried out according to special schemes. And then, using the methods of economic statistics, the results are processed. However, expert methods are most often used in the process of making forecast estimates for the potential profit and / or market share of the company.

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A separate category of research is occupied by deterministic methods used to assess the company's FC [6]. Methods of this kind are a priori based on functional, often rigid, deterministic relationships between factor characteristics. That is, in such models [6], each value of the factor attribute is associated with a non-random value of the effective attribute.

Since modern scientific approaches to a comprehensive assessment of the FC of companies are impossible without the use of a systematic approach. Moreover, a few researchers propose to use the potential of cognitive modeling to solve this problem [13]. In our opinion, this is especially promising, considering that such an approach will make it possible to link many processes into a single whole. These can be not only purely economic processes but also social, informational, environmental, etc. Often, the links between such processes are weakly structured [14, 15, 16]. And complex systems, including economic ones, for which the analysis and forecasting of FC are performed, are multi-connected. Accordingly, it can be concluded that the mathematical apparatus of cognitive modeling can be used to model such systems, and, consequently, to solve the local problem of assessing the FC and predicting the development of the company. These considerations became the motivation for this study, as well as the development of information technologies that implement the practical application of the cognitive model.

III. The Purpose and Objectives of the Study.

The purpose of the study is to develop a mathematical model for describing the conceptual and functional aspects of the formation and application of a knowledge base (KB) for an intelligent information system (IIS) used while assessing the financial condition (FC) of a company.

To achieve the goal of the study, it is necessary to solve the following tasks:

1) *The developed model should consider the circumstances (when assessing the company's FC) that are associated with individual semi-structured factors (features).*
1) *Develop an iterative algorithm for IIS that implements a model of cognitive modeling.*

IV. Methods and Models

Cognitive modeling for evaluating the company's FC makes it possible to combine both elements of the internal and external economic environment of companies into a single system. In addition, it becomes possible to analyze a complex system as a whole. And not just its individual components.

As an empirical basis for cognitive modeling in the economy in the task of assessing the FC of companies, the main cognitive tools are investigated. These tools include conceptual schemes; cognitive maps; meaningful charts; and others, see table I.

The identification of these tools for solving a specific problem, their use in the course of modeling, and the introduction of various ways of displaying variables in their description, will provide an opportunity to see phenomena traditional for economic processes in a new way, and, accordingly, give them a new interpretation, as well as propose approaches to their use.

Table I
An Example of Concepts used to Analyze the Economic Activity of a Company (Compiled based on [1, 4])

Concept number	Concept Name
C1	Scale of business activities of the company
C2	Investment attractiveness of the company
C3	Competitive advantages of the company
C4	The target audience of products or services
C5	Company costs or logistical effect
C6	Economic performance
C7	Investments in the creation of new products
C8	Potential risks associated with doing business in this segment
C9	Different channels usage to advertise products or services
C10	Channels for receiving orders and working with customers
C11	The quality of management decisions made by the company
C12	Other

Usually in scientific publications, for example [1], the following sequence of procedures implemented during cognitive modeling is given:

- initial conditions and trends are determined that interpret or characterize possible scenarios for the development of the situation at a particularly given stage. This is necessary to verify the adequacy of the model scenario for a particular situation.
- further, target desirable directions (for example, corresponding to an increase or decrease) of the impact of a certain factor, as well as the degree of impact (weak impact or strong impact) of the factor on situations are set.
- the choice of a complex of actions is made. Such a complex can be a combination of control factors. After that, it becomes possible to determine the possibilities of each of the factors, as well as the desired degree of impact and direction of impact on a particular situation.
- the choice of appropriate influences on the situation is carried out. For example, it can be individual factors or a group of factors. In some cases, it is required to clarify, for example, empirically, to what extent these factors and their orientation influence the situation.
- the choice of indicators (or studied factors) is made. Indicators make it possible to characterize the progress of the situation, and their choice is made depending on the objectives of the analysis in this case of the company's FC and the needs of the user.

It is easiest to visualize the impact of each of the concepts on the company's FC by resorting to the capabilities of the cognitive map of the model, for example, as shown in Table II.

The list of concepts presented in Table II for the developed cognitive model for evaluating the company's FC can be formed based on the results of a survey and agreement of the opinions of a group of experts, in which it is advisable to include specialists of various profiles, from economists to managers and marketers.

TABLE II
AN EXAMPLE OF A COGNITIVE MAP

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1		+					+					
C2			+									+
C3				+						+		
C4						+					+	
C5									+	+		
C6	+							+				
C7						+					+	
C8			+		+							
C9				+								+
C10		+					+					
C11					+				+			
C12	+							+				

Also, taking the expert survey procedure as a basis, it is possible to determine the relationship of influence between concepts. Moreover, a cognitive map can be developed as a fuzzy map, in which the decision maker (DM) will operate with fuzzy sets.

If the concepts are chosen correctly, then the result of such cognitive modeling, for example, using appropriate information technologies (IT), will allow us to determine mutual consonance and dissonance. In addition, computer modeling based on such a cognitive model will provide an opportunity to explore the positive and negative effects of concepts on each other and on the system. Additionally, it will be possible to study other systemic integral indicators that affect the company's FC. Ideally, the result of such studies will be a situation in which the decision maker will be able, using computer simulation, to identify the concepts that have the greatest impact on the target concepts, for example, those shown in Table I. But the list of concepts is largely determined by the specifics of the company's work, therefore, as it was mentioned above that to compile a list of concepts, it is advisable to involve specialists of a wide profile, and not be limited exclusively to economists. Note, in this regard, that to influence the parameters of the target concepts, it is necessary, first of all, to influence the concepts that have the greatest impact on the target ones. And, accordingly, to choose the degree of influence of such fundamental concepts.

Analysis of the company's financial conditions, based on financial statements, primarily accounting, makes it possible to get a complete picture of what is happening. But behind the seeming simplicity is quite painstaking work. However, such work does not always make it possible to find the only correct way out of the situation, which is expected from the results of the decision-maker's analysis. In this regard, cognitive modeling, although more complex from a methodological point of view, in our opinion is much more informative.

Based on the objectives of the study, we note that when describing weakly formalized, weakly structured systems of large dimensions and with many connections between elements, it is "soft" models that are preferable. Apparently, only the complete formalization of individual processes gives researchers the opportunity to obtain strictly formal representations for the systems and processes under study.

In the mathematical formulation of the problem, any "soft" models are sets of black boxes with given inputs and certain outputs. Then, when analyzing large systems, the researcher needs to find the impulse that will allow him to understand how the control functions are implemented in the system under study.

To describe cognitive models, one can use the mathematical apparatus of signed and weighted directed graphs [15, 16]. In purely cognitive models, the weights of arcs can be specified or searched using statistical information processing methods. In addition, expert methods are quite suitable for solving such a problem.

In the process, for example, mathematical and/or computer modeling, it is possible to vary the values of the factors by changing them step by step. In parallel, the response of the system under study is monitored. Such operations are performed until a change in its state occurs. Then, using a multi-criteria choice, it is possible to determine a set of favourable scenarios, the implementation of which will have a positive effect on the decision-maker. You can also rank the factors by determining which of them will have the greatest or least influence on the behaviour of the system. Cognitive analysis and modeling, in particular computer modeling, give researchers the opportunity not only to study the problem of behavior and response to various factors for the system as a whole. But they also consider changes occurring in the external environment, which, like the main factors, affect the system.

In IIS, while assessing the company's FC, we will consider the procedure for structuring the situation in functional and structural contexts.

A variant of the structural approach allows you to decompose the situation when assessing the FS and predicting the development of the company's state. This makes it possible to analyze the structural and functional relationships of its constituent components (se_i). Selection of component (se_i), implemented by IIS, and represented by the hierarchical component "Part-Whole" [14-16],

$$\langle PA, WH \rangle, \tag{1}$$

Where $PA = \{pa_i\}$ - an integer (for example, the alphabet (se_i)); WH – relation "Part-Whole" for the alphabet $PA, i = 1,...,n$.

For the variant of the functional approach, the definition of the situation will determine the basic estimates of the company's FC.

Accepted for all components of the situation $SI_i = \{si_{ij}\}, j = 1,...,m$ - lots of vertices AM_i – adjacency matrix (hereinafter referred to as AM) of a directed graph (hereinafter referred to as DG). DG per component (se_i) situation determines its functional structure (in the context of the impact on the FC of the company (pa_i)).

Using the experience of experts, we build cognitive maps (hereinafter referred to as COGM) (SI_i, AM_i). These COGMs will reflect the subjective interpretation of the regularities of the company's functioning and its FC. Then the

resulting COGMs are grouped as follows: (SI, AM), Where $SI = \cup SI_i$ – a set of features ("F") that characterize the change in the situation with the company's FC.

IIS uses a model of knowledge representation in the form of a sign DG. And, in addition, knowledge fields are used (hereinafter referred to as KNF) [14-16].

KNF is set by: input data (factors– X, part of the factors was given above) tasks for IIS; conclusions (output data - Y); model (*MO*) used to transform the initial data into conclusions about the current and prospective financial condition of the company.

The model is generally described by the systems SC_{pa}, FS_{si}. Systems SC_{pa} and FS_{si}, reflect, respectively, the structure of the situation and the patterns of implementation of the company's policy in matters of assessing the FC.

KOGM (SI, AM) are described in the functional system (FSYS) of the KNF. In the process of describing COGMs, the scale of feature informativeness was used [14].

To describe COGM, it is also possible to use methods for identifying the preferences of an expert (i.e., a decision maker). The decision maker, in turn, analyzes scenarios for the transformation of situations with the help of IIS (pa_i) with the FC of the company.

Using the methods described in [14, 15, 16], ordered sets were obtained $ML_{ij} = \{ml_{ijz}\}$ linguistic meanings (LM) $j-$ admitted it $i-$ judgment for $z-$ th LM number. The LM elements are displayed in the range [0,1].

For each sign of judgment, we determine the scale X_{ij}. The division of the scale will have a linguistic interpretation $ml_{ijz} \in ML_{ij}$.

For a situation where it is necessary to obtain a scenario for transforming a situation, the initial data are: many factors $SI = \{si_i\}$; scale(s) of factors X_{ij}; the initial state of the company before the occurrence of the analyzed situation (i.e., the FC of the company)

$$X(t_0) = (x_{11},...,x_{nm}) \quad (2)$$

$$\text{MC} \circ AM = |am_{ij\,sl}| \quad (3)$$

Where i,s – concept number; j,l - the number of the attribute of the judgment, respectively, with the numbers $i \vee s$.

In general, you need:

a) determine the feature addition vector (FAV) $V(t), V(t+1),...,V(t+n)$;

b) track the change in the state of the company for the input parameters $X(t), X(t+1),...,X(t+n)$ in moments $t,...,t+n$.

To solve the problem, the method of successive iterations was used, during which the FAV was determined from the expression:

$$V(t+1) = V(t) \circ AM \quad (4)$$

The state of the company at the moment $t+1$, is characterized by the expression $X(t+1) = X(t) + V(t+1)$. Each Adjacency Matrix (AM) $AM = |am_{ij\,sl}|_{n\times n}$ for positive and negative components will be converted under the following conditions:

$$\begin{aligned} &if\ am_{ij\,sl} > 0\ \ then\ \ am'_{i(2j-1)s(2l-1)} = am_{ij\,sl},\ am'_{i(2j)s(2l)} = am_{ij\,sl};\\ &if\ am_{ij\,sl} < 0\ \ then\ \ am'_{i(2j-1)s(2l-1)} = -am_{ij\,sl},\ am'_{i(2j)s(2l)} = -am_{ij\,sl} \end{aligned} \quad (5)$$

to a positive definite double matrix $AM' = |am'_{ij\,sl}|_{2n\times 2n}$.

Therefore, FAV $V(t)$ and predictive values of the trait(s) $V(t+1)$, also have the dimension *2n*.

We believe that the rules for the synthesis of the initial FAV are satisfied $V'(t)$ with dimension *2n*:

$$\begin{aligned} &if\ v_{ij}(t) > 0\ \ then\ \ v'_{i(2j-1)}(t) = v_{ij}(t), v'_{i(2j)}(t) = 0;\\ &if\ v_{ij}(t) < 0\ \ then\ \ v'_{i(2j)}(t) = v_{ij}(t), v'_{i(2j-1)}(t) = 0. \end{aligned} \quad (6)$$

In vector $V'(t) = (v^-_{11}, v^+_{11},..., v^-_{nm}, v^+_{nm})$ sign significance si_{ij} was determined by two components c index $2j$, characterizing v^+_{ij}, and with index $2j-1$ defining v^-_{ij} addition si_{ij}.

FAV $V'(t+1)$ for a positive definite matrix AM' presented like this - $V'(t+1) = V'(t) \circ AM'$.

As a result of the transposition, the FAV components for time points $V'(t+1),...,V'(t+n)$ block matrices (hereinafter - BM) were obtained.

In BM rows - adding a feature at moments *t*, columns - adding a feature (or features) at the point in time that corresponds to the column:

$$V^t = |V'(t+1)^T,...,P'(t+n)^T|. \quad (7)$$

Block Matrix (BM) V^t was used in the IIS to predict the transformation of the situation with the company's financial condition.

The target vector indicates the direction and magnitude of changes in the features characterizing the company's FC from the initial state $X(0)$ to the target X^P.

The management resources for the company were defined as follows: $V^R = (v^r_{11},..., v^r_{nm})$.

Lots of Conclusions $D = \{D_1,...D_{cv}\}$ is formed in the process of solving the inverse problem.

The synthesis of conclusions is carried out on the basis of the assessment alternatives to individual decisions about the company's FC.

The assessment is carried out during the introduction of structural transformations in the situational model

$$\langle SI, X\ X(0)\ AM \rangle \tag{8}$$

and subsequent solution of the inverse problem for the structure

$$\langle SI^*, X^*\ X(0)\ AM^* \rangle \tag{9}$$

As a result, after synthesizing the output, we obtain a subset

$$D^* = \{D_1^*, \ldots, D_a^*\}. \tag{10}$$

The conclusion is accepted if there is at least one solution $D_a^* \in D^{R*}$ preferable than $D_a \in D^R$. Moreover, the solutions were obtained in the course of considering the inverse problem for the initial configuration of the situation with the company's FC.

Based on the considerations proposed above, a structure of modules was developed that is designed to describe meta-knowledge in IIS for assessing the company's FC.

IIS user interfaces include modules that implement the operation of the subsystems shown in Fig. 1.

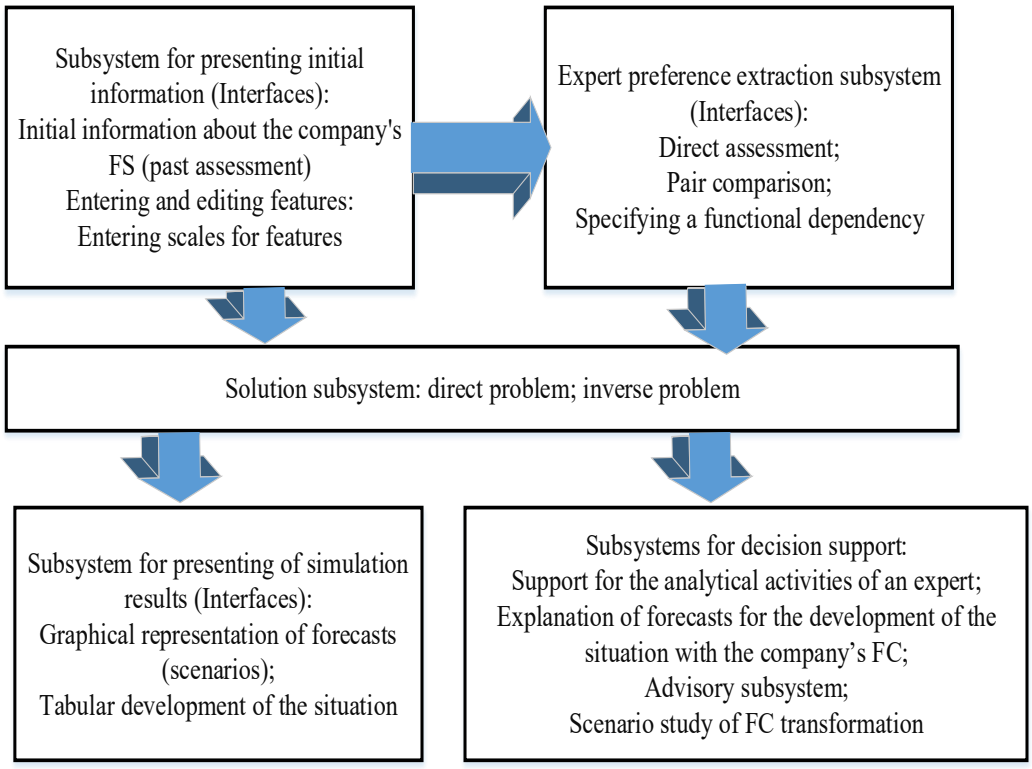

Fig. 1. IIS subsystems and user interfaces for the tasks of assessing the financial condition of a company

The decision maker's preference subsystem makes it possible to identify the degree of influence of each of the features of the company's FC on its general indicators, for example, investment attractiveness.

As initial data, we used the scale of informativeness of features ML_{ij}. In addition, IIS analyzes the current values ml_{ijk} taken on the basis of DG (SI, AM).

If the option *direct assessment* is selected, then the degree of influence of a feature, for example, an unstable FC of a company, was calculated as follows:

$$am_{ij\,sl} = v_{ij}^c \Big/ v_{sl}^r \tag{11}$$

Where v_{ij}^c, v_{sl}^r - adding characteristics of signs of cause and effect, respectively; *i,s* – concept number; *d, l* – identification number.

If the analyst of the financial service of the company or the auditor considers it appropriate to perform a paired comparison of the information content of the features of the FC, for example, in a situation requiring clarification of the features-causes si_{tl}, si_{sd} ("F-CL") and their influence on the sign-consequence link ("S-CL"), rank scale was used. The degree of influence of features on the FC was determined as follows:

$$am_{ij\,tl} = am_{ij\,sd} \cdot \left(\beta_{tl} \Big/ \beta_{sd} \right), \tag{12}$$

Where β is a parameter, describing the degree of influence of the link "S-CL" on "F-CL".

In a situation where a contradiction is revealed during the assessment of the company's FC, the adjustment module is activated. This module allows you to respond in real-time to emerging errors in the assessment of the company's FC.

The developed IIS provides for both manual and automated correction of the situation, for example, when the expert's assessment does not coincide with the automated assessment of the company's FC level.

When adjusting manually, the expert can change his choice, given in the previous step of the pair assessment.

A heuristic algorithm is involved in automated adjustment. In a situation where the quantitative characteristics of the "F-CL" and "S-CL" links, as well as the functional correlations "S-CL" from the set "F-CL" are known, the decision maker can use the functional dependence mode.

Accepted: $si_{ij} = \Theta(si_{tl}, si_{sd}, ..., si_{ze})$ and $x_{ij}^0 = \Theta(x_{tl}^0, x_{sd}^0, ..., x_{ze}^0)$. The strength of the influence of factors on the company's FC is defined as the sensitivity coefficient for each of the arguments [14]:

$$am_{tl\,ij} = \frac{\left(x_{ij}^0 - \Theta\left(x_{tl}^0 + x_{tl}^0 \cdot \lambda, x_{sd}^0, ..., x_{ze}^0\right)\right)}{\left(\lambda \cdot x_{tl}^0\right)} \quad (13)$$

and

$$am_{sd\,ij} = \frac{\left(x_{ij}^0 - \Theta\left(x_{tl}^0, x_{sd}^0 + x_{sd}^0 \cdot \lambda, ..., x_{ze}^0\right)\right)}{\left(\lambda \cdot x_{sd}^0\right)} \quad (14)$$

Where $0 < \lambda < 1$.

Thus, summarizing the above calculations, we can state that modeling complex systems using the example of the functioning of certain components of a company is a difficult task and often practically unsolvable by traditional methods due to the different dimensions of the data needed to build the model. And without the support of intelligent information systems, it is difficult or even impossible to solve it.

The formalized structure of the IIS, let's put it like this, see fig. 2.

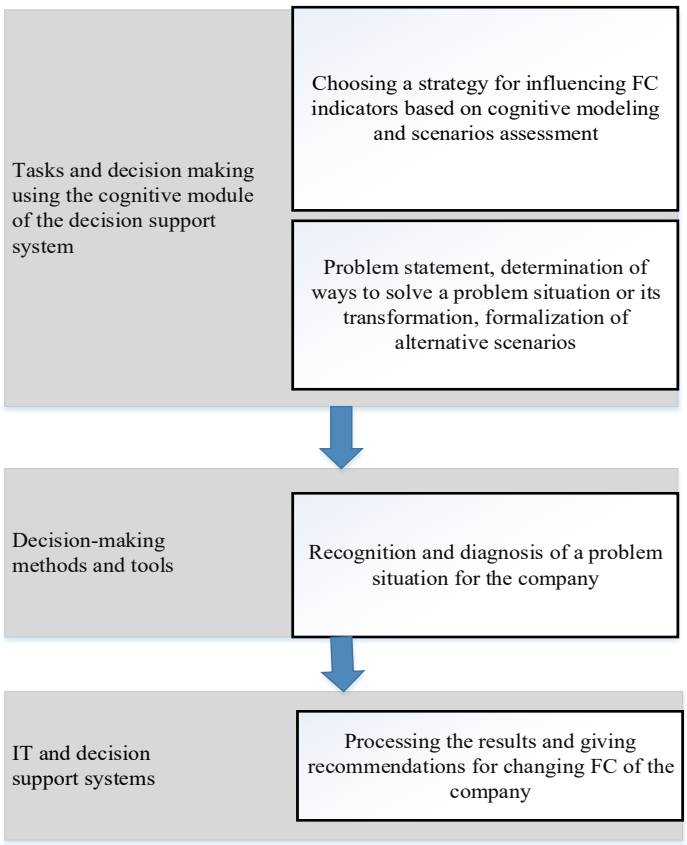

Fig.2. Conceptual diagram of the IIS for the tasks of assessing the financial condition of the company

In order to formalize the decision-making procedures in the course of assessing the company's FC, based on the methods of system analysis and the cognitive model described above, it is necessary to draw up a methodology for IIS. In this context, the technique is understood as a decision-making algorithm with the help developed by the IIS.

The algorithm includes the following main steps:

Stage 1. Aggregation of the object. At this stage, information about the current FC of the company is processed, for example, based on classical indicators.

Stage 2. Recognition and formalization of problem situations with the company's FC. Formalization can be performed based on the use of frames. Such frames are based on knowledge management, which relates to the state of the company and potential problem situations.

Stage 3. Building a cognitive model for assessing the company's FC.

Stage 4. At this stage, it is advisable to analyze the risks of threats that may arise during the development of problem situations. Solving the problem of risk assessment was not included in the list of research tasks. However, its solution can be made in the simplest form, for example, based on the risk matrix [19]. Note that we understand a problem situation a situation in which there is a disproportion in the development and/or functioning of the company, as well as potential conflicts that occur in the management object. Such disproportions and conflicts lead to the deterioration of the company's financial system, and, consequently, are the cause of problem situations and risks.

Stage 5. At this stage, the expediency of making one or another decision regarding a specific problem situation is evaluated. Such a decision is made on the basis of the performed analysis and cognitive modeling, as well as based on the results of processing the threat matrix and subsequent ranking of actual threats.

Stage 6. At this stage, the feasibility of making a decision is assessed. For example, the decision to adjust the control actions on the FC is not appropriate if the risk is of high weight. And, accordingly, the potential losses from the realization of such a risk are small. However, this kind of monitoring of the situation must be carried out continuously, which reduces the likelihood of an increase in negative trends with the company's financial system in the future.

Stage 7. At this stage, bottlenecks for the company are identified, for example, a lack of important resources (information, financial, human, etc.).

Stage 8. At this stage, frames are formed. This helps to understand what potential ways are available to overcome problematic situations, for example, those associated with a lack of resources.

Stage 9. Yes, at this stage, the target set is formed on the basis of descriptive functions. Such functions consider problem situations as chains of interrelated events. And besides, at this stage, there is a synthesis of control actions. Such influences, for example, maybe the adjustment of the investment, financial, personnel, tax, and other policies of the company.

Stage 10. Formalization of ideas about strategies for solving problem situations is carried out. Alternative scenarios are also considered, for example already based on the frames mentioned above in step 8.

Stage 11. At this stage, the transition strategies from the starting points (current states of the company) to the target points are formalized. Such a transition is carried out on the basis of the implementation of the main control functions.

Stage 12. Drawing up plans that are aimed at the specific implementation of alternative scenarios. Each such plan, for example, can be accompanied by network diagrams.

Stage 13. At this stage, the preferred, from the decision maker's point of view, alternative scenario is selected. Such a choice can also be made after the decision maker or experts have analyzed all the variants of the plans and the network diagrams accompanying them.

Stage 14. This stage provides for the adjustment and approval of the strategy for influencing the FC and the consolidation of responsibility between the participants in the process.

Stage 15. If necessary, if, for example, a large company with many structural subdivisions, it may be necessary to detail the plan with reference to a specific strategy for influencing the situation, contributing to the stabilization and / or improvement of the company's FC as a whole.

Stage 16. Also, as a rule, it is necessary to develop measures to control and coordinate various types of control actions that are aimed at implementing the strategy chosen by the decision maker.

Stage 17. And finally, at the final stage of this algorithm, the results obtained during the implementation of the chosen strategy are evaluated, as well as monitoring the compliance of the results obtained and comparing the results of cognitive modeling of the company's FC. That is, in fact, we can talk about checking the adequacy of the proposed cognitive model in practice.

The above algorithm is shown in Figure 3 and 4.

Moving on to the stage of formalizing the structure of the cognitive model, one of the classical approaches can be used, for example, taking as a basis: logical; production; frame; semantic networks; and/or other models.

You can also use new models that have appeared in the scientific community in recent years and are widely presented in scientific publications. The above-mentioned studies on the use of directed graphs can also be attributed to such models, which makes it possible to combine set theory and representation of the situation in the form of a multilevel structured scheme. Thus, the approach described in the previous paragraph based on the use of a directed graph makes it possible to reduce the process of evaluating a company's FC at different levels. For example, like this:

- if for a company (i.e. the object of study) it is possible to carry out its structural decomposition, for example, using information elements as a criterion;
- if in the process of synthesizing a cognitive model, some of the properties of the object of study can be used;
- if for each type of properties it is possible to additionally perform structural decomposition with the addition of vectors of controlled parameters;
- if for each vector of controlled parameters there is a certain range of acceptable values.

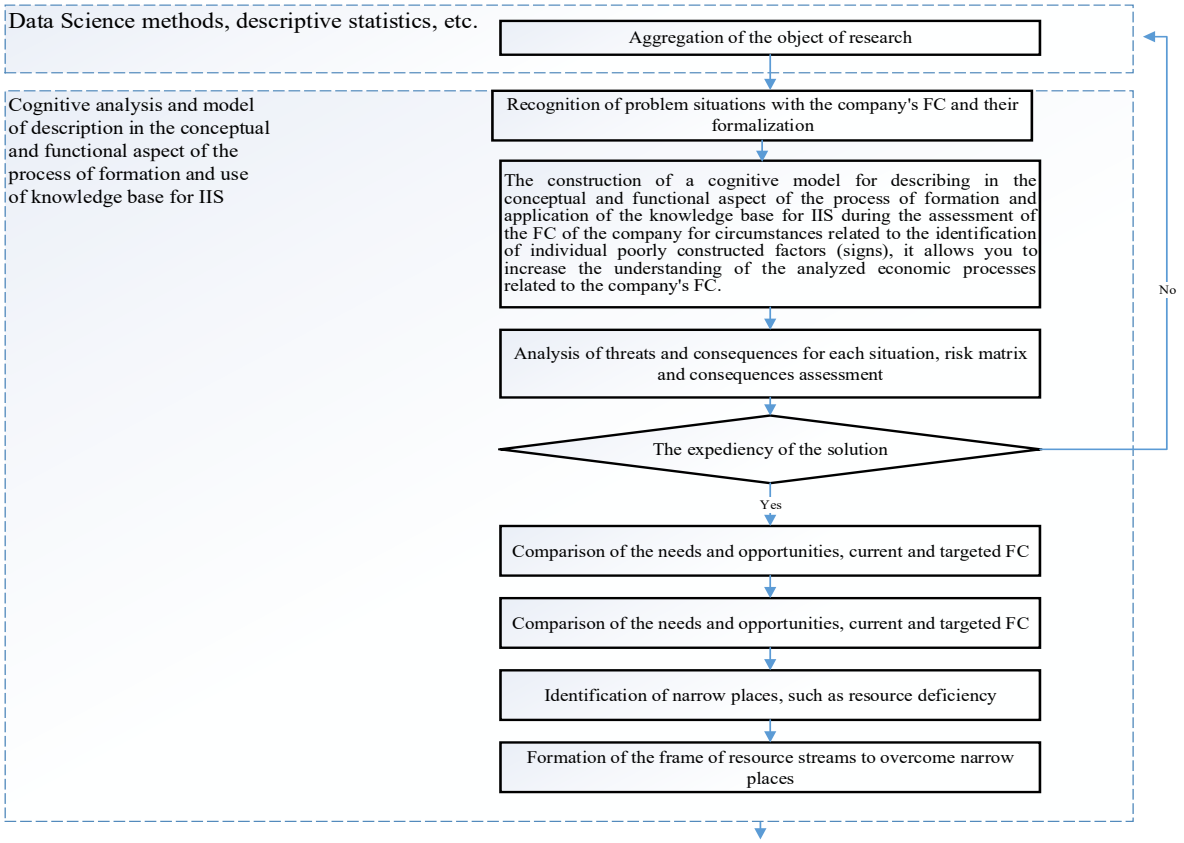

Fig.3. An Iterative Algorithm Implementing a Cognitive Modeling Model (Part 1)

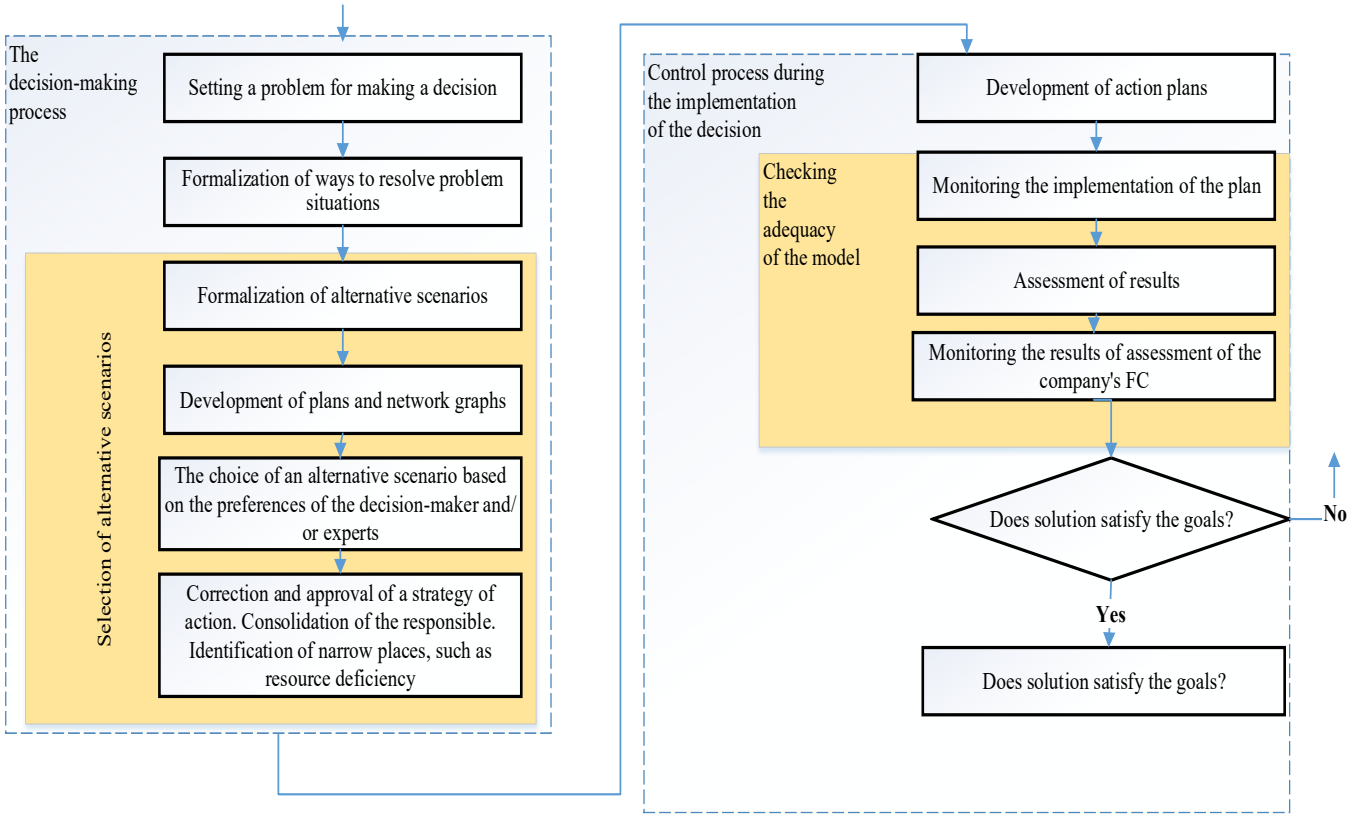

Fig.4. An Iterative Algorithm Implementing a Cognitive Modeling Model (Part 2)

V. Discussion of the Research Results

From the point of view of the potential scientific novelty of this approach, it can be said that the cognitive model strengthens the IIS and allows not only to more quickly perform work related to the assessment of the company's FC but also significantly saves labour costs for analyzing various scenarios for the development of the situation with its FS. It should be noted that the problems of developing methodological apparatus while applying modern information technologies and systems, including IIS, are dictated by the need to bring the requirements of decision-makers and the corresponding information environment of the company into line. At the same time, it is important to strike a balance between the company's existing information systems and new technologies, and systems focused on innovative technologies and models.

Modern IIS in the economy is not only a database (DB) and knowledge (KB), but also contains a set of models, criteria, and other parameters necessary to assess the economic condition of companies. If we talk about the potential of using IIS, which contains modules with cognitive models, then their difference from traditional information systems is the presence of subsystems that can model the state of the company under various scenarios of development or transformation of the situation. This is especially true for problematic situations when this kind of IIS can help simulate scenarios for the development of such a situation [17-21].

The disadvantages of the study include the fact that sufficient statistical material has not yet been accumulated to establish the correctness of the model for the analysis of practical problems.

Conclusion

As a result of the research, the following main results were obtained:

- A mathematical model of description in the conceptual and functional aspect of the process of formation and application of the knowledge base for the decision support system while assessing the financial condition of the company for the circumstances associated with the identification of individual semi-structured factors (signs) is proposed. The proposed model makes it possible to increase the understanding of the analyzed economic processes related to the company's financial system.
- An iterative algorithm is proposed that implements a model of cognitive modeling, which allows us to talk about its universality in the process of assessing the company's FS. The scientific novelty of the proposed approach lies in the fact that, unlike existing solutions, it is possible to form and adjust the structure of the algorithm depending on the characteristics of a particular company, as well as form the information basis for the process of assessing the company's FS and the parameters of the cognitive model.

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