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A FUZZY MODEL FOR THE ASSESSMENT OF FACTORS AFFECTING THE CHOICE OF AN INSTITUTION OF HIGHER EDUCATION

Abstract. *The proposed approach to the formalization of models of development projects and the development of a higher education institution (HEI) provides the possibility of modeling (research), processes of training future specialists and development with the selection of points of origin of projects for the implementation of management tasks. This makes it possible to simplify the description of the main processes of vocational training and to build models for the analysis of improvements through the system of quality and development in the training of specialists in vocational training. In order to conduct higher education diagnostics and form harmonized decisions in higher education development programs in the system of higher education, it is advisable to use programs for the development and management of business processes, the management functions of which are focused on the analysis of the state of the higher education institution and management functions that ensure a successful and less expensive result of higher education development with taking into account the increased requirements of the external environment and the labor market. One of the conceptual provisions of the development of information technologies and education management systems is the further development of information provision in the formation of a single perfect information environment, informatization of education management systems, and evaluation of the quality and effectiveness of training specialists for the production industries, taking into account the requirements of the labor market, production and modern development of science. The proposed technique and method of comprehensive assessment of the quality of education of graduates of higher education institutions with the help of IT on the basis of indicators and indicators of quality, according to quantitative and qualitative factors, their composition, taking into account the needs of production, the requirements of the external and internal and educational environment. Thus, the main technology of education quality management is the most widespread component of artificial intelligence - fuzzy systems. Thanks to its combination with classical models and methods of ensuring the process of management of higher education institutions, it was possible to obtain wider opportunities for working out those parameters that until then had not been considered due to their qualitative nature. It is advisable to include the following input components to the main indicators: finance, training and development, competence, satisfaction, requirements and assessment of higher education institutions, etc.*

Keywords: information systems harmonization; current fuzzy model; genetic algorithm scheme; property functions

Introduction

In the conditions of today's intensive problem of obtaining quality education, the seeker of educational services faces the problem of choosing among the available institutions of higher education precisely those that, when investing in the educational process of the most important human resources, will bring the greatest result from a complete, complete and high-quality education. However, each of the considered HEI is subject to the influence of various influencing factors: social, administrative, economic, political, environmental, etc. Of these factors, less than 10% can be measured by standard methods, and all others are of a qualitative nature. In view of the above reasons, a choice was made in favor of fuzzy sets, which are the basis of the proposed model for assessing factors influencing the choice of higher education institutions.

Analysis of sources

Among the available sources that highlight this issue, special attention should be paid to the following: in [1; 2; 5] a model is considered, the basis of which was used by the authors to build the current fuzzy model; in [3; 4], the scheme of the genetic algorithm, as well as its main components, is disclosed in full; and finally, in [5; 6], the process of fuzzy derivation, which was proposed by Mamdani, is described in detail.

Main part

To increase the effectiveness of the use of options for comparison and selection of higher education institutions for the needs of the recipient of educational services due to the considered model of fuzzy assessment of influencing factors. To increase the quality characteristics of the provided educational services and, accordingly, to improve the effectiveness of training from the point of view of minimizing the expenditure of time and money in their daily affairs.

As mentioned above, this model is the result of combining the most popular methods of strategic analysis and artificial intelligence. The general appearance of this model is presented in [7].

It is soft computing as a branch of artificial intelligence due to its simplicity and approach to reflecting human thinking that was chosen to build a fuzzy model of the evaluation of the HEI.

Since there are many groups of influencing factors and new ones inevitably appear in the process of research, it is necessary to group them in such a way that it is possible to work with them conveniently. For this purpose, a SWOT analysis was chosen, thanks to which, regardless of the number of investigated groups of factors, the work will be carried out in the end with only four categories: strength (S), weakness (W), opportunity (O) and threat (T).

And just to describe the influence of the relevant SWOT categories, that is, the result (R), as well as to provide more flexibility and expand the framework of the obtained results, Zade's fuzzy logic was used.

Membership functions of fuzzy sets, which describe SWOT categories, have a non-standard form, since their construction involved the opinions of experts in the assessment of urban health and safety centers to make the task more practical. The corresponding calculations were performed [6] using the formula:

$$\mu_{l_j}(u_i) = \frac{1}{K} \sum_{k=1,\ K} b_{j,i}^k,\ i = \overline{1,n},$$

where the following notations are used:

– K – number of experts;

– $b_{j,i}^k$ – opinion k -thexpert about the presence of the element u_i properties of the fuzzy set $\tilde{l}_j$, $k = \overline{1,K}$, $i = \overline{1,n}$, $j = \overline{1,m}$;

– $\tilde{l}_j = \left(\frac{\mu_{l_j}(u_1)}{u_1}, \frac{\mu_{l_j}(u_2)}{u_2}, \cdots, \frac{\mu_{l_j}(u_n)}{u_n} \right)$ – a fuzzy plural that describes a linguistic term l_j, $j = \overline{1,m}$ on the universal set U.

Accordingly, in the process of their construction, all the requirements for property functions were taken into account, so that they have the correct set uncertainty. Therefore, the received terms describe this model according to the existing reality on the construction market.

Each of the four SWOT categories is described as fuzzy sets according to a template that describes the structure of the attribute functions. Thus, there are the following terms, in the number equal to five [6 – 9, 11], which have the following general names:

– minimal (for S: negative, for W: poor, for O: negative, for T: poor and for R: negligible);

– medium-minimum (for S: satisfactory, for W: satisfactory, for O: satisfactory, for T: satisfactory and for R: small);

– average (for S: more than satisfactory, for W: more than satisfactory, for O: more than satisfactory, for T: more than satisfactory and for R: average);

– medium-maximum (for S: moderately positive, for W: almost good, for O: moderately positive, for T: almost good and for R: almost great);

– maximum (for S: positive, for W: good, for O: positive, for T: good and for R: great).

In order to give this model dynamism, or in other words, the ability to change over time, a technology known as a genetic algorithm was used.

In other words, the membership functions of fuzzy sets were obtained thanks to the opinions of experts on

the evaluation of the EI. But since the assessment can change, a mechanism is needed to automate this process. The solution was the use of an evolutionary approach.

Thanks to him, such concepts and possibilities as gene, individual, population, adaptation function, etc. were used, so that it was possible to change the type of belonging functions. In fig. 1 shows an example of the initial population of a fuzzy set.

From the figure above, it can be seen that the genes were used to display the values (in fact, this is the number of expert votes that evaluated a specific value of the universal set U. The value is obtained by dividing this number by the number of involved expert votes. For ease of presentation, the authors call it number), and individuals – to display the functions of belongings. The population obtained in this way is nothing but a fuzzy set.

The production system consists of a base of rules orset of rules, working memory and logical conclusion.Working memory (WP) is short-term memorystorage in which the describing conditions are storeda specific subject area (in this case,of free urban territory for residential construction)and the results obtained on their basis.Output mechanism or logical output – usefollows the rules in accordance with the content of the working memory.

Rules can be described using AND-OR-treesNO [2]. Fig. 1 shows a fragment of this datatrees.

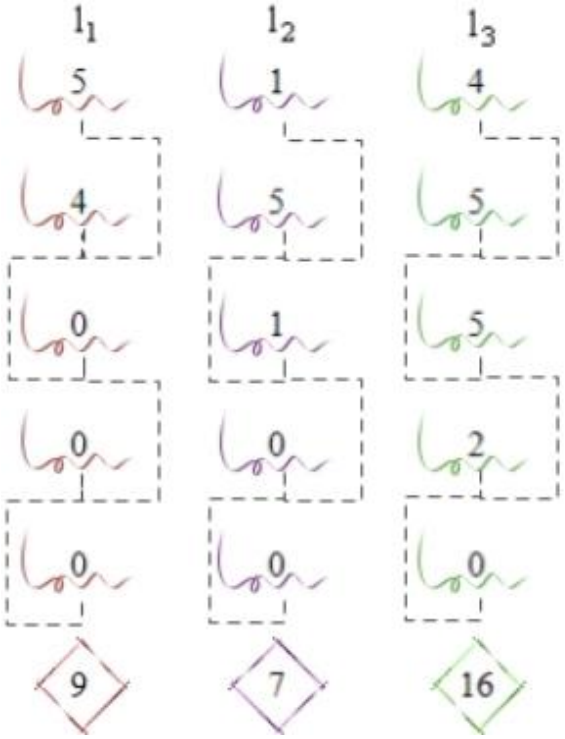

Figure 1 – Initial population and its fitting functions

Using genetic algorithm methods: selection (Fig. 2), crossing and mutation – we will get the final population.

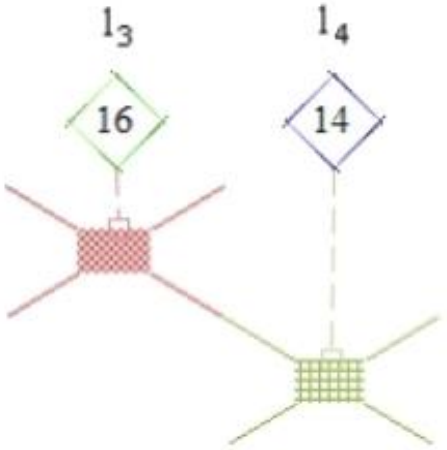

Figure 2 – Tournament selection with winning individuals

The picture shows the result of the tournament selection with the winners. As can be seen from this graphic diagram, the winners were those with the largest fitness function.

As mentioned above, during the execution of the evolutionary algorithm, situations may arise when the membership function ceases to meet the requirements imposed on it according to the theory of fuzzy sets. It is about its visual appearance, when a concave function can come out. To correct this problem, mutation is used. An example of its application is presented in Fig. 3.

Since in these rules there is a function "tokey OR", then the tree is built taking it into account.Functions whose images were used totree doves (Fig. 1) are presented in Fig. 2.

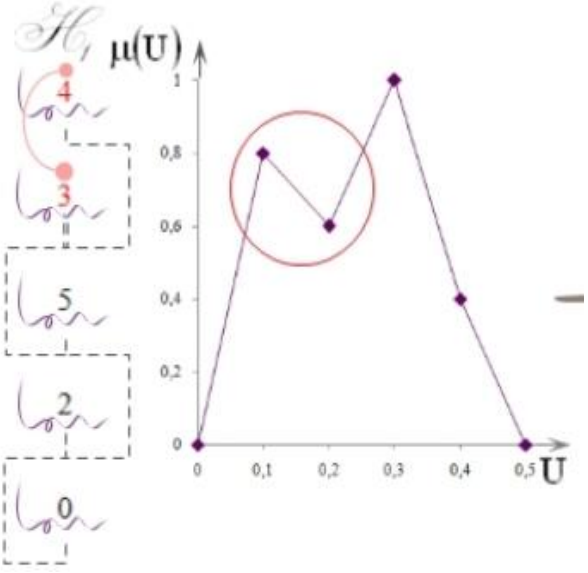

Figure 3 – Membership function before and after using mutation

The result obtained after applying the genetic algorithm will be the same fuzzy set, but with different values for its property functions.

To illustrate this process, Fig. 4, where two "temporary snapshots" of the membership functions of the fuzzy set describing the "Strength" category are presented: obtained before the application of the genetic algorithm based on the opinions of experts (in the form of dashed lines) and after its application (in the form of solid lines).

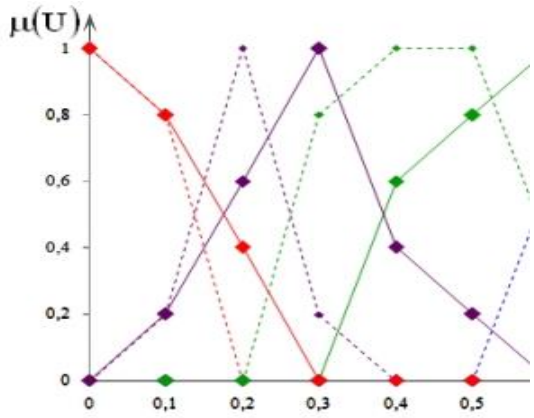

Figure 4 – View of the property functions of the final population

The fuzziness obtained in the evaluation of the ZVO can be reduced to a specific number using a technique known as fuzzy logic derivation. Its methods (aggregation, accumulation, defuzzification) make it possible to translate a vague estimate into a clear, unambiguous one. Among the existing technologies, the one that uses the simplest methods proposed by scientist Mamdani [6 – 9; 11 – 14] was chosen.

Applying the Mamdani method to the obtained property functions, 2 results were obtained on the basis of which a test graph was constructed (Fig. 5), which indicates that the genetic algorithm is more careful in working with influencing factors, which provides ample opportunities for further evaluation of factors and their use.

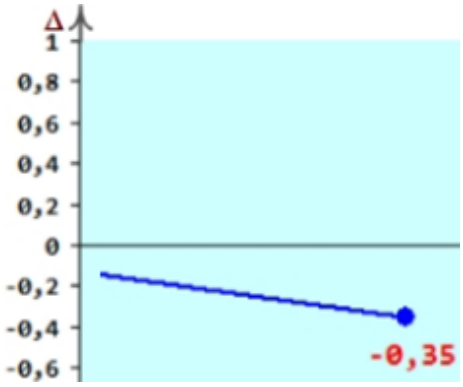

Figure 5 – Graph of the influence of factors of a pair of categories S and O on the test plot of land

On the basis of the considered model, an analysis of 10 specific institutions of higher education in the city of Kyiv was carried out Appendix "Strength". The graph obtained as a result (Fig. 6) directly indicates that the best educational institution is number nine (the value is taken at the maximum).

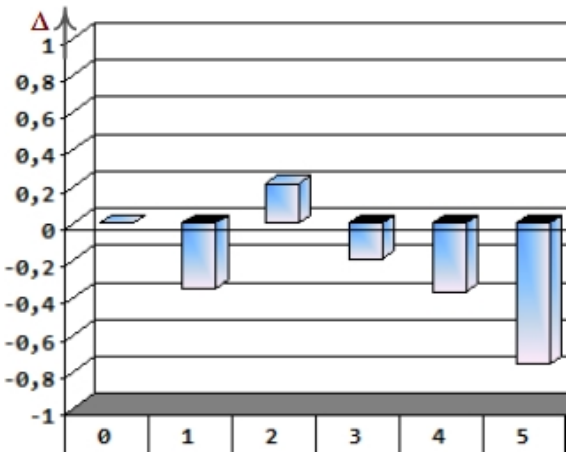

Figure 6 – Graph of influence of factors of all four pairs of SWOT-analysis categories

Conclusion

1. One of the conceptual provisions of the development of information technologies and education management systems is the further development of information provision in the formation of a single perfect information environment, informatization of education management systems, and evaluation of the quality and effectiveness of training specialists for the production industries, taking into account the requirements of the labor market, production and modern development science

2. The proposed technique and method of comprehensive assessment of the quality of education of graduates of higher education institutions using IT based on indicators and indicators of quality, according to quantitative and qualitative factors, their composition, taking into account the needs of production, the requirements of the external and internal and educational environment. It is advisable to include the following input components in the main indicators: finance, training and development, competence, satisfaction, requirements and assessment of enterprises, organizations, etc.

Proposed strategic goals and connections for the management of higher educational institutions and developed a balanced balanced system of indicators with their quantitative values from the following main groups: finances, services, the learning process and professorial staff, which allows to analyze the global strategy for the development of higher educational institutions and connect it with operational plans and tasks and to make an objective management decision on specific development issues.

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НЕЧІТКА МОДЕЛЬ ОЦІНКИ ФАКТОРІВ ВПЛИВУ НА ВИБІР ЗАКЛАДУ ВИЩОЇ ОСВІТИ

Анотація. *Запропонований підхід до формалізації моделей проєктів розвитку закладу вищої освіти (ЗВО) забезпечує можливість моделювання (дослідження) процесів навчання майбутніх фахівців і розвитку з виокремленням точок зародження проєктів для здійснення задач управління. Це дає змогу спростити опис основних процесів ЗВО і побудувати моделі аналізу поліпшень через систему якості і розвитку під час навчання спеціалістів у ЗВО. Для проведення діагностики ЗВО і формування гармонізованих рішень у програмах розвитку ЗВО в системі вищої школи доцільно використати програми розроблення та керування бізнес-процесами, функції управління яких орієнтовані на аналіз стану закладу вищої освіти і функції управління, що забезпечують успішний і менш затратний результат розвитку ЗВО з урахуванням посилених вимог зовнішнього середовища і ринку праці. Одним із концептуальних положень розвитку інформаційних технологій і систем управління освітою є подальший розвиток інформаційного забезпечення у формуванні єдиного досконалого інформаційного середовища, інформатизації систем управління освітою та оцінювання якості й ефективності підготовки спеціалістів для галузей виробництва з урахуванням вимог ринку праці, виробництв і сучасного розвитку науки. Запропоновано методику і метод комплексного оцінювання якості освіти випускників ЗВО за допомогою ІТ на основі показників та індикаторів якості (за кількісними та якісними чинниками), їхнього складу з урахуванням потреб виробництва, вимог зовнішнього, внутрішнього та освітнього середовищ. Отже, основною технологією управління якістю освіти є найбільш розповсюджена в практичній діяльності компонента штучного інтелекту – нечіткі системи. Завдяки її поєднанню з класичними моделями і методами забезпечення процесу керування закладами вищої освіти вдалось отримати більш широкі можливості до опрацювання саме тих параметрів, які до цього доводилося не розглядати через їхню якісну природу. До основних показників належать такі вхідні компоненти: фінанси, навчання та розвиток, компетентність, задоволеність, вимоги і оцінка ЗВО тощо.*

Ключові слова: інформаційні системи гармонізації; поточна нечітка модель; схема генетичного алгоритму; функції належностей

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