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Structural Information Management of Production Systems in Construction

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ABSTRACT

Management of the construction production system forms many organizational and technological problems, the solution of which is in the range of interconnected functional subsystems of production. To take into account the impact of structural relationships and information interaction, it is necessary to develop a model adequate to the conditions of the task of managing the production system, to disclose and take into account information, functional and other necessary interconnections that logically contribute to achieving effective results in modern realities.

The aim of the study is to develop a structural information model for the effective management of production systems in the construction industry on the basis of general laws and principles of systems and systems engineering.

The result of the study was developed a structural information model for the management of production systems in the construction industry on the basis of general laws and principles of systemology, systems engineering and logic. The proposed complex model provides a logical relationship of information modules, complete management functions and the expected state of the production system while achieving the goal of optimization and reliability.

Keywords: structure, systemology, systems engineering, logic, production system, information modules, control functions, system state, system reliability.

1. INTRODUCTION

Possibilities of solving actual organizational and technological problems of construction production are oriented in a complex of logical-structural interrelations between its functional subsystems. Global destabilization processes and violations of system methodology in production management have led to the disunity of logical and informational approaches to operation, the lack of unity of the modeling space and end-to-end information support in making effective organizational and technological decisions [2].

Under these conditions, the structural areas of the main management functions form subsystems for basic activities that require quality management by specialists of different levels, taking into account the criteria of optimality [4].

Thus, these motivational areas form the feasibility of reviewing the important characteristics of science and technology according to the requirements of a systematic approach to them.

2. MAIN MATERIAL

A key element in determining the problems of planning and development of the construction industry is the management of production systems. At present, there is a lot of research that is devoted to this issue. At the same time, they do not reveal aspects of the development of the production system, do not reflect its tendency to constantly generate changes in both external and internal environment. Due to this, the production system can be defined as a set of active elements that interact in the production process on the basis of agreed interests with a constant increase in production capacity. This increase involves the development of two subsystems: organizational and technical.

Effective management of the production construction system requires increased organizational and technological reliability and efficiency in the preparatory and initial stages of design. The competitiveness of construction projects requires the improvement of scientific, regulatory and methodological and information and technical support of the production process.

The study develops a structural information model to take into account the impact of interconnections and interactions for the management of production systems in construction. Production systems in construction are systems that are responsible for the technology and organization of construction and installation work through the rational management of material, financial, information and labor flows.

The object of study are complex systems created from interconnected elements (structural flows) into a single whole with all the connections and properties. To solve the problem of production system development, a flexible method of structural and information management of interconnected elements is proposed.

Combining a set of elements that interact with each other, the system forms a certain integrity, has certain integral properties, which allows it to perform a certain function in the environment. The efficient functioning of any production system is performed according to the general laws of systemology and systems engineering.

For production systems, where the ultimate goal of the system plays a significant role, these sciences combine a purposeful set of elements and act as a set of selectively involved elements that mutually contribute to the achievement of a given useful result, which is taken as the main system-forming factor. [1, 2, 4, 7, 8-11].

In the context of harmonization of management of production systems of construction and improvement of perspective strategies we will apply a technique of management of the complex consideration of arguments on the structural and information approach.

The sequence of actions of perspective development in management of production systems is reflected through the list of full functions of management which are system of communications and transformations between information modules of this system. The new material content of the element of the production system occurs during a certain information state (information control module), the result of which is information interaction, managerial interaction between the elements [1, 7].

We offer seven information modules of production systems management (ψ1…. Ψ7): assessment of the state of object management; determining the own state of the subject of management; determining the status of neighboring objects with which the interaction is performed; the state of the environment in which the interaction of system elements; the state of the structure that carries out management (subject of management); instructions and restrictions from higher management structures; comprehensive methodology of the system management process through a combination of all seven information modules.

Information circulation and transformation of information in the management process of the production system provide full management functions, which are a sequence of actions (X1… X7) of the management entity within a promising development strategy: recognition of environmental factors, ie factors affecting the system, with which the intellect faces; formation of the stereotype of recognition, ie recognition of the environmental factor for the future; forming a vector of targets for each environmental factor and making a partial vector to the total vector; formation of the objective function (concept), management on the basis of the decision of a problem of stability on predictability; organization of the structure that manages and carries out the target management function; control, monitoring of the structure of the system in the management process; maintenance of working capacity or liquidation - maintenance of working capacity of structure in the process of management or its liquidation (if necessary).

Full control functions of the production system can be implemented only in the intelligent control scheme, which involves the creativity of the control system, the presence of the intelligence of the leader, who must solve intellectual problems (χ1… χ5): identify environmental factors that affect the production system (without creativity) it is impossible to do); formation of goal vectors (this is also a creative process); formation of new management concepts (latest methods, latest tools); improving the methodology of forecasting and correction in solving problems of predictability; the ability of the control system to produce a new information module based on management systems [1, 8-11].

The logical combination of the above components of the management process of production systems can be successfully reflected in the structural information model (Figure 1). The structural-information complex model in Figure 1 logically reflects the relationship of information modules, complete functions of production systems management and combines the states of perspective development of the system through transformation phases: system environmental conditions (initial data) Ws; information capabilities of functional flows ψs; intelligent control circuit χs; functional processes of Xs system management; formation of the state of the Ss system; target capabilities of the system or system reliability (result of operation) Ns.

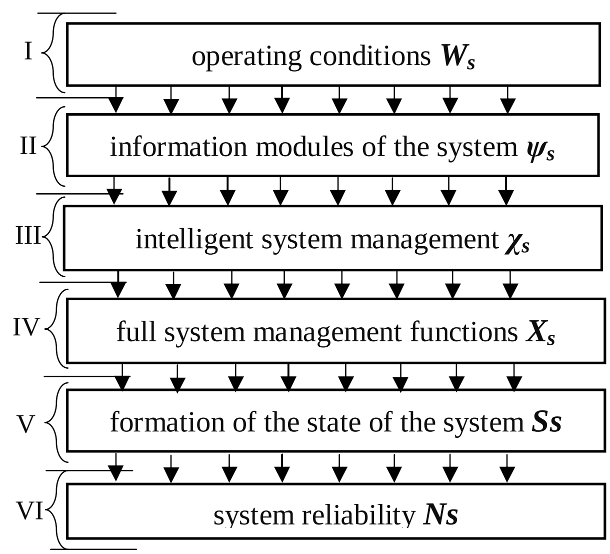

Figure 1: Structural and information complex model of production system management

When considering any production process, it is advisable to use methods of integrated representation of the control system, which are based on logical procedures of the structural-information approach. The study uses the method of group consideration of arguments in the modeling of optimality. The distribution of control factors is carried out according to the form of the matrix (1), adhering to the correspondence of each factor xij to its time period j.

$$YX = \begin{bmatrix} y_1 x_{11} & \cdots & x_{n1} \\ y_2 x_{12} & \cdots & x_{n2} \\ & \cdots & \\ y_m x_{1m} & \cdots & x_{nm} \end{bmatrix} \quad (1)$$

The initial statistics are divided into two parts: production and test sequences. The general description of the object (construction production system) will be presented in the form of a polynomial:

$$y = a_0 + \sum_i a_i x_i + \sum_{i,j} a_i a_j x_i x_j \quad (2)$$

Next, we transform (2) using private polynomials according to the scheme:

$$y_1 = f_1(x_1, x_2);\ y_2 = f_1(x_1, x_3);\ y_s = f_1(x_{n-1}, x_n);\ S = C_n^2 \quad (3)$$

$$z_1 = f_1(y_1, y_2);\ z_2 = f_2(y_1, y_3);\ z_p = f_1(y_{s-1}, y_s);\ p = C_s^2 \quad (4)$$

The coefficients of each of these equations are determined by the method of least squares. In other words, each particular description (polynomial) is a well-known regression equation.

The application of the combinatorial algorithm of the method of group consideration of arguments provides a polynomial form for private descriptions of variables, with the coefficients alternately "zeroed", resulting in a combinatorial search of all private descriptions for each pair of arguments. Everything turns out $7C_n^2$ comparable typical private models:

$$z = a_0 + a_1 x_i + a_2 x_j + a_3 x_i x_j\,, \quad (5)$$

A feature of statistical modeling of technical and economic indicators of construction production systems is the small number of observation points and possible data distortions. This is due to the presence in the construction of non-stationary indicators that characterize the processes of management and organization, in comparison with other industries.

The implementation of the structural-information complex model was performed using recurrent methods of calculation and subsequent obtaining of polynomial dependences of numerical values of matrices of elements of production systems (Figure 2, Table 1).

Table 1: Estimated dependencies

$y=0{,}0005x^2+0{,}0649x+0{,}4328$	W_s
$y = 0{,}0122x^2 + 0{,}1599x + 0{,}0445$	ψ_s
$y = -0{,}0028x^2 + 0{,}0107x + 0{,}8815$	χ_s
$y = 0{,}0045x^2 - 0{,}0734x + 1{,}619$	X_s
$y = -0{,}0098x^2 + 0{,}0518x + 0{,}5413$	S_s
$y = -0{,}003x^2 - 0{,}0187x + 1{,}0767$	N_s

The reliability of the approximation of the obtained results is demonstrated by the obtained correlation coefficients with values from 0.78 to 0.99. The results of the calculations determine the range of destabilizing factors that affect changes in technical and economic indicators of the elements of production systems of construction with additional determination of quantitative estimates of these effects.

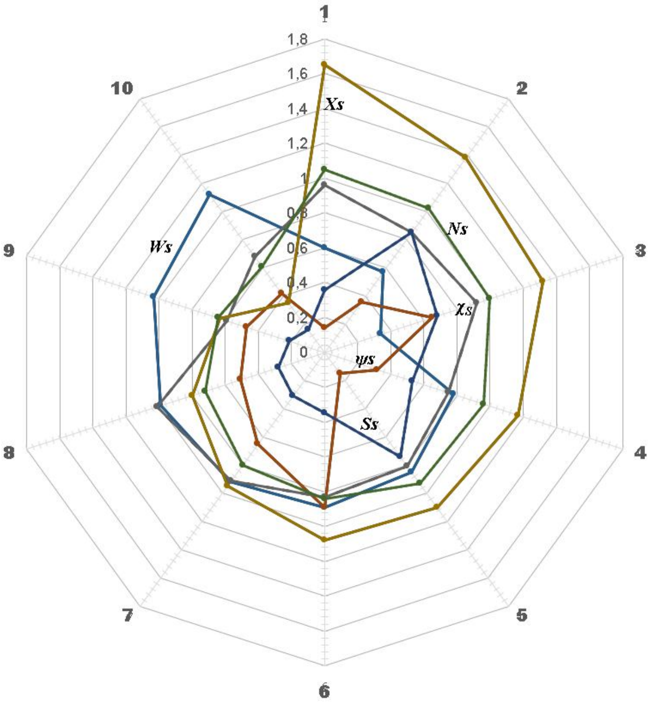

Figure 2: Estimated implementation of structural-information complex model of production systems management in construction

The study provides an opportunity to perform modeling with a small number of elements; to organize such way of control of results which for badly caused and degenerate matrices allows to catch the moment of "failure" of computing process and to receive the approximate decision; allows to find adequate mathematical models or for various technical and economic indicators of energy construction in the form of a series and "private descriptions" with intermediate variables.

3. CONCLUSION

The structural-information model of management of production systems of construction industry on the basis of the general laws and principles of systemology, system engineering and logic is offered, which reflects logical combination of components of management process by production systems of construction. and system reliability).

The analytical part of the study identified the possibility of a meaningful economic interpretation of the influence of factors on the criteria of efficiency, as well as the use of multifactor models for their forecasting.

The developed study of structural and information management of production systems determines the possibility of meaningful technical and economic interpretation of the impact of destabilizing factors on the management and organization of construction, as well as forecasting optimal conditions, which is a mechanism to counteract risk situations and their consequences. process.

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