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Modeling business processes of complex organizational systems

Ekaterina Surkova[1,*], *Anna* Klonitskaya[1], and *Elena* Ermolaeva[1]

[1]Moscow Aviation Institute, 4, Volokolamskoe shosse, 12599, Moscow, Russia

Abstract. The complex systems of the construction and industrial complex in the study of their properties and the general laws of functioning by methods of mathematical modeling require a systematic approach. Modeling is a complex multi-stage process of researching systems aimed at identifying the properties and patterns inherent in the studied systems in order to improve these systems. This article discusses the mathematical model of a complex socio-economic system, taking into account the quality indicators presented to the processes of this system. The analysis and design of the innovation system in the framework of technical regulation of activities. The result is a fundamentally new model of technical regulation taking into account the time factor in axonometric form.

1 Introduction

Modeling issues are becoming increasingly relevant in the process of systems research. Accordingly, modeling is a method of objects research, in this paper we will focus on the study of systems.

According to the type of correspondence, the models are divided into isomorphic and homomorphic. In isomorphic models, each element of the model corresponds to a separate element of the object [1,2].

In homomorphic models, each element of the models can correspond to several elements of the object.

A system T is a model of the system T_2 if patterns T_1^1 and T_2^1 of these systems exist: isomorphic when T_1 is identified with T_1^1 and T_2^1 and homomorphic when T_1 is identified with T_1^1 or T_2 is identified with T_2^1. In the collection of articles by E. Nagel , three types of models are considered, with the help of which they describe real objects, these are: physical, analog and mathematical models [3].

The physical model represents what is being investigated using an enlarged and reduced description of an object or system.

The analog model represents the studying object (an analog) that behaves like a real object, but is not real.

*Corresponding author: surkova.ekaterin@mai.ru

In a mathematical model, also called symbolic, symbols are used to describe properties or characteristics of an object or event.

From the perspective of assigning models of economic and social systems, A. Glichev divides models into three groups: abstract-research, abstract-design, and abstract-normative.

Abstract-research models are developed with the aim of studying the nature of systems, identifying common and specific structures in them, due to the specifics of systems [4,5].

Based on the abstract research models of quality systems, recommendations are made on the creation and improvement of the effectiveness of real systems, their typification, unification and standardization [6, 7].

Abstract design models are used by enterprises to create real systems. The main goal that can be solved with the help of models of this type is to apply the results of studies performed on the basis of the models of the first group to a specific production and at the same time to create a real effective system whose parameters correspond to those laid down in abstract normative models [8,9,10].

Abstract-regulatory models are models that make some form of requirements.

For practical and research purposes, quality system models are classified by the form of their presentation to the following groups:

- descriptive,
- graphic
- mixed.

In our opinion, this classification is applicable to a wide class of economic and social systems [11].

Descriptive models, i.e. models that have the verbal form of quality system models, are common. Descriptive models make it possible to present the system in detail, however, on their basis it is very difficult to visualize their general structure, to see the main elements, the scheme of forward and backward linkages between them.

The functional blocks available in the system are displayed and their hierarchy and relative position are shown with a help of structural-graphical models [12,13]. Processes that determine the relationships and options for the interaction of functional blocks with each other, occurring in the system are displayed by operational-graphical models.

It should be noted that there are no purely graphic models. To varying degrees, a descriptive part in such models is present. Thus, they can be grouped of mixed models [14,15].

The standard can describe both the system as a whole (for example, international standards ISO 9001: 2015 "Quality management systems - Requirements", IDT), as well as individual quality management processes, as well as the management object-specific products or services (standard technical specifications and standard for general technical requirements).

The international standards discussed above in terms of presentation can be classified as mixed, since they present a graphical model that makes it possible to visualize the general structure of the system, see the main subsystems and elements, and the forward and backward linkages scheme (Fig.1).

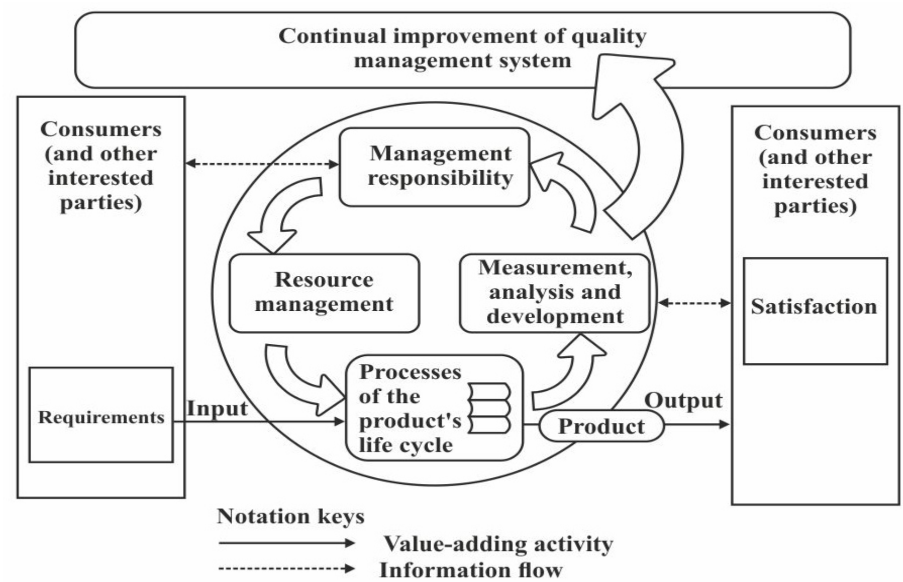

Fig. 1. Quality management system model.

In the study of economic processes, in most cases, logical models are used. Regarding social systems, they can also be modeled. Graphic models allow you to reproduce consideried phenomena at a given point in time.

2 Experimental

One of the effective ways of compiling, describing, and constructing a pictorial model is block modeling [3]. In fact, a transition from a planar two-dimensional image to a three-dimensional axonometric configuration has been made.

The modelled object is divided into blocks, each of which can be analyzed both independently and in conjunction with other blocks. By combining these blocks in different ways, you can create models of various proposed structures and study them. Each block of the model can be divided into blocks, in this case, the pictorial model of a system can be built from separate blocks, which are models of subsystems[6,7]. The first spatial model of the quality system is presented in Fig. 2.

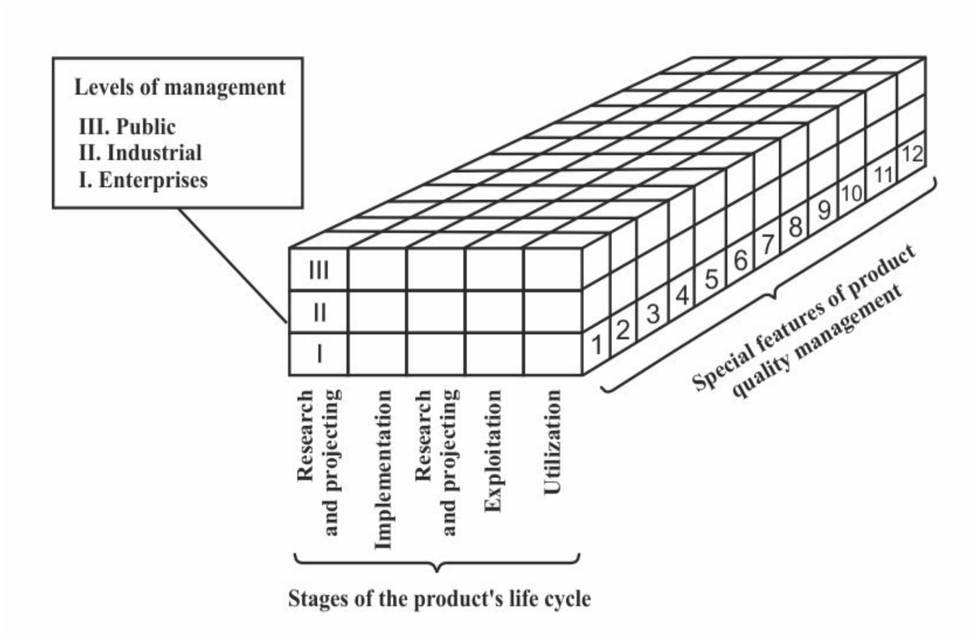

Fig. 2. 3-dimensional model of quality system.

To study it, one particular block model can be singled out from the general block model, and subject it to independent analysis. The general model can be analyzed by slices. If you select a vertical section (axis "Y"), then it can be analyzed by the aspects contained in the axes "X" and "Z". With further decomposition of the structure of the axonometric model, a significant, in our opinion, drawback of block modeling is revealed. At a certain stage of fragmentation of the block structure, difficulties arise in representing branched hierarchical relationships. These difficulties are overcome by using the Kaoru Ishikawa - "fish skeleton" model [4]. The introduction of this model into the internal space of the block was proposed by Belobragin V.Ya. [5]. Everything that is inside the cube serves to analyze a specific subsystem (element), its structure and relationships. For communication with other subsystems, vectors that converge at the point O located in the geometric center of the cube, are used.

We will try to describe this model using mathematical formulas. So, the Ishikawa diagram (Figure 3) shows some branching process that has R branches. Each branch is characterized by belonging to a certain kind of hierarchy j, j (j = 0, n), that is, n + 1 levels. Starting from j = 1, the j branch of the level is connected with its pole (arrow) to the j branch of the first level. Zero levels are not combined. Each zero-level branch is assigned a specific serial number i_0 ($i_0 = 1, t_0$), where t_0 is the number of zero-level branches. Each of them is connected by t_{i0}branches of the first level having the numbers i_1 (i_1=1,t_i), and i_1 =1 for the branch closest to the pole of the i_0 th branches of the zero level. With each i_1 (i_1=I,t_{i0}), a branch of the first level connects t_{i1} of the branches of the second level with the numbers i_2 (i_2=1,2…,t_i), i_0- is fixed. Thus, the entire set of R branches can be represented as the set R ={$r^j_{i0}, i_1, \dots i_j$}; j=0,1…n [9,10].

When analyzing existing or designing innovative systems, it is possible to describe them using models of three levels:

- black box level,

- system composition level,
- system structure level. [6]

3 Evaluation

Moreover, for the level of the "black box" and the level of the system's composition, qualitative (figurative) models are used, at the level of the system's structure, both qualitative and quantitative (mathematical) models are used. The black box level is the original model of the system[11,12].

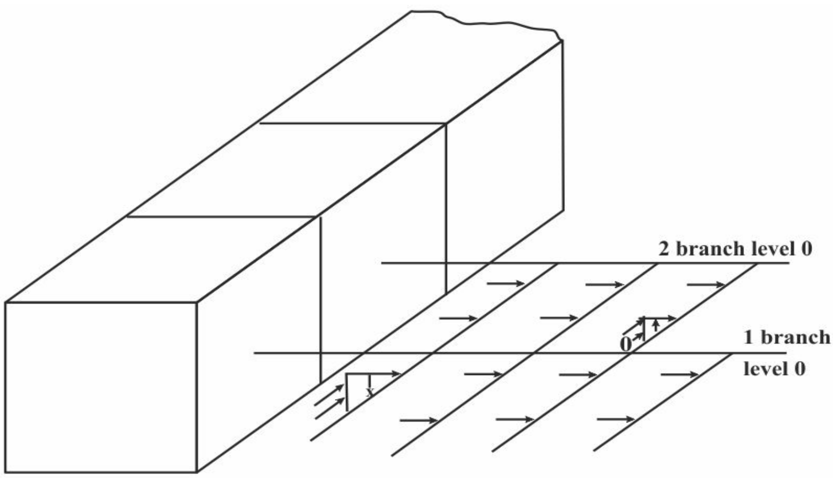

Fig. 3. Ishikawa diagram.

When analyzing the system at the black box level, the concepts of "input" and "output" are widely used. At the input, the system perceives external influences, with the help of the output it acts on the external environment [13]. A set of indicators characterizing the purpose of the system, restrictions for their achievement, and also information about the control object coming through backward linkages are set as control information at the input.

Characterizing the structure of the information input in a general way, it is necessary to systematize the types of circulating information. It is proposed to subdivide it into conceptual, directive and descriptive information [14]. Under the conceptual (theoretical and methodological) information refers to the basic concepts, theories of management, social sciences (economics, sociology, psychology, etc.). Directive information refers to legal acts, tasks of targeted (state) programs, standards and other normative documentation. Descriptive information is an information on issues of efficiency and quality, received through state and regional government, the media, and bodies of scientific and technical information [15,16].

In addition, the input of the system receives information via the backward linkage on the functioning of the system itself and its subsystems [17, 18]. Information at the input of the system can be one of the following main types:

- legal
- social (in the narrow sense of the word),
- economic
- scientific and technical.

The information output of the system is a group of indicators characterizing the quality of the functioning of the system, as well as scientific, technical and industrial-economic experience. The first group of information should include indicators of the actual fulfillment of the goals of the system, information about the presence of a discrepancy between the actual and normative state of the system, information about the costs of achieving the goal [19]. The second group of information should include doctrines and concepts that arose during the operation of the system, programs and forecasts, regulatory and technical documentation, including standards and regulations, as well as publishing products.

At the level of the composition of the organizational system, the disclosure of the “black box”, the identification of subsystems and elements is expected [20]. It is worth noting that the components of the system retain, within the framework of integrity, relative independence both structurally and functionally.

4 Conclusions

For complex large-scale socio-economic systems, substantiating goals on the basis of analyzing a problem situation taking into account conceptual and directive information by constructing a graph of problems and its subsequent transformation into a tree of goals turns out to be productive. In the framework of goal-setting, the authors proposed an approach to the formation of goals, which involves analyzing and building a tree of goals for functioning systems of technical regulation and an innovative system of valuation activities. A graphical representation of the goals allowed ranking and building a graph of goals.

Using the method of simulation based on the Gauss method, a fundamentally new model of technical regulation was developed taking into account the time factor in axonometric form. [7]

The model allows to quantify the contribution of each control action by type of services and elements of technical regulation to the achievement of the general goal; provides a methodological basis for choosing forms of influence on specific types of services in order to achieve the general goal: creating a system of technical regulation that ensures economic security, security of the owner, user, protection of competition and not misrepresentation. Thus, the modeling in the framework of this study makes it possible to analyze and synthesize the organizational structure, creates a practical basis for the reengineering of the system.

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