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TECHNOLOGY OF MULTIPLE-CRITERIA SYNTHESIS AND CHOICE OF DISTRIBUTED ORGANIZATIONAL MANAGEMENT STRUCTURE OF DISTRIBUTION LOGISTICS SYSTEM

У роботі запропонована технологія формування організаційної структури управління логістичної системи дистрибуції, яка складається з наступних етапів: синтез конфігурації логістичної системи; формування варіантів: ведення бізнесу, виконавців бізнес-процесів, організаційної структури управління; оцінка варіантів і вибір безлічі ефективних; прийняття рішення за вибором організаційної структури.

Ключові слова: організаційна структура, логістична система, дистрибуція, бізнес-процес, прийняття рішень.

В работе предложена технология формирования организационной структуры управления логистической системы дистрибуции, которая состоит из следующих этапов: синтез конфигурации логистической системы; формирование вариантов: ведения бизнеса, исполнителей бизнес-процессов, организационной структуры управления; оценка вариантов и выбор множества эффективных; принятие решения по выбору организационной структуры.

Ключевые слова: организационная структура, логистическая система, дистрибуция, бизнес-процесс, принятие решения.

Technology of the creation of distributed organizational management structure of logistics distribution system is proposed in this study and consists of the following stages: synthesis of logistics system configuration, elicitation of the alternatives in following aspects: business management, business-process executors, organizational management structure; the alternatives estimation and choice of effective ones; decision-making in the aspect of choosing rational organizational structure. The developed approach is a modification of the technology described in [4]. New criterion is added to implement stability issues on the stage of logistics system configuration. AHP method is used to choose rationally effective executors for the business-processes and supply chains.

Keywords: organizational structure, logistics system, distribution, business-process, decision-making.

Introduction. In the nowadays marketing conditions the orientation of manufacturers is directed towards the interests and requests of the end-consumers of goods and services. Maximization of net income under the situation of uncertain demand became a main economic interest of the manufacturers. Logistics approach implementation may allow company to reduce operational costs, increase shipments quality and, thus, achieve competitive advance on the market [1, 2].

It is necessary to consider logistics systems management in the context of governing company as a whole. Logistics strategy should be regarded as an integral component of corporate strategy which consists of sub-strategies in the next fields: marketing, logistics, production etc.

It is possible to say about mapping between several control loops and components of corporate strategy. For instance, logistics control loop consists of several components which correspond to the areas of system analysis. Strategic requirements elicitation matches with goal analysis procedure. Logistics network configuration corresponds to structural and functional analysis. Design of logistics system (LS) organizational management structure (OMS) coincides with organizational-procedural, technical-economic and social-economic analysis.

Strategical program of actions in logistics area is created after development of the logistics strategy, detailed and implemented under operational control. Special attention in logistics is paid to strategic planning, end-product of which is OMS which manages distributed LS. This paper focuses on the one of its components – distribution system [3]. **The aim** of study is further development of technology for creation of geographically distributed OMS [4] of distribution LS, which is discussed in [5].

This paper focuses on creation of dynamic model of company organizational activity synthesis based on

inter-functional and inter-organizational coordination of separate LS components as well as vertical and horizontal coordination of the whole system.

Literature review. The issues of formation of distributed OMS of LS were discussed in [5]. Authors created the basis for the solution of this problem and described it within the main stages which are presented on the fig. 1. They propose the way of creating the configuration of LS with the usage of transportation theory and inventory management topics. Furthermore, the idea of the hierarchical OMS of LS is discussed and the insight of distributed LS optimization via inter-functional and inter-organizational coordination is provided. To the best of our knowledge, the described technology and the ways of its stages implementation is a strong point of this paper but it is not supported by mathematical formalization. Hence, this is an area which this paper attempts to cover.

Problem definition. The main stages of technology describing the formation of distributed organizational structure for distribution logistics system are defined in [5]. As it was earlier mentioned the aim of this study is the improvement of presented in [5] technology, therefore, it's necessary to define the main areas of its correction.

In addition to the first stage (LS configuration) an additional criterion is proposed, which defines the stability of certain configuration to the external disturbances. Further, the best decisions which satisfy additional criterion are chosen from the set of effective configuration which is created according to [5]. Supply chain members' assigning is proposed to conduct in two sub-stages:

- Selection of the outsourcing alternatives from the set of existing ones for separate business process or group of processes;
- Assignment of executors to chosen processes.

Then modification of earlier mentioned technology is proposed.

The idea is that on the third stage experts and persons that generate decisions propose different variants of OMS and make their complex estimations according to indicators which characterize certain logistics operators. As a result, the most satisfactory OMS alternatives are gathered. Then the optimization task of OMS occurs from the point of satisfying defined KPIs because created OMS of LS with assigned members exists at the finite interval of time (plan period). Thus, dynamic task of inter-functional and inter-organizational coordination of separate two-layered subsystems is solved, and both horizontal and vertical coordination of system as a whole are reached.

Technology of distribution LS OMS synthesis. Technology consists of six stages (fig. 1), each of which allows returning to the previous ones. As it was mentioned earlier the aim of paper is further development and enhancement of technology mentioned in [5]. The step-by-step illustration of remastered approach is provided onwards.

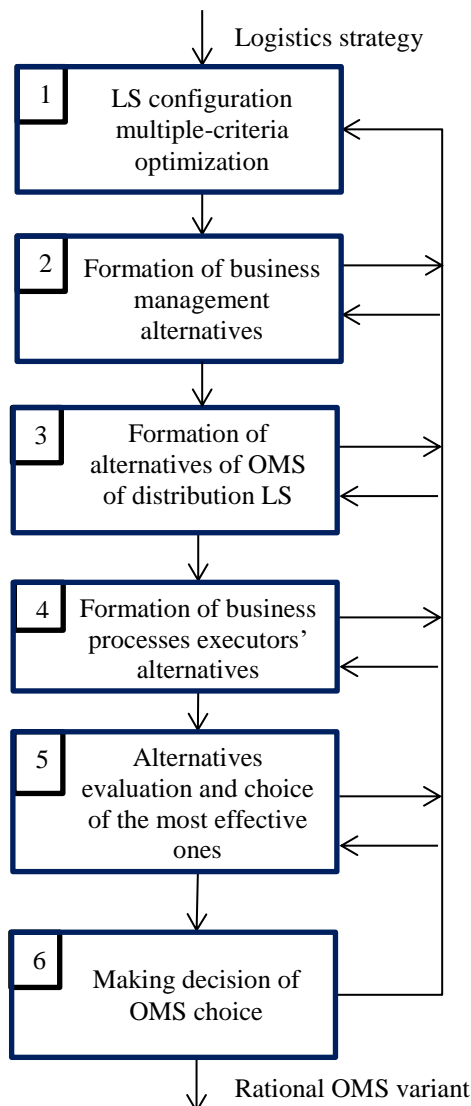


Fig. 1 – Technology of multiple-criteria synthesis and choice of distributed organizational management structure of logistics distribution system

The first stage occurs similarly to the earlier proposed one. During this stage the strategic logistic network is designed as a basis for the realization of logistics operations. The foundation of this stage is transportation theory approach [6]. S – summarized costs of production storage and transportation, and C – level of customer service, are chosen as the criteria for the network configuration. The set of task solution alternatives is created due to varying of control parameters such as the amount of intermediate warehouses, the inventory value, and the duration of product sales cycle. Then from this set Pareto-effective alternatives are chosen (B – Pareto set). Narrowing of the Pareto set occurs on account of adjusting the boundary values of weighting factors of importance vector ρ (fig. 2).

$$\bar{\rho} = (\bar{\rho}_S, \bar{\rho}_C) \text{ и } \underline{\rho} = (\underline{\rho}_S, \underline{\rho}_C)$$

$$\rho_C, \rho_S \geq 0, \rho_S + \rho_C = 1, \underline{\rho}_S \leq \rho_S \leq \bar{\rho}_S, \underline{\rho}_C \leq \rho_C \leq \bar{\rho}_C$$

As a result, the set $B \subseteq \bar{B}$. It consists of N configurations of logistics system.

$$B = \{B_1, B_2, B_3 \dots B_N\}$$

Considering that this task refers to strategic management it's important to investigate the factor of stability of formulated alternatives to emergencies such as failure of intermediate warehouses, incomplete production delivery, transport malfunction etc. Set of such adverse situations can be built with the usage of experts' estimations.

$$A = \{A_1, A_2, A_3 \dots A_N\}$$

It's assumed that the likelihood of such events is equal and each of them brings on occurrence the negative payoff U_{ij} in terms of criteria S and C .

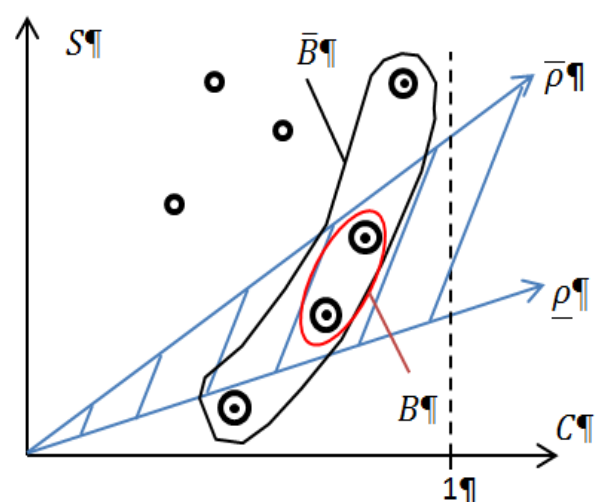


Fig. 2 – Formation of LS configuration alternatives

Let's focus on the formulation of aggregate indicator "negative payoff" from the combination of criteria S and C .

Due to the difference in scales all criteria should be normalized according to approach proposed in [7]. Preliminarily, it's necessary to define maximum and minimum of these criteria:

$$(B, A) = \left(\{B_i, i = \overline{1, N}\}, \{A_j, j = \overline{1, M}\} \right) \Rightarrow \\ \Rightarrow \left\{ (C_{ij}^*, S_{ij}^*), i = 1, N; j = 1, M \right\}$$

where S_{ij}^* and C_{ij}^* - the costs and the level of service for i variant of LS configuration at j variant of emergency. Then:

$$C_{\max} = \max_i \max_j C_{ij}^*; C_{\min} = \min_i \min_j C_{ij}^*; \\ S_{\max} = \max_i \max_j S_{ij}^*; S_{\min} = \min_i \min_j S_{ij}^*.$$

From the other side:

$$B = \{B_i, i = \overline{1, N}\} \Rightarrow \{C_i, S_i, i = \overline{1, N}\},$$

where S_i and C_i - the costs and the level of service under the condition of extreme event absence. Therefore, "negative payoff" of extreme events U_{ij} (table 1) can be defined as:

$$U_{ij} = W_{ij}^* - W_i, i = \overline{1, N}; j = \overline{1, M}; \\ W_{ij}^* = \rho_c^i * \omega_{ij}^c(C_{ij}^*) + \rho_s^i * \omega_{ij}^s(S_{ij}^*); \\ W_i = \rho_c^i * \omega_i^c(C_i) + \rho_s^i * \omega_i^s(S_i); \\ * \omega_{ij}^c(C_{ij}^*) = \frac{C_{\max} - C_{ij}^*}{C_{\max} - C_{\min}}; * \omega_{ij}^s(S_{ij}^*) = \frac{S_{ij}^* - S_{\min}}{S_{\max} - S_{\min}}; \\ \omega_i^c(C_i) = \frac{C_{\max} - C_i}{C_{\max} - C_{\min}}; \omega_i^s(S_i) = \frac{S_i - S_{\min}}{S_{\max} - S_{\min}}.$$

Apparently, weighting factors of importance $\{\rho_c^i, \rho_s^i, i = \overline{1, N}\}$ corresponds to the alternatives from the set B .

Because the task of strategic planning is considered, minimax criterion of choosing the preferable alternative U^* is proposed:

$$U^* = \min_{i=1, N} \max_{j=1, M} U_{ij}.$$

This is the criterion of maximum awareness. Such choice of alternative eliminates risk because decision-maker won't get the result that is worse than anticipated one. Therefore, it's possible to say that in the context of strategic planning this criterion is fundamental; although, in some situations risk elimination may cause sufficient losses.

The second stage which is dedicated to formulation of business management alternatives, in fact, is a basis for the creation of the organizational management structure carcass because on this step logistics providers are assigned to the business-processes and supply chains [8].

Table 1 – Types of negative payoffs

Configurations of logistics system	Types of negative payoffs from the emergencies occurrence			
	A_1	A_2	...	A_M
B_1	$U_{1,1}$	$U_{1,2}$...	$U_{1,M}$
B_2	$U_{2,1}$	$U_{2,2}$...	$U_{2,M}$
...
B_N	$U_{N,1}$	$U_{N,1}$...	$U_{N,M}$

In the study [9] the formal approach for choosing business management alternatives was formulated. It is based on the SWOT-analysis matrix and aggregation of different criteria. Now the new approach to formalization of SWOT-analysis matrix is proposed which is based on analytic hierarchy process (AHP). This method describes a process of aggregating the point of experts' views on different criteria and bringing them to the unified form with the checking of solution consistency. Created hierarchical structure of decision-making process is shown at the fig. 3.

On the third stage, the experts take into account the finite number of LS configuration alternatives, and the set of chosen business management variants. Then they generate the alternatives of distribution LS organizational management structure. This stage is poorly exposed to formalization and based on the experts' experience. It can be named as structural synthesis. Similarly, the stage where concrete executors are assigned to business processes is called parametric synthesis. Only after parametric synthesis the preliminary evaluation of LS organizational management structure can be done.

After conducting structural synthesis of OMS alternatives on the third stage the task of assigning specific executors to separate business-processes and supply chains is initiated. On the first step of third stage the weakest candidates are detected and discarded with the usage of the complex criterion. It consists of the set of indicators such as service reliability, skill base, economic indicators, quality of service, management skills, human policy etc. Further the set of OMS variants is built. Their preliminary estimation (stage 5) is conducted on the basis of three complex criteria: summarized logistics costs, level of customers' service, and stability to emergencies. Although, this process is similar to the first stage, nevertheless, on this stage it is based upon specific business-processes executors and organizational management structure.

On the six stage the dynamic task of rational OMS variant choosing is solved with the usage of horizontal and vertical coordination of three-layered (usually) OMS, which is based on two-layered models of inter-functional and inter-organizational coordination.

Conclusions. The modified technology of multiple-criteria synthesis and choice of distributional LS organizational management structure differs from proposed one in [5] on the following points:

- On the stage of LS configuration the stability criterion is used;

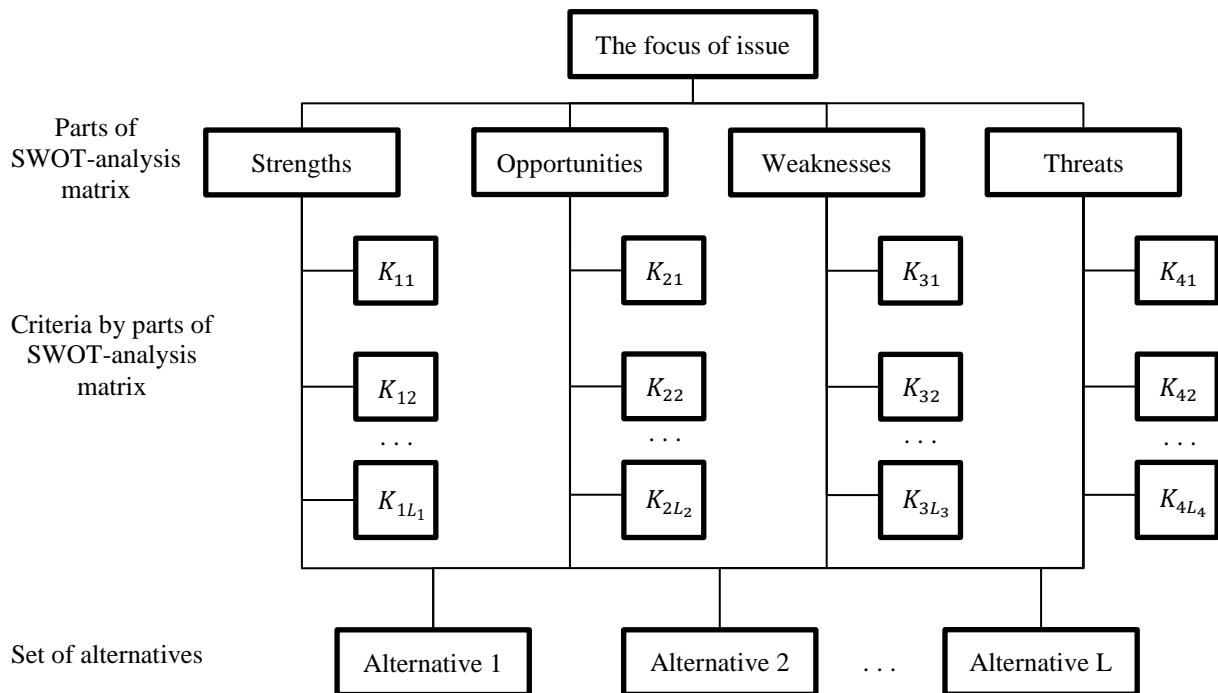


Fig. 3 – Applying AHP approach to SWOT-analysis

- Strategy of maximum awareness is used to eliminate risk of choosing worse alternative than anticipated one;
- AHP is implemented to solve the task of business management variants identification;
- Structural synthesis of OMS variants is conducted on the basis of business management variants and then the parametrical synthesis is done by choosing specific business-processes executors;
- Decision-making of OMS choice is based on the usage of dynamic models of its development with the satisfaction of specified KPIs.

Further research will be dedicated to the development of dynamic model of logistical system organizational management structure development and elaboration of information technology which covers all stages of OMS synthesis.

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