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MATHEMATICAL MODEL AND ALGORITHM FOR CALCULATION OF MANAGEMENT PROCESSES FOR ADVANCED TRAINING OF SPECIALISTS IN THE HYDROPOWER INDUSTRY

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ABSTRACT

The article deals with the practical issue of managing the educational process on the example of the hydropower industry. A mathematical model of the problem was created using the principle of systematic approach of management theory and the elements of set theory. A calculation algorithm for solving the problem is created, the results of the calculation experiment are presented, and practical recommendations are given.

KEYWORDS

Management theory, system, systematic approach, production, networks, educational process, training, object, subject, teacher, mathematical model, set, subset, intersection, union, information matrix, algorithm, computational experiment.

Introduction

The country's production and socio-economic sectors can be represented as a complex management system of one of the continuous processes of functioning.

As the complexity of systems increases, problems arise that are less related to the consideration of the properties and laws of functioning of elements, and more - with the choice of the best structure, optimal organization of interaction of elements, determination of optimal modes of their functioning, taking into account the influence of the external environment, etc. Therefore, it is advisable to use a systems approach in solving applied problems of analysis and synthesis of production (socio-economic) systems. The systems approach of control theory is based on the creation of a control structure and mathematical modeling using the theory of similarity, the theory of scientific experiment, set theory, mathematical statistics, the theory of algorithms and a number of other fundamental classical theories. At the same time, in the field of designing modern information and control systems and computer software, the so-called object-oriented approach is increasingly used in the analysis and synthesis of complex systems.[1]

To create a mathematical model of the management processes for improving the qualifications of engineering specialists (or engineering and technical workers), the principle of the system approach of management theory with elements of the theory of sets of functional analysis is used. Hydropower industries, as n subjects of the country, can be considered as the objects of management under study. The mathematical designation of these objects can be formulated as follows $A_1, A_2, A_3, ..., A_l$. Through

A_k hydroelectric power station marked k -th Ministry of Energy. Here $A_k, k=\overline{1,l}$ is the union of a finite number of non-self-intersecting sets, i.e. the following holds: $A=\bigcup_{k=1}^{l} A_k, A_i \cap A_{i+1}=\varnothing$.

The set A consists of subsets $A_1, A_2, A_3, ..., A_l$

the elements of these subsets are $B_{i,j}^{k}, (k=\overline{1,l},\ i=\overline{1,m}$, j=$\overline{1,n}$), these elements mean that j - oh hydroelectric power station i- the Ministry of Energy of the k-th region (or area). The set A_k is defined as follows $A_k=\bigcup_{i,j} B_{i,j}^{k}, (k=\overline{1,l},\ i=\overline{1,m}$, j=$\overline{1,n}$).

And so many A_k consists of unions of a finite number of sets $B_{i,j}^{k}, (k=\overline{1,l},\ i=\overline{1,m}$, j=$\overline{1,n}$).

As is known, in each hydroelectric power station the case of lower level elements can be designated as follows: $B_{i,j}^{k}=\bigcup_{\alpha,\beta} C_{\alpha,\beta}^{j}, \left(j=\overline{1,n}, \alpha=\overline{1,s1}, \beta=\overline{1,s2}\right)$.

Here $C_{\alpha,\beta}^{j}-\beta$ engineer, by specialty α, j - go hydroelectric power station.

Information about the level of knowledge, qualifications and skills of each hydroelectric power station engineer is always of interest to senior management personnel.

Continuous study and monitoring of information about the level (high, good, average, low) of knowledge of an engineer specialist is a necessary source of information for management specialists at the highest level of the hierarchy.

The functional task of this system is to form sources of information, collect and continuously process existing information, analyze this information and promptly transmit it to the first requests of management specialists at the highest level of the hierarchy.

In the production sphere (branch) of management such as the hydropower industry, the management structure is organized in a hierarchical form of functioning, i.e. a centralized management system.

We introduce the following concept of an information matrix. [3]

Definition. An information matrix is a matrix consisting of elements 1 and 0, having a finite number of columns and rows, and storing information, and having the form: $C_{\alpha,\beta}^{j}=\left\|\sigma_{\alpha,\beta}\right\|, \left(\alpha=\overline{1,s1}, \beta=\overline{1,s2}\right)$.

Elements of the information matrix $\sigma_{\alpha,\beta}$ is information about the knowledge of specialist engineers (or industry specialists), which is formed at low levels of the management hierarchy and is constantly stored in a database organized at higher levels of the hierarchy.

For everyone $\sigma_{\alpha,\beta}$ an information matrix is filled in, the row elements of which are sections (or parts) of individual theoretical knowledge, and the column elements are the numbers of questions in these sections or parts.

Elements of matrices $C_{\alpha,\beta}^{j}$ are formed as follows: $\sigma_{1,\beta}=\left\|a^{(1)}i, j\right\|, \sigma_{2,\beta}=\left\|a^{(2)}i, j\right\|, ...,$ $\sigma_{s1,\beta}=\left\|a^{(s1)}i, j\right\|, i=\overline{1,m_1}, j=\overline{1,n_1}$.

Table 1. General view of the information matrix

Number of sections of the subject	Multiple sequences of questions for each section	Number of questions in each section
σ_1	σ_{11} σ_{12} … σ_{1S_1}	S_1
σ_2	σ_{21} σ_{22} … σ_{2S_2}	S_2
…….	……...	……...
σ_i	σ_{i1} σ_{i2} … σ_{iS_i}	S_i
……	……	……..
σ_{S1}	$\sigma_{S_1 1}$ $\sigma_{S_1 2}$ … $\sigma_{S_1 S_n}$	S_n

Preparation of information is carried out in the following sequence. [2]

For everyone $\sigma_{\alpha,\beta}$, elements $a_{i,j}$ is formed as a sum of numbers 1 and 0 and the condition is checked

$$\sum_{i-1}^{m_1} a^{(1)} i,\ j < K,\ j = \overline{1, n_1} \quad (1)$$

(K given, constant value), if the condition is met, that $\sigma_{1,\beta} = 0$, otherwise $\sigma_{1,\beta} = 1$ is crossing over to the next line, and condition (1) is checked and the following is performed $\sigma_{2,\beta} = 1$ or $\sigma_{2,\beta} = 0$, and etc. $\sigma_{s,\beta} = 1$ or $\sigma_{s,\beta} = 0$, are formed as elements of rows and columns of the information matrix. For each specialist engineer, for each job position, an information matrix is formed on the degree, knowledge and experience for the job position.

An information matrix consisting of elements is filled in and an analysis of the computational experiment is carried out. Filled information matrices consisting of data analysis information at low levels of the hierarchy are re-analyzed at the middle and highest levels of the hierarchy. As a result of the conducted analyses of statistical data processing, a plan for improving the qualifications of specialist engineers for the new service year is created, from each hydroelectric power station. And a decision is made on planning advanced training related to the issues of how many specialist engineers, for what period of time it is necessary to send for advanced training.

To form elements of information matrices, it is advisable to conduct computational experiments of statistical data at low levels (at factory levels) of the hierarchy in the following sequence:

- the information matrix is filled in and the data is saved in the database;
- an organization is created for the time of testing the engineer-specialist (ITR) on what subjects (specialists), for what period and this plan is formalized by the corresponding order of the personnel department of the energy system;
- for all specialties of the hydrometallurgical plant, groups of experts prepare testing tasks (tests);
- analysis tasks are solved using the information matrix created (formed) by the result of testing the engineer-specialists;
- experts classify (or group) according to the results of the analysis of the results of testing on the knowledge and skills of engineer-specialists.

After carrying out the above sequences according to specific plans, the experts transmit information to the energy department about sending the specialist engineer to advanced training courses.

The given sequence of formation of elements of information matrices using computational experiments can be applied in most production sectors, in particular the hydropower industry.

The head of the hydrometallurgical plant makes a decision on upgrading the qualifications of specialist engineers for the service year and the prepared statistical data are transferred to the personnel department of the hydroelectric power station or hydropower industry.

The developed management system for upgrading the qualifications of industry specialists (as applied to the hydropower industries) is an open system, since the structure of the system can be continuously supplemented with additional elements and adjusted for application to other classes of production and social management facilities where upgrading the qualifications of specialists (or employees) is required.

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