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Building a Model of an Information Management System for Multilevel Organizational Structures

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Abstract: ***The paper considers the elements involved in building a model for the formation of information flows of organizational systems with the identification of the main sub-processes, converted and transformed resources, mechanisms and management resources. The problem of determining the elements of basic and supporting information is solved. A model for the distribution of data flows circulating in the system has been formed, which will allow the formation of the main characteristics to determine the optimal data processing time. Based on the results obtained, the time necessary for processing basic and providing information is estimated based on the algorithms proposed in the work.***

Keywords: decomposition of characteristics, basic information providing information, hierarchical multilevel systems, data streams, reference time for processing information streams.

I. INTRODUCTION

The decomposition of the characteristics of the system and their subsequent presentation in the form of a hierarchical structure is possible based on the use of the «black box» model and interaction models. In order to use the «black box» models, it is necessary to identify the inputs and outputs of IMOS (hierarchical multi-level organizational systems) in accordance with specific goals. After this, it is necessary to determine the interacting subsystems circulating in the IMOS structure. Next, you can use the model for the decomposition of resources, the interaction of subjects and objects, the life cycle of the system.

II. RESEARCH METHOD

The approach based on the formation of input and output resources allows us to solve the problem of constructing a tree of goals. The basis of this approach is a clear separation of the task of constructing a goal tree oriented to CS (control system) and the task of improving the functioning of IMOS. Figure 1 shows the process of decomposing the goals of the OS into stages in the form of a hierarchical set of models [1, 3]. The global goal of IMOS C_0 is formed on the basis of integrated requirements for this system. At the second stage, the integrated goal C_i is formulated for IMOS (i = 1, … N, where N are specialists (personnel of structural divisions) in each direction of functioning of the IMOS hierarchical structure) in each direction of specialists in N directions. Under the directions the priority tasks of the development of the organization are considered.

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In the third stage, the C_i targets are decomposed into the Chi targets. If such a partition is not enough, then the decomposition will continue until the option when these goals C_{ik} will be indivisible elements.

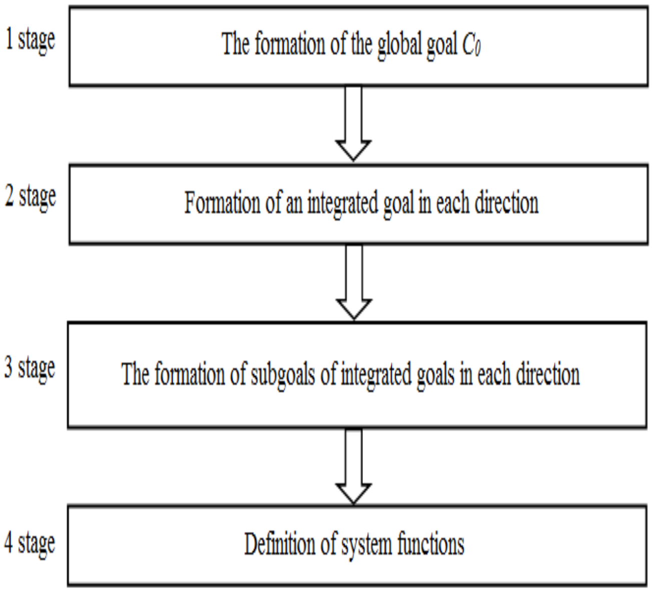

Fig 1. IMOS decomposition by purpose and function

At the fourth stage, the hierarchical structure of the goals must be associated with the structure of the functioning of IMOS. The many functions of IMOS ensure the fulfillment of the objectives of this system. Therefore, it is required to define the many functions F_{ik} that would ensure the fulfillment of the relevant IMOS objectives. They will determine the dynamic parameters of IMOS and the requirements for the elements of IMOS.

The functional requirements for IMOS are complexly interconnected and in the future they cannot be formalized without big assumptions with the desired adaptation of the requirements to the elements of IMOS and the hierarchy of goals.

To analyze the functioning of IMOS, it is necessary to describe all the resources involved in the system and information processes (IP) in IMOS.

We represent the set of IP in the form: $I = \{I_Б, I_O\}$, where:

$I_Б$ - basic information (BI);

I_O - providing information (OI).

BI will be described in the form of a set $I_Б = \{I_{Б_О}, I_{Б_Н}, I_{Б_Д}\}$, where

$I_{Б_О}$ - information on the results of monitoring current information;

$I_{Б_Н}$ - information generated from regulatory documents;

$I_{Б_Д}$ - additional information (for example, objects that form a hydrocarbon, etc.) are determined [1, 3].

We represent OI in the form of the set: $I_O = \{I_{O1}, I_{O2}, ..., I_{ON}\}$, where

I_{On} is the *n*-th element of the OI;

$n = \overline{1, N}$ - the number of elements of OI.

Formed sets allow you to optimize the information used to generate DM (decision maker).

We assume that $D = \{d_i\}$ - the procedures that perform actions on the BI, which are carried out to form the nth element of the OI, where:

d_1 - procedures that select data for a specific task;

d_2 - procedures that select data to select the necessary information from the available source information;

d_3 - procedures that select data to organize the selected information;

d_4 - procedures that select data for algebraic operations on the selected data;

d_5 - procedures that select data used in mathematical models using selected data;

d_6 - procedures that use: business graphics: clearance lists; Tables Charts etc. [2, 6].

Let us denote by $U = \{u_i\}$, where $i = \overline{1, n_I}$ is the set of DM that affect the control objects.

HC *U* are produced by decision makers based on an analysis of the relevant $I_O, I_{Б_Н}$ and personal experience of decision makers. OI I_O is formed through the functions h_n as follows: $I_{O_n} = h_n\left(I_{Б_O}, I_{Б_Д}\right)$.

For the function h_n, the required set and sequence d_j of the elements of the set of procedures from the set of actions $d_j \in D$ on $I_{Б_O}, I_{Б_Д}$ to determine are formed I_{O_n}.

Therefore, the formation of I_O on the basis $I_{Б_O}, I_{Б_Д}$ of is carried out on the basis of many functions $H = \{h_1, h_2, ..., h_N\}$.

Each element of the set h_n is a separate mathematical circuit (procedure), which is divided into subcircuits h_{nk}. The h_{nk} subcircuit performs the action of procedure set *D*.

The mathematical subcircuit h_{nk} can be described through the sets:

sets of input parameters $x^i_{nk} \in X_{nk}$, where $i = \overline{1, I}$ is the number of input parameters;

sets of output parameters $y^l_{nk} \in Y_{nk}$, where $i = \overline{1, L}$ is the number of output parameters;

sets $d_{nk} \in D$ - corresponding to the action on the input parameter X_{nk} to form the output parameter Y_{nk}.

Consider how to evaluate the processing time of the BI. The main volume of information $I_Б$ consists of elements $I_{Б_O}$; therefore, it is possible to estimate with some accuracy the processing time of the information contained in this element. [4]

It is possible to estimate the time of information processing based on the expression: $T_Б = f\left(V_Б, \bar{t}_Б\right)$, where

$V_Б$ - the amount of information collected;

$\bar{t}_Б$ - the processing time of the reference amount of information.

The *f* function is actually represented as a linear function and is representable in the form:

$$T_Б = \frac{V_Б}{\overline{V}_Б}\bar{t}_Б,$$ where $\overline{V}_Б$ is the reference volume.

Estimate the time to receive the OI. It is necessary to estimate the execution time of the function h_n through the set of actions D_n.

Depending on the content of the information in I_{On}, some procedures from the complete set *D* may be missing.

We denote

$$a^i_{On} = \begin{cases} 1, \text{if for } n-\text{th element } I_O \text{ execution required } i-\text{ action,} \\ 0, \text{if otherwise} \end{cases}$$

To estimate the execution time of the function h_n of the *n*-th element I_O, it is necessary to estimate the execution time of this function. This time can have different values depending on the volume of the processed BI.

We introduce the following notation:

$V_{Бn}$ - volume of BI processed when performing the *i*-th procedure to obtain the *n*-th element of the OI;

$t_{On(i)}$ - the execution time of the *i*-th procedure to obtain the *n*-th element of the OI;

$t_{On(i)-}$ - the execution time of the *i*-th procedure to obtain the *n*-th element of the OI for the reference volume of the BI.

For various procedures, the dependence of its execution time on the volume of the BI can be of a different nature, for example, for d_1 it is practically independent; for d_2 - linearly dependent; for d_4 - is not linearly dependent.

In this case $t^i_{On} = q_i\left(V^i_{Бn}, t^{-i}_{On}\right)$. The values of the functions q_i can have various forms of functions and algorithms.

Therefore, the execution time of the function h_n of the *n*-th element of the OI can be estimated as $T_{On} = \sum_{i=1}^{6} a^i_{On} q_i\left(V^i_{Бn}, t^{-i}_{On}\right)$.

The definition of any new element of OI increases the objectivity of the decision [6].

However, the restrictions imposed on the length of time a decision may not provide all the completeness of the possible elements of the OI.

We denote

$$x_n = \begin{cases} 1, if \ \ the\ decision\ making\ step\ the\ n-th\ of\ the \\ \ sup porting\ \ inf ormation\ is\ \ obtained \\ 0, if \ \ otherwise \end{cases}$$

The external essence in the presented model is an employee, data warehouses: group characteristics of BI, group characteristics of OI and the optimal time obtained based on control actions.

The total decision-making time of the decision maker can be estimated by the expression:

$$T(x) = \frac{V_Б}{\bar{V}_Б}\bar{t}Б + \sum_{n=1}^{N}\left(x_n \sum_{i=1}^{6} a^i_{On} q_i\left(V^i_{Бn}, \bar{t}^{-i}_{On}\right)\right) + \sum_{n=1}^{N} g\left(V_{Ln}, \bar{t}_{Ln}\right) + t_R$$

Let us consider in more detail how the assessment developed at the hydrocarbon step is justified.

Within the framework of the process under consideration, we accept that the validity of the HC will be greater, the more the number of elements of the OI will be used in the formation of the HC.

However, not all elements of OI equally affect the optimality of management decisions.

We set the coefficients of importance of the OI elements $\Omega = (w_1, w_2, ..., w_N)$.

Therefore, the generated hydrocarbon is defined as:

$$O(X) = \sum_{n=1}^{N} w_n x_n .$$

In general, the mathematical formulation of the optimization problem formed by the shock wave will have the following form.

To find

$$X = Arg \max O(X).$$

under restrictions

$$T(X) \le \bar{T}$$

$\bar{T}$ - allowable time for the development of hydrocarbons.

$$x_n \in \{0,1\},\ n = \overline{1, N} .$$

This task is a linear integer programming problem. All coefficients in the objective function and in the constraints have positive values, and this problem can be solved by the Lauler-Bell method [2, 5].

III. RESULTS AND ANALYSIS

As a result of the description of the model for the formation of information processes of organizational systems, the problem of optimizing the information necessary for the development of hydrocarbon decision-making through the decomposition of processes with the definition of data flows was solved.

IV. CONCLUSION

On the basis of the constructed model and the scheme of the information optimization process in IMOS, the problem of determining the elements of basic and providing information that allows estimating the time required for processing data based on the algorithms proposed in the work is solved.

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