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INTEGRATING INTELLIGENT DECISION SUPPORT SERVICES INTO ANALYTICAL MANAGEMENT SYSTEMS

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Annotation. The article discusses the approach to creating projects of organizational management systems that allow to use the theoretical and practical results of research in the field of artificial intelligence in their design. The importance of using the experience gained to support decision-making in the organizational management system was emphasized. In addition, appropriate recommendations will be developed for the intellectual support of decision-making in integrated management systems, as well as the introduction of service technologies. In the example of supporting management decisions, optimal solutions are put forward for the intellectual processing of information, the creation of services appropriate to expert systems. The article is based on theoretical and analytical data.

Key words: design of organizational management systems, decision support systems, content analysis, problem-oriented thesaurus, process ontologies.

INTRODUCTION

Management of large organizational structures is a complex of complex, semi-structured processes, the synergistic interaction of which should be aimed at the successful implementation of the strategic and tactical tasks of the organization. An important task of introducing rational management processes is to remove uncertainty in making management decisions, which can only be achieved by implementing the maximum possible information support [5].

Information systems created for these purposes differ in scale, architecture, principles of construction, and different functionality. The specificity of systems is also determined by the target orientation of management strategies (business, public administration), industry characteristics, types of management activities and etc.

Typical design solutions reflected in information standards such as MRP (Materials Resource Planning), MRP II (Manufacturing Resource Planning), ERP (Enterprise Resource Planning), CSRP (Customer Synchronized Resource Planning), etc. as a rule, they are not suitable for solving the problems of informatization of large organizational structures, due to the specificity of the tasks facing these organizations. Uniqueness is a characteristic feature of large projects [1, 2, 4].

The above is confirmed by the reports and publications of the research and consulting company Standish Group International, which conducts a study of the activities of information corporations, indicating that approximately 30% of completed information projects do not give the expected results. The study of the reasons for "unsuccessful" projects shows that one of the main design errors is insufficient study of the problem area of the organization, management methods, as well as insufficient consideration of the complexity and invariance of the control object [9].

It can be argued that the interest in research on methodologies for designing information systems, methods of their integration with decision support systems (DSS) is not waning. The relevance and many unsolved problems in this area are convincingly demonstrated by a large number of publications by domestic and foreign experts [2, 3, 7, 8, 10, 11, 13]. In the monograph by JF Lugger "Artificial Intelligence" [8], using examples of specific implementations, it is shown that the choice of methods is dictated by the peculiarities of the problem domain and the demand for certain operating modes. For organizational management tasks, it is possible to determine several levels of demand for the system - from the search for analogies and generalization of results to the formation of solutions and their estimates.

The idea of integrating applied information systems of organizational management with the modules of "intelligent management support", which this article is devoted to, is based on the main function of organizational management systems, which is to accumulate interrelated information about management processes in the organization. The implementation of the idea will expand the possibility of using the accumulated information potential, will significantly increase the functionality of the system due to intelligent decision support services (DSS). The task of extracting knowledge from the information accumulated in the system requires the use of methods and algorithms for data processing based on methodologies that are used in decision support systems and adapted to the operating conditions of organizational management systems [7, 8].

To solve the problem, the article proposes an approach that provides for the inclusion of methods and algorithms for the formation of knowledge in the project of an organizational management system already at the design stage. As an option for a practical solution to the problem, the author considers the construction of an automated system that has built-in tools for forming a knowledge base about the experience of successful and unsuccessful solutions to management tasks based on

the operational information of the system. Algorithms for using the knowledge base for organizing decision support processes are not considered in this article.

Main part

1. Conceptual formulation of the integration problem. Organizational management systems are designed to provide information support to management processes. When developing systems of organizational management, the main emphasis is on: management activities, monitoring the implementation of tasks, interaction with external, subordinate and higher organizations, monitoring the results of organizational decisions. The tasks of the systems include operational coordination of management issues in a distributed environment, regulation of the activities of a large number of process participants, accounting for hierarchical levels of management, provision of various services depending on the level of authority of an employee [5, 13].

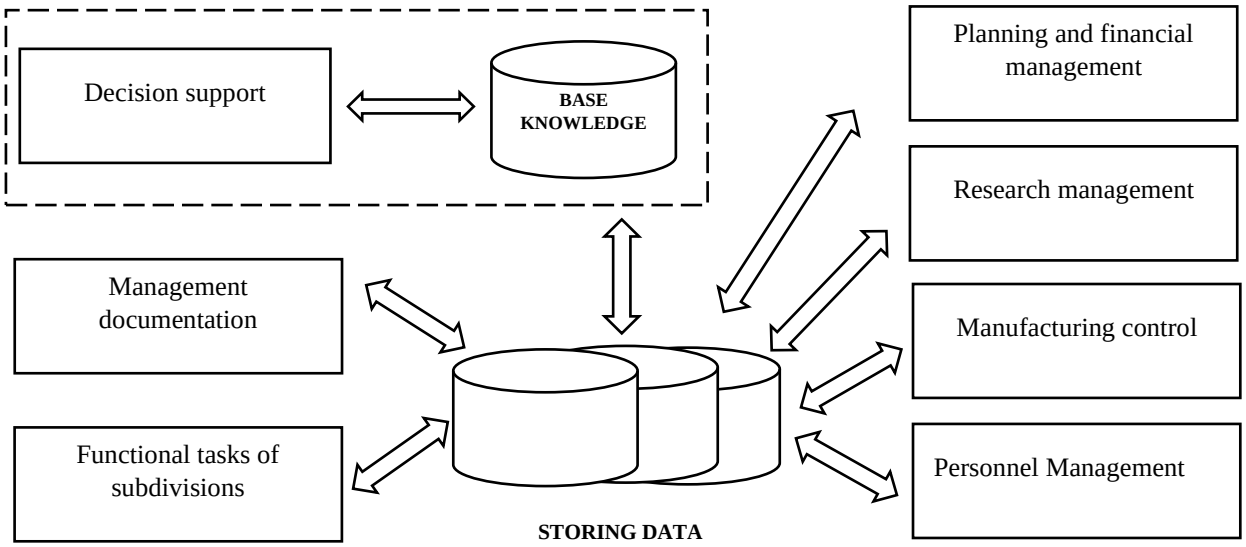

Figure: 1. Scheme of information interaction of the integrated system of organizational management

As a result of the work of automated systems that have been operating in large organizations for many years, the databases accumulate a powerful information potential about the processes of performing various management tasks, which could be successfully used by managers of different levels in solving operational problems of the organization. The systems have the functions of processing and receiving summary data: on the execution of orders, on the analysis of performing discipline, on human resources, on the estimates of information flows and other indicators of the system's functioning. However, there are no means providing for any kind of intellectual generalization of problems, identification of analogs of situations and assessment of the results of tasks (qualitative or quantitative).

The subsystems that make up the software complex of organizational management systems can be divided into two groups by purpose and function. The first group - operational subsystems - is designed to solve functional tasks of management units and general information tasks of an organization. The second group - administrative and organizational subsystems - is designed to manage the information complex, synchronize operational subsystems, analyze and summarize data, and ensure the life cycle of the software complex. The number, scale and specific purpose of subsystems of each group depends on the goals and objectives of the control object.

Operational subsystems provide automation of various management procedures, information and technological support for work performed in the organization, accumulation of information about the execution processes and the results of various management processes. Among the main functional modules traditionally included in organizational systems, the following subsystems can be distinguished:

- organization of information processes for passing documents;
- organization of financial support;
- management of personnel services;
- production management;
- planning tasks for various target areas; other.

During the functioning of the system, the database accumulates information (descriptive, quantitative, qualitative) about the processes and features of the implementation of specific management tasks, about the experience of solving problems, about the participants in the processes. Considering the importance of the accumulated material, the problem of intelligent processing of information arrays for the implementation of functions to support the adoption of managerial

decisions based on the experience of solving operational problems is of practical interest.

Decision support systems, as a rule, use knowledge bases, the formation of which is under the control of specialists in the subject area, which requires experts, certain time resources for data processing, restructuring the knowledge base, etc. The paper considers an approach that allows you to create tools for the rapid formation of specialized information arrays for organizing decision support modes, based on data accumulated in the organizational management system. As a tool for forming a knowledge base, it is envisaged to use special algorithms and tools for structuring information extracted from the system databases.

The conceptual formulation of the problem includes the issues of integrating systems with different functional purposes, the development of principles for extracting the necessary data from operational databases, the formation of a knowledge base in the chosen direction, the development of services that provide intelligent interfaces for work in the PPR modes. The result of the decision will improve the efficiency of the integrated system through the use of intelligent functions, provide additional services when making management decisions.

At the level of design solutions, it is required to determine the boundaries of integration of multi-level and multidimensional functional complexes of the organizational management system and DSS, develop models of basic fundamental decisions, consider the principles of interaction, choose methods for extracting data from the operational databases of the system, develop the structure and methods of forming a knowledge base.

As an example of setting a task (at the conceptual level), we can consider the scheme of information interaction in the organizational management system, presented in Fig. 1. The diagram shows the integration of the organizational management system with the software complex for intellectual support of management processes as information interaction with the integrated database storage of the system.

Depending on the tasks facing the subsystem of intellectual support of management processes, as well as taking into account the target areas of the applied field, when building the subsystem, various approaches can be applied that are used in artificial intelligence systems. In Fig. 2 shows possible options for constructing the interaction of intellectual support subsystems and organizational management systems. In the figure, all subsystems that support the modes of operational management activities are shown in the diagram as a single node. The software implementation of such subsystems is carried out according to the principles of constructing OLTP (Online Transaction Processing) tasks - processing transactions in real time.

The complex of intelligent data processing modules that can be used to organize decision support procedures in organizational management systems is shown in the diagram as a conditional decision support block (DSS). These modules can be used separately or in combination, depending on the requirements of the application area. The diagram shows the main software components that can be useful in organizing decision support procedures when managing large organizations:

– analytical information processing systems (OLAP);

– systems for the formation and use of knowledge available in the system;

– expert systems.

Analytical information processing systems are designed to analyze data obtained as a result of the operation of transactional systems from various points of view. Data warehouses that combine data from various systems can be used to analyze information; analytical cubes - special storages that allow you to quickly process large information arrays to obtain analytical information, assessments of future development, etc.; geographic information systems that allow obtaining analytical assessments from the point of view of the territorial distribution of management objects. These tasks belong to the class of OLAP (OnLine Analytical Processing) tasks and are mainly aimed at obtaining the economic indicators of the organization's activities.

The use of systems for the formation and use of knowledge available in the system requires specialized research on sampling and systematization of data [2, 6]. For example, knowledge about the decisions made in the process of performing the assigned operational tasks. Their analysis can be useful in making new decisions on current problems. Such knowledge can be formed on the basis of process ontologies, which should represent a conceptual specification of the subject area of management tasks in a specific organizational management system, reflected through the processes of implementing management decisions.

To build ontologies, it is required to define a conceptual area of management processes or part of an area, for example, only tasks that influence decision making. In this case, information about management decisions, about the processes and results of the implementation of these decisions, about the participants in the processes, etc. will be used. In the general case, the principles of building ontologies should be based on the used management paradigm, semantic analysis of textual information, synergy of interrelated indicators of management activity.

The use of expert systems in the process of supporting the management activities of a large organization or industry has significant limitations associated with a large number of problem areas. The construction and maintenance of knowledge bases in a wide range of subject areas creates significant difficulties in attempts to create integral expert systems. You can use expert systems in individual subject areas related to the most important areas.

All of these components can be used in organizational management systems individually or in combination.

The inclusion of even one of these components significantly increases the quality level of the system.

Systems for the formation and use of knowledge available in the system are of significant interest for general management purposes, since they provide for the combination of the organizational management system with a complex of intellectual support at the stage of system design, the formation and use of specialized knowledge bases extracted during the operation of the main system.

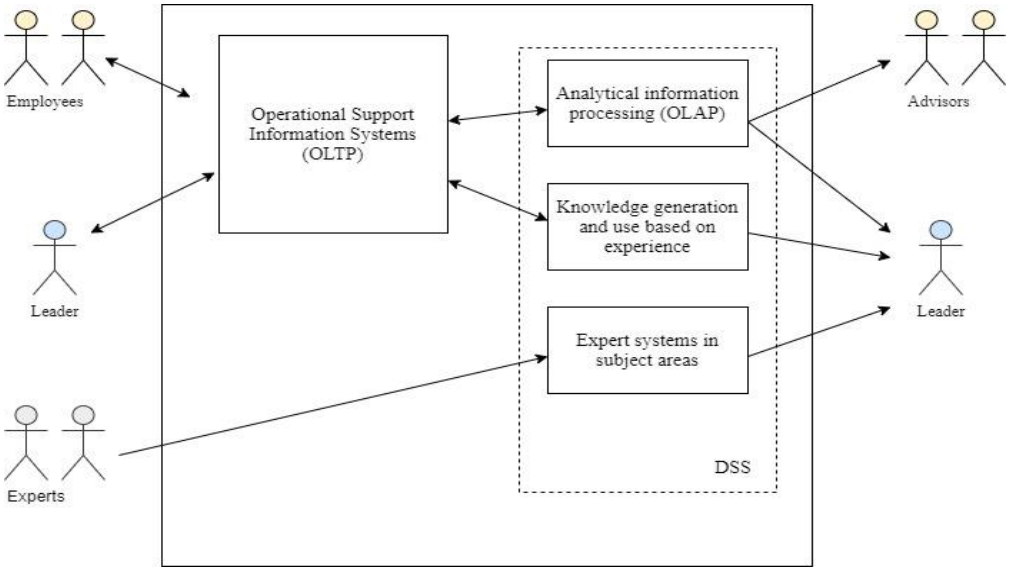

Figure: 2. Schematic diagram of an integrated organizational management system

2. Designing a complex of intellectual support in organizational management systems. The software complex of intellectual support in organizational management systems, from the point of view of the architecture of the entire computing complex, should represent some additional level that does not interfere with the work of the main applied tasks, extracts information about their functioning and processes this information for use in the implementation of intellectual functions. Integration of the system with a complex of intelligent control support complicates the architecture of the system and the design task, requires taking into account additional connections, including means of processing and storing intelligent data.

The architecture of the computing complex, with the inclusion of an additional level, can be represented as follows:

- the level of the operating environment;
- data storage level (DBMS);

the level of processes to ensure the life cycle (LC) of the system;

- the level of applied processes;
- the level of intellectual support systems.

The first two levels are systemic and based on operating systems, database management systems, and tools. The level of lifecycle assurance processes solves the problems of maintaining systems, including, among other things, monitoring tasks. The level of application processes of a specific system is the main one and is designed to solve specific problems of the organization, integrated into a single software and hardware complex. To implement the level of intellectual support of the organizational management system, it is advisable to use the accumulated information potential of the previous level of the system and use the capabilities provided by other levels of the computing complex.

In Fig. 3 shows an example of connecting the function of forming process ontologies and the function of decision support in the project of an organizational management system. The system design is presented in the form of a "UseCase" diagram in the notation of the UML (Unified Modeling Language) [3]. UseCase diagrams are designed to identify the basic functional requirements for using the system and indicate the "user roles" for which these functions are intended. In Fig. 3 shows the main "use cases" of the system (ovals with numbers 2, 3, 4 and 5) in the form of the following management processes: receipt and analysis of documents, decisions on the execution of documents, execution of tasks, fixing the result of execution of tasks for a document (transfer to the archive) ... The monitoring function collects information about the processing and execution of tasks in the system. The relationship of the main "use cases" to system monitoring (block 1) shows the "include" lines directed to this block. The formation of process ontologies (block 6) is an extension (extend) of the monitoring function. As a result, a specialized knowledge base will be formed that can be used by the decision support service (block 7), which is an extension of decision making on the execution of documents (block 4).

On the diagram, ovals 6 and 7, marked with a dashed line, show that the functions of "forming process

ontologies", developed on the basis of specialized algorithms, can be generated automatically and controlled by persons accompanying the system, and the

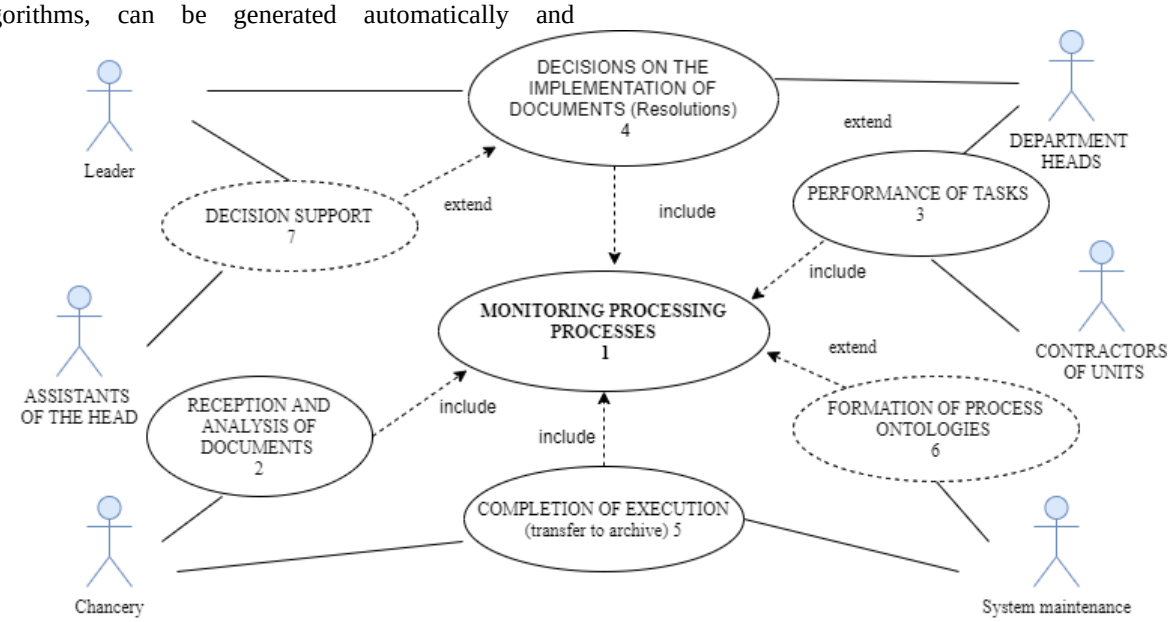

Figure: 3. Diagram Use Case, showing the inclusion of elements of intellectual support for management activities

functions of "decision support" are focused on the goals and objectives of persons, decision makers (DM).

Thus, the solution to the problem at the level of system requirements is concentrated in two blocks 6 and 7. The block of formation of process ontologies should contain a description of the conceptual scheme of the domain (interests) of management and include a hierarchy of concepts, as well as mechanisms for replenishing and adjusting the knowledge base. The PPR block should include a complex of intelligent services that provide decision support, taking into account the access levels in the hierarchical structure of the organization.

3. Formation of a knowledge base and implementation of decision support mechanisms. It is proposed to use information ontologies as a structure for representing knowledge, which will be created in the system in order to organize decision support procedures. In this case, ontologies will include a thesaurus of management domain terms associated with data on the implementation of management decisions.

To form process ontologies, it is necessary to determine the conceptual area of the organization's management processes, the main factors, their mutual influence on decision-making, explore possible ways to extract and process information stored in the operational databases of functional systems, develop the structure of objects (attributes, values) and a complex of software for extraction data.

Information content of databases of organizational management systems (Fig. 1) contains documents, dates, facts, events, text fragments, resolutions, links and numerical data. All information is linked by a storage structure and a hierarchical organization structure.

The formation of a knowledge base based on the available information requires preliminary semantic processing of text fragments, the use of rules for selection and generalization of data, the construction of specialized thesauri, content analysis for certain document attributes, the development of algorithms for identifying precedents that are logically close in terms of specified parameters, and the creation of the necessary presentation forms. data, etc.

As a result of the preliminary research carried out, the first level of formation of ontologies important for organizational management systems is tentatively determined:

- precedents - tasks (work) fundamentally important for management purposes.
- execution processes - data characterizing the processes of performing specific tasks associated with precedents;
- results - data characterizing the implementation of specific tasks related to precedents (execution of orders, terms, quality);
- external conditions (period, environment) - data characterizing temporary situations (changes in standards, legislative acts, etc., with reference to time).

Identifying precedents is the most important step in the task. Algorithms, processing must determine the documents associated with a certain task, assess the importance of the problem and determine whether this problem relates to use cases that deserve to be entered into the knowledge base. The algorithm should be focused on working with a specialized thesaurus and be based on textual information and information about

inter-document links. A specialized thesaurus will define the hierarchy of use cases. An essential part of the algorithm is determining the importance of the problem. In this case, you can use heuristic methods, methods of fuzzy logic, or develop methods for applying indicators of the value and usefulness of information to a specific situation. "The value indicator can be formed on the basis of the criteria of semantic correspondence (SSS), which determines the degree of proximity of the elements to the user's tuning characteristics" [12].

The results of specific assignments related to use cases can also be a useful clue when choosing a solution. Information on the results of assignments in organizational management systems may contain qualitative and quantitative indicators (completed on time, not fulfilled, time exceeded, etc.). Qualitative indicators are imprecise, unclear, and can be determined through descriptive variables. The main problem of the algorithm is also the development of estimates based on the results of work.

The development of intelligent decision support services based on the created knowledge base, as well as the development of the PPR interface must take into account the structure of the organization, the hierarchy and the powers of the system users. Services can be aimed at finding new solutions based on the experience of performing previous tasks, at finding similar situations, taking into account positive and negative factors that, to one degree or another, affect the performance of tasks. The interface should include the ability to customize the services used. In general, other possibilities of applying the developed information approaches can be considered.

The mechanism for creating intelligent services should be integrated into the project of the organizational management information system at the level of the conceptual model, which provides for the inclusion of specialized decision support modes focused on specific goals and objectives of management.

CONCLUSION

The implementation of modern automated systems aimed at informatization of management activities is of considerable scientific interest due to the increasing possibilities of including intellectual components in nformation systems. If earlier the central task of automating management activities was a systematic approach to registration, accounting, generalization and control of information flows, now interest is shifting to tasks that use decision support functions, situational management, quality management, expert systems and other elements of intellectual support for management activities.

The article proposes a method for implementing decision support modes, which allows you to use your own information resources of a management organization, accumulated in the process of functioning and containing data on the processes and results of solving various management tasks. Typically, this fund s used as a look-back array for obtaining inquiries on specific requests. The article outlines the fundamental approaches and methods that significantly expand the possibilities of using the accumulated information potential. The key point of the proposed approach is the formation of problem-oriented (process) ontologies based on the accumulated operational information of organizational management systems.

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