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Method of morphological analysis of enterprise management organizational structure

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Abstract. The essence of the method of morphological analysis of enterprise management organizational structure is described in the article. Setting levels of morphological decomposition and specification of sets of elements are necessary for morphological analysis. Based on empirical research identified factors that influence the formation and use of enterprises management organizational structures.

Key words: organizational management structure, method of morphological analysis, morphological graph, the levels of management, matrix of isomorphic distances, matrix of links distances, dendrite.

PROBLEM DEFINITION

Enterprise management organizational structure is a multilevel system organized according to functional definitions of its structural components. The analysis of the management organizational structure, therefore, should be conducted by means of decomposition of management layers and functions of its components. The morphological approach has been selected as the most appropriate method for this task. Although it has been used in science for nearly one thousand years, the morphological approach is still viewed as a set of system study principles rather than a precise methodological tool. This largely expands the field of its potential application, thus contributing to continuous development of morphology. The methodological aspects of morphological analysis are insufficiently developed, thus its practical application in enterprise management, in particular during the analysis of management organizational structure is problematic.

MAIN PRESENTATION

Morphological analysis method was developed by F. Zwicky. While working on specific problems in astrophysics, he proposed to break down a problem into individual components according to certain characteristics and attributes. F. Zwicky defined several principles of a morphological study such as equal interest to all objects of morphological analysis, elimination of all limitations and evaluations until the full structure of a studied area is defined, and most precise formulation of the problem [1, 255-256].

Based on these principles we propose a method of morphological analysis of enterprise management organizational structure. Its implementation foresees the following [2; 4; 7; 9]: 1) the formulation of the objective of morphological analysis – establishment of cause-result relationship between components and elements of the organizational structure and between the characterizing parameters; 2) definition of morphological decomposition levels fof the enterprise management organizational structure, including the parametrization of its elements (see Table 1); 3) identification of topological and metric spaces of the organizational structure of enterprise management; 4) synthesis of the analysis results.

To conduct a morphological analysis of organizational structure, levels of morphological decomposition (see Table 1) should be identified, and elements of sets that form local topological and metric spaces should be specified within each level. The topological space includes continuum (superset) and the system of subsets. We will build a fragment of the morphological graph of the upper enterprise management level based on notations provided in Table 1 (Fig. 1).

Table 1. Enterprise management organizational structure morphological decomposition levels

Management levels	Compo-nents of mana-gement organi-zational structure	Elements of manage-ment organi-zational structure	Indicators of efficient fulfillment of assigned tasks by employees[1]
B	B_1		$B_1 = f(x_1, x_2 .....x_n)$
	B_2		$B_2 = f(y_1, y_2 .....y_n)$
	B_n		$B_n = f(z_1, z_2 .....z_n)$
	C_1	$C_{1.1}$	$C_{1.1} = f(i_1, i_2 .....i_n)$
		$C_{1.2}$	$C_{1.2} = f(j_1, j_2 .....j_n)$
		$C_{1.n}$	$C_{1.n} = f(u_1, u_2 .....u_n)$
C	C_2	$C_{2.1}$	$C_{2.1} = f(o_1, o_2 .....o_n)$
		$C_{2.2}$	$C_{2.2} = f(t_1, t_2 .....t_n)$
		$C_{2.n}$	$C_{2.n} = f(r_1, r_2 .....r_n)$
	C_n	$C_{n.1}$	$C_{n.1} = f(e_1, e_2 .....e_n)$
		$C_{n.2}$	$C_{n.2} = f(w_1, w_2 .....w_n)$
		$C_{n.n}$	$C_{n.n} = f(q_1, q_2 .....q_n)$
	H_1	$H_{1.1}$	$H_{1.1} = f(p_1, p_2 .....p_n)$
		$H_{1.2}$	$H_{1.2} = f(l_1, l_2 .....l_n)$
		$H_{1.n}$	$H_{1.n} = f(k_1, k_2 .....k_n)$
H	H_2	$H_{2.1}$	$H_{2.1} = f(g_1, g_2 .....g_n)$
		$H_{2.2}$	$H_{2.2} = f(b_1, b_2 .....b_n)$
		$H_{2.n}$	$H_{2.n} = f(s_1, s_2 .....s_n)$
	H_n	$H_{n.1}$	$H_{n.1} = f(a_1, a_2 .....a_n)$
		$H_{n.2}$	$H_{n.2} = f(v_1, v_2 .....v_n)$
		$H_{n.n}$	$H_{n.n} = f(m_1, m_2 .....m_n)$

Note: Composed by article authors. Legend: B – the upper (institutional) level of enterprise management; B_1, B_2, B_n – the upper enterprise management includes the positions of director and his/her deputies; C – the middle enterprise management level; C_1, C_2, C_n – structura; $C_{2.1}, C_{2.2}, C_{2.n}$ – employees of department C_2; $C_{n.1}, C_{n.2}, C_{n.n}$ – employees of department C_n; H – the lower management level; H_1, H_2, H_n – structural departments of enterprise on the lower management level; $H_{1.1}, H_{1.2}, H_{1.n}$ – employees of department H_1; $H_{2.1}, H_{2.2}, H_{2.n}$ – employees of department H_2; $H_{n.1}, H_{n.2}, H_{n.n}$ – employees of department H_n.

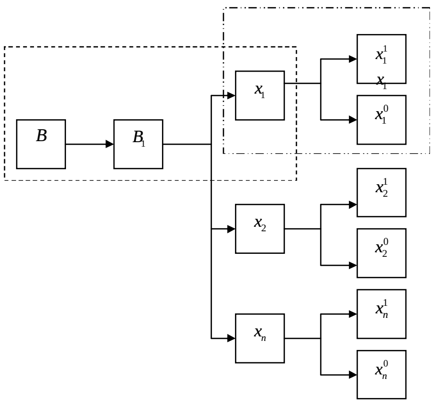


Fig. 1. A fragment of the morphological graph of the upper enterprise management level
Notes: Composed by article authors. A topological space is denoted with a dashed line, and a metric space with a dot-dashed line. Legend: x_1^1, x_1^0 – values of indicator x_1; x_2^1, x_2^0 – values of indicator x_2; x_n^1, x_n^0 – values of indicator

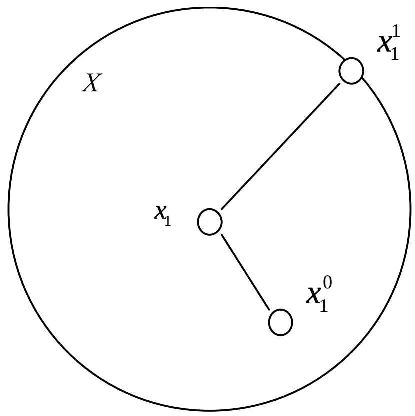


Fig. 2. Metric space of the morphological graph of the upper level of enterprise management
Note: Composed by article authors

All symbols with lower right index 1 represent indicators of timely completion of tasks by employees of the corresponding groups. Index 2 denotes indicators that reflect the completeness of task fulfillment, while index n refers to the quality of fulfillment.

The local topological space of the constructed morphological graph is denoted with a dashed line on Fig. 1. In this case $B \wedge B_1$ is an ordered pair, where B is a set, and B_1 is a system of subsets that satisfy the following conditions:

$$B \supset B_1 \equiv \Lambda_1; B_1 \supset x_1, x_2....x_n,$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_1, x_1 \in B\},$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_2, x_2 \in B\},$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_n, x_n \in B\},$$

where: Λ_1 is a topology on $B_{1.1}$.

Following the presented logic of relationship between elements of the morphological graph (see Fig. 1), it is level; $C_{1.1}, C_{1.2}, C_{1.n}$ – employees of department C_1; possible to create a topology $\Lambda_2 \wedge \Lambda_3$ on subsets $B_{2.2}$ i $B_{n.n}$:

$$B \supset B_2 \equiv \Lambda_2; B_2 \supset y_1, y_2....y_n,$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_1, y_1 \in B\},$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_2, y_2 \in B\},$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_n, y_n \in B\},$$
$$B \supset B_n \equiv \Lambda_3; B_n \supset z_1, z_2....z_n,$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_1, z_1 \in B\},$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_2, z_2 \in B\},$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_n, z_n \in B\}.$$

The values of indicators that characterize the completeness and quality of work tasks fulfillment by employees are presented on Fig. 1 with superscript indices. The indicators together with their possible values make up the metric space of morphological graph. A metric space is the pair of a certain set and a distance defined for any pair of elements within this set. The metric space (X) in the given morphological graph can be demonstrated as a sphere with radius x_1^1 and a center in x_1 (Fig. 2). In the given case:

$$x_1^1 \Leftrightarrow r; x_1 \wedge x_1^1 \equiv x_1^0 \in X \mid d(x_1^1, x_1^0)\ \mathbf{p}\ x_1^1,$$

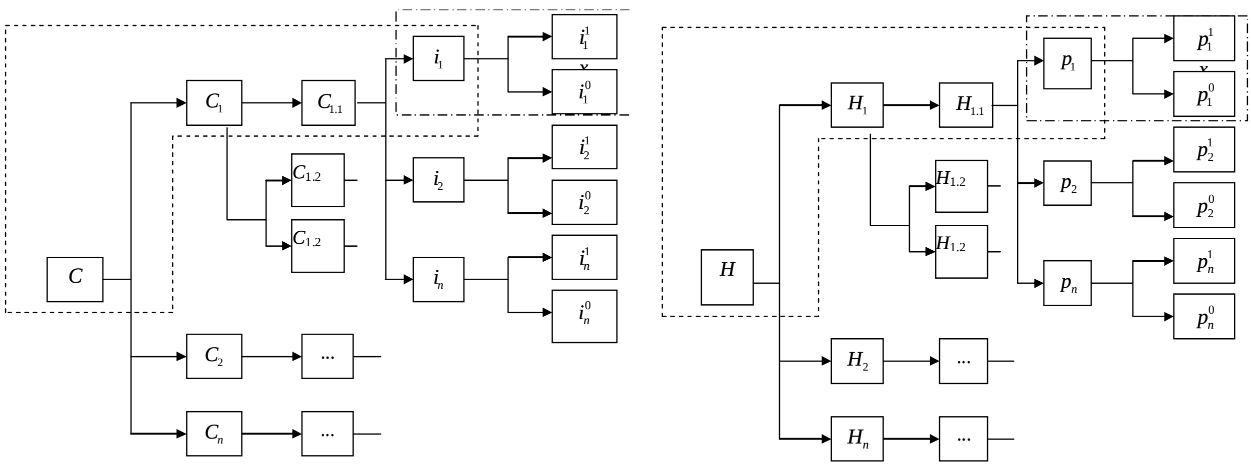
where: r – radius of sphere; d – distance between elements of the set.

Based on data from Table 1 and Fig. 1, beside the metric space $X : x_1 \wedge d(x_1^1, x_1^0)$, the upper level of enterprise management also includes other metric spaces (Y, Z), where $Y : x_2 \wedge d(x_2^1, x_2^0)$, $Z : x_n \wedge d(x_n^1, x_n^0)$.

The peculiarity of morphological decomposition of the organizational structure of enterprise management at middle and lower levels is that its components consist of more than one element, i.e., structural departments of the middle and lower management levels are not singleton sets [3; 5; 6]. A fragment of the morphological graph of middle and lower levels is presented at Fig. 3.

Topological spaces of the morphological graph of the middle enterprise management level are as follows:

1) $C \wedge C_1$, where C_1 denotes systems of subsets that satisfy the following conditions:



A) The middle level of management B) The lower level of management

Fig. 3. Fragments of the morphological graph of the middle and lower levels of enterprise management

Notes: Composed by article authors. A topological space is denoted with a dashed line, and a metric space with a dot-dashed line. Legend: i_1^1, i_1^0 – values of indicator i_1; i_2^1, i_2^0 – values of indicator i_2; i_n^1, i_n^0 – values of indicator i_n; p_1^1, p_1^0 – values of indicator p_1; p_2^1, p_2^0 – values of indicator p_2; p_n^1, p_n^0 – values of indicator p_n

$C \supset C_1 \supset C_{1.1} \equiv \Lambda_4; C_{1.1} \supset i_1, i_2 .... i_n,$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_1, i_1 \in C_1\},$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_2, i_2 \in C_1\},$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_n, i_n \in C_1\},$
$C \supset C_1 \supset C_{1.2} \equiv \Lambda_5; C_{1.2} \supset j_1, j_2 .... j_n,$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_1, j_1 \in C_1\},$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_2, j_2 \in C_1\},$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_n, j_n \in C_1\},$
$C \supset C_1 \supset C_{1.n} \equiv \Lambda_6; C_{1.n} \supset u_1, u_2 .... u_n,$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_1, u_1 \in C_1\},$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_2, u_2 \in C_1\},$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_n, u_n \in C_1\},$

$C \supset C_2 \supset C_{2.1} \equiv \Lambda_7; C_{2.1} \supset o_1, o_2 .... o_n,$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_1, o_1 \in C_2\},$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_2, o_2 \in C_2\},$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_n, o_n \in C_2\},$
$C \supset C_2 \supset C_{2.2} \equiv \Lambda_8; C_{2.2} \supset t_1, t_2 .... t_n,$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.2} \cap t_1, t_1 \in C_2\},$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.2} \cap t_2, t_2 \in C_2\},$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap t_n, t_n \in C_2\},$
$C \supset C_2 \supset C_{2.n} \equiv \Lambda_9; C_{2.n} \supset r_1, r_2 .... r_n,$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_1, r_1 \in C_2\},$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_2, r_2 \in C_2\},$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_n, r_n \in C_2\},$
where: Λ_7 is a topology on $C_{2.1}$; Λ_8 is a topology on $C_{2.2}$; Λ_9 is a topology on $C_{2.n}$,

3) $C \wedge C_n$,

where: C_n denotes systems of subsets that satisfy the following conditions:

$C \supset C_n \supset C_{n.1} \equiv \Lambda_{10}; C_{n.1} \supset e_1, e_2 .... e_n,$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_1, e_1 \in C_n\},$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_2, e_2 \in C_n\},$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_n, e_n \in C_n\},$
$C \supset C_n \supset C_{n.2} \equiv \Lambda_{11}; C_{n.2} \supset w_1, w_2 .... w_n,$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_1, w_1 \in C_n\},$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_2, w_2 \in C_n\},$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_n, w_n \in C_n\},$
$C \supset C_n \supset C_{n.n} \equiv \Lambda_{12}; C_{n.n} \supset q_1, q_2 .... q_n,$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_1, q_1 \in C_n\},$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_2, q_2 \in C_n\},$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_n, q_n \in C_n\},$

where: Λ_{10} is a topology on $C_{n.1}$; Λ_{11} is a topology on $C_{n.2}$; Λ_{12} is a topology on $C_{n.n}$.

Topological spaces of the morphological graph of the lower enterprise management level are as follows:

1) $H \wedge H_1$, where H_1 denotes systems of subsets that satisfy the following conditions:

$H \supset H_1 \supset H_{1.1} \equiv \Lambda_{13}; H_{1.1} \supset p_1, p_2 .... p_n,$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_1, p_1 \in H_1\},$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_2, p_2 \in H_1\},$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_n, p_n \in H_1\},$
$H \supset H_1 \supset H_{1.2} \equiv \Lambda_{14}; H_{1.2} \supset l_1, l_2 .... l_n,$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_1, l_1 \in H_1\},$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_2, l_2 \in H_1\},$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_n, l_n \in H_1\},$
$H \supset H_1 \supset H_{1.n} \equiv \Lambda_{15}; H_{1.n} \supset k_1, k_2 .... k_n,$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_1, k_1 \in H_1\},$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_2, k_2 \in H_1\},$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_n, k_n \in H_1\},$
where: Λ_{13} is a topology on $H_{1.1}$; Λ_{14} is a topology on $H_{1.2}$; Λ_{15} is a topology on $H_{1.n}$,

2) $H \wedge H_1$, where H_1 denotes systems of subsets that satisfy the following conditions:

$H \supset H_2 \supset H_{2.1} \equiv \Lambda_{16}; H_{2.1} \supset g_1, g_2 .... g_n,$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_1, g_1 \in H_2\},$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_2, g_2 \in H_2\},$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_n, g_n \in H_2\},$
$H \supset H_2 \supset H_{2.2} \equiv \Lambda_{17}; H_{2.2} \supset b_1, b_2 .... b_n,$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_1, b_1 \in H_2\},$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_2, b_2 \in H_2\},$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_n, b_n \in H_2\},$
$H \supset H_2 \supset H_{2.n} \equiv \Lambda_{18}; H_{2.n} \supset s_1, s_2 .... s_n,$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_1, s_1 \in H_2\},$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_2, s_2 \in H_2\},$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_n, s_n \in H_2\},$
where: Λ_{16} is a topology on $H_{2.1}$, Λ_{17} is a topology on $H_{2.2}$; Λ_{18} is a topology on $H_{2.n}$,

3) $H \wedge H_n$, where H_n denotes systems of subsets that satisfy the following conditions:

$H \supset H_n \supset H_{n.1} \equiv \Lambda_{19}; H_{n.1} \supset a_1, a_2 .... a_n,$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_1, a_1 \in H_n\},$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_2, a_2 \in H_n\},$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_n, a_n \in H_n\}.$

$$H \supset H_n \supset H_{n.2} \equiv \Lambda_{20}; H_{n.2} \supset v_1, v_2....v_n,$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_1, v_1 \in H_n\},$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_2, v_2 \in H_n\},$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_n, v_n \in H_n\},$$
$$H \supset H_n \supset H_{n.n} \equiv \Lambda_{21}; H_{n.n} \supset m_1, m_2....m_n,$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_1, m_1 \in H_n\},$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_2, m_2 \in H_n\},$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_n, m_n \in H_n\},$$

where: Λ_{19} is a topology on $H_{n.1}$; Λ_{20} is a topology on $H_{n.2}$; Λ_{21} is a topology on $H_{n.n}$.

Table 2 presents metric spaces of the graphs of the middle and lower enterprise management levels.

Table 2. Metric spaces of the graphs of the middle and lower enterprise management levels

Management levels	Metric spaces
Middle enterprise management level	$I_1 : i_1 \wedge d(i_1^1, i_1^0); I_2 : i_2 \wedge d(i_2^1, i_2^0); I_n : i_n \wedge d(i_n^1, i_n^0),$ $J_1 : j_1 \wedge d(j_1^1, j_1^0); J_2 : j_2 \wedge d(j_2^1, j_2^0); J_n : j_n \wedge d(j_n^1, j_n^0),$ $U_1 : u_1 \wedge d(u_1^1, u_1^0); U_2 : u_2 \wedge d(u_2^1, u_2^0); U_n : u_n \wedge d(u_n^1, u_n^0),$ $O_1 : o_1 \wedge d(o_1^1, o_1^0); O_2 : o_2 \wedge d(o_2^1, o_2^0); O_n : o_n \wedge d(o_n^1, o_n^0),$ $T_1 : t_1 \wedge d(t_1^1, t_1^0); T_2 : t_2 \wedge d(t_2^1, t_2^0); T_n : t_n \wedge d(t_n^1, t_n^0),$ $R_1 : r_1 \wedge d(r_1^1, r_1^0); R_2 : r_2 \wedge d(r_2^1, r_2^0); R_n : r_n \wedge d(r_n^1, r_n^0),$ $E_1 : e_1 \wedge d(e_1^1, e_1^0); E_2 : e_2 \wedge d(e_2^1, e_2^0); E_n : e_n \wedge d(e_n^1, e_n^0),$ $W_1 : w_1 \wedge d(w_1^1, w_1^0); W_2 : w_2 \wedge d(w_2^1, w_2^0); W_n : w_n \wedge d(w_n^1, w_n^0),$ $Q_1 : q_1 \wedge d(q_1^1, q_1^0); Q_2 : q_2 \wedge d(q_2^1, q_2^0); Q_n : q_n \wedge d(q_n^1, q_n^0).$
Lower enterprise management level	$P_1 : p_1 \wedge d(p_1^1, p_1^0); P_2 : p_2 \wedge d(p_2^1, p_2^0); P_n : p_n \wedge d(p_n^1, p_n^0),$ $L_1 : l_1 \wedge d(l_1^1, l_1^0); L_2 : l_2 \wedge d(l_2^1, l_2^0); L_n : l_n \wedge d(l_n^1, l_n^0),$ $K_1 : k_1 \wedge d(k_1^1, k_1^0); K_2 : k_2 \wedge d(k_2^1, k_2^0); K_n : k_n \wedge d(k_n^1, k_n^0),$ $G_1 : g_1 \wedge d(g_1^1, g_1^0); G_2 : g_2 \wedge d(g_2^1, g_2^0); G_n : g_n \wedge d(g_n^1, g_n^0),$ $B_1 : b_1 \wedge d(b_1^1, b_1^0); B_2 : b_2 \wedge d(b_2^1, b_2^0); B_n : b_n \wedge d(b_n^1, b_n^0),$ $S_1 : s_1 \wedge d(s_1^1, s_1^0); S_2 : s_2 \wedge d(s_2^1, s_2^0); S_n : s_n \wedge d(s_n^1, s_n^0),$ $A_1 : a_1 \wedge d(a_1^1, a_1^0); A_2 : a_2 \wedge d(a_2^1, a_2^0); A_n : a_n \wedge d(a_n^1, a_n^0),$ $V_1 : v_1 \wedge d(v_1^1, v_1^0); V_2 : v_2 \wedge d(v_2^1, v_2^0); V_n : v_n \wedge d(v_n^1, v_n^0),$ $M_1 : m_1 \wedge d(m_1^1, m_1^0); M_2 : m_2 \wedge d(m_2^1, m_2^0); M_n : m_n \wedge d(m_n^1, m_n^0).$

Note: Composed by article authors.

Legend: $I_1, I_2, I_n, J_1, J_2, J_n, U_1, U_2, U_n$, $O_1, O_2, O_n, T_1, T_2, T_n, R_1, R_2, R_n$, $E_1, E_2, E_n, W_1, W_2, W_n, Q_1, Q_2, Q_n$ – metric spaces of the middle enterprise management level; $P_1, P_2, P_n, L_1, L_2, L_n, K_1, K_2, K_n, G_1, G_2, G_n$, $B_1, B_2, B_n, S_1, S_2, S_n, A_1, A_2$, $A_n, V_1, V_2, V_n, M_1, M_2, M_n$ – metric spaces of the lower enterprise management level.

The method of morphological analysis is normally concluded with results generalization. While studying organizational structures of enterprise management it is appropriate to perform this task with the aid of tools traditionally employed in digital systems synthesis. For example, an expression $B_1 = f(x_1, x_2.....x_n)$ from Table 1 can be viewed as a "blackbox" (Fig. 4), where the resulting value B_1 depends on factor values $x_1, x_2.....x_n$.

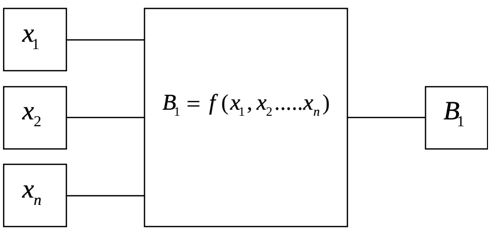


Fig. 4. "Blackbox" graphic model
Note: Composed by article authors.

Taking into consideration three inputs and one output, a truth table will be composed of eight variables and will reflect a ternary transformation of $x_1, x_2.....x_n$ into B_1 (Table 3).

Table 3. A truth table for x_2

	x_1	x_2	x_n	B_1
	0	0	0	0
1	0	0	1	1
2	0	1	0	1
	0	1	1	0
3	1	0	0	1
	1	0	1	0
4	1	1	0	1
5	1	1	1	1

Note: Composed by article authors.

The underlined and numbered rows in Table 3 have the resulting value of a "blackbox" equal to 1. We will develop a separate scheme of factor values transformation into the result value for each underlined row (Fig. 5).

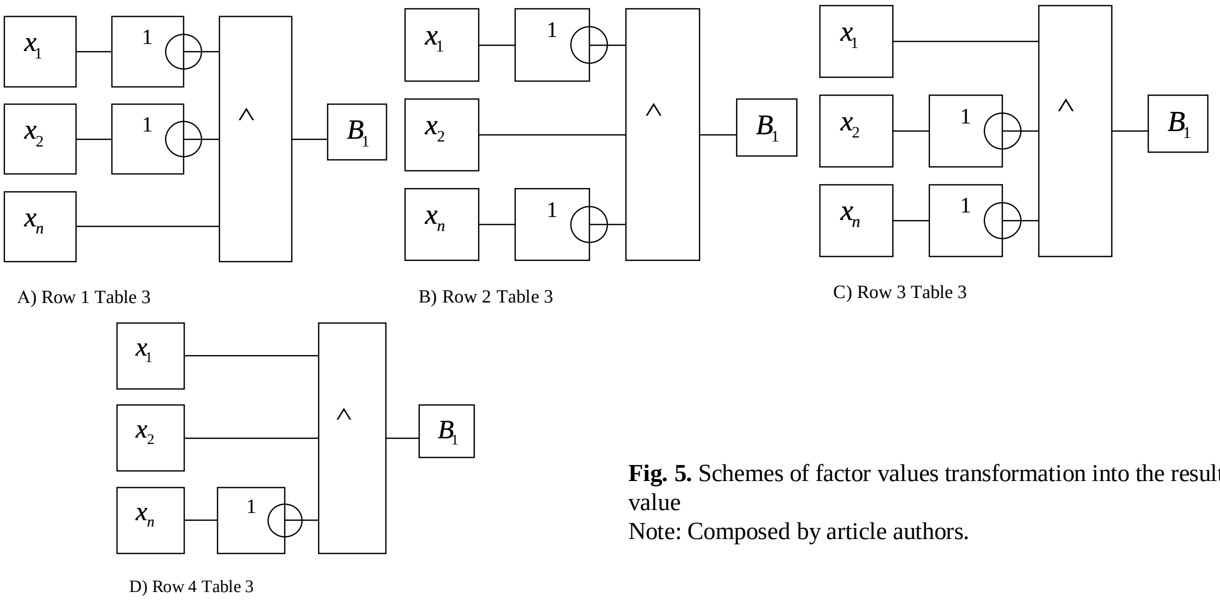


Fig. 5. Schemes of factor values transformation into the result value
Note: Composed by article authors.

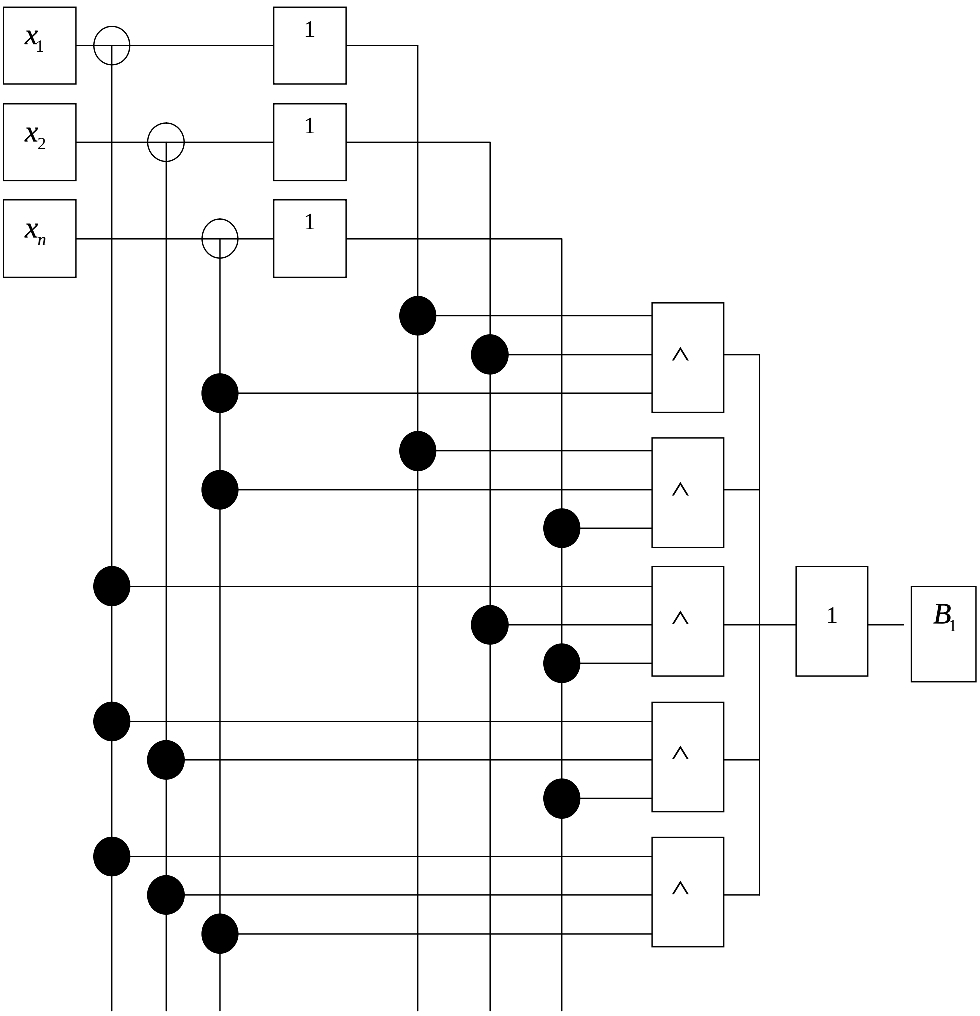


Fig. 6. Recompositional synthesized model of the reflection of the values of factor values $x_1, x_2 .....x_n$ into the resulting value B_1

Notes: Composed by article authors. Transparent circles represent factor values that reflect the fifth row of Table 3. Positions of other rows of this table are represented with black circles.

For an enterprise analyst this scheme can serve as algorithm for reduction of disparate data on individual parameters of the considered fragment of the enterprise management organizational structure into an integral decision-making support system on current enterprise management structure reorganization.

Table 4. Classification of the factors that influence the enterprise management organizational structures

Classification by	Types of factors
Content	– Type of business activity – Form of business organization – Size of an enterprise – Objectives of an enterprise – Production automation – Enterprise integration into economic and production structures – Legal provisions that regulate activities of an enterprise – Level of managerial professionalism of directors, their vision, beliefs, and ambitions – Relevant qualification of departments staff – Competition and market conditions
Character	– Factors that positively influence the formation and use of enterprise management organizational structure – Factors that negatively influence the formation and use of enterprise management organizational structure
Impact	– Factors with strong influence on the formation and use of enterprise management organizational structure – Factors with weak influence on the formation and use of enterprise management organizational structure – Factors with neutral influence on the formation and use of enterprise management organizational structure
Connections	– Factors with direct connections – Factors with indirect connections
Source	– Factors of the internal organizational environment – Factors of the external organizational environment
Level of regulation	– Factors that can be regulated – Factors that require adaptation

Note: Composed by article authors.

It is possible to synthesize the results of morphological analysis on the basis of the schemes of the transformation of factor values into the result value. We will develop a recompositional synthesized model for the conversion of $x_1, x_2.....x_n$ values into result B_1 (Fig. 6).

As shown on Fig. 6, factor values can either define the result value with three inputs $(x_1 \wedge x_2 \wedge x_n) \to B_1$, or they can define it with as many as five inputs under condition that factor values are built into a cascade scheme.

The factors that influence the formation and use of enterprise management organizational structures have been identified and classified through empirical research (Table 4).

The type of business activity influences the enterprise management organizational structures. Beyond any doubt, the type of business activity (industrial production, financial services, commerce, etc.) defines the establishment of structural departments, division of their functions, internal communication, etc. Therefore the type of business activity defines business processes within the organization and, correspondingly, the enterprise management organizational structure is formed and used. The type of business activity is a factor of internal organizational environment. Considering the fact that every business entity can select its activity types, add other activities over time, or even change from one type of business activity to another, this factor can be regulated. From the point of view of the character of influence on the formation and use of enterprise management organizational structure, the type of business activity can be either positive or negative. The character of this factor can be changed under the influence of other factors, for example, due to changes in legislation, personal decisions of directors, etc.

The form of business organization and legal provisions that regulate business activities of enterprise are also factors that influence the enterprise management organizational structure during its formation and use. The applicable legislation, including provisions of Commercial Code of Ukraine (an external environment factor) defines the organizational structure of public limited companies, joint stock companies, limited liability companies, additional liability partnerships, etc. Although the legislation regulates types of management structure for particular forms of business entities, the form of business organization, selected during its foundation is an internal environment factor as the selection of the form of business is an individual or collective decision of its owners. Therefore, this factor can be regulated, contrary to the applicable legislation, which requires adaptation. The studies have shown the widespread examples of changing the form of business from one to another. Usually this happens while the initially selected form of enterprise for certain reasons transforms into the negative factor, for example, it does not allow using certain investment mechanisms, creates a threat of acquisition by competitors, etc.

The size of business entity also has influence on the formation and use of the enterprise management organizational structure. This is also a factor of the internal organizational environment, the influence of which can be regulated by owners and/or directors. Numerous examples show that the size of an enterprise is beyond doubt one of the determining factors that influence the size of its management organizational structure, the number of functional and direct connections within the management organizational structure, geographical diversification of structural departments, number of employees, etc. Beside that, an uncertain nature of the impact of this factor on the effective use of enterprise management organizational structure remains. On the one hand, it is known that the size of an enterprise and, for example, geographical diversification of the management organizational structure allows savings on scale and an increase in revenue due to decrease of fixed costs per unit of production delivered by the company. On the other hand, the absence of effective logistics system and underuse of production capacity can become a precondition that turns the size of the entity into a negative factor and lead to the overspending on maintenance of a cumbersome enterprise management organizational structure. Therefore, the factor of enterprise size should be continuously monitored and its interconnection with other factors should be studied, the measures towards positive cash flows domination over negative cash flows should be taken, while investments into the development of enterprise management organizational structure should ensure the desired increase of economic development indices of the enterprise.

Production automation is a factor of internal organizational environment, and its influence on the formation and use of the enterprise management organizational structure can be regulated. The conducted studies showed that an increase in level of production automation causes the decrease in the number of employees at production level, requires higher level of professional training of employees, and causes the increase in the number of required managerial departments. Nevertheless, many companies with well-known global trademarks have reached high levels of production automation and became pioneers in the implementation of robotic manufacturing systems. As a result these companies ended up with a situation when their products are too expensive for the majority of countries of the world due to high capital and intellectual intensity of production and thus the export of their products is limited. Therefore, these companies try to transfer their production facilities to countries with lower level of economic development, where certain automated operations can be substituted by manual labor while salaries and social benefits to employees can be reduced. In conclusion, production automation has a positive influence on the formation and use of the enterprise management organizational structure but only to a certain degree and under certain conditions.

The objectives of an enterprise influence the formation and use of the enterprise management organizational structure as well. The design of any management organizational structure during the establishment of a business is based on defining the mission and setting the system of objectives of the organization. To be precise, the management organizational structure is being built in such a way that established objectives of the business enterprise can be achieved. It means that the fulfillment of assigned tasks by structural departments of an enterprise is a precondition for achieving the objectives of enterprise in general. In correspondence to the developed classification (Table 4), the objectives of organization are a factor of internal organizational environment that can be regulated. A need to regulate the influence of this factor on the formation and use of the enterprise management organizational structure emerges in cases when set objectives are not adequate, i.e., not sufficiently qualitatively and quantitatively parameterized and not defined in time, or their assigned realization period is unrealistic.

Enterprise integration into economic and production structures is also among factors that influence the formation and use of the enterprise management organizational structure. The conducted studies have shown that approximately three thousand national industrial enterprises active in mechanical engineering and instrumentation sphere are to certain extent integrated into various economic and production structures, such as innovative clusters, associations, concerns, consortiums, scientific and production associations etc. Whether this factor can be regulated or not depends on the character of the integration (statutory merger or union agreement). The decision on integration of a enterprise into a certain economic and production structure can be taken either by its owners and directors, or by competitors that acquire this enterprise. While taking this into consideration, the circumstances under which the incorporation of an enterprise into certain economic and production structures can also determine a possibility to regulate the influence of this factor on the formation and use of the enterprise management organizational structure.

Level of managerial professionalism of directors, their vision, beliefs and ambitions are a factor of direct action on the formation and use of the enterprise management organizational structure. The importance of the influence of this factor is difficult to overestimate because managers of an enterprise set objectives of the organization, take decisions on disbanding the existing perform the division of functions, roles and responsibilities, lay down the foundation for subordination within the organization, etc. This factor belongs to internal organizational environment, but due to its subjective character, its influence on the formation and use of the enterprise management organizational structure can vary. A possibility to regulate its impact on the formation and use of the enterprise management organizational structure significantly depends on management style implemented within the organization and on the extent of control that owners of the enterprise can exercise in the organization.

Empirical studies have shown that understaffing of the structural departments is often a reason for organizational changes that lead to the liquidation or merger of two or more structural departments into one. Therefore, sufficient staffing of the structural departments of enterprise is also a factor of internal enviro-

Table 5. Indicators that determine the significance of factors that influence the enterprise management organizational structure

Factor number	The average total score designated by experts	The general total score designated by experts	Coefficient of relative factor significance
1	8,70	435	0,87
2	8,72	436	0,872
3	9,36	468	0,936
4	9,46	473	0,946
5	8,06	403	0,806
6	8,10	405	0,81
7	8,10	405	0,81
8	9,30	465	0,93
9	4,24	212	0,424
10	5,14	257	0,514

Notes: Composed by article authors based on the results of experiments. The experts used a 10 point scale, where 1 was the lowest score and 10 was the highest score. Meaning of the factor numbers: 1. Type of business activity. 2. Form of business organization at foundation. 3. Size of an enterprise. 4. Objectives of an enterprise. 5. Production automation. 6. Enterprise integration into economic and production structures. 7. Legal provisions that regulate activities of an enterprise. 8. Level of managerial professionalism of directors, their vision, beliefs, and ambitions. 9. Relevant qualification of departments staff. 10. Level of competition and market conditions.

nment of the enterprise that has an influence on the formation and use of the enterprise management organizational structure. Its impact on the studied subject can be regulated by managers of an enterprise. The character of this factor can change with time, therefore managers should closely monitor and execute such human resources policy that leads towards constant increase of staff qualification, decrease in the number of conflicts at workplace, and stimulate employees towards improvement of performance.

In a market economy, known to be characterized by competition predominantly for markets and consumers, the level of market competition and market conditions is an important factor that influences the formation and use of the enterprise management organizational structure. This is an external environmental factor and an enterprise has to adapt to it. In practice this adaptation takes place through the realization of organizational changes with the help of which the existing enterprise management organizational structures get reorganized into new ones. The managers' ability to precisely identify the character of market fluctuations is directly linked with the adequate decisions on improving market positions of an enterprise. The study of the competition among transnational corporations for market positions in commodity sales has shown that they use combined, in particular matrix management structures. Their geographical distribution in general takes place within two stages. Initially mother companies create non-operational representations on a market, where their production and sales networks are planned to be developed. Their designation is to study the market, in particular consumer demands, prices, possible volumes of sales, existing and potential competitors, peculiarities of national legislation, and so on. After the consumer demands are known and the market is assessed as promising, the strategy for market entry, including the formation of complex advertisement campaigns, is being elaborated. During the second stage non-operational representations start organizing the launch of factories, sales centers, service centers, etc. on new territories. Domestic enterprises also have certain positive experience in taking into consideration the influence of this factor on the formation and use of the enterprise management organizational structure.

Based on the results of the conducted expert research the coefficients of significance of the discussed factors that influence the formation and use of the enterprise management organizational structure have been established (Table 5).Based on the results, the most significant factors are objectives of an enterprise (0,946), its size (0,936), and also the level of managerial professionalism of directors, their vision, beliefs, and ambitions (0,930). Relevant qualification of departments staff (0,424) and the level of competition and market conditions (0,514), in turn, appear to be the least significant factors.

During the process of the formation and use of the enterprise management organizational structure it is important to have information on the list of factors, their content, relevant significance and to understand how much these factors are interlinked with each other. This information is important from the point of view of understanding how decisions on the regulation of a certain factor will be reflected on other factors.

The appropriate way to study links between factors is to use cluster analysis tools, in particular spheres method that envisages the grouping of factors on the basis of establishing isomorphic similarities among them. With the help of a matrix of isomorphic distances (Table 6), initial chains between factors that have the highest isomorphic similarity can be obtained:

Chain 1 - 1 — 0,016504 — 3 — 0,015027 — 4 — 0,022933 — 6 — 0,023062 — 7 — 0,032783 — 10

Chain 2 - 2 — 0,018316 — 5 — 0,01744 — 8 — 0,034971 — 9

Table 6. Matrix of isomorphic distances between factors

Factors	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	0	0,022986	0,016504	0,017482	0,02034	0,024679	0,020704	0,021341	0,038024	0,029451
2	0,022986	0	0,01921	0,019453	0,018316	0,025676	0,024959	0,022651	0,033792	0,036036
3	0,016504	0,01921	0	0,015027	0,020039	0,018277	0,018427	0,020395	0,035924	0,030302
4	0,017482	0,019453	0,015027	0	0,018795	0,022933	0,020527	0,019906	0,034477	0,028193
5	0,02034	0,018316	0,020039	0,018795	0	0,026748	0,023393	0,01744	0,029082	0,030686
6	0,024679	0,025676	0,018277	0,022933	0,026748	0	0,023062	0,024956	0,039121	0,032279
7	0,020704	0,024959	0,018427	0,020527	0,023393	0,023062	0	0,025466	0,038432	0,032783
8	0,021341	0,022651	0,020395	0,019906	0,01744	0,024956	0,025466	0	0,034971	0,032937
9	0,038024	0,033792	0,035924	0,034477	0,029082	0,039121	0,038432	0,034971	0	0,041711
10	0,029451	0,036036	0,030302	0,028193	0,030686	0,032279	0,032783	0,032937	0,041711	0

Note: Composed by article authors.

According to the spheres method in order to cluster the objects, a critical value between objects based on the similarity of their structure should be determined with the help of a matrix of isomorphic distances. For this purpose we will select minimal isomorphic distances within the section of each column, and later we will select the maximum distance between the studied objects. As we can see, the minimum distances are the following: 0,016504; 0,01921; 0,016504; 0,015027; 0,01744; 0,018277; 0,018427; 0,01744; 0,029082; 0,029451. Among them the maximum distance is the distance between the first and the tenth factors – 0,029451.

Clusters can be formed based on the identification of the critical distance (Fig. 7).

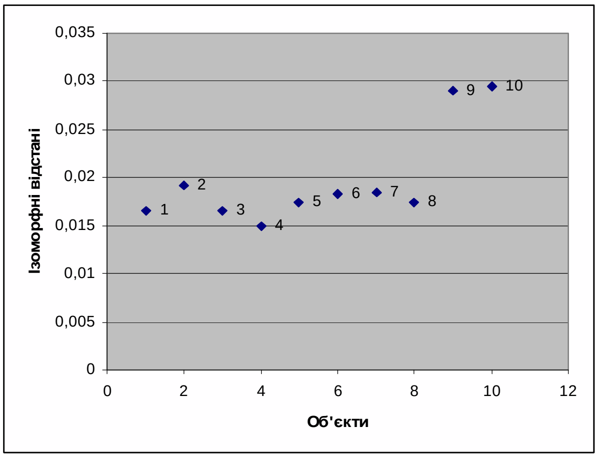


Fig. 7. Groups of factors that influence enterprise management organizational structure
Note: Composed by article authors

To identify the strings between the factors within the formed clusters it is important to form a dendrite. For this purpose we will use the above mentioned chains of factors and the matrix of distances between chains (Table 7).

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Table 7. Matrix of links distances

Chains	1	2
1	0	0,018795
2	0,018795	0
Minimal distances	0,018795	0,018795
Chains with the shortest distances	1 and 2	2 and 1

Note: Composed by article authors.

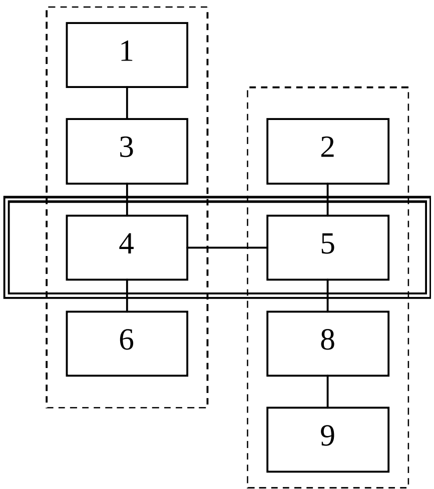

Fig. 8. Dendrite of factors that have influence on the enterprise management organizational structures
Note: Composed by article authors.

Table 7 shows that chains 1 i 2 are interconnected with each other through the fourth and fifth factors. The isomorphic distance between these factors is equal to 0,018795th of a unit. Based on this we will form a dendrite of factors that influence the enterprise management organizational structure (Fig. 8).

The formed dendrite indicated that while taking a decision on the regulation of any of the factors that influence the formation and use of the enterprise management organizational structure, it is important to take into consideration that this decision can have impact on the character of those factors that form the same chain together with the given factor. Also the impact of the decision, to certain extent, can be reflected on the factors from another chain, as these factors are directly or or indirectly interconnected. The situation that regulates the fourth and the fifth factor should be considered as a special case. These factors connect two chains into one tree-like structure. From this point of view, within the given situation there are more linear (direct) connections than in any other situation. It foresees stronger impact of the used measures on the list of selected factors than in any other situation.

CONCLUSIONS

Considering the fact that enterprise management organizational structure is a multilevel formation with a large number of components, elements and connections, the analytical results for the management decision-making process on improvement of the current management organizational structure should be sufficiently informative. By ‘sufficiently informative’ we understand both sufficient data for certain organizational decision-making and data objectivity. The data is considered to be objective if it has been obtained from different sources with the aid of scientific methods. The results of the undertaken studies prove that high level of informativeness of the analytical information on current enterprise management organizational structures can be achieved by means of morphological analysis. It allows considering all decomposition levels of the management organizational structure as topological and metric spaces, elements of which are interlinked with each other by causal relationships. With the aid of morphological analysis it is possible to identify the causes of problems emerging within the existing management organizational structures, determine the factors that are common for two or more local decisions towards solving them.

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