CONCEPTUAL BASIS OF THE INTELLIGENT DECISION-MAKING SUPPORT SYSTEM OF REGIONAL RESEARCH MEDICAL CENTER

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Annotation. The principles and conceptual structure of the intelligent automated system to support strategic and operational decisions for a particular Research Medical Center, combining scientific experimental and curative activities, are described and structured. The scheme of intellectual system of support management decisions for the Regional Research Medical Center is developed with the use of systematic and structural functional approaches. The system is designed to support both strategic and operational decisions based on previous experience of leading relevant medical centers. It includes a system of search and analysis of information from open sources and databases. The system also includes the use of an expert approach, that is, the final decision will be made on the basis of the recommendations of experts in the light of leading medical centers accumulated experience, research and logistic sustainment.

Key words: intelligent system of decision-making support, strategic and operational management, regional research medical center.

Introduction. The successful development of significant enterprises and organizations in the regions is largely ensured by the level of analysis and assessment at the planning stage of its innovative development. It is the lack of quality of work at this stage that reduces the effectiveness of projects to create and implement breakthrough research, and, therefore, it provides poor performance of innovative development of enterprises and organizations (including regional research medical centers). The problem is complemented by the lack of a set of interconnected low-cost flexible technologies and models for monitoring and analyzing the performance indicators of regional research medical centers, and by the lack of customizable automated data systems with databases and knowledge using intelligent interfaces.

The purpose of this work is to develop a conceptual scheme for the construction of the intelligent decision support system in the field of strategic and operational management of regional research medical center. The study object is a large regional research medical center – Tomsk Research Medical Institute of Balneology and Physiotherapy (further – Balneology Research Institute).

Literature review. Researchers and practitioners are currently working in exploring the possibilities of introducing IT products in order to improve the efficiency of activities in public health. One of the directions is the development and implementation of decision support systems both practical and strategic in medicine. Such decision support systems can be targeted to:

- operationalization of the specialist activities in tactical terms, which is connected with the monitoring and assessment of the state of physiological parameters and patient health condition;
- management of data related to the systematization and processing of information on the current activities of the centre/institution;
- management of long-term strategic changes.

The last direction is the least developed because of the complexity of solving the problem on the strategic development of large medical centres, with a view to advancing the development of territories and regions.

We note the works [9, 11, 16], among the existing publications on the subject of this work, on research and assessment of IT solutions for decision support systems in the assessment and project and technology selection, assessment of the effectiveness of health policy and organizational issues of medical centers.

According to the general architecture of the decision support system, algorithms for search and selection of data, sources for the formation of input data for the system, cloud storage and processing of data are the most important works [6, 8, 9, 11].

The most important work on the problems of implementation of comprehensive studies to assess strategies aimed at different groups of stakeholders and tasks in medicine (health profession-

als; legislators and managers; patients and other consumers of medical services; diagnostic tests, health policy) is the work [15].

The principles of creating information decision support systems based on cognitive models are considered in the studies [7, 12-14, 18].

The basis for the formation of intelligent information and analytical systems to support strategic decisions is a multi-criteria analysis based on the impact of factors affecting the efficiency of resource allocation (energy, financial, labor, etc.), using aggregated efficiency indices (in the works [1, 5, 10]), calculated on the basis of the growth of indicator values. With their help, the contribution of various factors to the dynamics of the resource cost is estimated [19-21]. The result of factor analysis depends on the decomposition method, the level of detail of the analysis, the definitions (from the interpretation of "structural factor", "technological factor") and data availability. An alternative approach is based on the construction of sign or vague cognitive maps. Analysis of the indirect impact of many factors on the level of efficiency of resource allocation, performed on cognitive maps (for example, in the work [16]) is based on expert assessments of the direction and strength of the interaction of factors. The authors propose to apply hierarchical hybrid cognitive maps (HHCM) to combine an approach based on the processing of real data (indicator values) characterizing research medical institutions, and an approach using expert opinions about the nature of the influence of factors against each other [19-21].

Methodology of the study. The development of a conceptual model and methodological frameworks for the construction of an intelligent decision-making support system involves the use of systematic and structural functional approaches to the study.

Sources of information for the study included:

- works of foreign and Russian scientists in the field of strategic management, development of intelligent decision-making systems;
- information about the activity of the Balneology Research Institute.

The following features of the Balneology Research Institute were also taken into account:

- availability of the approved development program in the coming years;
- a wide range of activities including the implementation of two main functions – medical and innovative, and also research;
- a widespread network of branches located in Tomsk and Seversk, which requires the formation of an adequate automated system for collecting and processing information;
- features of financing of health services within the system of CHI and other systems.

Features of formation of the conceptual scheme of the description of functional areas of managerial decision-making. In accordance with the stated purpose in this article, the main aspect of the study was to study the operational processes occurring in the Balneology Research Institute, taking into account the features of the architecture of the institution management. This allowed to identify and describe the content of the main functional areas of decision-making affecting the effectiveness of the organization. According to the generally accepted concepts given in the works of the majority of the founders of modern management [2-4], the authors attributed among these areas:

1. Ambitions/desires of the management of the organization, embodied in their desire to achieve success in the short and long terms, realized through goal-setting, formulation of vision and mission, development of the strategy and program of institution development, and also through the solution of emerging problems at different taxonomic levels.
2. The capacity of the organization with available resources, staff competencies, organizational culture, infrastructural features of the research and curative activities of the Balneology Research Institute.

The universal nature of the inclusion of the information system in the management line of the organization increases the speed and flexibility of the system's response to current changes and strategic planning (Figure 1).

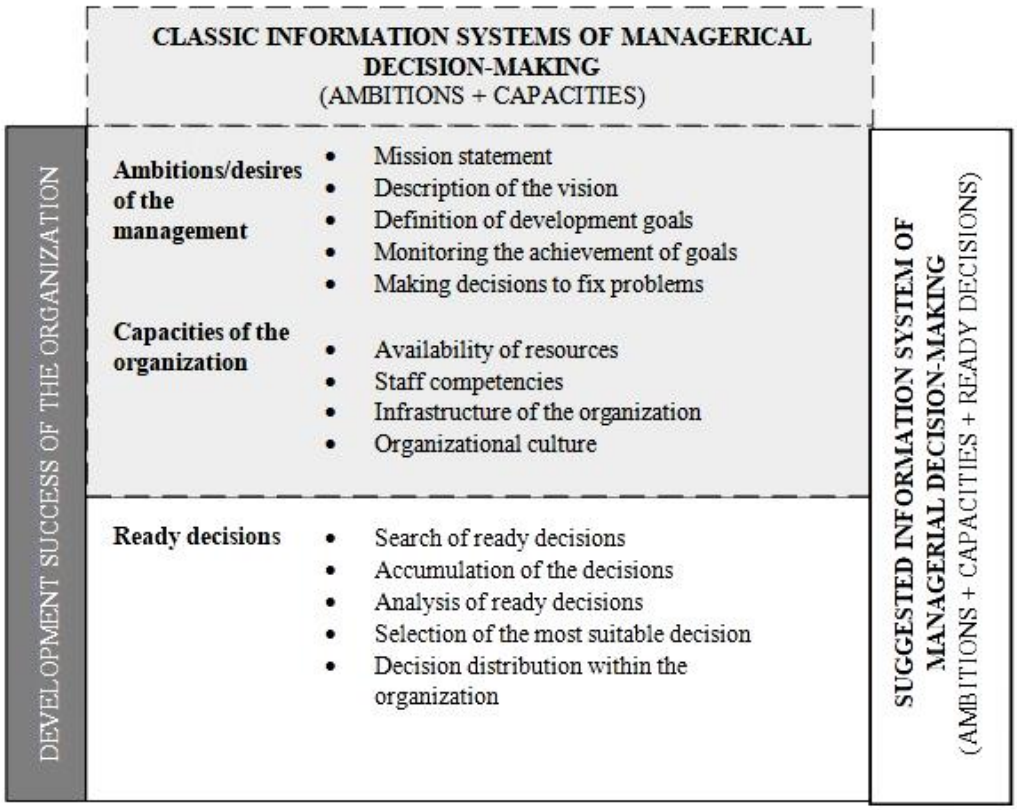

Figure – 1. Structure of functional areas of intelligent managerial decision-making system

It should be noted that the success of achieving the goals and solving the problems expressed in the documents of organizations is connected to their own experience of the management of the institution and the experience of other organizations, which necessitated an allocation of a separate functional unit "Ready Decisions" aimed at solving internal and external problems of the organization. The need for this unit is dictated by the acceleration of technology transfer, including medicine.

The emphasis on the search for ready-made decisions, according to the authors, increases the organization's abilities to successfully development and implements its development program. Ignoring of this add-in pushes medical institutions for a backlog in research and curative activities. Ultimately, it leads to a decrease in competitiveness and increased waste of resources in resolving internal problems.

Further study of the major functional areas of decision-making in the Balneology Research Institute allowed the authors to identify specific major functional subsystems within their frameworks, which have an impact on the successful development of the institution. Allocation was carried out taking into account the taxonomy of management (i.e. strategic and operational management). As a result, it is revealed that the effectiveness of the decision is connected to functional subsystems at the strategic level: "goals and priorities of the development of the organization" (as an element of the functional area of "ambitions of the management"), "capacity of Tomsk Research Medical Institute of Balneology and Physiotherapy" (as an element of the functional area of "organization's opportunities") and "global and Russian tendencies of development of science and practice" (as an element of the functional area "search of ready-made decisions").

A similar approach to the operational level of management of the institution has made it possible to identify functional subsystems that relate not only to the three functional areas mentioned above, but also to the strategic and operational levels:

- operational management system which is built on the basis of strategic and operational KPI (key performance indicators) and characterising the area of "ambitions of the management",
- business processes of the organization that have a direct impact on the capacity of the organization and its capabilities,

- research methods and greatest management practices related to the experience of the institution and other organizations.

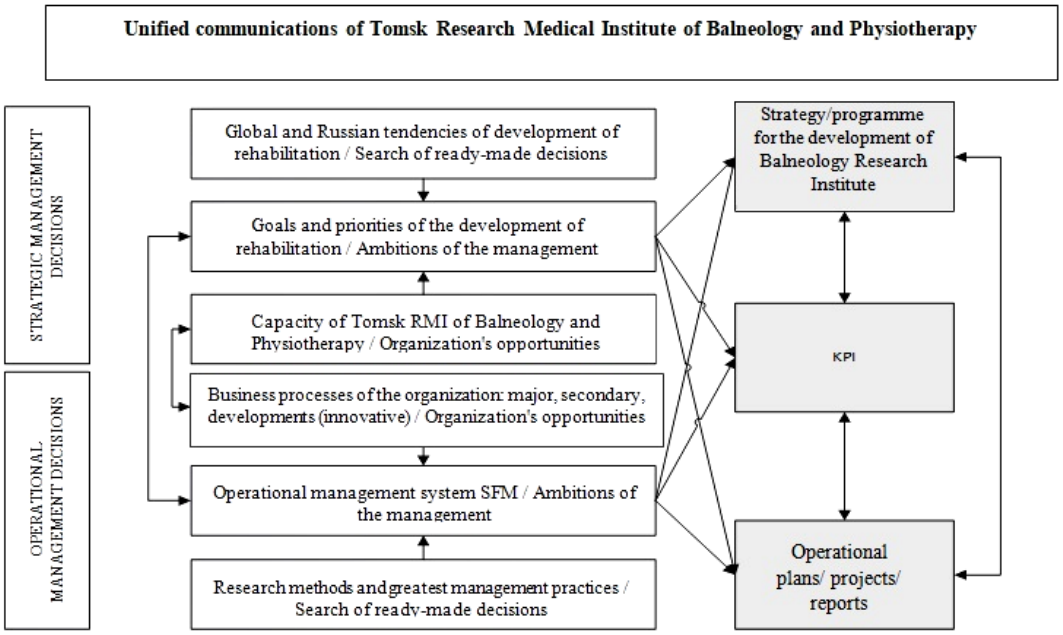

Figure – 2. Structure of managerial decision-making of the Balneology Research Institute

The implementation of this system of managerial decision-making in practice should be connected to the organization's formalized results. Within the framework of the information system, there will be internal documents of the organization at the strategic (strategy, development program, roadmap for advancement of institution) and operational levels (operational plans / projects/ schemes of implementation of operational processes), which are interconnected through a single system of goals and indicators.

The analysis of the work results of the medical institution, which was carried out in the framework of the study, concluded the discrepancy of the current indicators given in the development program with the real business processes implemented in the organization and world trends in medical services. For example, the development directions of the Research Medical Institute of Balneology and Physiotherapy for 2017-2021 reflect the groups of development indicators for the following tasks:

1. Improving the effectiveness of research projects (without describing the major topics of projects and their correlation with the world research trends of the leading research medical centers in the field of institution's activity);
2. The development of clinics of FSBI SibFCRC (Siberian Federal Clinical Research Center) of FMBA of Russia and formation on its basis of a multidisciplinary center providing quality and affordable health care to the population of Tomsk region and other regions of the Russian Federation (without analysis of the dynamic changes in health status and projections of research needs in the field of the institution);
3. Human resource capacity of the institution;
4. Research infrastructure developments (the development plan shows a steady decline or lack of indicators growth connected to the attraction of funding and contracts for the development of new medical technologies).

Some indicators describing some of the activities of the institution are shown in the tasks above. In doing so, there are no tasks and indicators aimed at a comprehensive assessment of development processes and processes to support major management decisions.

Overcoming of this restriction in the author's information system will be implemented through the organization of interaction between functional subsystems and performance. This will make it possible to improve the management efficiency of the medical institution and to ensure the growth of its competitiveness.

The current plan of the institution is drafted in a manner that it does not allow to reliably diagnose the achieved organization's position in the scientific section. Strategy indicators do not show the current level of organization's efficiency, do not reflect the prospects of development (level of innovation development, compliance with world / national priorities of innovation)

The scheme suggested by the authors will allow to correlate strategic management decisions with operational ones (Figure 3).

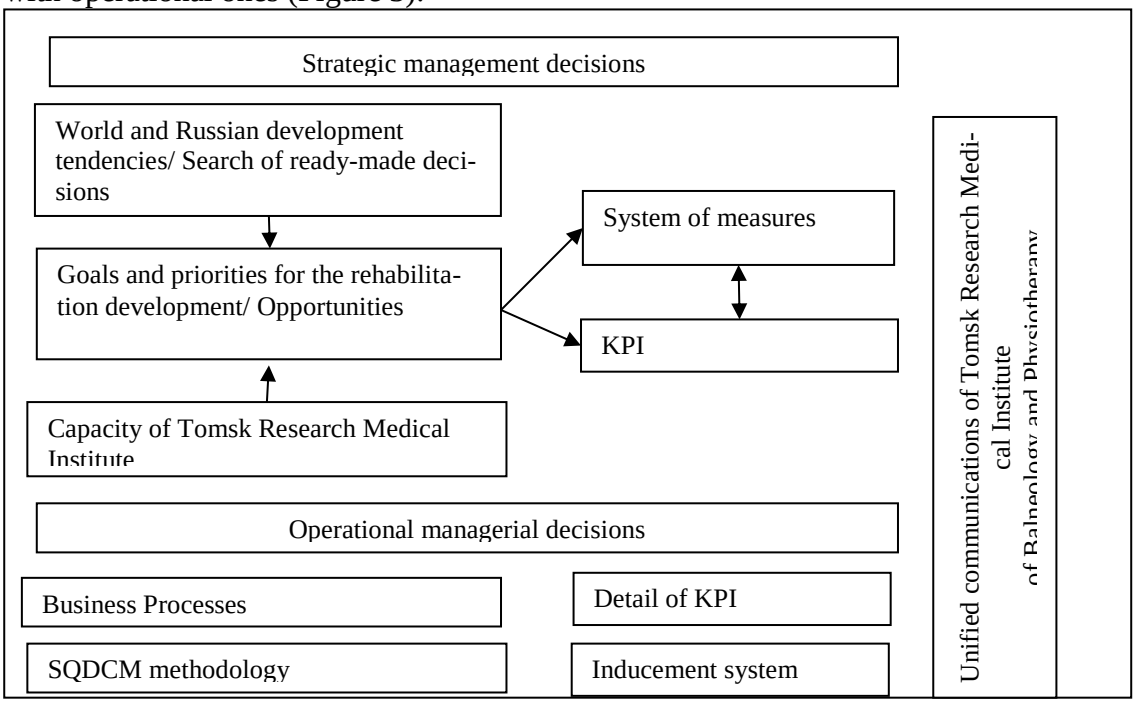

Figure – 3. Conceptual scheme of the intelligent decision support system in the rehabilitation direction of Tomsk Research Medical Institute of Balneology and Physiotherapy

Conclusion and the application of the results. The conceptual description model of functional areas of management decision-making suggested by the authors allows to take into account the latest scientific and practical achievements in the field of institution activity, offering ready-made decisions for use by institution's specialists. The authors are planning to use the following technologies to build an information system that will become the basis for optimizing solutions:

1) in the field of assessment of innovative potential: methods for assessing the long-term prospects of the formation of breakthrough directions (FORSIGHT); methods of collection and analysis of information obtained with the help of experts (SWOT analysis; method of formation of an expert opinion developed by the project executors; method of analysis of Saaty's hierarchies); statistical methods of data analysis, including methods of correlation, factor and cluster analysis.

2) in the field of intelligent data analysis: methods of analysis of big data; methods of machine learning; methods of soft computing; method of constructing cognitive maps.

3) in the field of software development of decision support systems:

- methods of software development; methods of describing business processes (BP);
- methods of datasets analysis (OLAP).

The developed system of search places on the Internet will be systematized and structured by the stages of the innovation process, by countries and regions, by the currency and by the areas of specialization of the major research medical centers studied in this project.

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МОДЕЛИРОВАНИЕ ГИДРАТАЦИИ ПОРТЛАНДЦЕМЕНТА В ЕСТЕСТВЕННЫХ УСЛОВИЯХ

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MODELING OF PORTLAND CEMENT HYDRATION IN NATURAL CONDITIONS

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Abstract. The paper presents research results on Portland cement curing during a long period of time with natural hardening (T = 20 °C). Investigations are performed in a virtual testing laboratory environment provided by the Virtual Cement and Concrete Testing Laboratory software. It is shown that after 28 days, hydration of the type Cem I 42.5B Portland cement is ~0.75. Further, the hydration process substantially retards and lasts for about a year. The amount of cement brick in Portland cement increases and achieves 0.7 of the amount of the solid phase and the pore volume. It is found that effective values of elasticity modules intensively grow during 400 h and then monotonely decrease down to the following values: 16.79 volume modulus of elasticity; 8.90 shear modulus and 22.69 MPa Young modulus. It must be noted that after 28 days, the curing process in Portland cement continues. A free aqueous solution with pH higher than 12.96 can be a source of unfavorable fatigue effect during operation.

Key words: hydration, alite, belite, ferrite, alumoferrite, cement stone, portlandite.

Введение. В процессе твердения в портландцементах наблюдается ряд химических реакций с формированием различных продуктов. На количественное содержание конечного продукта гидратации оказывает заметное влияние исходный состав клинкерных минералов. В пределах 24 часов примерно 50% цемента трансформируется в гидраты, а в течение 28 дней – около 80%. Реакции гидратации алита (C_3S), белита (C_2S), алюмината кальция (C_3A) и алюмоферрита кальция (C_4AF) связаны с растворением клинкерных минералов и выделением продуктов гидратации, образование которых происходят с разной скоростью. Взаимодействие с водой алита C_3S описывается реакцией [1–5]

$$C_3S + (3 - x + y)H \rightarrow C_xSH_y + (3 - x)CH, \quad (1)$$

где x – доля перераспределенного оксида (CaO) между силикатом гидрата и портландитом, y – доля присоединенной воды (H_2O) к гидрату, которое вследствие вариации исходного состава может не соответствовать точной стехиометрии (C_xSH_y).

Гидратация цемента – это сложный процесс, включающий в себя большое число механизмов, каждый из которых описывается собственной группой переменных. Для система-