Materials of the Conferences

MATHEMATICAL MODELLING OF MANAGEMENT IN MULTILEVEL SYSTEM OF PUBLIC HEALTH SERVICE

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The general task of public health service management as a whole, as well as treatment-and-prophylactic establishment management of public health service based on information technologies assumes, first of all, the development and application of some "tool" of management which is the mathematical models describing the process of organization functioning. In other words, in «the virtual environment», formed by information technologies, mathematical models act in the role of some «matter» on the basis of which the analysis and synthesis of managing influences is carried out.

In modern conditions, while developing mathematical models principles of systems approach are widely used, the basic among which are the following:

principle of unity: joint consideration of system as the whole and as sets of elements from the position of realization of general aim;

principle of connectivity: as a rule the approach is quantitative for any part together with its connections with environment;

structural description of system constructed for majority of cases by hierarchical principle.

Mathematical models of optimal control of public health service should realize the principles of system approach taking into account specific features of public health service. In 1982 E.N.Shigan stated the methodology of systems approach, classification of methods of system researches is made in the field of medicine in the work «Systems analysis in public health service» [1.2]. In this work the conceptual device of systems analysis and its place in managerial process by system of rendering of medical aid is considered.

1. System of public health services is the complex self-organizing system which elements are people and technical objects. The specific feature of such systems is the presence of theirs own purposes not always conterminous to the global purpose. The self-organizing systems possess the following attributes: stochasticity of behaviour, not stationarity of separate parameters and processes. There are also such attributes as unpredictability of behaviour, ability to adapt to changing conditions of environment, to change structure during interaction of system with environment, preserving property of integrity, ability to form probable variants of behaviour and to choose the best from them. System of public health services is complex organizational system. As rule the organizational systems are based on hierarchical principle: the subordination of lower levels to upper levels.

The account of own purposes of elements does not only brings an uncertain factor in process of its functioning, but demands studying and modeling both the system as a whole and its separate elements (subsystems).

The system includes set of the interconnected subsystems which functioning is multi-purpose, directed on achievement of several own purposes.

2. The system is dynamic, and its condition is defined by big enough set of quantitative indexes.

3. The system has set of uncertainty factors and accidents and it provides necessity of use of stochastic models.

The listed attributes allow to relate system of public health services from the point of view of mathematical modeling to complex control systems which can be submitted by three-level model (fig. 1).

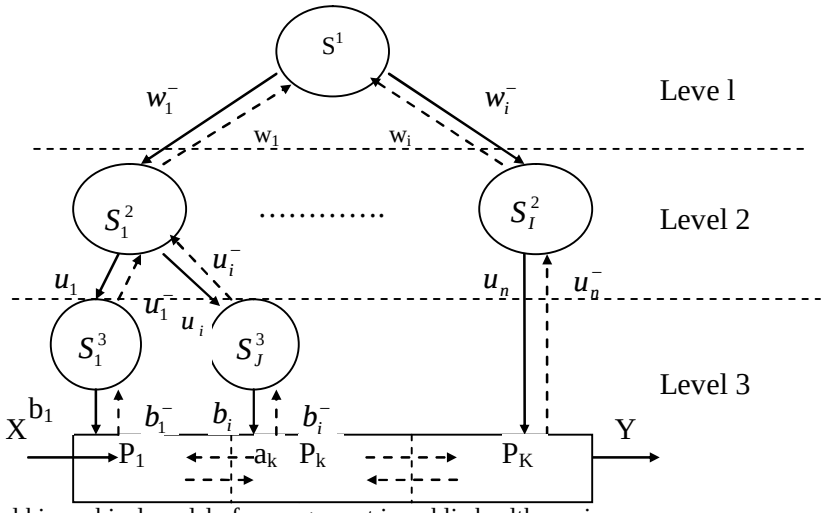

Fig. 1. Three-level hierarchical model of management in public health service

If to consider the system of public health services as a whole, the top level of management S^1 is the Ministry of Health of the Russian Federation. The level $S_i^2, \quad i=\overline{1,I}$ is submitted by bodies of territorial management of public health service. The level $S_j^3, \quad j=\overline{1,J}$ is a level of medical establishment. $P_k, k=\overline{1,K}$ represents object of management which is submitted by the state of health of the population. It is the level of birth rate, diseases and death rates, medical-ecological and medical-climatic parameters, etc.

If we consider such complex systems of public health service as polyclinics, hospitals, clinics, dispensary, cardiological and other services, the top level of management S^1 is the Head Health Service (the head physician), the level $S_i^2, \quad i=\overline{1,I}$ is submitted by branches, the level $S_j^3, \quad j=\overline{1,J}$ is the level of the doctor (the doctor of the general practice or the particular expert). As object of management $P_k, k=\overline{1,K}$ is the state of health of the population.

As complex system of public health services it is also possible to consider processes: medical-diagnostic, preventive, dispensary, educational, etc. Interpretation of levels of management in this case will be another.

There are also other elements of control system of public health services to which it is possible to relate system of obligatory medical insurance, system of voluntary medical insurance, medical associations, associations and the unions of consumers, etc.

The development of complex systems causes the problems concerning not only to properties of elements making them and subsystems, but also to laws of functioning of system as a whole. So it results specific tasks:

definition of the general system structure;

organization of interaction between elements and subsystems;

account of influence of an environment;

choice of optimum modes of functioning of system;

optimum control of system, including optimum decision-making at all levels.

In complex control systems, according to [3] the following concepts of management are possible:

authoritative (command) when orders, instructions of higher body of management should be carried out strictly by all subordinate objects, i.e. it is supposed that the higher body in all situations operates rationally (optimum);

democratic (conciliatory) when higher body, before issuing the order, previously will coordinate, i.e. discusses with subordinate objects;

scientifically grounded when research activities are previously carried out,

mathematical modeling and calculations with the real data and only then (after the coordination at all levels) is issued the corresponding order;

mixed when the democratic concept is applied on one sections, on another - authoritative, and on the third sections – scientifically grounded.

It is clear that in a real life rational management of complex system can be carried out only applying the mixed concept at a rational combination of authoritative, demographic and scientifically-grounded, proceeding from economic social and ecological criteria.

The scientific substantiation of all accepted decisions now demands both too great volumes working hours, and material and financial assets. As, on the one hand, the level of development of science in the field of management of complex systems at the given stage does not correspond to advanced achievements in the field of a computerization, and on another - the administrative personnel accepting and supervising execution of decisions, not always having corresponding scientific preparation.

The democratic coordination of all accepted decisions without a sufficient scientific substantiation also demands a lot of time for discussion and the coordination (though less), but thus accepted decisions will be less concrete, that will lead to inevitable losses at their realization.

The cheapest is realization of the authoritative concept when it is not required to waste time on the coordination and discussion of decisions. It is necessary to bring them to executors only. However, if the higher body of management is badly equipped technically, completed with experts with low qualification and a small operational experience in a control system, acceptance of erroneous decisions resulting in large material, ecological and social losses is possible.

Significant difficulties in management of complex system of public health service arise also in connection with multilevel hierarchical character of objects (subsystems) and criteria of their optimization. Basically it occurs because of weak methods of decision making in multilevel hierarchical systems in conditions of uncertainty.

These systems are characterized not only by big number of elements and complex structure, but also by more high level of the organization. A high degree of the organization of such systems, with the presence of hierarchical structure corresponds also the greater densities of the expenses connected with processing of information (non-material) streams, providing purposeful behavior of dynamic system that causes wide draft on funds of computer facilities and formal methods of decision making while managing such systems.

When deciding optimized tasks in management of complex systems of public health service it is necessary to apply vector criteria which allow to take into account optimum technological modes of separate objects. At the same time the chosen optimum mode should provide achievement of ultimate goal of subsystem of public health services. It is to maximize quality of rendering medical aid. For this purpose it is necessary to carry out the control and management of one of the major processes, influencing on an eventual result – the process of rendering primary medical aid.

While controlling the process of rendering medical aid various parameters are used. They characterize this process only indirectly, frequently they are inconsistent and usually developed for concrete medical establishment or territory. Therefore it is necessary on the basis of lines of models and algorithms, on the various parameters received on the basis of information technologies to coordinate decisions for various levels of system and inside it. Thus it is required to make decision at presence of complex multilevel hierarchical system of models of management in public health service.

Thus for tasks of the control and management it is necessary to create a uniform method of making decision in multilevel hierarchical systems in conditions of various kinds of uncertainty.

Hierarchical management structure has been caused by the escalating complexity of technology of controlled objects creating big difficulties for a centralized direction. There was necessity of division of all decision-making

process for such number of levels so that the task solution of optimization for each of them was not complex. But with occurrence of multilevel hierarchical control systems the new task of coordination of decisions accepted in all levels of management has appeared also.

The general scheme of coordination in two-level system is reduced to the following. The elements transfer a set of variants of the work in the center. Each variant represents the vector parameter of an element allowable from the point of view of its local restrictions. On the basis of variants received from elements the center forms the plan, optimum from the point of view of all system [3]. This plan is transferred by elements and further is detailed by them.

To advantages of hierarchical structure of automated management in which at the bottom level there is a plenty of simple tasks, and at higher levels - a small number of challenges, it is necessary to relate (according to the foreign data) decrease in a total cost of information handling in system, increase of throughput in networks of the computer and stability to refusals. Critical functions for system should be carried out by local control systems at failure of a server or communication lines.

Now a big attention is paid to the questions of making decision in complex organizational hierarchical systems both in our country and abroad. The feature of these tasks is the absence of material flows between various levels of hierarchical system.

The basic points of the theory multilevel hierarchical systems have been developed by M.Mesarovich and his cooperators [4]. In this work for the first time the essence and interrelation of three basic categories of hierarchy is opened: stratification, multisection and multiechelonment.

M.Mesarovich defines three types of hierarchical systems which somewhat reflect classification of hierarchies. He enters three concepts of levels:

1. Level of the description, or abstraction;
2. Level of complexity of the accepted decision;
3. Organizational level.

However all three concepts can simultaneously be used in the description of real hierarchical systems

Levels of the description or abstraction. The complex system cannot be described fully and in details it follows from the definition of such system. The basic dilemma is to find the compromise between simplicity of the description that is one of preconditions of understanding and necessity of the account numerous behavioral (type of input - output) characteristics of complex system. The decision of this dilemma is searched in the hierarchical description.

The system is set by family of models, each describes behavior of system from the point of view of various levels of abstraction. For each level there is a number of prominent features and variables, laws and principles to describe the behavior of system. To make such hierarchical description effective, in opinion of M.Mesarovich, it is necessary to reach independence of models for various levels of system.

However the assumption of full independence of strata would be unjustified, therefore the neglect of their interdependence can lead only to incomplete understanding of behavior of system as a whole.

Levels of complexity of the accepted decision. Other concept of hierarchy concerns to processes of acceptance of complex decisions. In this case family of problems is defined which try to be resolved in the consecutive way in the sense that the decision of any problem from this sequence defines and fixes any parameters in the following problem, so last becomes completely determined and it is possible to start its decision. The decision of the initial problem is reached as soon as all sub-problems will be solved. M.Mesarovich calls such hierarchy of layers decision-making.

The so-called functional hierarchy of decision-making or management concerns also to the same category. This hierarchy arises naturally in connection with three basic aspects of the problem of decision making under uncertainty: a) a choice of strategy which should be used during the decision; b) reduction or elimination of uncertainty; c) search of

preferable or allowable way of the actions satisfying set restrictions.

The functional hierarchy consists of three layers.

1. The layer of a choice: the task of this layer is a choice of way of actions. The element accepting the decision on this layer receives external data (information) and applying this or that algorithm determined on the top layers, finds the necessary way of actions.

2. The layer of training or adaptation. The task of this layer is a concrete definition and narrowing of set uncertainties with which the layer of a choice deals.

3. The layer of self-organizing. This layer must choose structure, functions and the strategy used on underlaying layers so that whenever possible it will come nearer to the global purpose. If the overall aim is not reached this layer can change functions on the first layer or strategy of training on the second layer in case of insufficiency of estimation of uncertainty.

Organizational hierarchies. This category of hierarchy means that:

1. The system will consist of family of cooperating subsystems;

2. Some of subsystems are decisive elements;

3. Accepting decisions elements settle down hierarchically in the sense that some of them are under the influence or coped by other decisive elements.

Though the top level elements cause purposeful activity of elements of the bottom levels, but not completely operate it. Some freedom in a choice of their own decisions should be given to elements of the bottom levels accepting decision.

Such systems are named multiechelon. The presence of some supreme command element is considered to be the basic distinctive feature of such systems; the problem of decision-making in the order this element is the basic problem in theory of multilevel systems.

Each of the entered concepts has the scope, namely: the concept of strata is entered for the purposes of modeling, the concept of layers - for vertical decomposition of a solved problem on sub-problems; the concept of echelons concerns interdependence between elements of decision-making forming system.

Despite of distinction of the specified categories, there are also the general for all three concepts of feature.

1. The element of the top level deals with larger subsystems or with wider aspects of behavior of system as a whole.

2. The period of decision-making for elements of a higher level is more than for elements of the bottom levels.

3. The element of the top level deals with slower aspects of behavior of all system.

4. Descriptions and problems at the top levels are structured, contain more uncertainties and are more difficult for quantitative formalization.

While accepting the operative decisions in complex hierarchical system the basic purpose is finding a vector of decisions $x_i^0(t)$ in each level $i, i=\overline{1,I}$ which provide a maximum of system criterion function $F(x_1^0,...,x_N^0)$ at the coordination task $x_{N+1}^0(t)$ received from (N+1) of a level of management. And decision-making process is carried out discretely in points of time $t=\overline{1,T}$ and generally, the step of digitization on management grows from the bottom levels to the top. The part of decisions (basically at the bottom levels) is characterized by managing influences, and the most part only coordinates work of subsystems of different levels. The assignment to subordinate subsystems of criterion functions is also the means of coordination, however in the given task it is supposed that they are already chosen.

The found decision $\{x_i^0\}, \quad i=\overline{1,N}$, should belong to the subset of modes allowable for system (technological, economic, etc.) $C \subset X$ i.e. to be coordinated with opportunities of technology.

The attempt of direct use of uniform global criterion of the top level $F(\bar{x}_N)$ with its subsequent decomposition for subsystems of all levels makes the task of optimization to be extremely complex and ignores presence of own criterion functions at active subsystems.

Besides, global criterion function $F(\bar{x}_N)$ does not depend obviously on the decisions accepted by subsystems of subordinate levels that complicates a choice of operating modes of subsystems and ways of its improvement. We shall assume therefore, that for each subsystems of first level are set the purposes $F(\bar{x}_{ij})$ on sets of decisions of subsystems, and system criterion function $F(\bar{x}_1,...,\bar{x}_N)$ depends both on global criterion $F(\bar{x}_N)$ and from criterion functions of subsystems $F(\bar{x}_N)$.

Now it is accepted to investigate questions of optimization for two-level system and to accept this task as the basic module for anyone N-level systems [6], and for a task solution on (i-1) level it is considered set result of optimization in the order i. Or if to write down $\bar{x}_N$ as:

$$\bar{x}_N = \{\bar{x}_{ij}\}, i = \overline{1,N}, \quad j = \overline{1,M},$$

where $M = m_i$ is the number of subsystems on i level of management it is supposed, that at a presence of decisions $x_{(i-1)j}, \quad j = \overline{1,m}_{i-1}$ all decisions $\bar{x}_{ij}^0, \quad j = \overline{1,m}_j$ are already accepted.

Therefore the various methods of iterative aggregation intended for iterative coordination of subtasks which parameters given with a different level of detail are used for optimization in multilevel organizational systems [7,8].

In general view the task of management in public health service can be formulated by processes as follows: to find optimum managing influences (strategy) for the complex dynamic process, providing satisfaction of requirements of a final vector of quality (standard) at limited material and a manpower.

Mathematically the task of optimum control in health service can be expressed as follows:

to find dependence $U_n^*(t)$ for stochastic criterion function $Y_k\left[U_n^*(t), \overline{A_s}\right]$

At restrictions:

$$\begin{cases} T \le T_{np} \\ \overline{A}_S \le \overline{A}_{np} \end{cases} \quad (4)$$

Where T is the term of treatment dependent on controlled factors;

$T_{пр}$ is a critical time;

$\overline{A}_S$ is vector of estimated expenditure;

$\overline{A}_{np}$ is vector of limiting expenses for treatment.

The given formulation has the general view and does not take into account the features of system described above: hierarchy, structure, activity, character of probable between elements, etc. All listed above features will be expedient for taking into account at statement and the decision of concrete individual tasks.

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VICTIMIZATION FACTORS OF THE SMALL BUSINESS ENTREPRENEURS

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The bribe-takers must tremble,
If they have stolen as much
As only they need.
When they have taken enough to share with the others
They have nothing to fear…

Criminal aphorism

The author of this article devoted 10 years to studies of problems in small business. Being a lecturer he is investigating the matter of these problems. It is possible to say the initial sociological data is objective; the results are representational, because the businessmen trust his colleague and give the objective information.

The forming of market relations lay down principally new demands to the business class. In Russia the experience of creation of new market relations has shown that the birth of a new class in the economy is rather a difficult process and it cannot depend only on the conditions.

There are many obstacles to the development of every business: small, medium and big. The analysis has shown it depends not only on the business laws, but also the range of factors not dependant on the businessmen.

In Siberia the small business sphere does not governs on the labour market, but it plays the great role in slowing down the unemployment nowadays. At the moment the industrials suppose the small business development to be paid a special, but not enough and not goal-oriented attention. That can explain the minority of the enterprise owners and the small business employees.

There are lots of reasons of such slow development in the small business in Siberia. Small business is very attackable now; it has serious problems, everyday difficulties, various obstacles and executive barriers. The favourable conditions for the small business have just begun to be created but the problems are being solved very slowly.

This research was organized in 5 Siberian Regions in the period from 2000 till 2004. The sample was formed by 500 small business enterprises; 100 respondents in 5 districts of the Region. The method of the research was an enquiry, questionnaire in writing (intramural, extramural and postal), and verbal interviewing (at business meetings, phone interview). The study purpose is to find out victimization factors of the small business entrepreneurs in the concrete Region of Russia.

91% businessmen (455 respondents) consider bureaucracy and bribery to be the weightiest factor of destabilization in the sphere of small business.

The main factor of victimization is classified by periodicity as the following:

1. Normative acts, which can be differently and unlawfully interpreted;
2. Corrupt practice at the top echelons of power;
3. Illegal revisal of control organizations;
4. Bureaucracy and red-tapery while execution of documents;
5. Assign authorization of enterprises by the overhead organizations;
6. Tax inspection by an anonymous call;
7. Front organizations of the criminals or police;
8. Financial risks;
9. Price discrimination;
10. Kickbacks;
11. Racket;
12. Wrapped financial insolvency of prospective clients;
13. Official hiding of necessary information about suppliers and demanders;