Comprehensive Methods of Evaluation of Efficiency of Distance Learning System Functioning

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Abstract: The current pace of development of information technology has created the preconditions for the emergence of a wide range of tools for providing educational services using distance learning technologies. This is confirmed by the intensification of the use of distance learning systems in the conditions of sanitary and epidemiological restrictions and the need for acute cost savings.

The existing scientific and methodological apparatus for studying the quality of functioning of distance learning systems is mostly based on approaches to separate assessment of the effectiveness of their elements and the relevant quality indicators. This limits the ability to take into account important factors in the decision-making process and requires comprehensive consideration of the contributions of relevant subsystems to the functioning of the distance learning system.

In order to solve this problem, the article presents a comprehensive methodology for assessing the effectiveness of distance learning system, based on methods of probability theory and hierarchy analysis and describes the patterns of influence on the effectiveness of distance learning system of importance and contributions of its subsystems. Comparative analysis of the data obtained by monitoring and forecasting performance indicators based on the proposed method, shows an increase in the reliability of the assessment within 15-18%, which in contrast to the existing reduction of standard deviation of performance indicators by an average of 26% and ensures the adequacy of the results within certain assumptions and hypotheses.

In such conditions, the choice of an appropriate option for the construction of the DN system is ensured by the reliability of the forecast of the results of its operation in the range of 82-85%, which is high enough to make appropriate decisions.

The value of this study lies in the possibility of using the tested scientific and methodological apparatus in forecasting the outcome of the system and saving material, financial and human resources in the process of implementing the relevant recommendations in practice. This fact makes it possible to eliminate limitations in the practice of building distance learning systems and creates a new opportunity to cover a wider range of factors that affect the quality of operation.The application of this technique makes it possible to predict the results of the joint operation of the relevant subsystems of the distance learning system, taking into account their contribution to the overall result.

Index Terms: Methodology, Efficiency, Distance learning, Quality indicator.

1. Introduction

Current trends in the development of educational technologies require efforts to develop distance learning as one of the effective tools for implementing the model of lifelong learning [1]. The actualization of this issue acquires characteristics in the context of sanitary and epidemiological restrictions around the world and requires the improvement of procedures for providing quality educational services.

Distance learning is a special form of purposeful process of mastering knowledge, skills and abilities, the distinguishing feature of which is the interaction of remote participants in the learning process in a specialized environment based on modern psychological, pedagogical and information and communication technologies [2].

Distance learning technologies can be used in other forms of education: full-time, part-time and blended forms of education, the system of retraining and advanced training, the system of individual learning in the study of individual disciplines (topics) or blocks of the discipline.

Global trends in the development of distance learning in advanced countries show efforts to ensure, on the one hand, the approximation of the virtual learning environment to real life through the use of simulation technologies and gamification, on the other - the introduction of learning individual skills and knowledge of learners. The issues of using the results of distance learning courses in order to select personnel to participate in specific operations (missions) taking into account the relevant requirements are considered. Promising distance learning tools should provide effective individual training of relevant specialists, taking into account the applied needs and capabilities of specialists, the introduction of a rating system for their evaluation at the departmental level, as well as distance learning [4-7,27].

Analysis of trends in education has shown that the most appropriate is the use of blended learning using different forms of learning.

The existing scientific and methodological apparatus does not fully take into account the impact on the effectiveness of the distance learning system of the quality of its components and receives an objective forecast of the outcome of its operation to select the most appropriate option.

Approaches to a separate assessment of the effectiveness of the elements of the distance learning system and the corresponding indicators of their quality are used. This limits the possibility of taking into account important factors in the decision-making process and requires a comprehensive consideration of the contribution of the relevant subsystems to the functioning of the distance learning system.

As the analysis showed, in the absence of dependences of the description of mutual influence on the results of subsystems functioning and the distance learning system in general, it is best to use the method of expert evaluations to improve the methodology and use it to compare obtained and expected results.

The limitation of the application of these methods is the availability of professional knowledge about the processes, objects and methods of functioning of the distance learning system. The use of distance learning technologies, along with improving the quality of education through the use of new technologies, will reduce the cost of education, significantly reducing the need for classrooms and appropriate equipment, reducing the time and number of trips to school, minimizing the required number of publications.

Therefore, the development of a comprehensive model of continuing education based on appropriate scientific methods and improving the methodology for evaluating the effectiveness of distance learning for its use to predict the effectiveness of distance learning in accordance with its options, taking into account the value and contribution of its subsystems

2. Literature Review

Distance learning is a modern complex organized form of learning that can meet the educational needs of users regardless of their spatial and temporal location relative to educational institutions.

The [1] describes the distance learning process as a complex process. This process must meet educational standards, the result of interaction between teacher and student, be implemented through telecommunications technology in a specific information and educational environment. But there are no specific ways of implementation.

The paper [2] considers the components of distance learning, which can not exist and be considered separately, but it should be noted that the effective organization, content, and use of information and educational environment is a

prerequisite for high-quality distance learning and combined with effective learning methods in general. At the same time, no attention is paid to the fact that a significant role is played by a set of distance learning software, which consists of: tools for organizing and managing to learn, tools for developing distance learning resources (especially distance courses), tools for teacher-student interaction and students among themselves (means of web communication). Therefore the problem is not completely solved.

In [3] the main attention is paid to the separate assessment of individual elements of the system and indicators of the quality of their functioning, in particular the processes of development of educational content, software products, etc. However, the comprehensive consideration of the nature of the impact and contribution to the functioning of the distance learning system as a whole is not described

In [5], when assessing the quality indicators of distance learning, no attention is paid to the comprehensive assessment of the relevant quality indicators and the volume of satisfying needs (applications) of consumers of educational services. In particular, the results of the functioning of the subsystems of regulatory support need additional consideration; organizational support; scientific and methodological support; information and telecommunication support; mathematical and software; logistics; staffing; financial and economic support. Therefore, the problem of distance learning is not fully resolved

The analysis of modern literature has shown that the process of joint functioning of subsystems, which provides the tasks of the distance learning system, has not been fully disclosed. Taking into account the nature of learning indicators and their impact on performance indicators can be the basis for determining areas for achieving expected results. Therefore, there is an urgent need to improve the relevant scientific and methodological apparatus and create a comprehensive methodology for assessing the efficiency of the functioning of the distance learning system.

The aim of the study

Improving the methodology for evaluating the effectiveness of the Distance Learning System to ensure the reliability of the evaluation of the results of its operation and the objectivity of the comparison of warrants for its construction to select the appropriate.

3. Methodology for Evaluation of the Efficiency of the Functioning of the Distance Learning System

The methodology is based on a comprehensive approach to assessing the effectiveness of the DL system based on the contributions of subsystems of regulatory, organizational, scientific-methodological, information and telecommunications, mathematical and software, logistics, personnel, financial and economic support. It is based on the methods of probability theory [7] and analysis of hierarchies [9] to describe the impact of the importance of contributions of subsystems of the DL system.

The validity of the choice of the method lies in its greatest suitability for use in the absence of analytical dependences of the description of the mutual influence on the results of the functioning of the subsystems of the DN system.

The effectiveness of the chosen research method is determined by its simplicity, the possibility of operational objective forecasting of the results of the functioning of subsystems and the system as a whole.

The structural and logical scheme of the methodology for evaluating the effectiveness of the distance learning system is presented in Fig. 1.
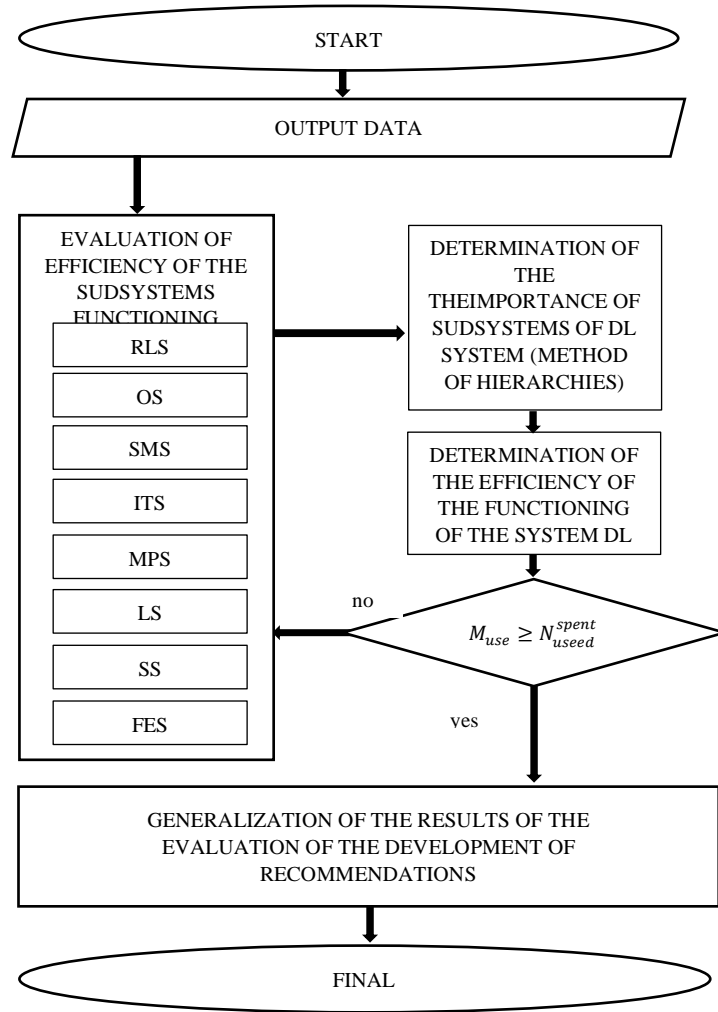
Fig.1. Structural and logical scheme of methods for evaluating the effectiveness of the distance learning system

The block "Output data" generates initial data on: the tasks of the system and its subsystems, the staffing of distance learning units and the provision of technical means of training, the number of consumers and the needs for educational services that need to be met.

The block "Evaluation of the efficiency of the SDL subsystem" determines the indicators of the efficiency of the DLS subsystem - the probability of performing tasks subsystems of legal, organizational, scientific-methodical, information-telecommunication, mathematical and software, logistical, personnel, financial and economic support of the DL system as a function of the degree of implementation of a set of appropriate measures.

In the block "Determination of the importance of contributions of subsystems of the DL system" using the method of hierarchy analysis (MHA) the importance of contributions of subsystems of normative-legal, organizational, scientific-methodical, information-telecommunication, mathematical and program, material-technical, personnel, financial-economic ensuring the result (efficiency) of the DL system.

The MAH describes the influence of formalized and non-formalized factors on the degree of importance of subsystem contributions in the absence of analytical relationships between them. The main advantage of the method is a rational combination of subjective assessments of specialists on the relative importance of the main characteristics and objective (calculated) parameters of the processes that characterize the properties of subsystems. To describe the properties of subsystems selected: the number of tasks assigned to the subsystems; the average value of the performance of typical technological operations by the executive elements of the respective subsystems; the number of actuators from each of the subsystems.

At each level of the hierarchy, the required number of matrices of pairwise comparisons is compiled - one matrix for each element that is adjacent to the top of the corresponding level of the hierarchy. The formation of local priorities from a group of matrices of pairwise comparisons, which characterize the influence of the set of elements on the element adjacent to the top of the corresponding level of the hierarchy. Next, the global priority is determined and the consistency of the whole hierarchy is checked.

It is assumed to rank the problem in the form of a hierarchy. The hierarchy is built from the top - this is the general purpose of the problem, determining the importance of contributions to the subsystems of legal, organizational,

scientific and methodological, information and telecommunications, mathematical and software, logistics, personnel, financial and economic support (Fig. 2).
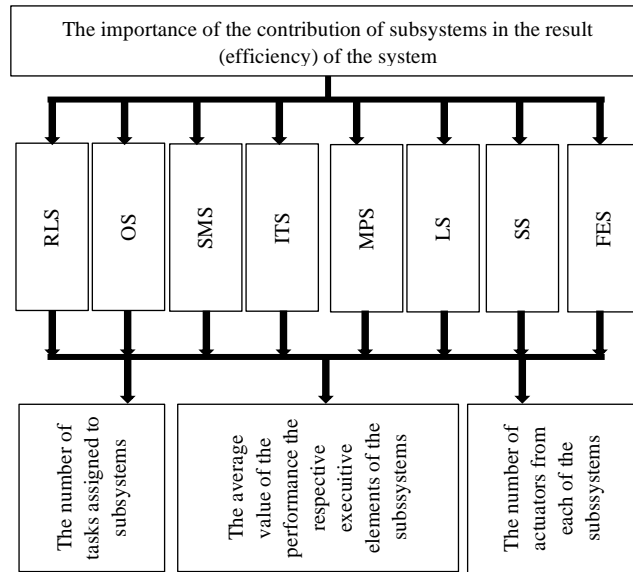

Fig.2. Hierarchical representation of the problem of determining the importance of the contributions of subsystems in the result (efficiency) of the functioning of the distance learning system

The first stage of determining the priorities of parameters (characteristics) of subsystems is their expert assessment.

For this purpose, the results of expert evaluation by a group of experts in this field are used. The decision-maker in building the hierarchy must get to the bottom of the problem. The final results of decision-making depend on this stage.

It is estimated that the optimal number of experts will be 10-15 people. In this case, the probability of the truth of the collective expert opinion is approximately 0.8 [18, 20,22].

The following level of the hierarchical structure presents the characteristics of the subsystems that affect the values of the contributions of the respective subsystems of the DLS:

the number of tasks assigned to the subsystem;

the average value of the performance of the respective executive elements of the subsystems;

the number of actuators from each of the subsystems.

The ratio of indicators by importance in each of the levels of the hierarchical structure is determined by the method of pairwise comparisons based on the judgments of experts on the scale of relative importance.

The results of calculating local priorities for the lower level of the hierarchy are the initial data for determining such an indicator as the importance of the contribution of the results of the operation of subsystems in the results (efficiency) of the operation of the DLS.

Thus, the use of the method of hierarchy analysis to assess the importance of the contribution of each subsystem as a result of the functioning of the distance learning system is a meaningful part of the methodology for assessing the effectiveness of the distance learning system.

The block "Determining the efficiency of the DL system" determines the mathematical expectation of the number of consumers whose needs for educational services were met by M_{use}.

Based on the results of the evaluation of the performance indicators of the DL system in the specified block, the value of the efficiency indicator is compared with its desired value N_{useed}^{spend}, which ensures the performance of tasks by the distance learning system (1)

$$M_{use} \geq N_{useed}^{spend} \tag{1}$$

Subject to meeting the requirements for the level of effectiveness of DLS in the next block is a summary of the evaluation results and practical recommendations for a set of measures.

Research Methodology

1. Formation of initial data on the tasks of the i-th subsystem DLS (N_i), the average value of productivity of tasks i-th subsystem (μ_i), the number of executive elements of the subsystem, taking into account the staffing of distance learning units and technical training facilities (n_i):

$R_1 = \{n_1, \mu_1, N_1\}$ – regulatory and legal support;

$R_2 = \{n_2, \mu_2, N_2\}$ – organizational support;

$R_3 = \{n_3, \mu_3, N_3\}$ – scientific and methodological support;

$R_4 = \{n_4, \mu_4, N_4\}$ – information and telecommunication support;

$R_5 = \{n_5, \mu_5, N_5\}$ – mathematical and program support;

$R_6 = \{n_6, \mu_6, N_6\}$ – logistics support;

$R_7 = \{n_7, \mu_7, N_7\}$ – staffing support;

$R_8 = \{n_8, \mu_8, N_8\}$ – financial and economic support.

2. Evaluation of the efficiency of the DLS subsystem is carried out according to the indicators of the efficiency of its subsystem - the probabilities of tasks subsystems of legal, organizational, scientific-methodical, information-telecommunication, mathematical and software, logistical, personnel, financial and economic support of the DL system as functions of the degree of implementation of a set of appropriate measures

$$P_i(t_n) = \frac{M_i(t_n)}{N_i} = n_i \frac{\mu_i t_n}{N_i} . \qquad (2)$$

3. Determining the importance of contributions to the subsystems of the DL system.

The choice of parameters of DLS subsystems is based on the tasks of each of the subsystems (Table 1) [10].

Table 1. Parameters of DLS subsystems

Indicator	Name	Marking
P1	Number of executive elements of the subsystem	n_i
P2	The average value of the performance of tasks by the subsystem	μ_i
P3	The number of tasks performed by the subsystem	N_i

Determining the relative importance of the components of the DL system. Experts use a scale from 1 to 9 (Table 2):

Table 2. Scale of relative importance

Quantitative assessment of the intensity of relative importance	Qualitative assessment of the intensity of relative importance	Explanation
1	Equal importance	Equal contribution of two parameters
3	Moderate advantage of one over the other	Experience and judgment give a slight advantage of one parameter over another
5	Significant or strong advantage	Experience and judgment give a strong advantage of one parameter over another
7	A significant advantage	One parameter has such a strong advantage that it becomes almost significant
2,4,6,8	Intermediate decision between two adjacent judgments	Used in a compromise case

Formation of a matrix of pairwise comparisons Table 3, where expert estimates are placed in the form of ratios of weights of the i-th and j-th element (ω_i / ω_j), which are determined by assessing the importance of the i-th element in comparison with the j-th in relation to the defined element of the previous equal.

Table 3. Matrix of pairwise comparisons of priorities of parameters of DLS subsystems

Indicator	*P1*	*P2*	*P3*	Geometric mean	Weights	Consistency index
P1	1	$\dfrac{\omega_1}{\omega_2}$	$\dfrac{\omega_1}{\omega_3}$	a_1	X_1	$r_1 X_1$
P2	$\dfrac{\omega_2}{\omega_1}$	1	$\dfrac{\omega_2}{\omega_3}$	a_2	X_2	$r_2 X_2$
P3	$\dfrac{\omega_3}{\omega_1}$	$\dfrac{\omega_3}{\omega_2}$	1	a_3	X_3	$r_3 X_3$
				$\sum\limits_i a_i$	1	λ_{max}
Sum	r_1	r_2	r_3			

4. Calculate the eigenvector of the evaluation matrix to determine the significance of each element. To do this, the components of the rows are multiplied and then the root of the M-th degree is extracted

$$a_i = M\sqrt{(\omega_i / \omega_1)(\omega_i / \omega_2)\ldots(\omega_i / \omega_M)} \tag{3}$$

5. Normalization of geometric means is carried out (the estimation of a vector of priorities is received)

$$B_i = \frac{a_i}{\sum\limits_i a_i}, i = \overline{1,M}; \sum\limits_i B_i = 1 \tag{4}$$

6. Consistency of matrices of pairwise comparisons is characterized by the consistency index. To do this, determine the sum of the elements of each column of the matrix of pairwise comparisons $r_j, j = \overline{1,M}$, calculate the value of λ_{max} by the formula

$$\lambda_{max} = r_1 X_1 + r_2 X_2 + \ldots + r_M X_M \tag{5}$$

7. The consistency index is determined as follows:

$$CI = \frac{\lambda_{max} - M}{M - 1}, \quad M > 1 \tag{6}$$

For an inversely symmetric matrix always $\lambda_{max} \geq M$.

8. In Table 4. shows the average consistencies for random matrices of different order.

Table 4. Average consistencies for random matrices

The size of the matrix	1	2	3	4	5	6	7	8	9	10
Average random consistency	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

The coefficient of consistency (CR) is determined by the ratio of CI to the number that corresponds to the random consistency of the matrix of the same order. The CR value should not exceed 10%. When the CD exceeds these limits, it is necessary to investigate the correctness of the problem and check the opinions of experts.

In the future, based on the data entered in the research work:

"Discussion of recommendations for improving distance learning systems of the Armed Forces of Ukraine" National

Ivan Chernyakhovsky University of Defense of Ukraine, for 2019. Let's make a sample and calculate

eigenvector for each pairwise matrix of pairwise comparisons, which are defined similarly.

Table 5. Matrix of pairwise comparisons of tasks priorities of DLS subsystems

Subsystem	RLS	OS	SMS	ITS	MPS	LS	SS	FES
RLS	1	$\dfrac{N_1}{N_2}$	$\dfrac{N_1}{N_3}$	$\dfrac{N_1}{N_4}$	$\dfrac{N_1}{N_5}$	$\dfrac{N_1}{N_6}$	$\dfrac{N_1}{N_7}$	$\dfrac{N_1}{N_8}$
OS	$\dfrac{N_2}{N_1}$	1	$\dfrac{N_2}{N_3}$	$\dfrac{N_2}{N_4}$	$\dfrac{N_2}{N_5}$	$\dfrac{N_2}{N_6}$	$\dfrac{N_2}{N_7}$	$\dfrac{N_2}{N_8}$
SMS	$\dfrac{N_3}{N_1}$	$\dfrac{N_3}{N_2}$	1	$\dfrac{N_3}{N_4}$	$\dfrac{N_3}{N_5}$	$\dfrac{N_3}{N_6}$	$\dfrac{N_3}{N_7}$	$\dfrac{N_3}{N_8}$
ITS	$\dfrac{N_4}{N_1}$	$\dfrac{N_4}{N_2}$	$\dfrac{N_4}{N_3}$	1	$\dfrac{N_4}{N_5}$	$\dfrac{N_4}{N_6}$	$\dfrac{N_4}{N_7}$	$\dfrac{N_4}{N_8}$
MPS	$\dfrac{N_5}{N_1}$	$\dfrac{N_5}{N_2}$	$\dfrac{N_5}{N_3}$	$\dfrac{N_5}{N_4}$	1	$\dfrac{N_5}{N_6}$	$\dfrac{N_5}{N_7}$	$\dfrac{N_5}{N_8}$
LS	$\dfrac{N_6}{N_1}$	$\dfrac{N_6}{N_2}$	$\dfrac{N_6}{N_3}$	$\dfrac{N_6}{N_4}$	$\dfrac{N_6}{N_5}$	1	$\dfrac{N_6}{N_7}$	$\dfrac{N_6}{N_8}$
SS	$\dfrac{N_7}{N_1}$	$\dfrac{N_7}{N_2}$	$\dfrac{N_7}{N_3}$	$\dfrac{N_7}{N_4}$	$\dfrac{N_7}{N_5}$	$\dfrac{N_7}{N_6}$	1	$\dfrac{N_7}{N_8}$
FES	$\dfrac{N_8}{N_1}$	$\dfrac{N_8}{N_2}$	$\dfrac{N_8}{N_3}$	$\dfrac{N_8}{N_4}$	$\dfrac{N_8}{N_5}$	$\dfrac{N_8}{N_6}$	$\dfrac{N_8}{N_7}$	1

Similarly, matrices of pairwise comparisons of productivity priorities μ_i and executive elements n_i are formed. The integral indicator of importance of contributions of subsystems of system DL is defined.

$$\begin{cases} B_1 = X_1 \cdot X_1(N_1) + X_2 \cdot X_2(N_2) + ... + X_8 \cdot X_8(N_8) \\ B_2 = X_1 \cdot X_1(\mu_1) + X_2 \cdot X_2(\mu_2) + ... + X_8 \cdot X_8(\mu_8) \\ .... \\ B_8 = X_1 \cdot X_1(n_1) + X_2 \cdot X_2(n_2) + ... + X_8 \cdot X_8(n_8) \end{cases} \tag{7}$$

Table 6. Matrix of importance of contributions of DLS subsystems

Subsystem	B_i
RLS	B_1
OS	B_2
SMS	B_3
ITS	B_4
MPS	B_5
LS	B_6
SS	B_7
FES	B_8

4. Determination of the efficiency of the DL system is carried out as a weighted average of the probability of the task of the DL $P_i(t_n)$ system, taking into account the importance of the results of the subsystems of regulatory, organizational, scientific, methodological, information and telecommunications, mathematical and software, logistics, personnel, financial and economic support, as well as the negative impact of significant factors on the realization of the potential of the system

$$M_{used}(t_n) = n_{useed}^{spend} \sum_{i=1}^{s} (1 - K_i) B_i P_i(t_n) . \tag{8}$$

5. Comparison of the value of the efficiency indicator with its desired value, which ensures the performance of tasks by the distance learning system

$$M_{use} \geq N_{useed}^{spend} \tag{9}$$

4. Result and Discussion

Evaluation of the effectiveness of the distance learning system of the university was carried out for the typical structure of the distance learning system deployed on the Moodle platform and possible options for its use in order to meet consumer needs in educational services, the state of development of methods and ways of providing educational services.

The results of determining the importance of the contributions of the subsystems of the distance learning system showed (Figure 3) that the greatest contribution is made by the subsystems of organizational, scientific and methodological, information and telecommunication support.
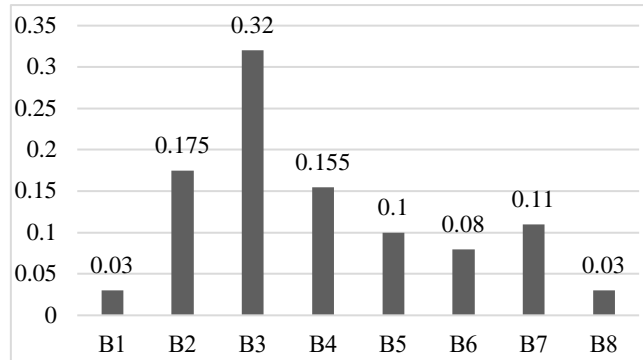
Fig.3. The results of determining the importance of the contribution of the subsystems of the distance learning system of the university deployed on the Moodle platform

The contributions to the result of the DLS operation of the ZSU of these subsystems are the most significant. The physical content of the values of indicators is the degree of their impact on achieving the main goal of the distance learning system to meet the needs of consumers in educational services[16,17,21],.

At the same time, the results of research calculations showed that the degree of compliance of universities with the requirements for organizational, personnel, scientific and methodological, logistical, software and information support of higher education institutions, postgraduate education institutions, scientific, educational and scientific institutions [13,15,19,26] reproduce significant impact on each of the contributions of subsystems $M_i(t_n)$. The general picture of the possibility of higher education institutions to provide educational services using distance learning technologies.

This approach to the analysis will make it possible to determine the priority of measures to eliminate inconsistencies and improve the relevant types of educational activities using distance learning technologies.

As can be seen from Figure 3, Figure 4 and Figure 5, taking into account the contribution to the result of DLS B_i operation, the subsystems of providing scientific-methodical, organizational, information-telecommunication as the most important contributors with low and medium degree of conformity deserve special attention.
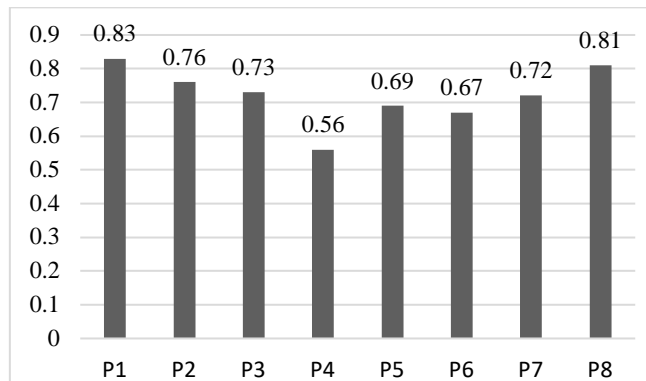

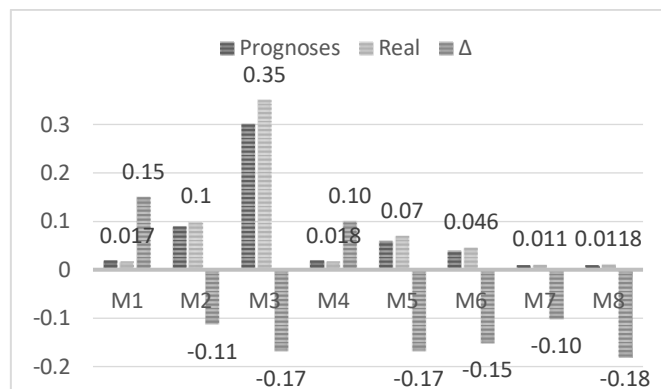Fig.4. The results of the evaluation of the capabilities of DLS subsystems

Fig.5. The results of the comparative assessment of the contributions of DLS subsystems

Priority of the second level is given to the subsystems of ensuring the rest of the group of low level of compliance.

At the same time, it is advisable to take into account the contributions of subsystems from the first group. Their improvement, in some cases, may provide an opportunity to complete the formation of procedures to ensure the functioning of the distance learning system.

This judgment is confirmed by the results of using the method of evaluating the effectiveness of the system. According to the existing variant, they showed the ability to sustainably perform the tasks of the subsystem with the level of reliability $P_i(t_n) \geq 0,75$ [12,14,23,25-28], namely: regulatory, legal, organizational, financial and economic support.

Taking into account the contributions of the relevant subsystems to the results of the DLS operation showed that, despite the average degree of compliance, the subsystem of scientific and methodological support makes the largest contribution. At the same time, this result of evaluating the effectiveness of the distance learning system showed that the needs of system users in educational services can be met within not less than 0.55.

This state of affairs does not meet the requirements of the criterion for assessing the effectiveness of the distance learning system of higher education, and given the growing trends in consumer needs for educational services requires finding ways to improve the quality of relevant processes.

The purpose of the study is to improve the methodology for assessing the effectiveness of the distance learning system in order to use it to predict the effectiveness of the distance learning system, taking into account the importance of the contributions of its subsystems.

The presented results of calculations show the value of the importance of contributions of subsystems of the distance learning system deployed on the Moodle platform (Fig. 3), the value of stochastic performance indicators of each subsystem separately (Fig. 4), the results of assessing their contributions to the functioning of the distance learning system. evaluation.

The objectives of the study are achieved through the analysis of the values obtained with the help of advanced methods. In fig. 5, in essence, presents a deterministic model of the process of providing educational services using a system of distance learning, taking into account the peculiarities of its construction.

The value of each contribution is an indicator of the success of the operation, and the reliability of the original data and the quality of expert judgments ensure the objectivity of assessing the effectiveness of the system.

5. Conclusions

An improved methodology for evaluating the effectiveness of the distance learning system is presented, which is based on ensuring the reliability of evaluating the results of its operation and the objectivity of comparing the options for its construction in order to select the appropriate learning option.

This methodology, in contrast to existing ones, provides a reliable forecast of the efficiency of the distance learning system according to the options for its construction, taking into account the degree of importance and contributions of its subsystems. The proposed methodology is a perfect tool for the study of distance learning systems. It allows you to choose effective learning options. The methodology contains a stochastic model of contributions of subsystems of the distance learning system obtained on the basis of expert evaluation methods.

Analysis of the results of statistical data obtained from the results of observations and the results predicted using the proposed method, indicate an increase in the reliability of the estimate by 15-18%.

The standard deviation of the efficiency indicators was reduced by 26%.

Due to the obtained results, the reliability of the obtained data will be about 82-85%, which is high enough to make informed decisions.

The developed motology indicates the possibility of eliminating restrictions in the field of distance learning and forms a new opportunity to cover a wider range of factors that affect the quality of distance learning.

Reliability and accuracy of performance evaluation results is determined by the use of proven, adequate to the real process of scientific and methodological evaluation apparatus, involvement of experts in the field with practical experience in the use of distance learning technologies in a specialized expert environment. Its complexity and versatility are offset by careful preparation for its implementation, taking into account the characteristics of the DN system based on its deep decomposition and clearly defined rules for evaluating the relevant performance indicators of its subsystems.

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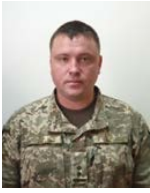The number of articles in international databases – 15

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