SOFTWARE FOR ASSESSING THE QUALITY OF EDUCATIONAL INFORMATION SYSTEMS ON THE BASIS OF FUZZY KONETIVE MODELING

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Annotation. *The paper considers the problem of assessing the quality of educational information systems (EIS) in the context of the digital transformation of society. An algorithm for determining the quality of information systems based on expert information is proposed. This approach differs in that it allows one to formalize qualitative assessments of the state of the system using the theory of fuzzy sets. The fuzzy quality assessment models included in the methodology, as well as the algorithms corresponding to them, allow, based on expert data, to assess the quality of educational information systems at the stage of their development, implementation and use. The implementation of the methodology makes it possible to increase the efficiency of the quality management process of educational information systems and the educational process as a whole. The article considers the use of a software package for the analysis and evaluation of the quality of educational information systems. The developed software product implements the following declared functions: assessment of the initial level of quality of the intellectual property; assessment of the possible level of quality of intellectual property in the event of attacks on the information resources of institutions.*

Key words: *educational information system, quality of information systems, software product.*

TA'LIM AXBOROT TIZIMLARI SIFATINI BAHOLASH UCHUN DASTURIY MAHSULOTLAR MAJMUASI.

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Annotatsiya. *Maqolada jamiyatning raqamli transformatsiyasi sharoitida ta'lim axborot tizimlarining (TAT) sifatini baholash muammosi ko'rib chiqilgan. Ekspert ma'lumotlari asosida axborot tizimlarining sifatini aniqlash algoritmi taklif etilgan. Ushbu yondashuv noravshan to'plamlar nazariyasidan foydalangan holda tizim holatini sifatli baholashni rasmiylashtirishga imkon berish bilan farq qiladi. Metodikaga kiritilgan sifatni baholashning noaniq modellari,*

shuningdek ularga mos keladigan algoritmlar ekspert ma'lumotlari asosida ta''lim axborot tizimlarining sifatini ularni ishlab chiqish, amalga oshirish va ulardan foydalanish bosqichida baholashga imkon beradi. Metodologiyani joriy etish ta'lim axborot tizimlari va umuman o'quv jarayonining sifatini boshqarish jarayonining samaradorligini oshirishga imkon beradi. Shu bilan bir qatorda maqolada ta'lim axborot tizimlari sifatini tahlil qilish va baholash uchun dasturiy ta'minot to'plamidan foydalanish ko'rib chiqilgan. Ishlab chiqilgan dasturiy mahsulot quyidagi e'lon qilingan funktsiyalarni amalga oshiradi: TAT sifatining dastlabki darajasini baholash; muassasalarning axborot resurslariga hujumlar sodir etilgan taqdirda TAT sifatining holati darajasini baholash.

Kalit so'zlar: *ta'lim axborot tizimi, axborot tizimlari sifati, dasturiy mahsulot.*

КОМПЛЕКС ПРОГРАММНЫХ ПРОДУКТОВ ДЛЯ ОЦЕНКИ КАЧЕСТВА ОБРАЗОВАТЕЛЬНЫХ ИНФОРМАЦИОННЫХ СИСТЕМ

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Аннотация. *В статье рассматривается проблема оценки качества образовательных информационных систем (ОИС) в контексте цифровой трансформации общества. Предложен алгоритм определения качества информационных систем на основе экспертной информации. Этот подход отличается тем, что позволяет формализовать качественные оценки состояния системы с использованием теории нечетких множеств. Включенные в методику нечеткие модели оценки качества, а также соответствующие им алгоритмы позволяют на основе экспертных данных оценивать качество образовательных информационных систем на этапе их разработки, внедрения и использования. Внедрение методологии позволяет повысить эффективность процесса управления качеством образовательных информационных систем и образовательного процесса в целом. Также в статье рассмотрено применение комплекса программного продукта для анализа и оценки качества образовательных информационных систем. Разработанный программный продукт реализует следующие заявленные функции: оценка исходного уровня качества ОИС; оценка возможного уровня качества ОИС в случае реализации атак на информационные ресурсы учреждений.*

Ключевые слова: *образовательная информационная система, качество информационных систем, программный продукт.*

Introduction

The sphere of education forms and stimulates the intellectual, cultural, spiritual development of the society of the state. Its content and focus are reflected in educational programs and standards. Scientific and technological progress stimulates the introduction of new tools that can and should be used in the educational process. At the same time, it is important to understand that the educational

information system (EIS) must be of high quality and meet the quality requirements of not only the information system, but also educational standards and security.

After 2018, the paradigm of the active introduction of online courses has strengthened in higher education institutions, including the practice of replacing (on an alternative or non-alternative basis) disciplines traditional in the form of education with distance learning. These practices caused heated discussions, since not all disciplines turned out to be meaningfully and methodically adaptable to the online format. However, no one considered the option of a complete transition "to digital" as the only true one.

The problems caused by the coronavirus pandemic have affected all spheres of public life, including education. If previously higher educational institutions gravitated towards the remote conduct of the educational process, interested in reaching an audience and implementing projects of continuous and affordable education, then forced self-isolation has led to the fact that remote technologies that are poorly demanded by the school have become an urgent need. The mass transition of all schools to online learning clearly showed the problem of assessing the level of information security of educational information systems, the relevance of which was missed in "peacetime", because. an increase in the load on these systems led to various negative consequences, for example, educational portals not designed for a simultaneous stay of a large number of users could not cope with the load and errors occurred, as a result of which students could not receive the task. Also, the number of hacker attacks on educational systems has also frighteningly increased, in connection with this, there is an urgent need to develop a software package that evaluates the state of the intellectual property for information security, while such an assessment should be carried out constantly as part of the quality management of the intellectual property [1].

Literature review

World scientists have studied the issue of quality assessment and the quality management process of information systems from different angles. There is a description of the general principles and methods of evaluation that are typical for systems for a specific purpose (A.N. Shchennikov, T.G. Ozernikova, L.V. Glukhova). Attempts have been made to formulate universal methods for managing quality assessment (Gurpreet Dhillon, Carlo Batini). There are also works related to the description of individual parameters that determine quality: reliability (A.V. Baranova, V.K. Dedkov, A.I. Kovalev, V.N. Matusko, etc.); information security (A.A. Shelupanov, Viet Pham, Reijo Savola), etc.

The existing approaches do not fully take into account the specific features of the task of assessing the quality of IP, primarily the presence of subjective uncertainty associated with the need for widespread use of expert information. In addition, significant shortcomings include the inconsistency of the methods proposed by the authors with the world regulations that cover the problem of quality management, which not only define the concept of "quality", but also include a recommended list of indicators that may affect it.

Research methodology

After analyzing the available methods for assessing the quality of information systems, it was found that the existing approaches do not take into account various states at points in time and are mainly aimed at assessing only the current state, and also do not take into account the specifics of educational information systems. To achieve the goals, fuzzy cognitive modeling (FCM) was used as the main mathematical apparatus in solving the problem of quality management of the educational information system [4].

The main structural elements of cognitive modeling are cognitive maps, an example of which is a sign graph. Its peculiarity lies in the fact that its edges have positive or negative weights and indicate the nature of the connection between its vertices. The path along the graph is the product of the weights of its edges: the path is positive if there are an even number of negative edges, or negative if there are an odd number of negative edges in the graph [3]. If the connections between the vertices are positive, then the amplification of the initial parameter leads to an increase in the final parameter, in the opposite case, to a decrease. If it is possible to pass from one parameter to another along the

graph both along a positive and a negative path, then it is not possible to determine the influence of one parameter on another [8].

Based on the foregoing, we can conclude that the use of FCM based on production rules and principles of fuzzy logic is a good solution for describing the dependencies between the parameters of the subject area and their impact on the overall quality level of the EIS.

In order to formalize the evaluation of the individual components of the quality of the EIS, it is proposed to introduce the linguistic variable "Parameter value" and contrast it with a term-set of values, designated as VP. This term-set will include 5 levels belonging to the non-negative region of estimates:

$$VP = \{ «0»; \text{ Short (D); Medium (C); Above average (B); High (A)}\} \quad (1)$$

In order to represent VP in a graphical form, a 5-level classifier was developed, which implies that the membership functions of fuzzy numbers on the interval $[0,1] \in R$ are equivalent to trapezoids:

$$\{ «Zero»(0; 0; 0,15; 0,25); \ A (0,15; 0,25; 0,35; 0,45); \ B (0,35; 0,45; 0,55; 0,65); \ C(0,55;$$
$$0,65; 0,75; 0,85); D(0,75; 0,85; 1;1)\}, \quad (2)$$

where in the given fuzzy numbers of the form $N(z1, z2, z3, z4)$ $z1$ and $z4$ are the abscissas of the lower base of the trapezoid, $z2$ and $z3$ are the abscissas of its upper base [12]. The graphical view of the classifier is shown in Figure 1.
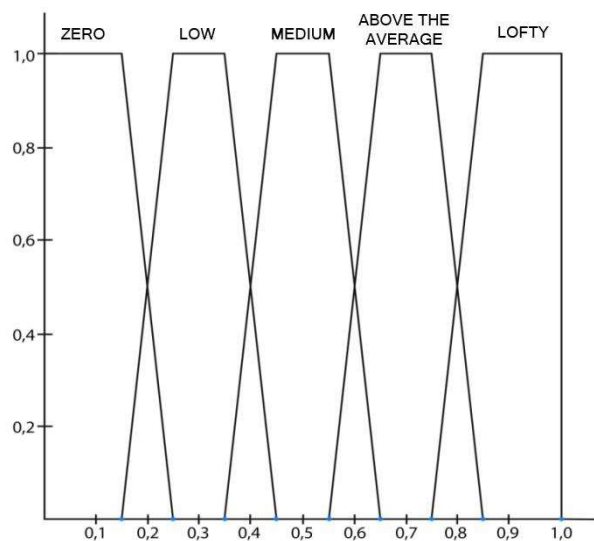

Figure 1. Graphical representation of a fuzzy classifier

It is important to note that the sum of all membership functions for any number lying in the interval $x \in [0, 1]$ must be equal to one to ensure the principle of consistency.

Results

To establish an assessment of the quality of EIS, it is necessary to formulate mathematical models that connect the initial information about the assessments of the existing and possible quality levels of EIS. To identify the list of initial data of the developed models, the rules for their use for calculations, it is necessary to develop a unified algorithm for assessing and managing the quality of EIS at all stages of its life cycle. To do this, it is necessary, first of all, to determine these stages.

The analysis of legal documents made it possible to identify the following stages of the EIS life cycle:

1. Designing EIS
2. Commissioning of the EIS
3. EIS operation and maintenance
4. Removal from service

Taking into account the identified stages of the EIS life cycle, an algorithm for managing its quality was developed, the block diagram of which is shown in Figure 2.

1. Formation of requirements for EIS (from teachers, students and management of an educational institution, as well as the requirements of the regulator). The resulting information of this stage is a list of non-formalized requirements for the quality of EIS, determined by its various characteristics.
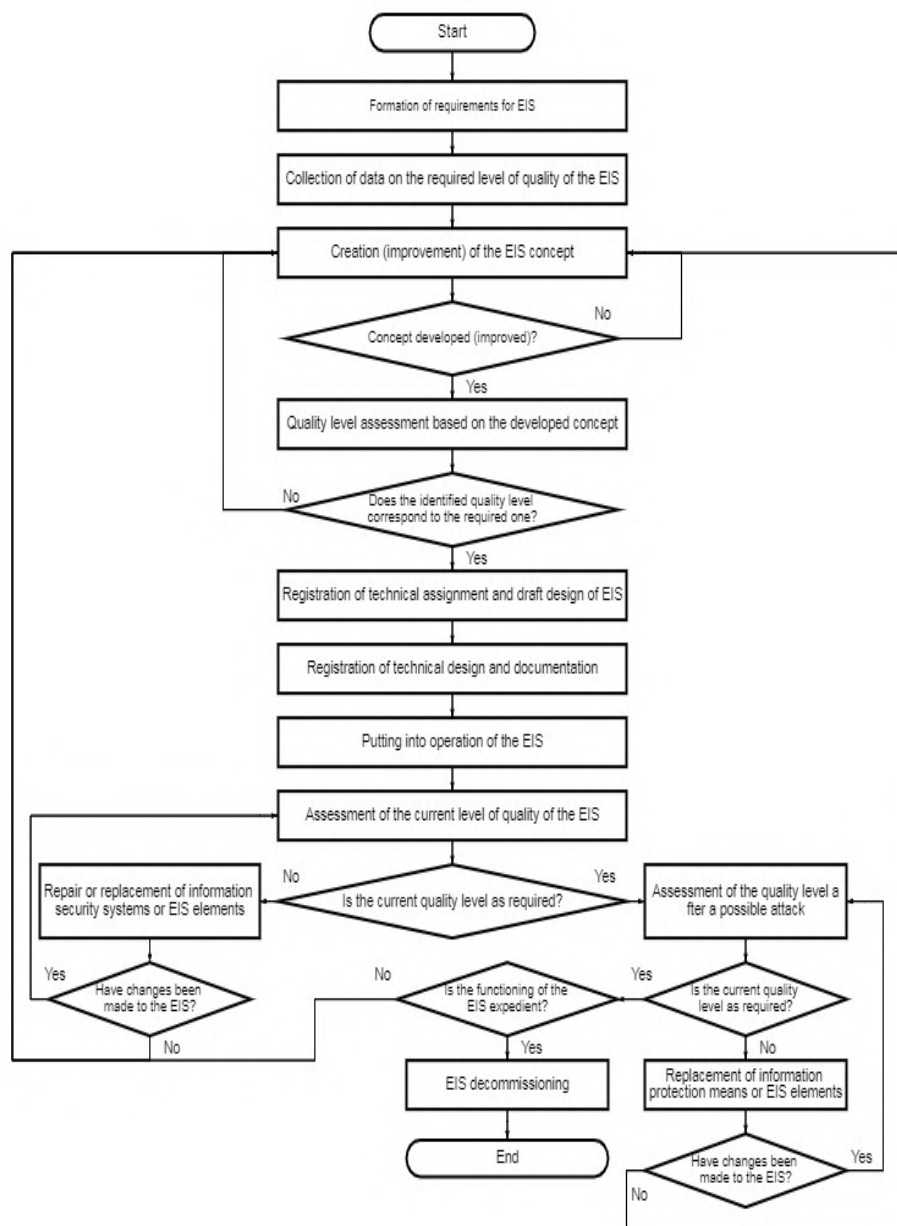

Figure 2. EIS quality management algorithm

2. Combining data on the required level of quality of the EIS. The result is a formalized level of EIS quality. In addition, at this stage, you can also set a promising level of quality of the EIS, in case you plan to improve the system over time.

3. Creation (improvement) of the concept of EIS. This procedure is aimed at ensuring the requirements of clause

4. Evaluation of the level of quality that is achieved by implementing the concept of EIS. If even at the planning stage of EIS the level of its quality is insufficient, the concept needs to be revised. As a result of an attack on EIS, the level of its quality may decrease. As a result of the execution of clause 4, the DMR a formalized assessment of the quality of EIS in the event of a possible attack.

5. Checking the quality level of EIS obtained in paragraph 4 for compliance with the required level. As a result, the decision maker receives recommendations on whether it is necessary to make

changes to the Information Security Tools or change the concept of EIS in order to meet the required level of quality.

6. Assessment of the existing quality level of the EIS. At this stage, an estimate of the current quality indicator of the EIS is calculated. [6]

Thus, the process of quality management of EIS can be represented as the following sequence of steps:

1. Setting the required quality level of the EIS

2. Assessment of the quality level of the EIS at the present time

3. Assessment of the possible level of quality of the EIS in the event of a threat to the information resources of the institution.

Each of the above stages of quality management has different goals and involves the receipt and use of heterogeneous information obtained from various sources.

The proposed method for determining the quality of information systems based on expert assessments differs in that it allows formalizing qualitative assessments of the state of the system using fuzzy set theory. The fuzzy quality assessment models included in the methodology, as well as the algorithms corresponding to them, allow, based on expert data, to assess the quality of educational information systems at the stage of their development, implementation and use. The implementation of the methodology allows to increase the efficiency of the quality management process of educational information systems and the educational process as a whole [7].

Software package for assessing the quality of EIS. Based on the algorithm and method for assessing the quality of the EIS, a set of software products was developed, consisting of two interconnected modules:

- "Module for assessing and managing the quality level of the educational information system",

- "Module for assessing the current levels of parameters of the educational information system".

The relationship of these structural components is shown in Fig.3. In addition, both software modules are registered in the state register of programs for electronic computers, in the Agency for Intellectual Property under the Ministry of Justice of the Republic of Uzbekistan.
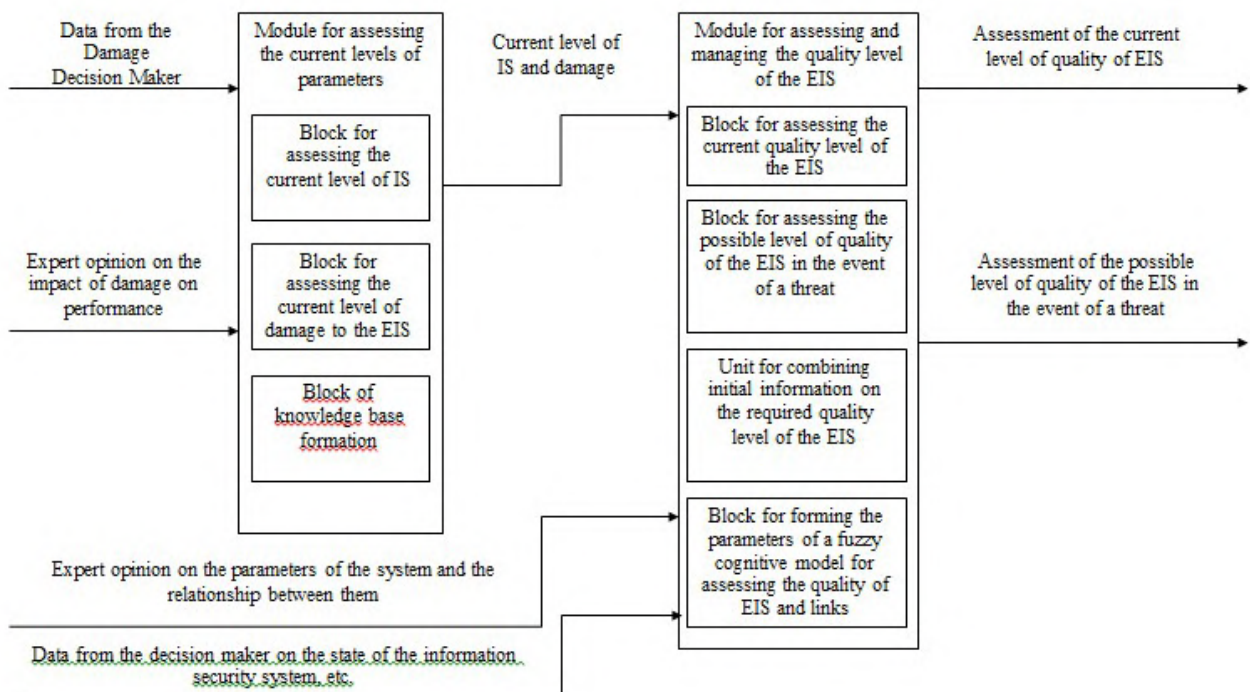

Figure 3. Scheme of relationships between the developed modules

The module for assessing the current levels of system parameters evaluates the existing level of information security of the EIS, as well as the strength of the influence of damage to the EIS. As input parameters, the module receives data on the current state of the EIS and its damage, as well as information on how damage currently affects the system parameters. [2]

The assessments that were formed upon completion of the program module became the input for the next module - the module for assessing and managing the quality of the EIS, the task of which is, among other things, to assess the possible level of quality of the EIS in the event of threats. It is worth recalling that in the case of evaluating various indicators of the system outside the framework of solving the problem of managing the quality of the EIS, the software package allows you to save the results of evaluations for further analysis. The following set of information is fed to the input of the program module:

- judgment of experts on the inclusion of certain concepts and their relationships in fuzzy cognitive models;

- information about the initial level of information security of the EIS;

- current values of assessments of the status of information protection tools of EIS and other indicators.

The work of the listed software modules as part of a single complex allows not only to assess the quality of the EIS, but also to conduct logging, fixing the assessments made earlier. This makes it possible to observe the dynamics of changes in the state of the EIS and evaluate the effectiveness of the quality management process in an educational organization. The journal records not only the assessment itself, but also the date of its implementation, as well as a pointer to a detailed description of the result obtained.
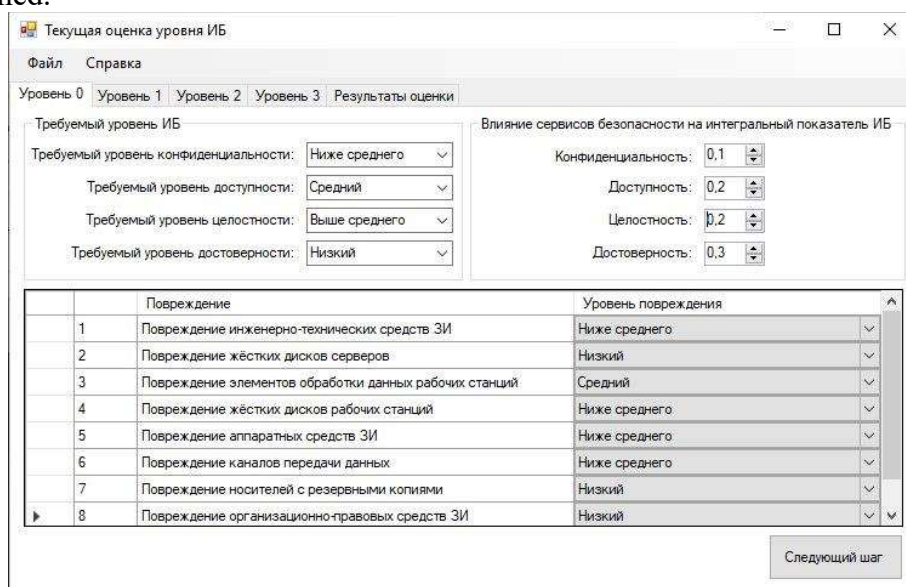

Figure 4. Program module interface

Conclusion

The developed software product implements the following declared functions: assessment of the initial level of quality of the EIS; assessment of the possible level of quality of the EIS in the event of attacks on the information resources of institutions.

The developed methodology and its software implementation were accepted for trial operation in educational institutions of various levels (school, university, center of additional education), which is confirmed by implementation acts. As a result of trial operation, the effectiveness of the approaches considered in the study was tested and shown.

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