Systemic Analysis of Factors Affecting Organizational Systems: A Case Study of the Development of Conflict-Affected Regions

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Abstract

In contemporary organizational systems, particularly in conflict-affected regions, the decision-making process becomes even more complex due to high environmental instability, unpredictability of political, social, and economic factors, and the nonlinear dynamics of processes. Under such conditions, traditional management approaches often fail to ensure adequate situation assessment and optimal decision-making. To address these challenges, it is essential to employ systems modeling methodologies that enable understanding of complex system behavior, identification of interconnections, and formalization of the decision-making process.

The article examines a systems modeling methodology based on goal structuring, ranking, and weighting mechanisms. The use of cognitive maps is proposed, which enables visualization of interdependencies between system elements and identification of influence directions. Through this approach, it becomes possible to analyze different scenarios and conduct preliminary assessment of decision outcomes.

Keywords: System Modeling, Cognitive Map, Decision Making

1. Introduction

To study the management of an organizational system, it is necessary to analyze the factors (development indicators) and their influence on the main criteria of regional development. Because there are so many criteria, simulation experiments involve an extremely large number of possible scenarios. This work aims to identify a subspace of highly significant factors-those with the greatest impact-from the full set of organizational system factors. This subspace serves as a foundation for studying the economics of organizational system development, which is a current and important issue.

To achieve these goals, modeling of socio-political situations is used effectively. The study covers the construction of the model, testing it with different experimental approaches, and analyzing economic sustainability based on managerial influence.

In organizational systems, during the management process, the necessity of decision-making often arises. In such systems, the laws and regularities of situation development are mainly described qualitatively. However, there are circumstances in which the dynamics of processes do not follow established patterns, making forecasting difficult.

In the decision-making process, an important role is played by experts and analysts, who rely on their experience, professional intuition, and empirical knowledge. They assess the situation, determine possible alternatives, and choose optimal solutions, taking into account existing constraints and available resources.

For the creation, development, and effective implementation of an organizational system, its prior analysis and modeling are of decisive importance. Modern large-scale and complex systems have created the necessity to introduce modeling methods that reveal the relationships between interdependent

factors and assess goal-oriented behavior. Modeling takes into account not only the formal description of the system's elements but also the modeling of interactions between them.

2. Research Methodology

Building on the analysis of organizational systems and the role of experts in decision-making, the modeling of these systems can be structured into several main stages. These stages include the identification of system goals, the structuring of goals into a hierarchical goal tree, the ranking and weighting of goals, and the creation of cognitive maps to reveal interdependencies.

The modeling process includes several main stages:

- Identification of system goals
- Structuring of goals (construction of a goal tree)
- Ranking and weighting of goals
- Creation of cognitive maps to identify interdependencies.

The identification of objectives represents the initial stage that defines the direction and priorities of an organizational system. The structuring of objectives ensures their hierarchical organization, which facilitates multi-level analysis of system behavior. Furthermore, the use of cognitive maps makes it possible to reveal cause-and-effect relationships among objectives, as well as to determine the strength and direction of their influence.

In the analysis of complex organizational systems, it is possible to identify a wide spectrum of objectives and factors that determine the directions and outcomes of system development.

For the structuring of objectives - that is, for creating a structured informational model - the main (global) objective is identified, denoted as C_0. It represents the assessment of the effectiveness of internal-state regulation of conflicts and is assigned to the zero level. At the next stage, the global objective is decomposed into sub-objectives. The first-level indicators are C_1 (political), C_2 (social), and C_3 (economic). At the second level, each sub-objective is further decomposed into smaller sub-objectives (C_{11}, C_{12}, …, C_{21}, …, C_{31}, etc.).

Table 1. Example of Goal Decomposition (Fragment)

Denote	Description
C_0	Effectiveness of intra-state conflict regulation
C_1	Political Indicator
C_2	Social Indicator
C_3	Economic Indicator
C_{11}	Mutually opposing geopolitical orientations
	. . .
	. . .
C_2	Cultural and civilizational cleavage
C_{211}	Value orientation among various social and ethnic groups within a single state

The goal tree representing the above-mentioned goals and sub-goals will appear as follows (fragment) (see Fig. 1).)

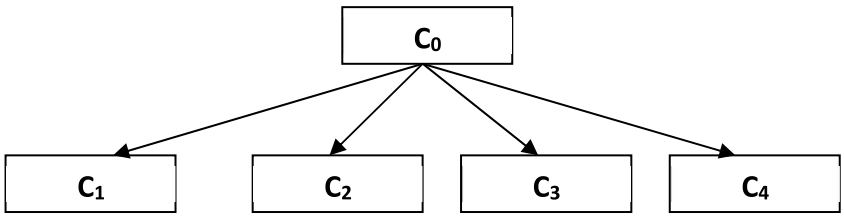

Figure 1. Goal tree representing goals and sub-goals (fragment)

At the next stage, weights are assigned to the system's goals. To determine the importance of each goal, linguistic evaluations are used, which are then converted into numerical scores within the interval [1–10] (Table 2).

Table 2. Linguistic assessments and their corresponding numerical scores

Linguistic values	Numerical (scores) values
When Ci and Cj have the same significance	1
When Ci is weakly dependent on the value of Cj	3
When Ci is strongly dependent on the value of Cj	5
When Ci is very strongly dependent on the value of Cj	7
Absolute dependence of Ci on the value of Cj	9
The assessment lies between two linguistic evaluations	2,4,6,8

AI facilitates the automatic construction of cognitive maps, where the interactions between goals are calculated based on statistical and textual data. The achievability of the global goal (C_0) is determined using the weights of sub-goals and influence indicators:

For each fragment of the goal tree, starting from zero, construct a square matrix R=||rij|| .

The columns of the matrix correspond to the nodes of the tree. In the top cell of the left column, the weight of the root node is given (C0 for the global goal with weight W0 = 1). At the intersection of row Ci and column Cj, the value of rij is assigned. This value is 1 if $C_i = C_j$. If Ci is more important than Cj, then the value bij is assigned; otherwise, if Ci is less important than Cj, the value 1/ bij is assigned.

Assume that the rows (and columns) of the matrix correspond to the goals $C_1, \ldots, C_p$, weighted by $W_1, \ldots, W_p$. The root node has weight W_0. Then the following condition holds:

$$W_q = \sum_{i=1}^{p} W_i \qquad (1)$$

The weights W_1represent the solution of the following system of equations:

$$w_I = \frac{1}{P_I} \sum_{J=1}^{P} r_{Ij}\, W_j \qquad (2)$$

$$w_{p-1} = \frac{1}{p} \sum_{J=1}^{P} r_{p-1,j}\, W_j$$

$$w_{p-1} = \frac{1}{p} \sum_{J=1}^{P} r_{p-1,j}\, W_j$$

The tree corresponding to zero-level rank for factors affecting sustainable development is (C_0, C_1, C_2, C_3, C_4) (Fig. 2).

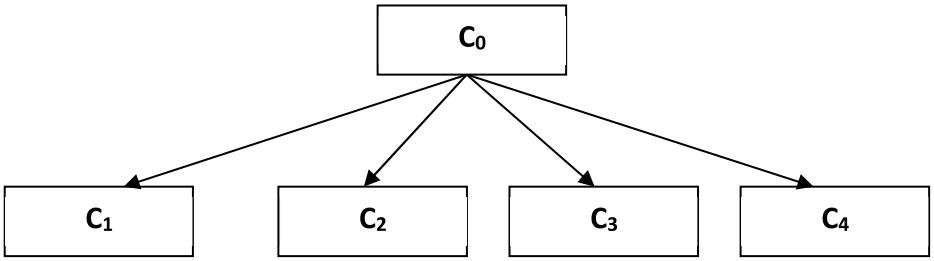

Figure 2. Zero-rank tree

At the next stage, it is necessary to minimize the system's local goals. Since there may be a large number of simple goals and factors, it is required to carry out quantitative evaluations and ranking of the most significant goals and factors to select the most effective ones. To construct a cognitive map of the interdependence of local goals, it should be taken into account that the columns and rows of the table correspond to the local goals. Based on the analysis and agreement with experts, a cognitive map is obtained, which for the given fragment has the following form (Fig. 3).

მიზნები	C1	C2	C3	C4	C11	C12	C13	C14	C15	C21	C22	წონები
C1	+1,				+0,	-0,7	+0,	+0,	+0,			0.5000
C2		+1,								+0,	0	0.2778
C3			+1,									0.1543
C4				+1,	0	0	0	0	0			0.0679
C11	-0,5	0	0	0	+1,	0	0	0	0			0.2143
C12	+0,	0	0	0		+1,						0.1327
C13	+0,	0	0	0	0	0	+1,					0.0821
C14	+0,	0	0	0		0		+1,				0.0508
C15	+0,				0	0	0	0	+1,			0.0201

Figure 3. Cognitive map (fragment)

To determine the interactions between goals on the cognitive map, numerical indicators are introduced - the degree of achievability of the global goal (C_0) and local goals (Cj), which for the fragment of the zero-level goal tree under consideration has the following form:

$$(C_0) = \sum_{j=1}^{N} (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_i$$

$$= (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_1 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_2 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_3 + (\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14}) \cdot W_4 = 3{,}5101$$

After performing the above calculations $J(C_0)$=3, 501,

The degree of achievement of goal subsets, taking their interdependencies into account, is expressed by the formula:

$$J(C^*) = J(c_{ji}) + \cdots + J(c_{jk})$$

Let the maximum allowable value of $J(C^*)$be denoted by Δ. In the case under consideration, it is equal to 0.2101.

The minimization problem can be formulated as follows: we need to find C^*such that the following conditions are simultaneously satisfied:

$$J(C^*) \leq \Delta$$
$$|C^*| = max$$

Taking the above calculations into account, we obtain the result of minimizing the local goals as $E = \{b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8\}$, which means that, out of more than 150 factors, the more significant ones are selected.

3. Conclusion.

This study presents systems modeling methodology for managing organizational systems, particularly in the context of conflict-affected regional development. The research findings demonstrate that the application of goal structuring, ranking, and weighting methods, combined with the use of cognitive maps, enables effective analysis of complex organizational systems and the identification of the most significant factors influencing their development. The proposed approach provides an effective tool for analyzing and managing complex organizational systems, especially in situations where traditional methods fail to ensure adequate assessment and optimal decision-making.

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