

## TOPOLOGICAL PROPERTIES AND METHODOLOGY OF RESEARCH OF COMPLEX LOGISTIC SYSTEMS EFFICIENCY

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**Abstract.** It is indicated that sets of elements of complex logistic system, their parameters, numerical values, properties and finally – structures of complex logistic system, are topological spaces between which properties of homeomorphism can exist, that allows to apply mathematical apparatus of the theory of topology at the solution of a number of tasks. The general principles of an estimation of efficiency of functioning of logistical complexes on the basis of modeling with the account of hierarchical construction and influence of the human factor are considered.

**Key words:** logistic system, logistical complexes, topological space, set members, structure.

### INTRODUCTION

At present we observe significant interest increase in development of logistics and the data systems that provide effective integration and interaction of logistic processes in the world community. The development of this trend is very important for Republic of Belarus, as it carry out search of new ways of accelerated development of economy. As the world experience shows, one of such ways is the use of instruments of logistics and creation of logistic systems at micro and macroeconomic level. The development of logistic production, trade, transport and data systems has paramount importance, because

it will allow us to accelerate integration of our country into outer economic and information space.

The solution of logistic tasks in the modern world is impossible without active use of information technologies. It is impossible to imagine formation and the organization of work of a logistic chain without intensive exchange of information real-time, without opportunities and means of supply of fast dynamics response of the market requirements. At present it is almost impossible to provide quality of goods and services, demanded by consumers, without use of information systems and software packages for the analysis, planning and commercial decision-making support in a logistic chain. Moreover, because of the development of information systems and technologies, that provided possibility of automation of standard technological operations, logistics became a dominating form of the organization of goods movement in highly competitive markets of economically developed countries. And the most perspective trend is adoption of information systems and technologies into logistic integration processes.

The most important feature of the functioning of logistics information systems (LIS) is associated with the participation of people in data reduction process and decision-making control. Man's role in the management process is manifested in all elements of the logistical system.

Another significant feature of the functioning of LIS is their random nature, which is caused not by full the conditions difinedness, in which these processes occur, and also various random deviations and errors encountered when collecting information, generating control signals and their performance.

Thus, the result of the functioning of the LIS is random and characterized, on the quantitative side, by laws distribution parameters expressing this result.

#### MODELS AND OBJECTS OF LOGISTIC SYSTEMS

Mathematical models of logistic systems can have various forms depending on a stated task and research methods. The economic-mathematical methods applied in logistics, include [4,13,14,18-20]:

- statistical analysis methods;
- methods of mathematical economy and econometrics,
- operations research methods,
- methods of economical cybernetics.

Each of the methods is based on the use of the appropriate mathematical apparatus.

In most cases the logistic system represents the set of elements (producers, mediators, consumers), united by logistic streams [2,18]. There are material, financial, service and accompanying them, data streams. Thus a logistic stream is the set of the objects (sets) united on a certain sign, moved in space and in time and adapted to quantitative and qualitative transformations according to the influence of the agent of management of logistic system [3,15].

Each of logistic streams is characterized by a set of the objects. In a material stream objects are material resources (raw materials, materials, products, etc.), subjects of production and complete product. In a

financial stream objects are financial assets in the cash or non-cash form, providing effective functioning of logistic system and its parts in the conditions of the commodity-money relations. The certain set of the nonmaterial values received by clients according to their demands acts as the set of objects of a service stream.

Data streams accompany all the other types of streams and represent certain finished messages generally – in the electronic form, intended for decision-making and implementation of administrative decisions. Data streams form the logistic data systems, classified by scale, range of application and a way of the organization [7-11].

According to tasks and methods of research the following types of models of logistic systems can be considered [1,3-6, 12,16]:

- models covering separate logistic operations or functions,
- models covering several logistic operations or functions,
- models of logistic systems (channels, networks).

According to [2,16], at mathematical formalization it is convenient to describe complex logistic system as a certain set of the interconnected and interacted subsystems on the basis of graph theory. That gives a graphical idea of structure of system and functional relations between its elements. Thus the specific properties become apparent. That, at research of technical system, allows us to use ample opportunities for mathematical apparatus of the set theory and topology.

We will consider properties of the graph  $G(V,E)$  that corresponds to the complex logistic system. This graph is characterized by two finite sets:

$V = \{v_1, v_2, \dots, v_{nv}\}$  - vertex set,

$E = \{e_1, e_2, \dots, e_{ne}\}$  - set of graph edges,

$nv, ne$  - number of vertices and number of edges of a system graph, respectively.

As each edge is defined by two vertices, the set of edges  $E$  represents the system (family) of subsets from  $V$ , meeting the following conditions:

- 1) empty set  $\emptyset$  and  $V$  belong to  $E$ ,

2) if the sets belong to E, than the crossing also belongs to E,

3) combination of any family of sets from E belongs to E.

Therefore, E is a topology in V and the pair is a topological space [17].

### TOPOLOGICAL PROPERTIES OF LOGISTIC STREAMS

For real logistic system at elementary level of the description the set  $V = \{v_1, v_2 \dots v_m\}$  represents a set of elements, which form the given system  $N = \{N_1, N_2 \dots N_m\}$ . For material streams, for example, it can be points of delivery and consumption of materials, production, for financial streams – points of implementation of financial operations. By transition to higher level of the description (abstraction) of systems, the whole systems (subsystems) can be represented as set members N.

There is certain basic material or financial parameter, corresponding with each element of  $N_i \in N$ , that characterize it. For example, for material or financial streams, mentioned above, it can be various goods, currency, etc. For the systems with high level of abstraction, parameters of elements of the system (subsystems) accept as a set of the parameters reduced to one generalizing. Therefore, a certain set of parameters of  $\theta = \{\theta_1, \theta_2 \dots \theta_{n\theta}\}$  of these elements corresponds with a set of elements of system N. If each element of the system is characterized by only one parameter, than  $n\theta = n\theta$  and sets of N and  $\theta$  are equipotent.

Each parameter  $\theta_i \in \theta$  can take various numerical values  $\varphi_i \in \Phi_i$ , and  $\Phi_i \in \Phi$ , where  $\Phi = \{\Phi_1, \Phi_2 \dots \Phi_{n\Phi}\}$  - a set of numerical values of parameters of material or financial streams.

In one's turn the data characteristics of  $N_i$  - x elements which in their turn represent a set of objects of logistic data streams  $\Pi = \{\Pi_1, \Pi_2 \dots \Pi_{n\Pi}\}$ , depend on numerical values of parameters  $\varphi_i \in \Phi_i$ .

On its own the logistic data stream is rather complex system and it is divided into

number of components: accessory, indicator, document and array [2].

Accessory is an elementary unit of the message. The accessory characterizes a quantitative or qualitative component of information set. For example, accessories — the organization name, the description of goods, the goods price, etc. Each accessory can be represented by a set of symbols: digital, alphabetic, special.

The documents used in control process, can include one or several indicators with obligatory certificate (the signature or the seal) of the person responsible for information containing in documents. As the organization of basic data is a field of activity of the person, the majority of documents is created at a stage of collecting and logging of data, though the considerable share of documents enter the system from external (higher, etc.) organizations. For example, in accounting the indicator, its basis is a result of the account, weighing, etc. It forms a basis for organization of summary accounting and statistical data which in their turn will be incoming information by drawing up statistical reports in a perspective of the organization, branch, region, etc.

The array represents a set of homogeneous data that have a single technological base and it is united by single meaning content. Data (processes, phenomena, facts, etc.) represented in the formalized condition suitable for transfer by communication channels and for processing on the computer. Records are the basic elements of arrays defining their contents.

Records are the elements of arrays which the users use when information processing. Information fields are the elements of the records having single meaning content.

The data belonging to one array, record by the general rules (according to technology of accumulation, storage and processing of data adopted in the organization). The type of the array is defined by its content (for example, an array of material standards, the array of materials suppliers), functions in data processing (input, output, intermediate arrays). The information array supplied with a symbolical name, unambiguously defining it in information system, is called the file.

If information streams represent relational databases as Microsoft Access, than the tables, inquiries, forms, reports, pages of access to data, macros, moduli are the objects  $\Pi$ . Sets  $\Phi$  and  $\Pi$  are not equipotent because between their elements there is no one-one imaging ( $n_\Phi \neq n_\Pi$ ), the quantity of their elements is various.

Between sets  $N$  and  $\theta$ ,  $\theta$  and  $\Phi$ ,  $\Phi$  and  $\Pi$  there are connections and dependences which are generally defined by the binary relations  $r$  that establish compliance between elements of one and the other set:

$$\begin{array}{ccc} r_1 & r_2 & r_3 \\ N \sim \theta, & \theta \sim \Phi, & \Phi \sim \Pi. \end{array}$$

Let us consider a  $N \times \theta$  - a set of the ordered pairs of elements  $(N_i, \theta_j)$ , from which  $N_i \in N$ ,  $\theta_j \in \theta$ . As the binary relation  $r \subset N \times \theta$  is defined everywhere on  $N$ , that is its range of definition  $dom\ r$  coincides with a set  $N$ , than it is imaging of a set  $N$  in a set  $\theta$  and writes down as  $\phi_1: N \rightarrow \theta$ . Therefore, the set  $\{N: |\exists \theta((N, \theta) \in r)\}$  is a prototype of the relation  $r_1$ , and the set  $\{\theta: |\exists N((N, \theta) \in r)\}$  is an image of the relation of  $r_1$ . For any two various elements  $N_1$  and  $N_2$  from  $N$  their images  $\theta_1 = \theta(N_1)$  and  $\theta_2 = \theta(N_2)$  are also various. At the same time, being image for  $N$ , the set  $\theta$  is a prototype for a set  $\Phi$  which in its turn is an image for  $\theta$  and a prototype for a set  $\Pi$ , i.e.  $\phi_2: \theta \rightarrow \Phi$ ,  $\phi_3: \Phi \rightarrow \Pi$ . In practice, taking into account properties of real logistic system, images  $\phi_1$  and  $\phi_3$  are single-valued, and the relation  $\phi_2$  is multiple-valued.

As the result, the vertex set  $V = \{v_1, v_2, \dots, v_{nv}\}$  can characterize different physical notions, depending on what is the purpose of the researcher, and the use of the homomorphism – a mapping of set of elements of one model in a set of elements of another model system - allows for the same technical system to create and explore various types of models: physical, abstract, information, conceptual and other.

The graph edge set of a complex system  $E = \{e_1, e_2, \dots, e_{ne}\}$  characterizes the relationship between the elements (the topology into  $V$ ). The pair  $(N, E)$  is a topological space of the system elements.

Under the homomorphism into another set (to the other models), corresponding connection (topology) between the parameters  $\theta$ , and their numerical values  $\Phi$  and properties  $\Pi$  are obtained. Thus, a transition to a new topological spaces is carried:  $(\theta, E)$ ,  $(\Phi, E)$ ,  $(\Pi, E)$ .

Mapping of a topological space  $(N, E)$  into a topological space  $(\theta, E)$  is continuous at each  $N$  point. Here we have the mutual inverse mapping  $\phi_1^{-1}: \theta \rightarrow N$ , it follows that we are dealing with homeomorphic topological spaces  $(N, E)$  and  $(\theta, E)$ . In general, this is not true of topological spaces  $(\Phi, E)$  and  $(\Pi, E)$ , which do not have a one-to-one direct and inverse mapping. However, for a number of practical problems, in applying additional restrictions, homeomorphism between all of the above topological spaces can be achieved:  $(N, E)$ ,  $(\theta, E)$ ,  $(\Phi, E)$ ,  $(\Pi, E)$ .

In real complex logistics system some connections between system elements (subsystems) for various technical or subjective reasons can die out or change at random times. This means that there is a weakening of the topology - instead of  $E$ , we have a set  $E^{(s)} = \{\dots, e_{ns}\}$ , ( $s = \overline{1, ns}$ ). If there are no other sudden changes in the system, except the changing relations between the subsystems,  $ns$  – is a number of possible system states (structures)  $E^{(s)} \subset E$ , as a result  $E^{(s)}$  is the weaker topology compared to  $E$ . Among all topologies on  $V$ , zero  $(V, \emptyset)$  – is the weakest, and the so-called discrete  $(V, E)$  is the strongest, as it consists of all subsets (edges). Both these topologies are extreme in the scale of comparison of topologies.

In general, under the condition (structure) of a complex logistics system means not only the presence or absence of appropriate links between subsystems, but also the subsystems' state, which is characterized by a significant difference between their properties. A complex of possible structures with the logistics system is a set of

$S = \{s_1, s_2, \dots, s_{ns}\}$ . This set depends on many system properties  $\Pi = \{\Pi_1, \Pi_2, \dots, \Pi_{n\Pi}\}$ .

There bijection between the sets  $\Pi$  and  $S$ , since they have different potencies (cardinals). However, due to the fact that the elements of  $S$  (subsystems structure) are defined by the elements of  $\Pi$  (subsystems properties), for the  $i$ -th subsystem  $s_i$  is the image for  $\Pi_i$  what it is  $\phi_4 : \Pi_i \rightarrow s_i$ . Consequently, there is a map  $\phi_5 : \Pi \rightarrow S$ .

The  $S$  is finite and for each  $s_i$  an explicit mathematical model is valid, which in a state of space is characterized by a variety of phase coordinate system  $X^{(s)} = \{X_1^{(s)}, X_2^{(s)}, \dots, X_{nx}^{(s)}\}$ .

$X_i^{(s)}$  - is the set of phase coordinates of  $i$ -th subsystem - a subset of  $X$ ;  $X_i^{(s)} \subset X_i^{(s)}$ .

The  $X = X(t)$  and  $S = S(t)$  sets are the basis for the use of the mathematical apparatus of the theory of dynamical systems with random structure and the use of methods of the topology theory allows to take into account the specific properties of complex multistructural systems under their analysis and synthesis.

In summary, sets of elements of a complex logistics multistructural system, their parameters, numerical values, properties, and finally, logistics system structures are topological spaces that have the properties of the homeomorphism that allows using the mathematical apparatus of topology in solving logistics management system tasks.

Formation of information systems is impossible without streams research in section of certain indicators. For example, it is impossible to complete the task of equipping a certain workplace computer technology without knowledge of the information content passing through this workplace, and without determining the required speed processing.

It is possible to manage the information flow quickly and efficiently through the organization of information system, performing the following operations:

- Redirection of the information flow,
- Limiting the transmission rate to the corresponding reception rate,
- Increasing or decreasing information content in certain slots of information transmission,

- Limiting the stream capacity to the amount of data trough put of separate unit or route section.

- Information systems in logistics allow managing of material and financial flows at the enterprise level, and can contribute to the organization of logistical processes in the regions, countries and groups of countries.

### MULTILEVEL SIMULATION OF LOGISTICAL COMPLEXES

The main method of studying the functioning laws of logistical complexes, which include LIS, is the simulation of logistical processes. In a broad sense, modeling is an imitation of studied processes no matter by what means it is secured. In practice, the modeling of complex systems that have to deal with the evaluation of the effectiveness of logistical complexes, there are two different approaches to the construction of models.

The first approach, which is essentially a simulation, involves modeling states of each element of the system from beginning to end the process. Let's conventionally call it "moving" modeling. Consolidation of information in such models occurs only at the output of the model.

The advantage of "moving" models is in principle possibility to use all the information for research and for the organization of rational (optimal) operation of involved system. Disadvantages of "moving" modeling are associated with practical difficulties of detailed modeling of complex systems, which leads to the need for introduce a number of significant assumptions and, consequently, the loss of some information.

The second approach is that, in accordance with the hierarchical structure of involved system, where information of varying degrees of detail at different levels of information is used, the model of such a system is a hierarchical system models. Each model of a lower-level unit is the block of highest level model and linked it with a limited number of channels through which circulates already partially generalized information. This

simulation is conventionally called "hierarchical".

The advantage of these models is that the information used in them for quite a detailed analysis of logistical information of complexes at the lower levels of the model is applied to the highest levels in the form of summarized indexes. This scythes the information content circulated in the model, and therefore, simplifies it. Under the same level, details of background information "hierarchical" model are then much easier to "moving". Disadvantages of "hierarchical" models are associated with the loss of information, which occurs during its partial generalization at the lower levels of the model, and as a result, the inability to use the full information content to optimize the functioning of the whole system.

Despite its disadvantages, the "hierarchical" modeling usually is a more effective method for complex systems studying, as it allows analyze research in a number of relatively particular problems, which are united by limited number of connections.

Let's dwell on the structure of "hierarchical" models and introduce the following terminology. We will name "level model" a number of stages of partial consolidation of information in it. Thus, the I level model is a "moving" model. It summarizes all the information only on the output. II level model consists of I level models and the block of II level model, that processes the information received from the outputs of the I level models and maybe a limited portion of the original information. N-level model consists of (N-1) level and the block of N level models. And, the (N-1) level model is a model of the final control element and control element of the N- level complex. Thus, the N-level model is obtained by adding to it on a limited small number of links of the block N-th level. The problem consists in determining the number of required connections, the nature and information content on the inputs and outputs of the units withdrawn from the model. The values or functions taken from the "outputs" of each model should characterize the functioning of an appropriate set of results and allows us to calculate the criteria (indicators) its

effectiveness. Resolving this issue is determined by the structure and objectives of the system being simulated, as well as the objectives of this particular study.

During each research as well appears the following question: "A model of which scale is needed to solve the problem of the current research?" The matter is that the effectiveness of functioning of any complex of the lower level has an impact on effectiveness of complexes on higher levels. It's clear that the effectiveness on the economics on the whole depends on the effectiveness of the enterprise logistics. Thus the following question arises: "The phenomenon of what scale should be viewed in order to estimate the impact of the given set of parameters of the complex on its effectiveness?" To answer the question let's take the notions of "necessity" and of "sufficiency" of the level of model for the purpose of the given research. Say that for the purpose of the research of the impact of the given set of parameters on the effectiveness of the system is needed the model of the level N, if at least one of the researched parameters is directly used in the N level model (is given on the input of N level block). The N-level model is sufficient for the research of the given set of parameters if none of the researched parameters is used in higher level models (not given on the input of higher level models). This means that all the researched parameters appear indirectly with the help of composite index in the N+1 model and higher level models. For example, "necessary" and "sufficient" model of the research of the influence of sales of products of enterprises on the effectiveness of the sector is the functioning enterprise model in the production and sales product process. The model is "necessary" because the demand is used during the realization modeling as a parameter describing the terms of raw materials purchase, components and production. The model is "sufficient" because during the sector working modeling (higher level complex) the raw materials purchase and components don't appear in it. In this case enterprise is the final control element in the sector and is characterized by generalized parameters, which is, for example, the possibility of successful sales of products. Production value

has an indirect impact on the sector functioning, through the possibility of its realization.

Hierarchical model systems give us the opportunity to study each of the models separately, and each of the models is built by one and the same way. It consists of 3 major elements which are the block that models input information: control block and block modeling final control element.

Thus functioning logistic complex model of any rank supposes the necessity of solving 3 major problems:

1) Modeling of input information according to the properties of the information complex element. It consists of realization on the distributional law in the models which are measured (observed) by the information element of the given set of parameters (elements) of the economic situation.

2) Modeling of the control element functioning. It consists of realization of “control law” complex. What is meant by the notion “control law” is the set of rules (algorithm) according to which control commands are worked out depending on the existing economic information.

3) Modeling of the final control element functioning. It consists of realization of functioning complex result in the model depending on control commands.

Creation of functioning model of each of the logistic complex in general assumes the formulation and realization of “control law” in the model, during forming of which human activity plays a huge role, taking into account that human activity hardly can be exactly described and optimized. In these cases the satisfying modeling of the working complex can be reached either by including a person or a group of persons into modeling process who will imitate human activity in the studying process or by creating specific subprograms which will model the actions of people, the so-called heuristic programs, which may possess a certain property of teaching or self-teaching. Such modeling could provide the fullest description of the real processes. However theory and practice of the creation of such models currently aren't perfect and can't be considered as completed. Thus when modeling of functioning of logistic complex

the “control law” is usually set on the basis of the study of the economic methods of its use in the form of its functions or algorithms which set into accordance the meaning of parameters of control commands meanings of a limited number of basic parameters which characterize the information about the economic situation.

Modeling of the work of the information and control final elements of the logistic complex is not a difficult task, but the reception of the distribution parameter law, which characterizes the result of functioning analytically, in most cases, has many difficulties because of complicatedness of the researched objects. Thus it's appropriate to consider the problem of modeling of functioning of logistic complex to be solved if the block-diagram of the model functioning is built, which enables us to receive the realization of parameters which characterize the result of functioning (output) when the realization of parameters is put on “input”. Such decision presupposes the indication of input and output parameters of the midship section blocks and the formulating of transformation law of input parameters into output parameters. If such model is built the reception of the necessary distribution laws with any given accuracy can be reached by using the statistical test method after processing of a special output realizations set which appear as a result of multiple modeling processes when the distribution laws of input parameters are given.

When using the method you may not put unnecessary limits on the ongoing processes and consider the task to be done. Alongside with it we will examine the analytical methods mainly based on the linear theory of transformation of random variables and random functions. At the same time random variables and functions will be characterized by their numerical characteristics. In some cases the knowledge of numerical characteristics of random variables and random functions enables us to define the distribution laws of particular random variables, if the conclusions based on physical considerations and limiting probability theorems about the kind of distribution law can be made. The set of approximate analytical

methods can be viewed as approximate economic efficiency theory.

Thus the primal problem of the economic efficiency research of the logistic complexes is receiving distribution laws of parameters characterized the result of their functioning possessing a goal of calculating the criteria of efficiency.

The basic research logistic complex method is the modeling of economic processes which consist of:

- Hierarchical model systems of certain complexes which have similar structure and linked to each other by a limited number of inputs and outputs.

- Modeling the functioning of each complex.

Calculating the performance of logistics centers is not an end in itself. Practical value of cost-effectiveness studies is the ability to analyze the impact of various factors on the cost-effectiveness of systems. The results of cost-effectiveness studies are used in two main ways:

- Study of the influence of technical parameters of logistics complexes on their cost-effectiveness with a view to bringing legitimate claims to the parameters of complexes and their choice in the design and modernization.

- Quantitative research methods of using logistic complexes with a view to making recommendations to improve the application, to develop rational (optimal) "control laws" complexes.

Methods for solving these two major problems are not fundamentally different from each other. The only difference is in the degree of detail of the accounting or other factors. Thus, when solving the first problem is basic. Attention to detail the technical aspects of accounting, while the "control law" is usually given with a sufficient degree of conditionality, not distorting, however, the nature of the influence of technical parameters on the result of functioning systems. In solving this problem more important to obtain comparative estimates. In solving the second problem focuses on "the laws of the control" of the complex, while the technical parameters can appear in the form of a relatively generalized averages. To solve this problem

relatively greater importance is attached to the possibility of obtaining absolute estimates.

### MODELING OF EACH COMPLEX FUNCTIONING

The calculation of indicators of effectiveness of logistic complexes is not an end in itself. The practical value of economic efficiency research result is lying in the possibility of analyzing of the influence of different factors onto economic efficiency of the complexes. The result of economic efficiency research is used in two major directions:

The research of the logistic complex technical parameters influence of their economic efficiency for the purpose of presentation of grounded requirements to the complex parameters and their choice during designing and modernization;

The quantitative research of the ways of logistic complex use for the purpose of generating recommendations in order to increase effectiveness of use i.e. generating optimal "control law" complexes.

The methods of solving these two major problems don't differ. They differ only in the level of detail of taken factors. Thus while solving the first problem details of technical aspects are in the center of attention; and the "control law" as a rule is set with sufficient level of conditionality without deceiving the character of technical parameter impact onto the complex functioning result. While solving this problem more attention is given to the receiving of comparative evaluations. While solving the second problem "law control" complex is under center attention and the technical parameters may appear as relatively generalized mean value. While solving the problem more attention is given to the opportunity of receiving absolute estimates.

### LOGISTIC COMPLEX EFFECTIVENESS

When designing logistic information systems as the key elements of logistic complexes or when taking them into exploitation we have to solve the problem



concerning the alternative rational choice which could be effective enough in the given conditions of application. Suppose the existence of different ways of solving the problem (for example different types of production):

$$B_1, B_2, \dots, B_m$$

and the set of conditions of its distribution:

$$A_1, A_2, \dots, A_n.$$

Let  $W_{ij}$  is the indicator of effectiveness (probability of receiving economic effectiveness) when applying i-type decision (i-type production) and applying j conditions. Let's make up the matrix of effectiveness. (table 1).

**Table 1.** Matrix of effectiveness

Alternate solutions	Alternate conditions			
	$A_1$	$A_2$	...	$A_n$
$B_1$	$W_{11}$	$W_{12}$	...	$W_{1n}$
$B_2$	$W_{21}$	$W_{22}$	...	$W_{2n}$
...	...	...	...	...
$B_m$	$W_{m1}$	$W_{m2}$	...	$W_{mn}$

To illustrate the example we can built a diagram of dependency between indicators of effectiveness and alternate conditions for each alternative solution. Let's put the effectiveness  $W$  on the ordinate axis and alternate conditions on the abscissa axis put in a certain order. Let us connect  $W_{ij}$  by appropriate lines. In the result we will get a typical case when in some cases one solution gives more effectiveness, and in the other cases the other solution gives is more effective. However it's impossible from economic point of view to have many technical solutions and use each of them in a certain case. Thus you have to choose one or sometimes it's possible to choose few solutions which would be most effective for the whole range of use.

In some cases a problem of stating the probability or frequency of condition appearing:

$$p_1, p_2, \dots, p_n,$$

arises and it's necessary to choose the solution when averaged indicator and  $W_i$  will be greatest:

$$W_i = p_1W_{i1} + p_2W_{i2} + \dots + p_nW_{in}.$$

If the probabilities  $p_j$  ( $j = 1, \dots, n$ ) are given and don't change in time it should be taken as that. However it's impossible to get the  $p_j$  value. Besides, this alternative may turn to be effective only in certain conditions of stable operation of economy. In the result the solution will be effective for a short period of time. Thus it makes no sense to choose the solution accordingly to the given formula and to lose. Therefore it's better to find a compromise which would suit for all the range of conditions even if it's not optimal in certain range of conditions. The best solution is based on the tutor's analysis of the matrix of effectiveness taking into account the forecast in economy environment change.

## CONCLUSIONS

1. A method for determining the effectiveness of the main tasks of LIS is researched.
2. There is recommended decisions making method for use under uncertainty information conditions.

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