Methods for evaluating information in managing the enterprise on the basis of a hybrid three-tier system

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Abstract. The article presents data on the influence of information upon the functioning of complex systems in the process of ensuring their effective management. Ways and methods for evaluating multidimensional information that reduce time and resources, improve the validity of the studied system management decisions, were proposed.

1. Introduction

In the operation of complex systems, such as an enterprise, a set of information that characterizes the internal and external environment is formed. The study of the analysis and processing of the information about the functioning of complex systems is an important task, designed to simplify the assessing process of the functional state of the complex systems and to ensure their effective management [1–3].

Normally, a system of information indicators concerning a complex technical, economic, or social object of research is a complicated hierarchical structure with a lot of individual indicators, which may include various criteria, reflecting its status and depending on the management tasks [4, 5].

To organize, control and process information, enterprises are to create a single database of indicators and reporting data on innovation activities, and develop the indicator framework and software. This system will allow evaluating qualitative and quantitative changes, and monitoring the management of innovative activity of the enterprise.

It is important to develop new ways and methods for evaluating information about the innovative potential of the enterprise, aimed at enhancing the efficiency of the enterprise management using intelligent decision support.

2. Methods and methodology

To solve this problem, it is proposed to use a method, based on a fuzzy representation model of multidimensional data, using a device to transform source information into a single knowledge base in the units and methods for reducing the feature space to ensure the objectivity in the obtained results [1, 2]. The method includes ten stages:

1. Input of initial information (the system structure entry into the storage device (SD).
2. Reducing the dimensionality of the feature space based on correlation and factor analysis, and the preferences of decision makers (DM), using coefficient *G*.

3. Transformation of information features into a single information space. This study uses 'soft' and linguistic data transformation, which codes in a numerical form in the range of 0–100.
4. Creating a groups' feature vector.
5. Identification of the characteristic group level.
6. Calculation of the efficiency coefficient of the system functioning.
7. Analyzing compliance of the decision with the situation (ensuring availability of the decision for the current state).
8. Determining the number of the made decisions.
9. Estimating the time of execution by the decision maker.
10. Calculation of the efficiency of the system management.

The algorithm implementing the method is shown in Fig. 1.

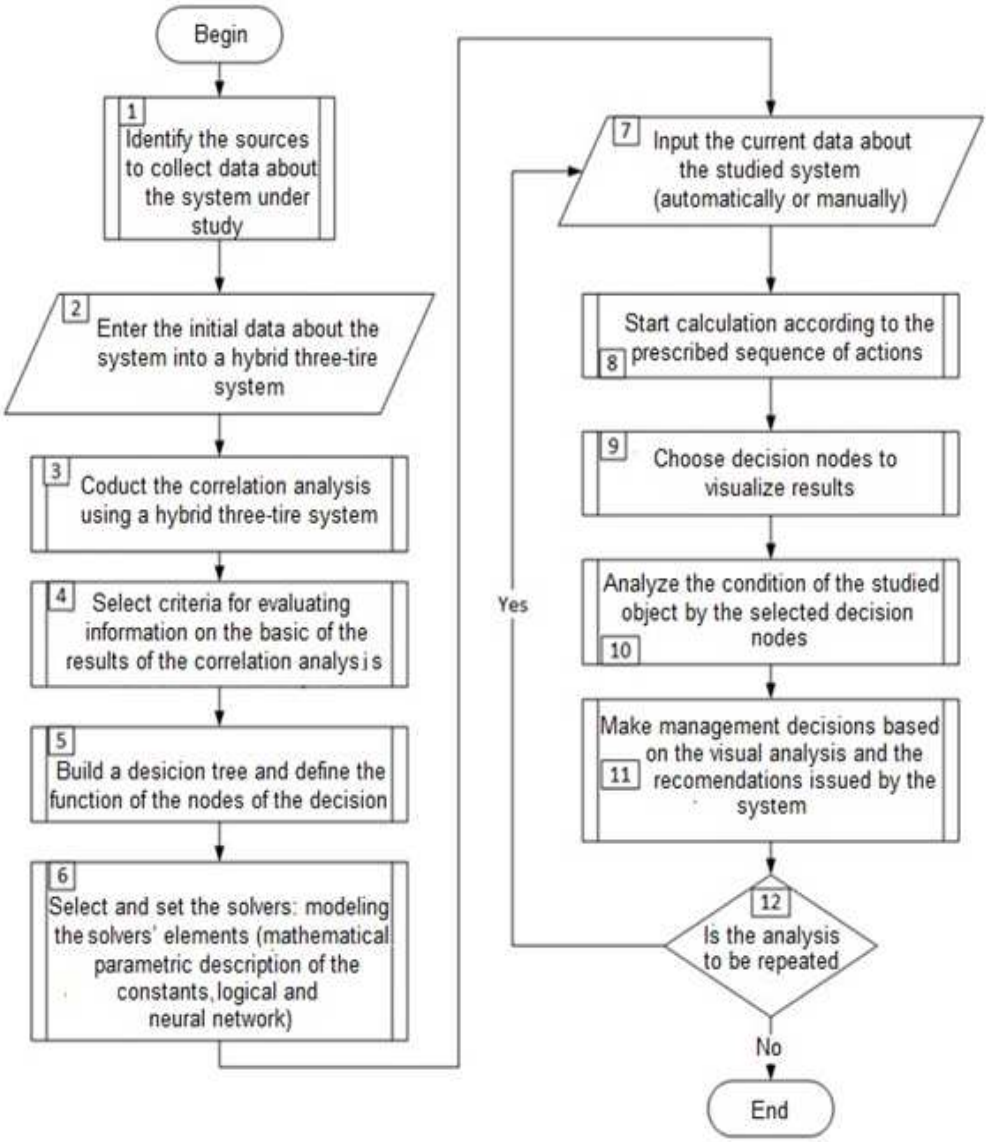

Figure 1. The method for evaluating information on a complex object state (an enterprise).

The method has a number of attractive properties, namely:

- no restrictions on the quality and quantity of data;
- possibility of reducing the dimensionality of the information indicators of the situation, and bringing them to relative units;

- calculation on the basis thereof generalized information indicators and ranking them according to their characteristic levels;
- reducing the number of decision makers to one;
- eliminating the need of both control over the timeliness of decision making and the weighting factor calculation;
- possibility of computing any efficiency aggregates for each subsystem.

To assess information about the state of a complex object (an enterprise), it is advisable to apply the technique, having the following advantages: the possibility of assessing the system state in real time; using heterogeneous qualitative and quantitative information as input data; carrying out correlation analysis; determination of optimal values between the features; a visual display of the evaluation results by the user-friendly way ('Chernoff faces', multidimensional charts, radar charts, statistical reports) that improves the quality of information processing and greatly simplifies the decision-making process.

3. Practical implementation

There is a hybrid three-tier system to realize the proposed method and the technique for evaluating information in the form of a software product. There are no analogues of the proposed system on an industrial scale due to theoretical approaches of the known methods, or their narrow specialization and the limited usage of information, or the complexity of their use (at the moment there is no known software on the market, designed to assess the innovative potential of the enterprise and its functional state on the basis of heterogeneous information). The use of the hybrid three-tier system is suitable for the enterprises where the information security policy prohibits the installation of foreign software products, and the significant financial costs of their purchase and software license are decreasing.

The hybrid three-tier system is the core of the information field formed by the enterprise management systems (fig. 2), and it handles all incoming data from those systems, forming a coherent picture of the functional state of the enterprise.

The system consists of an initial configuration unit, a decision tree unit, data input and output modules, a DM workplace and a database (fig. 3). Each of these units consists of various modules of information processing and transformation.

The system is interacted with: an expert - at the setup stage; with the system user - at the calculation stage; a decision maker - at the evaluation stage.

The initial configuration unit consists of the following modules:

1. A module of variables is a module of variables' description used by the system for analyzing, processing and evaluating information (it consists of a variable setup module, allowing one to select the type of the variable and the rules of its fuzzification and defuzzification, and a module of data load and storage from the system database and external sources).
2. A dimensionality reduction module is to reduce the number of the used variables, and identify the most important ones in the assessment information on the system state (it consists of a statistical analysis module and a module of data load and storage).
3. A module of mathematical and parametric modeling is to describe parametric solvers. If the solver calculates formulas, then the modeling acquires a mathematical form; and if a constant value is assigned, then the modeling is parametric.
4. A logical modeling module is a system of building production rules of an expert system. The complexity of the rules can be arbitrary. A rule may be described in the form of a tree. The calculation of the rules results in computing activation of the parametric solver.
5. A neural network module is a set of features to work with the functionality of neural networks. The module allows setting up the work, to train, to adjust the structure, to test the results.
6. An expert opinion module is a logical modeling, designed to display recommendations in an understandable for the user form based on the calculated values.

The decision tree unit consists of the following modules:

1. A solver node module is used to configure a calculation node. The module consists of determining the solution order in the node, the solver method selection, setting the result of the solver according to the node (settings recommendations), as well as a module to save and to load the solution node from the database system.

2. A calculation module is designed to perform calculations and consists of selecting a decision node (it is made in accordance with the hierarchy of the decision tree), determining the order of the decision (the decision node is configured with the solution order inside the unit), and data saving and loading from the database system.

The system saves all the intermediate results that allow tracing the dynamics and considering the results at all levels of the decision tree [4].

Based on the decomposition of the decision tree to levels of information groups, the decision-maker can identify trouble spots at the enterprise, and, based on the recommendations of management, choose the control action appropriate to the specific current situation. It is also possible to predict the change of the current situation in dynamics on the basis of the graphs in the reporting period.

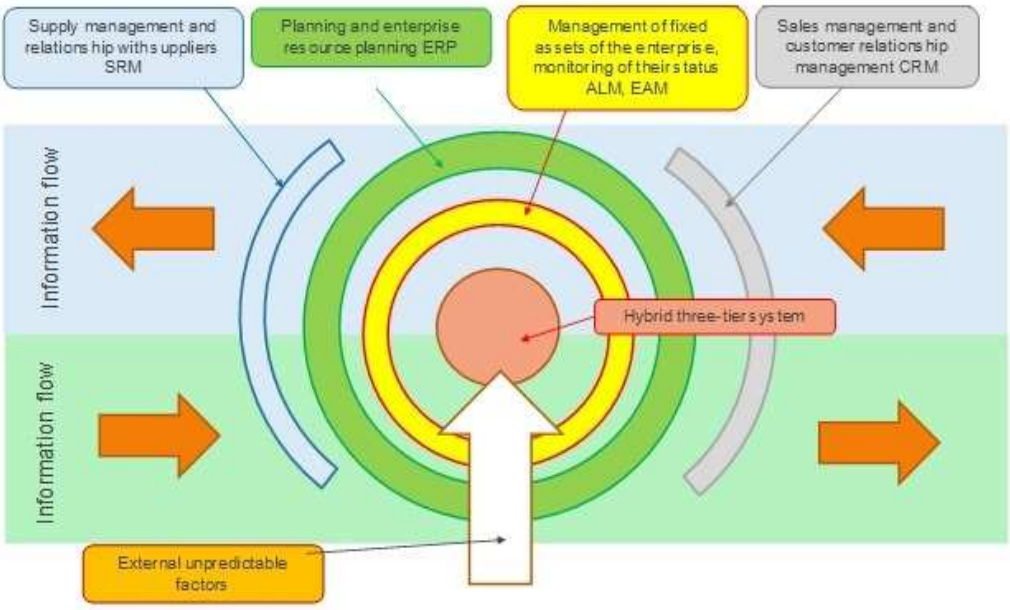

Figure 2. The hybrid three-tier system in the information field of the enterprise.

4. Conclusion

Thus, the developed hybrid three-tier system can be widely used in the analyzing, processing and evaluating heterogeneous information on any complex system (economic, social, technical), thanks to its versatility in various applications and advantages, namely: the possibility of assessing the system state in real time; using heterogeneous qualitative and quantitative information as input data; reducing the dimensionality of input indicators; transforming the indicators into a single information space; analyzing and evaluating information using the mathematical apparatus, expert systems and neural networks; forecasting the development; analyzing the evaluation results by the user-friendly way ('Chernoff faces', multidimensional charts, radar charts, statistical reports) that improves the quality of information processing and greatly simplifies the decision-making process.

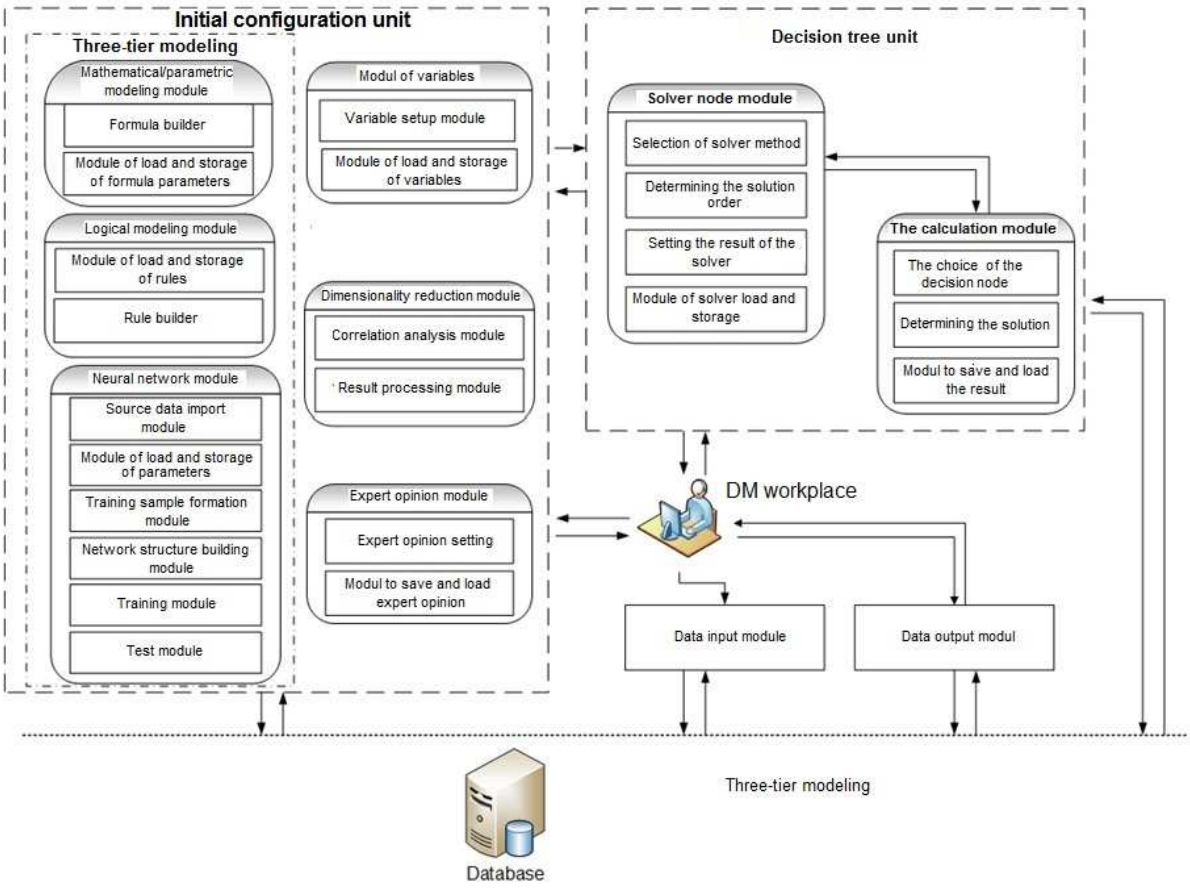

Figure 3. The block diagram for a hybrid three-tier system.

5. Acknowledgments

The authors thank the Ministry of Education and Science of the Russian Federation for the financial support to fulfill this work within the framework of the government task, project no. 1267.

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