UDC 004.89:65.011.56

K. Ostapchenko, O. Lisovychenko, V. Evdokimov

FUNCTIONAL ORGANIZATION OF SYSTEM OF SUPPORT OF DECISION-MAKING OF ORGANIZATIONAL MANAGEMENT

Abstract: the results of the approach to designing an object-oriented decision support system for automating organizational management processes in the electricity market. The structure of the components of the decision support system and its functional organization are proposed.

Key words: organizational management, electricity market, decision support system, information technology platform.

Introduction

Many experts associate the increase in the productivity of solving organizational management problems with the development of research on the problems of improving methods and means of mathematical and computer modeling of decision-making processes and the creation on their basis of qualitatively new computer-based organizational management systems (OMS) [1]. It is natural to assume that the construction of a modeling system as part of OMS, which is actually designed to implement the functions of an interactive adaptive decision support system (ADSS), possible only with the help of information technology platform (ITP), providing the ability to design and build simulation computer models of the OMS functioning processes.

Therefore, the urgent task is to build the ADSS with developed means of semantic data processing and a user interface for designing computer models and computational algorithms for analysis and synthesis of the OMS functioning mechanisms, forecasting the consequences of making decisions on the implementation of new functioning mechanisms at all levels of organizational management.

Problem analysis and purpose of paper

In foreign literature, computer systems of a similar ADSS purpose are intended to assist management personnel, analysts, and decision-makers at various levels in unstructured or poorly structured situations of choice [2].

This definition is quite general, because almost any information system falls under it to one degree or another. Therefore, at the moment there is a fairly broad interpretation of the features that often intersect with each other, which does not allow us to formulate a single ADSS classification.

So, in a paper [3] analysis of the current state of modeling complex sociotechnical systems based on artificial neural networks made it possible to see the strengths and weaknesses of the use of intelligent technologies for building an ADSS for various subject areas. It has been established that the problems of the practical implementation of ADSS are generated by the variety and complexity of the objects of study. And today a significant group can be distinguished in them, in which data analysis, state diagnostics, behavior forecasting and control cannot be performed by traditional methods and automation tools.

For example, in a paper [4] a solution to the problem of choosing the best version of the simulation model from a finite set of alternatives in the decision support process was proposed. To evaluate the solutions, the methods of multicriteria analysis of alternatives are used, which makes it possible to rank the alternatives presented by simulation models. However, following the trends in the global development of information technologies, applied ADSS for a specific subject area can be built on the basis of basic mathematical software that implements the theory of control of the structural dynamics of automated systems that solve the problems of monitoring and managing complex objects [5]. Within the framework of this theory, from a unified standpoint, one can approach both the solution of problems of structural and functional synthesis of the appearance of these systems, and the operational solution of the problems of configuring and reconfiguring their structures in a dynamically changing environment. Moreover, in contrast to the existing specialized narrow approaches and technologies widely used in practice for solving problems of monitoring and managing complex objects, the proposed methodology and methodological foundations of intelligent interactive monitoring and managing complex objects have been widely and successfully implemented in various subject areas [6].

Thus, it can be argued about the diversity, both in the field of application and in approaches to the implementation of an ADSS.

However, trends in the description of the subject area of ADSS have been outlined both in approaches to the classification of such systems and in their definition. So, in paper [7] the main indicator of the ADSS classification is proposed to divide them according to the functional attribute relative to the decision-making cycle implemented by the system. In the framework of the new classification, it is proposed to replace the class “according to the level of the user” that is currently used, using the class “by functionality”, which includes information, settlement, information and intellectual systems. This paper is devoted to the implementation proposed in [8],

 ISSN 1560-8956

approach to the design of computer OMS is based on the transition to an object-oriented ADSS and the inclusion of an information-analytical monitoring system (IAMS) in its structure to build an integrated system focused on the study of the main indicators of the state of production and the economy of the organizational and technical system (OTS) subjects, particular electricity market. The basic in this approach is the direction of development of information technology tools designed to create a software environment for designing computer models of organizational management tasks in order to automate decision-making processes for forecasting and planning price and volume indicators of electricity consumption and generation.

Design problem statement

The structures of complex control systems, which include computer-based OMS, are usually built using hierarchical and functional principles for distinguishing subsystems of situational management - control based on prevailing facts and circumstances, which can be represented as a set of indicators of the functioning of the control [9]. As a result, the control systems of each level are represented as subsystems in the general control system of a higher level. Moreover, each level is characterized by its own characteristics of management goals and operations, which are associated with data processing [10].

It is known that control operations implement the information function of the control object, which consists in the automated collection, processing, interpretation and presentation of information to perform the production function of this object, i.e. implementation of management tasks [11].

The solution of such problems as analysis and a comprehensive assessment of the situation, forecasting changes in the situation and assessing the consequences of decisions made, intelligent user support, analysis and forecasting the development of the external economic and political situation requires the creation of ADSS-oriented data analysis using special simulation, forecasting, calculation models and means of solving optimization problems [12].

To solve management problems in the OTS, a hierarchical system can also be formed, at the lower level of which there are tasks of interpreting and presenting data, and the following levels form the tasks of generating new data and knowledge to support the development and adoption of management decisions in computer OMSs.

As a result, it is possible to determine the following subsystem levels, due to the varying degree of automation of the information function of the OTS:

1) information retrieval systems for automating data interpretation processes and preparing interaction interfaces;

2) information and registration systems for automating the processes of collecting, accumulating and transmitting data;

3) information and analytical systems for automating monitoring processes and carrying out computational tasks;

4) information-modeling systems for the preparation and analysis of development options based on models of the control object;

5) information and decision systems for automating the processes of development and management decision-making.

Based on the analysis of the peculiarities of organizational management mechanisms, further development of the approach to building computerized OMSs should be carried out not only on the basis of a transition to an object-oriented ADSS, but also taking into account its hierarchical structure and integration of components into a single information management system to resolve difficulties in organizing management activities of OTS entities.

Thus, under the ADSS, an interactive object-oriented IAMS is considered, driven by data and models, the main purpose of which is to satisfy the information and analytical needs of the decision-maker in solving unstructured or poorly structured tasks [13].

One of the main conditions for creating the ADSS as an adaptive information system is data unification. The development of a unified system of unification is a complex and time-consuming task, for the solution of which it is advisable to use international experience and standards. The basis for building a unified classification system and a single information data space should be a generalized information model, which in a uniform way according to IEC standards [14] describes the whole set of typical physical entities of the OMS based on the principles of object-oriented modeling (OOM). Following the principles of the OOM, in such a generalized information model, a description of the physical entities of the OMS at all levels of the OTS is supported, which allows them to be represented uniformly in the information support of the system, their properties and communications, thereby ensuring the possibility of creating a unified system of classifiers, directories and unification of access to data.

Functional Organization of an ADSS

In this paper, in order to develop and improve the IAMS, it is proposed to include the following problem-independent presentation components in the structure of the ADSS for managing OTS subjects (Pic. 1):

- models of subjects involved in structure-forming relations of organizational management that determine the rules for the functioning of the OTS;
- models of indicators (parameters) of the functioning of the OTS;
- modeling algorithms (models for various purposes) that determine the rules for the formation and change in the values of indicators of the functioning of the OTS;
- model of interaction (interface) and presentation of data to the user;
- managers of data, interfaces, models.

Data manager. When using an object-oriented approach to creating adaptive ADSS, it is supposed to carry out a stage of an object analysis of a subject area (SA), and then, on its basis, an implementation of a stage of an object-oriented modeling of a SA of a control object. The essence of this analysis is to identify the entities - subjects and processes of the SA of a OMS in the form of a set of information objects that interact with each other on the basis of the principles of the OOM and the development on their basis of a unified specification of the SA functioning of the subjects of the OMS.

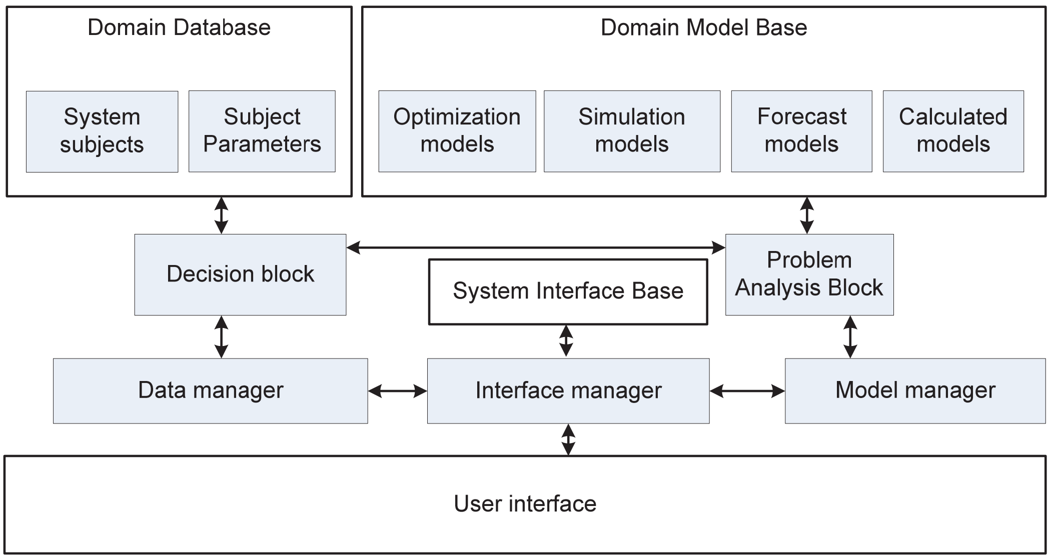

Figure. 1. -Conceptual model of an ADSS organizational management

The subject area is a set of information elements-entities that characterize the activities of subjects of organizational management, their composition and structure, and allow you to describe the necessary functional tasks that are solved in the system to achieve management goals. The subject area as a whole is determined by the composition of its subjects and scenarios of their functioning [15]:

$$SA = (S, f^S, SC),$$

where $S = (C, P), S \subseteq ST \times C, P \subseteq PT \times S$ – subjects of the SA; C – static property identifying the subject in its class (type of subject) ST; P – dynamic parameter, which refers to one of the classes established in the software (parameter types) PT and characterizes the component of the vector of the current state of the subject S; $f^S : S \times S \to LT$ – structure of entities; LT — many classes of relationships (types of relationships) established between subjects in the framework of the SA; $SC = (O, f^O, V, M, f^V)$ – scenarios of functioning of the subjects of anti-missile defense; O – settlement and technological operations (groups of operations); $f^O : O \times O \to \{0,1\}$ – scheme of carrying out (calculation) operations; $V \subseteq P \times D$ – indicators for calculating the parameters of the subject in the estimated time intervals D; $M = (R_i \mid i = 1, n)$ – algorithms (rules) for the implementation of settlement and technological operations based on statements of product rules R_i; $f^V : O \to V \times M$ – purpose of settlement and technological operations.

Thus, the specification of adaptive ADSS design software can be represented as a semantic network of information model classes consisting of the components of the software dictionary: subject, property, state, parameter, calculation indicator, script, rule, statement, method, operator, formula, operand, calculation, result.

The selection of such a set of information classes that have the listed characteristics and the relationships between them makes it possible to build an object information model of a specific software and on this basis in the future to develop a unified system of classifiers and directories, a data storage structure, a unified system of protocols and interfaces, as well as common programming tools computer models of the functioning of technological processes in the OTS.

Thus, the data manager provides manipulation of the state of the information model of the software through the organization of flows of incoming and outgoing data. As a result, all incoming and outgoing data in the information model are presented in the form of information blocks of data about: subjects; subject parameters; calculation algorithms; calculation results; formation of reporting documents, etc.

The block of data on the subjects is intended to describe the states of the subjects of the technological process during calculations. These subjects of the technological process are subjects of the subject area, sources of information, regulatory documents, equipment, etc.

A block of data on the parameters of subjects is intended to describe indicators that reflect the state of processes in objects and have a numerical value. These indicators include: input parameters; regulatory parameters; technological parameters; design parameters, etc.

The data block on the calculation algorithms is intended to describe the calculation rules by which the values of the calculation parameters are generated.

The data block on tasks and calculation results is intended to describe the actions that the user performs on functional responsibilities during the settlement operations, as well as to accumulate data obtained as a result of calculations for subsequent use in the formation of output forms of documents.

Interface Manager An interface manager acts as a link between data and model managers, playing the role of a means of presenting and interpreting information that is generated from data and models.

The software of an object-oriented hierarchical ADSS built on the basis of adaptive ITP should consist of subsystems oriented towards solving functional problems within the framework of ensuring the information needs of the user of the SA of the OMS. Each functional task, as a whole, is characterized by input data (data streams), output data (result streams) and methods of their processing (interpretation and presentation). Under the methods of processing should be understood instrumental functions that provide a variety of mechanisms for manipulating the input data of functional tasks. Such methods include operations of data sampling, filtering data, making changes to data elements, deleting data, aggregating data to generate analytical reporting information or other result data.

The adaptive organizational model of the interface manager should be based on typical features that allow you to classify and reflect the differences between objects from each other. The feasibility of such an analysis and the allocation of classes of SA objects in the development of an information model is due to the fact that the same visualization and conversion operations on information data streams are often used for different functional tasks. In addition, the functions and data processing processes during the phased implementation of the ADSS are quickly modified, recreating the variable requirements of users to the software. All this requires such an organization of the structure of the ITP system in which the objects of the software and the relationships between them would be determined regardless of the implementation of specific functional tasks of data processing in the procedures and interfaces of the application program, and represent a single structure. Such a mechanism is a dynamic linking method, which is implemented in the form of a proprietary model by creating a dictionary of mappings of data structures of functional problems of software for visualization operations [13].

As a result, the requirements of universality and uniformity in the methods of presenting data to the user necessitate the creation of so-called metadata. Consider the mechanism for presenting data in an object-oriented ADSS built using metadata technology. The software application adaptive to changes in an ITP will be declared as a set of the form:

$$P = (T, U, G, f_G, f_T),$$

where $T = \{t_i \mid i \in I\}$ – many functional tasks of the application, $U = \{u_j \mid j \in J\}$ – many application users, $G = \{g_k \mid k \in K\}$ – many user groups, $f_G : U \times G \to \{0,1\}$ – group membership function, $f_T : (U \cup G) \times T \to \{0,1\}$ – function access.

Functional tasks of the application are defined as sets of the following form:

$$t_i = (R, A, f_R^T, f_A^T, D, f_D, M, f_M),$$

where $R = \{r_i \mid i \in I\}$ - many data structures of functional tasks presented in the relationship model $f_R^T : T \to R$, $A = \{a_y \mid y \in Y\}$ - many elements of data structures of functional tasks represented in the attribute model $f_A^T : A \times T \to R$, $D = \{d_h \mid h \in H\}$ - many methods - processing functions of data structures of functional tasks $f_D : D \to T$, $M = \{m_l \mid l \in L\}$ - many types of data structure binding defining a functional task interface model $f_M : T \to M$ (table, tree, map, report).

Methods for processing data structure elements are defined as sets:

$$d_h = (S, f_S, f_R^D, f_A^D)$$

$S = \{s_v \mid v \in V\}$- many models of data processing methods (viewing, editing, creating, deleting, searching, forming a summary of data, transition to related data structures), $f_S : D \to S$ – membership function of data processing methods,

$f_R^D : D \to R$ - membership function to the processing method of a plurality of related data structures, $f_A^D : A \times D \to R$ - function of belonging to the processing method of many elements of the accompanying data structures.

The application of the principles of vertical and horizontal decomposition makes it possible to distinguish three levels of the interface for interacting with data from the proprietary and conceptual models of the functional problems of the ADSS when building the organizational structure of the ITP software complex:

1) level of the functional environment of the SA user of the automation object;

2) level of tools for solving a functional task selected by the user;

3) level of implementation of the function of the tool of the functional task.

As a result, the applied part of the ADSS will be structured from subsystems that are distinguished not by problem-oriented, but by functional signs. These features are focused on typical operations of interaction with the object environment in the interpretation and presentation of data.

Model manager. The model manager acts as a means of generating models in the ADSS, which implement the functions of problem analysis and are presented as unified ITP methods, which include:

- settlement-modeling, which, according to a known functional dependence, forms the calculation result; presented in the form of a formula and used to calculate the status of indicators;

- settlement and search, which in a cyclically repeating procedure form the result of the calculation; are presented in the form of a procedure from the list of formulas and are used for the procedure of simulation modeling changes;

- settlement and optimization, which, using the organization of enumeration (selection and comparison) of options form the result of the calculation; are presented as a set of algorithms and criteria for evaluating options and are used to optimize indicators;

- settlement and forecasting, which with the help of a focused synthesis of options and analysis of the results of their calculation form a settlement solution; presented in the form of prognostic procedures and used to forecast indicators.

In general, the basic software package of object-oriented ADSS is built on the principles of decomposition and structured from subsystems that implement tasks that reflect the stages of functioning of the information model of the subject area (Pic. 2).

In the organizational structure of such an ADSS, software is formed from functional subsystems and a software interpreter of functional task interfaces. And information support is presented in the form of conceptual representation models of subject domain subjects and metadata of the user interaction interface with functional tasks. The organization of the technological process ensures the fulfillment of the functions of preparing, conducting and processing data of calculation results, consists of the sequential implementation of the tasks of the functional subsystems, the purpose of which corresponds to the basic standard operations of the interaction of the end user with the ADSS.

Such typical operations are: making changes to calculation algorithms; collection and preparation of source data; carrying out calculations of indicators of the functioning of the organizational system; formation of reporting data with the results of calculations of their presentation in visual form; visual data analysis and monitoring of calculation results.

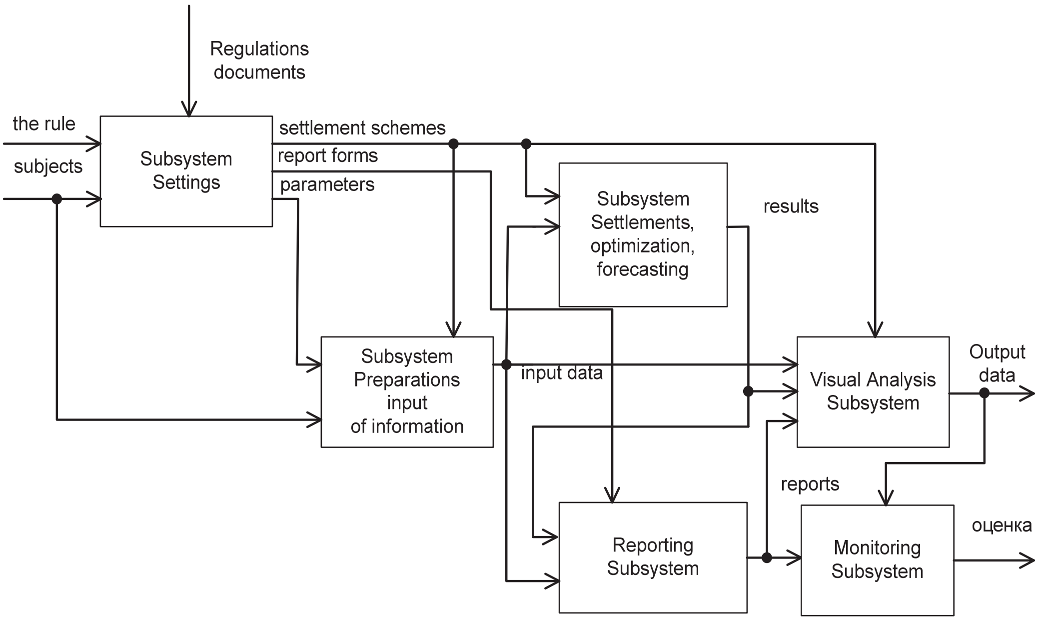

Figure. 2. Functional organization of an ADSS

A functional organization is a structured representation of the functions of the OMS, data streams and entities of the information model that link these functions. It is constructed by the method of decomposition from complex functions to simpler ones. Elements of each level of decomposition are actions to transform information flows using predetermined processes of functioning of the OMS under their control. A functional organization is formed by subsystems that are characterized by input and

 ISSN 1560-8956

output data streams, as well as control mechanisms and implemented data processing functions.

Thus, at the upper level of the decomposition of the OMS functions, the ADSS includes the following subsystems: “Settings”; “Preparation of input information”; "Carrying out calculations, optimization, forecasting"; “Monitoring” “Reporting”; "Visual analysis." And at the next levels of decomposition, functional subsystems are detailed by a set of tasks to be solved.

The subsystem "Settings" provides the ability to adapt and configure an ADSS to changes in the functioning mechanisms of the organizational system, options for calculating the parameters of technological processes and control components.

The following tasks are solved in the subsystem: maintaining calculation schemes, maintaining indicators for calculating calculation parameters, generating algorithms for calculating parameters, maintaining calculation formulas.

Maintaining calculation schemes is intended to create the structure of the calculation process, to describe its elements, algorithms and formulas for calculating parameter values in the calculations. The task is the main one in the subsystem when making changes to the algorithms for performing calculations of all kinds into the ADSS.

Maintaining indicators for calculating calculation parameters is intended to accompany and control the creation and use of calculation parameters in calculation schemes and rules.

The formation of algorithms for the rules for calculating parameters is intended to accompany and control the creation of rules for calculating the parameters of calculation schemes.

Maintaining calculation formulas is intended to accompany and control the creation of calculation formulas used in statements of calculation rules.

The subsystem “Preparation of input information” on the basis of regulatory documents and primary data provides the formation of information structures necessary for use by other subsystems. The subsystem provides for the adjustment of current (operational) and retrospective input data, the preparation of additional data for their subsequent use in various calculations.

The following tasks are solved in the subsystem: maintaining regulatory documents, generating regulatory parameters, maintaining technological parameters of the system, loading input data.

Maintaining normative documents provides maintenance of the list of information sources, on the basis of which changes are made to the calculation algorithms when improving the functioning mechanisms of the OMS and the necessary input data on the subjects of the system are entered.

The formation of regulatory parameters ensures the fulfillment of the requirements for the preparation of initial data for subsequent calculations. The current state of normative parameters is ensured by the implementation of actions related to maintaining the description of the parameter and its new values.

Maintaining the technological parameters of the system provides the adjustment of its operation modes according to certain requirements that affect the technological processes of calculations.

Downloading the input data ensures that the requirements for verifying the sufficiency, verification and preparation of the input data in the necessary form for the calculations are met. The loading functions are performed from information sources, which can be either internal or external with respect to the ADSS data structures.

The subsystem "Calculation, optimization, forecasting" provides the ability to conduct and obtain the results of calculations of the calculation parameters that are valid on the settlement date of the basic calculation schemes defined in the subsystem "System Setup" and prepared for this when loading data in the subsystem "Preparing input information".

The technological process of calculations is carried out according to the stages: preparation for the calculation, the formation and implementation of the calculation plan, monitoring the status of the calculation, analysis of changes in the array of input data and results.

Each calculation operation is determined by the following attributes: calculation date, information source data date, calculation version, download option, lead time, sign of progress, location of results.

Preparation for the calculation involves the implementation of the following steps: making the necessary adjustments to the input data or performing a new download, analysis of the loading of the input data.

In the future, it is necessary to make a choice of a calculation task, conduct the calculation itself and final analysis of both the final results and the status of the completion of the calculation process.

 ISSN 1560-8956

The status of the calculation is recorded in a special journal, which has the form of a list of messages about situations that arise in the process of calculating the parameters of the subjects.

The "Monitoring" subsystem provides, using appropriate means, the preparation of the main information indicators for assessing the functioning efficiency of the SDA entities, the formation of evaluation decisions in the form of reporting forms of documents. For this, the subsystem provides for the solution of the following tasks: preparation of forms for evaluating information indicators, the formation of reporting forms of documents.

The subsystem "Reporting" is intended for the formation in electronic and printed form of standard reporting forms of documents based on input data and calculation results. To achieve this goal, the following tasks are solved in the subsystem: preparation of information presentation forms, generation of output reporting documents.

The technological process of preparing document forms is carried out in stages and involves: a description of the presentation of the reporting document; creating a template for the report document form, describing the structure of the document data array, forming a list of document form fields; forming a list of fields of the document data filter.

The subsystem "Visual analysis" provides for the analysis of the results of calculations of the parameters of entities operating on the settlement date of the main calculation schemes, which are defined in the subsystem "Settings" and prepared when loading data in the subsystem "Preparation of input information".

Conclusions

Based on the application of the method of object-oriented modeling, information and technological tools are proposed for organizing the process of preparation and verification of primary information and computational methods, including structural and algorithmic organization, for constructing adaptive object-oriented ADSS organizational management, including:

- a unified system for describing the subjects of the OMS, decision-making processes, a unified system of classifiers and reference books of data about the objects of the OTS and the subjects of the OMS, a unified data storage structure;

- unified systems for collecting, verifying the reliability, sufficiency, redundancy of real-time data characterizing the state of the object of organizational management under study, the formation of commercial production accounting data;

- procedures for the development of the organizational, conceptual, informational and functional components of the ADSS that provide an adequate representation of organizational management processes based on real relationships between subjects of the OMS, analysis, interpretation and visualization of modeling results.

REFERENCES

1. Новиков Д.А. Теория управления организационными системами / Д.А. Новиков. – М.: Изд-во физ.-мат. лит., 2012. - 604 с.
2. Ларичев О.И. Системы поддержки принятия решений. Современное состояние и перспективы их развития / О.И.Ларичев, А.В.Петровский // Итоги науки и техники: Сер. Технич. кибернетика. - М.: Изд-во ВИНИТИ, 1987. - Т.21. - С. 131–164.
3. Морозов А.А. Состояние и перспективы нейросетевого моделирования СППР в сложных социотехнических системах / А.А.Морозов, В.П.Клименко, А.Л.Ляхов, С.П.Алешин // Математичні машини і системи. - 2010, № 1. – С. 127–149.
4. Куренных А.Е. Поддержка принятия решений на основе имитационного моделирования / А.Е.Куренных, В.А.Судаков // Научно-технический вестник информационных технологий, механики и оптики. - 2017. - Т.17, № 2. - С. 348–353.
5. Охтилев М.Ю. Интеллектуальные технологии мониторинга и управления структурной динамикой сложных объектов / М.Ю.Охтилев, Б.В.Соколов, Р.М.Юсупов. – М.: Наука, 2006. – 410 с.
6. Автамонов П.Н. Актуальные научно-технические проблемы разработки и внедрения взаимосвязанного комплекса унифицированных интегрированных систем поддержки принятия решений в АСУ объектами военно-государственного управления / П.Н.Автамонов, М.Ю.Охтилев, Б.В.Соколов, Р.М.Юсупов // Известия ЮФУ. Технические науки. – 2014. - №3(152). - С. 14-27
7. Тиханичев О.В. О некоторых проблемах предметной области поддержки принятия решений/ О.В.Тиханичев // Программные продукты и системы. – 2016.- Т.29,№3.- С. 24-28.
8. Борукаев З.Х. Подход к построению систем поддержки принятия решений для автоматизации процессов организационного управления энергорынком / З.Х. Борукаев, К.Б. Остапченко, О.И. Лисовиченко // Адаптивные системы автоматического управления. – 2017. – №1(30). – С. 29-43.

9. Поспелов Д.А. Ситуационное управление: Теория и практика / Д.А. Поспелов. – М.:Наука. – 1986. – 288с.

10. Макаров И.М. Основы автоматизации управления производством / И.М. Макаров, Н.М. Евтихиев, Н.Д. Дмитриева и др.; Под ред. И.М. Макарова. – М.: Высшая школа. – 1983. – 504 с.

11. Ямпольський Л.С. Гнучкі комп‘ютерно-інтегровані системи: планування, моделювання, верифікація, управління / Л.С. Ямпольський, П.П. Мельничук, К.Б. Остапченко, О.І. Лісовиченко. – Житомир: ЖДТУ. – 2010. – 786 с.

12. Трахтенгерц Э.А. Компьютерные системы поддержки принятия управленческих решений / Э.А. Трахтенгерц // Информационные технологии в управлении: Проблемы управления.- 2003.- № 1, С. 13-28.

13. Борукаев З.Х. Концепция построения информационно-технологической платформы проектирования систем поддержки принятия решений для организационного управления энергорынком / З.Х. Борукаев, К.Б. Остапченко, О.И. Лисовиченко // Адаптивные системы автоматического управления. – 2018. - №1(32). - С. 3-14.

14. Framework for energy market communications. Part 301: Common information model (CIM) extensions for markets: IEC 62325-301:2018. - International Electrotechnical Commission, 2018. – 909 p. – (International Standard). - Режим доступа: https://webstore.iec.ch/publication/31487.

15. Остапченко К.Б. Объектно-ориентированное моделирование процессов функционирования субъектов организационно-технических систем / К.Б. Остапченко, О.И. Лисовиченко, З.Х. Борукаев // Электронное моделирование. – 2018. - Т.40, №6. - С. 37-52.