THE EVALUATION OF UZBEK UNIVERSITIES USING FUZZY LOGIC APPROACH

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Abstract. The excellence of Uzbek Universities can be effectively classified by systematic and objective design criteria, which participates in developing the learning outcomes in Uzbekistan. In the first phase of this research, suitable quantitative and qualitative performance evaluation criteria are determined and defined, pairwise comparisons and evaluation forms are designed and exploited in order to get experts opinions/preference on the evaluation criteria that are used to measure the universities and academic staff performance using different types of survey. The research presents a fuzzy logic computational model based on this survey to measure and classify the performance of Uzbek universities, which includes computation of criteria weights and overall evaluation of Uzbek Universities using AHP and TOPSIS techniques. This study presents a Fuzzy Consistency Algorithm (FCA) to check and evaluate the consistency level of expert's judgment. The new algorithm proposes a consistent preference linguistic value(s) as an option to the experts in case of inconsistency judgment in evaluation performance. Based on the proposed algorithm, the research introduces new tool that allows experts to trace and understand the roots of inconsistency and select the relevant consistent option(s). The algorithm allows the degree of consistency to be configured by user. The study also applies the proposed algorithm to the performance evaluation of Uzbek universities as an empirical study.

Key words: higher education, Fuzzy method, logic, computational model, algorithm

O'ZBEKISTON UNIVERSITETLARINI BAHOLASHDA NORAVSHAN MANTIQIY USULDAN FOYDALANISH

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Annotatsiya. O'zbekiston universitetlarining mukammalligini ta'lim natijalarini ishlab chiqishda ishtirok etadigan tizimli va obyektiv loyihalash mezonlari bo'yicha samarali tasniflash mumkin.Ushbu maqolaning birinchi qismida akademik xodimlarning ish faoliyatini baholashning tegishli miqdoriy va sifat mezonlari aniqlanadi, shuningdek, universitetlar va akademik xodimlarni faoliyatini turli xil so'rovlar yordamida o'lchash uchun foydalaniladigan baholash mezonlari bo'yicha ekspertlarning fikrlari/takliflarini olish uchun juftlik taqqoslash va baholash shakllari ishlab chiqiladi va foydalaniladi. Tadqiqot O'zbekiston universitetlari faoliyatini o'lchash va tasniflash uchun ushbu so'rovga asoslangan noravshan mantiqiy hisoblash modelini taqdim etadi, u AHP va TOPSIS usullaridan foydalangan holda mezon vaznlarini hisoblab, O'zbekiston universitetlarini umumiy baholashni o'z ichiga oladi. Ushbu tadqiqot ekspert xulosasining muvofiqlik darajasini tekshirish va baholash uchun noaniq izchillik algoritmini (FCA) taqdim etadi. Yangi algoritm baholash natijalarida nomuvofiq mulohazalar bo'lgan taqdirda mutaxassislarga variant sifatida izchil afzal lingvistik qiymat(lar)ni taklif qiladi. Taklif etilgan algoritmga asoslanib, tadqiqot mutaxassislarga nomuvofiqlik ildizlarini kuzatish va tushunish hamda tegishli izchil variant(lar)ni tanlash imkonini beruvchi yangi vositani taqdim etadi. Algoritm izchillik darajasini foydalanuvchi tomonidan sozlash imkonini beradi. Tadqiqotda taklif etilayotgan algoritm empirik tadqiqot sifatida O'zbekiston universitetlari faoliyatini baholashda ham qo'llaniladi.

Kalit so'zlar: oliy ta'lim, noravshan usullar, mantiq, hisoblash usuli, algoritim.

1. Introduction

During the past years there have been considerable increases in the number of institutions of higher education in Uzbekistan. The total number raised from 54 institutes in 2000s to more than 127 higher education institutes in 2017s. Figure 1 represents the total numbers of different types of institutes and the growth rate of public & private universities with Bar chart and Combo chart respectively. Most of those universities have several faculties such as medicine, engineering, science, arts, etc. There was a critical need for increasing the number of Uzbek institutions to accommodate the accumulated number of applicants. This rapid increase requires continues and enough scientific research in performance evaluation (PE) and proper processed information that can help and guide the following [1]:

- Education institutes to match up their current capabilities versus the standard requirements and plan for future development.
- Applicants & Students' Parents to figure out the best education institutions and the best faculty.
- Ministry of higher education, science and innovation to follow up the required standards and establish future plans.

Globally, also there are significant changes in university system of organization and funding. The classical activities of teaching, research and service are increasingly dedicated to the necessities of society [2] and universities have been assuming active accountabilities within the economy [3]. Making university, faculty, and academic staff evaluation in line with the changes in the university system has become a priority especially in Uzbekistan and in many other countries around the world. University assessment is becoming more official and complex, and numerous organizations have recommended transparency in standards and procedures, consistency over time between candidates with similar profiles, openness in the evaluation of tenure-track faculty and care for unsuccessful candidates [4].
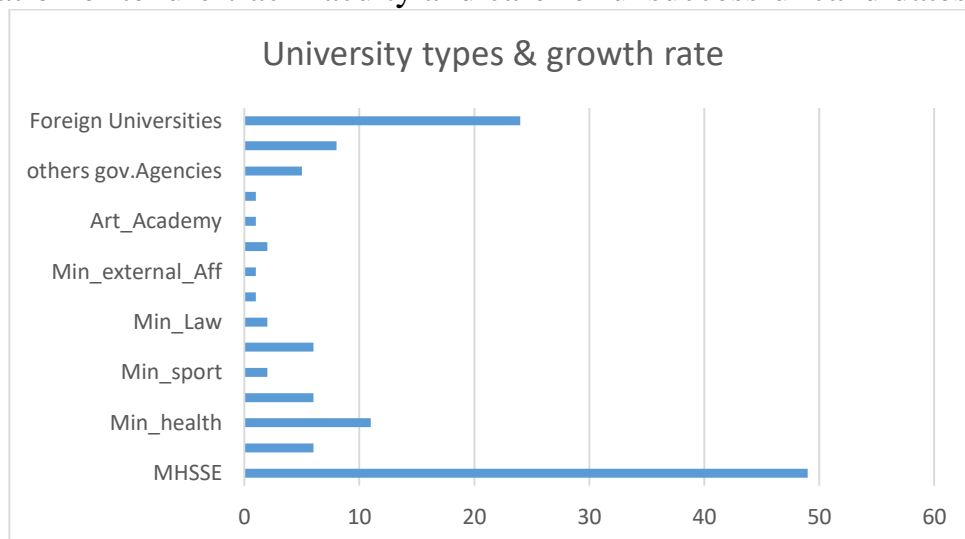

Fig. 1. Higher Institution Types and Universities Growth Rate

As an outcome of these changes, there is a chance and a challenge for each university to arrange the activity of its faculty members with its mission and strategic plans. Universities are supposed to make evaluations on promoting, recruiting, granting tenure, and compensating excellence based on accepted objective evaluation criteria. However, in spite of the global rising interest in the performance

evaluation of university activities, and in particular in faculty assessment, there are only a few research that attempt to appraise the overall activity of the academic staff [5], [6]. Thus, there is a demand to acquire comprehensive appraisal systems, based on new techniques that can effectively indicate the variances among the academic staff and faculties considering the university mission.

Performance evaluation (PE) is an organized and regular process that evaluates an organization or an individual employee's job functioning and output in relative to certain pre-established criteria and organizational goals. In higher educational institutes, the performance evaluation is key factor in improving the quality of work input, inspires staff and make them more engaged. Academic staff is appraised on the basis of definite factors like student's feedback, teaching-learning and assessment of related activities, expert development activities such as doing research work, contributing to national and international conferences, publishing research papers, leading and contributing to technical workshops. The judgments and views of managements, coworkers, and subordinates also plays an essential role in performance measurement. All these factors are jointly used to evaluate an academic staff's performance.

Employee/organization performance is related to job duties which are expected by a worker/organization and how perfectly those duties are accomplished. Many managers assess the employee performance on an annual or quarterly basis in order to help them identify areas for enhancement. PE system depends on the type of the business for an organization. PE mostly relates to the product output of a company or the end users of an organization.

Several appraisal methods are used for employee performance appraisal such as Graphic rating scale method, forced choice distribution method, behavioral check list method, etc. Some methods that were utilized in the past are not currently used like ranking, critical incident, and narrative essays. New methods have been suggested for performance appraisal technique like Management by Objective (MBO) and assessment Centers.

Generally, performance evaluation aims to recognize current skills' status and capabilities of the work force or an organization. Any standard appraisal system consists of collection of data in which information is extracted from then converted into a real number called performance rating. The employees'/organization's contribution to an organization/society depends on the evaluation of his/her/it rating. It is essential to have accurate unbiased appraisal assessment in order to measure the appraisee' contribution to organization objectives. Employers/managers/experts use characteristics such as knowledge in particular field, skills to achieve a goal and target achieving attitude in order to decide on the employee's/organization's performance level. Since these factors mostly are uncertain and vague in nature, a fuzzy performance appraisal method is more appropriate.

Majority of the occurrences that we encounter daily involve a certain level of ambiguity and fuzziness in the description of their nature. "John's performance is unsatisfied" & "The Weather is warm today". These are examples of fuzzy propositions. What degree of performance is considered unsatisfied? By how much does performance have been increased to be considered excellent, and not

unsatisfying? Do we all have the same view about his performance? This type of fuzziness associated with continuous phenomena is common in any field of study. In the conventional mathematical methods, the logic of these methods is the precise Boolean logic which has two states 1 or 0 which means that each proposition must either be false or true [7].

Lotfi Zadeh [8] introduced fuzzy logic as means to model and handle uncertainty in natural language. Fuzzy logic describes the qualitative nature of the object while conventional logic systems focus on their quantitative aspects.

2. Problem Statement

Although many universities and colleges were established in the recent few years in Uzbekistan, but very few of them are truly following proper and regular process that offering quality performance evaluation. The following are some of the current issues facing Uzbek universities:

• There is need to find an accurate technique that can determine the gap between the standards established by the ministry of higher education, science and innovation and the actual status of Uzbek universities.

• The stakeholders (parents, students, education officials, etc.) are in a state of complete confusion in choosing a quality education Institution for their career planning. Furthermore, there is lake of information about the current level of quality in the mature and well-established universities in Uzbekistan.

• The lake of effective methods to assess academic staff and proper evaluation information cascade several problems in planning, management and developing the resources.

3 Methods

Fuzzy Analytical Hierarchal Process (FAHP) and the technique for order of preference by similarity to ideal solution (FTOPSIS) have been used in developing our evaluation model system. The FAHP is used to construct the Uzbek universities hierarchical frameworks of performance evaluation criteria and to determine the relative criteria weights. Fuzzy TOPSIS method is used to obtain the final rank of the alternative (i.e. Universities) [9]. Alternatives' bottom criteria were used by FTOPSIS methods to calculate the distance of each alternative from ideal negative & positive ideal solutions. Microsoft Excel is used to develop and process several operational functions such as calculating the consistency ratio, aggregation, normalizations, preference approximation and separation measures.

4 Research Objectives & Outcomes

Given this problem, the base objectives of the proposed research are as follows:

• To identify the performance measurement indicators for evaluating the best academic staffs, faculties and Uzbek academic institutions.

• To design and develop an appropriate Fuzzy performance evaluation model with possibly new theorems and fuzzy data structures which can handle both subjective and objective factors in the evaluation process that can fit the Uzbek culture. This helps evaluators to objectively assess the key entities involved in academic process starting from academic staff, faculty, and university.

• To implement and test the proposed system

The evaluation result serves the Uzbek communities as follows:

• Students/Applicants and students' parents will find an accurate source of processed information that guides and helps applicants and students' parents to select the best university for their future study in a specific field.

• Regular ranking process based on agreed performance evaluation criteria will help the Ministry of Higher Education and Research in Uzbekistan to follow up and observe the faculties and universities academic standard level and maintain future plans.

• Regular ranking process based on agreed performance evaluation criteria & appraisal system for academic staff will help university and faculty management to upgrade and promote their staff as well as to bridge any gap and to maintain the future plans.

Application of the theory of fuzzy sets to the issues of assessing the competence of academic staffs. This case is the next step in the process of studying such an object of fuzzy set theory as a linguistic variable (competence) [10]. In the future, it is planned to build a model for monitoring academic staff competence indicators. We will limit ourselves to considering the issues of developing professional competence when implementing the academic staff's individual plan [11].

Let us recall that the problem of monitoring indicators of quality factors in education has not yet been resolved, until it is possible to obtain a clear answer to the questions:

• how to compare the number of lectures given with changes in indicators of academic staffs' competence.

• when the number of practical classes conducted turns into the development of the socio-communicative competence of the academic staff, etc.

The solution to these problems, in our opinion, can be found in the use of the mathematical apparatus of the theory of fuzzy sets [12]. The actual scheme of reasoning that a academic staff usually uses when assessing indicators of competence is as follows: **if** the plan is completed, contains a competent theoretical justification, rational methods of reasoning are used, the design of the task complies with established standards, deadlines are met, clear answers to questions are given during the defense of the solution, **then** the academic staff deserves an "excellent" rating.

Oral or even written instructions for implementing an individual plan are usually available in all graduating departments of universities. In addition, you can refer to the list of indicators of academic staff competence from the discipline's work program. This allows them to be used as algorithms in the theory of fuzzy sets.

The final indicator of the development of academic staff competence as a result of the implementation of an individual plan traditionally consists of three components:

• theoretical competence (X);
• practical competence (skills in performing practical tasks) (Y);
• socio-communicative competence (public defense of the task) (Z).

Theoretical competence, for example, can be assessed by the following indicators:

x_1 – ability to independently work with literature;

x_2 – knowledge of the basic theoretical facts of the discipline;

x_3 – knowledge of methods for solving basic problems of the discipline;

x_4 – theoretical validity of the reasoning.

Practical competence can be assessed by the following indicators:

y_1 – volume of practical tasks;

y_2 – compliance with deadlines for completing the task.

y_3 – use of rational methods of reasoning.

y_4 – quality of design and graphic material of the task.

y_5 – obtaining correct results.

y_6 – degree of independence when performing a task.

y_7 – use of application packages.

Social and communicative – (protection of individual plan) according to indicators:

z_1 – literacy and validity of speech during defense;

z_2 – clarity of answers to additional questions;

z_3 – final score for the task.

Let us define each of the component competencies *X, Y, Z* as a linguistic variable [13], for example for x_1.

Definition 1. *Let us define **competence** x_1 as a linguistic variable, i.e. set {b, T, D, M}, where*

b – characteristic of the student's qualifications (competence);

D – [10, 100] universal set or domain b

T – basic term set (values);

T = {A_1, A_2, A_3, A_4, A_5 }, where the names of the fuzzy variables: A_1 - low competence, A_2 - below average, A_3 - average; A_4 - above average; A_5 - high competence, defined at [10, 100];

M – semantic procedure for specifying A_1, A_2, A_3, A_4, A_5 on [10,100].

An example of recommendations for assessing the private competencies of academic staffs is presented in Table 1.

Table 1. Recommendations for assessment (theoretical competence) *X*

Private Competency assessment levels indicator x_i					
	Low	Below the average	Average	Above average	High
x_1	Insufficient study of recommended literature	Works only with lecture course	Works with basic literature	Uses additional literature	Actively finds and uses additional literature

x2	Ignorance of basic facts	Poor knowledge of basic facts	Knowledge of individual facts	Knowing all the basic facts	Knowledge of additional theoretical facts
x3	Lack of knowledge of the simplest solution methods	Poor knowledge of solution methods	Knowledge of some methods	Knowledge of all basic methods	Knowledge of additional solution methods
x4	Lack of theoretical justification	Weak rationale	Justification of the main facts	Justification of all facts	Detailed justification of all facts

It is not difficult to develop recommendations for assessing private competencies *Y* and *Z*. After this, you can construct some mathematical expressions - interpretations of fuzzy linguistic formulations.

$R = f R (X,Y,Z); X = f X (x1, x2, x3, x4); Y = f Y (y1, y2, y3, y4, y5, y6); Z = f Z (z1, z2, z3)$ Data obtained in the form of the indicated relationships can be specified in the form of matrices (see Table 2).

Table 2. Fragment of data matrix f_X

x 1	x 2	x 3	x 4	X
High	High	High	High	High
High	High	Above average	Above average	High
High	High	Above average	Above average	High
High	Above average	Above average	Above average	Above average
...	...	...	...	...
Low	Low	Low	Low	Low

Each set of rows in this table represents a statement that relates the fuzzy values of the input and output variables.

For example: if (X=B)and(Y=B)and(Z=B) than R=B or
if (X = B)and(Y=B)and(Z= bC) than R=B.

Matrices [13] for all positions of linguistic variables *X, Y,Z* can be constructed in a clear manner. After this, you can move on to constructing the final grade R; there may be different approaches depending on the traditions of the university [15],

the qualifications and demands of the manager. For example, at the Tashkent Institute of Chemical Technology, the academic staff's performance quality scale is as follows: $[85 - 100]$ – excellent; $[70 - 85)$ – good; $[50 - 70)$ – satisfactory; $[0 - 50)$ – unsatisfactory.

We believe that the use of this automated system for assessing the competence of a academic staff when implementing an individual plan can have a positive effect in developing the professional competence of an academic staff, because the academic staff has the opportunity to predict the results of his activities and thereby manage the process of developing his individual competence, and the manager has the opportunity to control this process.

5. Results and Contributions

In this dissertation, nine main criteria and forty-one sub criteria were identified, considered, and weighted as performance evaluation criteria for Uzbek high academic institutes. Furthermore, there levels of academic staff evaluation criteria were identified, considered, and weighted. The first level consists of six criteria, the second level consist of twenty-seven criteria and the last level consist of fifty criteria.

Classification model for performance evaluation of Uzbek university was developed and proposed. It consists of all steps required such consistency check, aggregation, approximation, and final ranking.

New Fuzzy Consistency Algorithm (FCA) to check and evaluate the consistency level of expert's judgment was designed and proposed. The new algorithm proposes a consistent preference linguistic value(s) as an option to the experts in case of inconsistency judgment in evaluation performance. Based on the proposed algorithm, the research introduces new tools that allows experts to trace and understand the roots of inconsistency and select the relevant consistent option(s).

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