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 \( (i = 1, \ldots, N) \), 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 organization are considered.

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 \( C_i \) will be indivisible elements.

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 \( F_\alpha \) 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.

Fig 1. IMOS decomposition by purpose and function

We represent the set of IP in the form: \( I = \{I_B, I_O\} \), where:

- \( I_B \) - basic information (BI);
- \( I_O \) - providing information (OI).

BI will be described in the form of a set \( I_B = \{I_B, I_B, I_B\} \), where

- \( I_B \) - information on the results of monitoring current information;
- \( I_B \) - information generated from regulatory documents;

| Stage | Description |
|-------|-------------|
| 1 stage | The formation of the global goal \( C_0 \) |
| 2 stage | Formation of an integrated goal in each direction |
| 3 stage | The formation of subgoals of integrated goals in each direction |
| 4 stage | Definition of system functions |

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$I_{E_3}$ - 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;

$n = 1, N$ - 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 $n$-th 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 $i = 1, h_i$ is the set of DM that affect the control objects.

HC $U$ are produced by decision makers based on an analysis of the relevant $I_{O1}, I_{E_3}$ and personal experience of decision makers. OI $I_{O1}$ is formed through the functions $h_n$ as follows: $I_{O1} = h_n(I_{E_3}, I_{E_2})$.

For the function $h_n$, the required set and sequence $d_i$ of the elements of the set of procedures from the set of actions $d_j \in D$ on $I_{E_3}, I_{E_2}$ to determine are formed $I_{O1}$.

Therefore, the formation of $I_O$ on the basis $I_{E_3}, I_{E_2}$ of is carried out on the basis of many functions $H = \{h_1, h_2, ..., h_{h_n}\}$.

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 $X_{nk}^i \in X_{nk}$, where $i = 1, I$ is the number of input parameters;
- sets of output parameters $Y_{nk}^i \in Y_{nk}$, where $i = 1, L$ 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 $I_{B}$ consists of elements $I_{E_3}$; 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: $T_B = f(V_B, I_B)$, where

$V_B$ - the amount of information collected;

$I_B$ - 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:

$T_B = \frac{V_B}{V_{e}} I_{B}$, where $V_{e}$ 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

$a^i_{On} = 1$, if for n-th element $I_{O}$ execution required i - action,

$0$, if otherwise

To estimate the execution time of the function $h_n$ of the n-th element $I_{On}$, 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:

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

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

$I_{On(i)}$ - 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 $d_2$ it is linearly independent; for $d_4$ is not linearly dependent.

In this case $I_{On(i)} = q_i \left( V_{bn(i)}^{I_{On}}, r_{On(i)}^{I_{On}} \right)$. 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

$T_{On} = \sum_{i=1}^{6} a^i_{On} q_i \left( V_{bn(i)}, r_{On(i)}^{I_{On}} \right)$.

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
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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