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MEASURING THE PERFORMANCE OF EMPLOYEES WITH FUZZY LOGIC

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Abstract

Employees are the most valuable assets for an organization today. Many factors such as educational background, job skills and abilities should be considered when selecting and evaluating employees. Any institution or organization aims to improve the performance of its employees, to achieve its business goals and to select the right employee when recruiting. Fuzzy logic, which is one of the artificial intelligence techniques, is a decision-making method that enables the strengthening and improvement of human resources and finding the best solution to uncertain problems. In order to select the right employee by using fuzzy logic, many performance evaluation criteria are considered, and the candidates are scored with a decision-making mechanism. This study's objective is to use fuzzy set theory, the Mamdani method, to measure and assess performance during the personnel evaluation and selection process in order to produce the most accurate conclusions for the organization. Fuzzy logic clusters with multiple parameters to provide answers to uncertainties will be used in this study. The performance of current employees is measured using the Mamdani method and training help and awards are given in accordance. According to the outcome as measured, improvements should be made. Candidates are ranked according to their scores, and it is aimed to determine the best one as a result. In order to improve the performance of existing employees with a fuzzy logic decision-making mechanism, first of all, it should be determined which rating criteria the employees lack. Afterward, it is expected that the person will improve himself/herself in this field by providing training according to the needs. If the person is still not at the desired level, the job can be terminated.

Keywords: Fuzzy Logic, Human Resources, Mamdani Method, Performance Measurement
JEL Code: M51, J62

ÇALIŞANLARIN PERFORMANSININ BULANIK MANTIK İLE ÖLÇÜLMESİ

Özet

Günümüzde bir organizasyonun en değerli varlığı çalışanlardır. Çalışanları seçerken ve değerlendirirken eğitim durumu, iş becerileri ve yetenekleri gibi birçok faktör dikkate alınmalıdır. Her kurum veya kuruluş işe alımlarda çalışanlarının performansını artırmayı, iş hedeflerine ulaşmayı ve doğru çalışanı seçmeyi amaçlar. Yapay zeka tekniklerinden biri olan bulanık mantık, insan kaynaklarının güçlendirilmesini, geliştirilmesini ve belirsiz problemlere en iyi çözümün bulunmasını sağlayan bir karar verme yöntemidir. Bulanık mantık kullanılarak doğru çalışanın seçilebilmesi için birçok performans değerlendirme kriteri dikkate alınmakta ve bir karar verme mekanizması ile adaylar puanlanmaktadır. Bu çalışmanın amacı, kuruluş için en doğru sonuçları üretebilmek amacıyla personel değerlendirme ve seçim sürecinde performansı ölçmek ve değerlendirmek amacıyla bulanık küme teorisi olan Mamdani yöntemini kullanmaktır. Bu çalışmada belirsizliklere cevap verecek çoklu parametreli bulanık mantık kümeleri kullanılacaktır. Mevcut çalışanların performansı Mamdani yöntemi kullanılarak ölçülmekte ve buna göre eğitim yardımı ve ödüller verilmektedir. Ölçülen sonuca göre iyileştirmeler yapılmalıdır. Adayların aldıkları puanlara göre sıralanması ve sonunda en iyinin belirlenmesi amaçlanmaktadır. Bulanık mantık karar verme mekanizması ile mevcut çalışanların performansının arttırılması için öncelikle çalışanların hangi derecelendirme kriterlerine sahip olmadıklarının belirlenmesi gerekmektedir. Daha sonra ihtiyaca göre eğitimler verilerek kişinin bu alanda kendini geliştirmesi beklenir. Eğer kişi hala istenilen seviyede değilse işine son verilebilir.

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Anahtar Kelimeler: Bulanık Mantık, İnsan Kaynakları, Mamdani Yöntemi, Performans Ölçümü.
JEL Kodu: M51, J62

1. INTRODUCTION

Along with the information technology revolution around the world, human resources have been greatly affected in every field. Accompanied by the invention of the internet and human resources starting to benefit from this service, rapid developments created a compulsory competitive environment. In order to gain an advantage in this competitive environment, human resources aimed to increase process efficiency by transforming their systems from traditional approaches to technological approaches.

It is called artificial intelligence when machines learn something and think, interpret, and act like humans due to mass data entries. Artificial intelligence is the loading of higher cognitive functions such as learning, thinking, speaking, communicating, making decisions, and finding solutions to problems, which are specific to human intelligence, into a machine. Artificial intelligence technologies provide the most optimal solution by evaluating a lot of data in the decision-making mechanism while measuring performance. Topics covered in artificial intelligence are fuzzy logic, artificial neural networks, expert systems, and genetic algorithms.

Fuzzy systems are an alternative to the classical concepts of set membership and logic, which have their origins in ancient Greek philosophy. Fuzzy logic is a system in which it exists and can be applied in intermediate values instead of logic based only on 0 or 1 (Goguen, 1973). It aims to bring numerical net expressions closer to human thoughts and is based on the set theorem. In the normal approach, the entity is either a member of a cluster or not, but according to the fuzzy logic approach, the entity can be a member of more than one cluster (Golec and Kahya, 2007). Fuzzy logic characterizes our reasoning logic, giving it the tools with which it can be quantified and formulated to make certain. In order to make an effective performance evaluation in human resources management, it is necessary to consider more than one parameter at the same time. Fuzzy logic can provide solutions to uncertainties by clustering with more than one parameter.

Human resource management is a system that serves the interests and benefits of managers in organizations and is designed to increase the performance of employees to the best level. Managers are faced with many situations that require them to evaluate performance by using different data types at the same time when making decisions about their job hiring. The human resources department has many tasks such as hiring personnel, evaluating the current performance of employees, training, and rewarding them. There are numerous methods available to determine the performance of employees. This study will use the fuzzy logic method (Chang and Hahn, 2006; Klein et al., 2001; Armentrout, 1986; Arvey and Murphy, 1998; Sanchez and Torre, 1996; Stronge, 1991). In order to stay ahead or survive in the competitive environment, organizations should determine their strategy and apply the latest technologies as they move towards their goals.

This study aims to measure and evaluate the performances in personnel evaluation and selection stages with fuzzy set theory and to draw the most accurate results for the benefit of the institution. In order to make an effective performance evaluation in human resources management, it is necessary to consider more than one parameter at the same time. Fuzzy logic provides solutions to uncertainties by clustering with more than one parameter (Efferin and Hopper, 2007). By using the fuzzy logic technique, the performances of the existing employees are measured, and training support and rewards are made accordingly. Improvements should be made according to the result measured by fuzzy logic algorithms.

In the second part, the literature review is mentioned. In the third section, methods along with the application and software developed in this study are stated in detail. Afterward, the results are explained. In the final section, conclusions are indicated, and suggestions are given.

2. LITERATURE REVIEW

The importance of employee performance appraisal and management and its relationship to firm performance is well documented in the literature (Lowe, 1986; Katzenbach and Smith, 2015; Kilduff et al., 2000; Higgs et al., 2005).

It is very important to choose the right people in the recruitment process in human resources and to guide them quickly and correctly during this process. In the operation of these processes, a search based on Structured Query Language (SQL) queries is made according to the decision structure determined by the company in the candidate registration list in the database. However, the probability of identifying candidates who meet all the necessary criteria is very low. At this point, it would be appropriate to transform the fuzzy query structure and the standard into a fuzzy set structure as a membership function. For this reason, by running fuzzy-based SQL queries in classical databases, the best candidate or sequential candidate list that meets the required criteria (close to absolute value 1) can be determined. Based on these inferences, fuzzy logic measurement and evaluation procedures will increase the success rate in educational activities and production activities. It also proves the necessity of the most successful database and fuzzy logic-based query in the future (Gultekin et al., 2015).

Despite all the difficulties of educational performance evaluation, in this research, it has been determined which standard can be used to evaluate teacher performance, to create an exemplary performance evaluation model using fuzzy logic methods, and examples are used to evaluate performance. The reason for using fuzzy logic methods in performance evaluation is that systems using fuzzy logic theory can think about symbols like humans and handle missing data. The fuzzy logic method provides a natural way of dealing with problems arising from uncertainties. The biggest benefit of the fuzzy logic method is that it learns from human experiences. It is easy to model and can even express ambiguous concepts mathematically. Therefore, the fuzzy logic method is non-linear, it is mathematical. It is very suitable for applications that cannot be expressed with formulas (Kuscu, 2007).

Ying-Feng and Ling-Show conducted a study using fuzzy-scoped decision-making methods to measure the performance of teachers at Taiwanese universities. The procedure for measuring a lecturer's performance is of particular importance, and the standard for its value ranges from 1 to 5. Since reform is a common theme of public administration in the United States, Kellough and Sally examined the extent to which the state government has implemented reforms for such personnel. A reform index has been developed to record significant differences in personnel practices across states (Ying-Feng and Ling-Show, 2002).

The focus of most organizations is to select employees at the required and desired level by applying appropriate recruitment and selection methods before planning personnel needs. It is therefore essential to develop a systematic method that can be used regularly to evaluate performance at the planning stage. To help organizations with the selection process, Jafari et al. (2009) presented a framework for the selection of appraisal methods and compared some performance appraisal approaches. The benefit of using this framework is that, before implementing any technique or incurring further resources, organizations can assess their performance appraisal method for its essential aspects. In their 2011 study, Rasheed et al. looked into several aspects of the performance appraisal systems used by professors in higher education. In the current study, researchers used the Public Sector University of Pakistan as a case study.

Employee evaluation criteria can complicate the whole process because each criterion has different rules and different priorities. For this reason, it is a difficult process to obtain general performance indicators by considering all criteria at the same time. In this process, decisions based on rules using fuzzy logic can easily solve this problem. Fuzzy logic considers various standards and provides a simpler method for performing compound calculations based on some rules that are difficult to complete with traditional methods. Therefore, fuzzy logic can be applied to create a model in which the performance of employees will be rated to a certain degree. These performance evaluations will be used as inputs in determining the general performance indicators of the employees, and the results will be determined accordingly. Fuzzy logic helps evaluate a person's performance if company performance data and appraisal ratings are available (Yeh et al., 2000).

Sirb (2012) created a technique based on fuzzy logic for choosing top management in mining projects in Rosia Montana as well as choosing human resources in general for organizations. The suggested methodology is multidisciplinary, tackling problems in fields like business, math, or psychology. By demonstrating its use in employee performance reviews, Beheshti and Lollar (2008) created a fuzzy logic model approach to decision-making and its value for managers. In order to structure an evaluation procedure of the performance levels of human resources who work in both industrial and service-providing organizations, Paladini (2009) used fuzzy logic. Each sector has a model that has been designed.

For evaluating banking performance, Wu et al. (2009) suggested a fuzzy multiple-criteria decision-making approach. They provided an overview of the evaluation metrics chosen from the banking performance literature. Then, 23 measures appropriate for assessing banking performance were chosen using expert questionnaires. For the evaluation of suppliers' environmental performances, Tuzkaya et al. (2009) created a hybrid fuzzy analytic network process and fuzzy preference ranking organization approach. They also gave a numerical example with sensitivity analyses for better comprehension. Yee and Chen (2009) presented a performance appraisal system that deals with appraisal grades using a multifactorial evaluation model and evaluates staff performance using particular performance appraisal criteria.

Sun (2010) created a performance evaluation model based on the Fuzzy Analytic Hierarchy Process (FAHP) and The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for ranking performance by how closely it resembles the ideal answer. This model handles subjectivity and vagueness with linguistic values parameterized by triangular fuzzy integers. Zemkova (2011) employed fuzzy sets to evaluate employee performance in a business that used various evaluation criteria. Ahmed et. al (2013) made a study related to employee performance based on a fuzzy approach. For any type of organization where performance evaluation is crucial for staff motivation, the development of attitudes and behaviors, the communication and alignment of individual and organizational goals, and the promotion of constructive working relationships between management and staff, a model is created. By integrating performance outcomes for a few selected criteria and providing them as numerical values, fuzzy control is utilized to calculate the overall performance index, which will certainly make the concerned human resource staff's performance rating calculation easier (Ahmed et. al, 2013).

Based on fuzzy logic approaches, Yadav and Singh (2011) suggested a fuzzy expert system for evaluating the academic achievement of students. The application of an integrated tool, such as fuzzy multi attribute decision-making, with FAHP, fuzzy quality function deployment, as a fair evaluating and sorting tool to support the performance appraisal system was shown by Manoharan et al. (2011). The academic performance of students has been evaluated using a variety of fuzzy logic-based approaches, and the outcomes have been contrasted with those obtained using traditional statistical methods.

However, the performances of academicians were not evaluated using fuzzy systems and this study uses fuzzy Mamdani method to design a performance appraisal system for academicians.

When designing and implementing an appraisal system, managers must first determine what the performance appraisal system will be used for and then establish the process of implementing the system. The methods chosen and the tools used to implement them are critical to determining whether an organization is successfully managing its performance. These evaluation methods are based on quantitative techniques that can provide accurate results to describe employee performance. However, most information cannot be measured, and the boundaries are not clear. In order for the company to achieve its goals, it is necessary to increase the performance of the employees. It is used to monitor the individual's contribution and performance to the company's goals, to identify personal strength and future improvement opportunities, and to evaluate whether the company's goals are being met, or to lay a foundation for the company's future and development. Many studies have proven that an effective appraisal system is directly related to the motivation and productivity of the employee. It is difficult to consider many factors simultaneously to evaluate the performance of employees in an organization. Fuzzy logic produces a result according to the evaluations, considering multiple input parameters and the uncertainty of each factor. Based on 20 specific performance evaluation criteria using fuzzy logic, this study proposes a case study of a performance evaluation system for people working in an organization (Ahmed et. al, 2013).

According to literature research, it is seen that the most appropriate method and approach in performance evaluation and optimization is fuzzy logic. In this study, rules are created in line with the criteria determined by the managers in the human resources recruitment process with the fuzzy logic method. In line with these rules, according to the results of the performance evaluation, it is determined whether the person is at a sufficient level for personnel recruitment. At the same time, it is recommended to provide the necessary training after measuring and evaluating the performance of the people working. In the next section, methods will be mentioned.

3. METHODS

The criteria of the fuzzy logic system model proposed in this study is a system based on basic performance characteristics approved and published by subject experts. The implementation of the fuzzy logic model was carried out as follows: A questionnaire was created by dividing 37 questions from the existing literature that affect the performance of academicians into 10 groups. 60 volunteers and highly qualified lecturers from Maltepe University responded to the survey. According to these answers, the input data was obtained in the fuzzy logic model, numerical outputs were obtained, and the performance of the academician was determined by general evaluation.

3.1. Academics' Score Calculation System During the Semester

In the study conducted with the academic staff of Maltepe University, the scores of the people who answered yes to the questions in the questionnaire were calculated separately according to the groups. Weight is set to 10 as a default value. This value can be changed according to management requests. The scoring system of the questions is based on the evaluation criteria in the organization. The scoring criteria of the questions are shown in the below table. The scores obtained from the questions will be evaluated separately according to the groups. In the application developed to calculate the survey scores, the questions are divided into groups. The total score obtained in each group is calculated by blurring and defuzzification. Each group affects the result within itself. The membership degree of the scores obtained from all groups is determined and processed according to the rule base, and the performance

of the person is determined. The survey results will be evaluated, and the best five survey results will be shown.

Table 1. Questionnaire Groups and General Scores

GROUPS	Scores of Questions (in Points)	Weights	General Scores
Group 1: Management Tasks	Question 1: 4 P.	10	4*10 = 40
	Question 2: 3 P.		3*10 = 30
	Question 3: 2 P.		2*10 = 20
	Question 4: 1 P.		1*10 = 10
Group 2: Publications	Question 5: 3 P.	10	3*10= 30
	Question 6: 2 P.		2*10= 20
	Question 7: 1 P.		1*10= 10
	Question 8: 0.95 P.		0.95*10= 9.5
	Question 9: 0.70 P.		0.70*10= 7
	Question 10: 0.55 P.		0.55*10= 5.5
	Question 11: 0.45 P.		0.45*10= 4.5
	Question 12: 0.35 P.		0.35*10= 3.5
	Question 13: 0.30 P.		0.30*10= 3
	Question 14: 0.25 P.		0.25*10= 2.5
	Question 15: 0.20 P.		0.20*10= 2
	Question 16: 0.15 P.		0.15*10= 1.5
	Question 17: 0.10 P.		0.10*10= 1
Group 3: Organizational Tasks	Question 18: 5 P.	10	5*10= 50
Group 4: Educational and Teaching Tasks	Question 19: 5 | 2 |3 P.	10	5*10= 50 | 2*10=20 | 3*10=30
	Question 20: 2 P.		2*10= 20
Group 5: Project Tasks	Question 21: 4 | 3 | 2 |2 P.	10	4*10= 40 | 3*10 =30 | 2*10=20 | 2*10=20
	Question 22: 3 | 2 | 1 |1 P.		3*10= 30 | 2*10 =20 | 1*10=10 | 1*10=10
	Question 23: 2 | 1 | 1 |1 P.		2*10= 20 | 1*10 =10 | 1*10=10 | 1*10=10
	Question 24: 1 P.		1*10= 10
Group 6: Refereeing and Editorial	Question 25: 2 P.		2*10= 20
	Question 26: 2 P.		2*10= 20

	Question 27: 3 P.	10	3*10= 30
	Question 28: 2 P.		2*10= 20
	Question 29: 1 P.		1*10= 10
Group 7: Awards	Question 30: 4 | 3 P.	10	4*10= 40 | 3*10=30
	Question 31: 2 |1 P.		2*10= 20 | 1*10 =10
Group 8: Citations	Question 32: 2 |1 P.	10	2*10= 20 | 1*10 =10
Group 9: Patents	Question 33: 5 P.	10	5*10= 50
Group 10: Thesis Management	Question 34: 4 P.	10	4*10= 40
	Question 35: 3 P.		3*10= 30
	Question 36: 2 P.		2*10= 20

4. RESULTS

An application has been written to receive survey data. In the application, the questions were answered without using the demographic information of 60 volunteer engineering academicians of Maltepe University. Filling in the demographic information in the survey was voluntary. Among those who filled out demographic information, the ratios of men and women were almost equal, and their ages ranged between 25 and 70. The questions are based on information from the last 1 year. In the questionnaire, 37 questions were divided into 10 different groups. Each group will be evaluated on its own. After answering the questions, it is necessary to save the questionnaire. The recorded survey information is reflected on the result screen. Then, the scores obtained will be calculated with the Mamdani method in the Matlab application. As a result of the joint evaluation of all these results, the actual performance result of the person will be reached. It is mandatory to answer all survey questions. Each answer is scored separately according to the answers given.

If the system is to be evaluated individually, the scores obtained from each group should be included in the system as a single entry, a single result in the Matlab application to be evaluated. If the system is to be evaluated jointly at once, all entries should be included in the system and a single conclusion must be drawn. The performance of the people participating in the survey should be evaluated using the results and the rule base.

4.1 Creating Membership Functions

Membership functions for groups will be expressed as follows.
Input membership functions are abbreviated as follows and shown in Figure 1.
0-20➔ Very Bad: CK

20-40➔ Bad: K

40-60 ➔ Good: I

60-80 ➔ Very Good: CI

80-100➔ Perfect: M

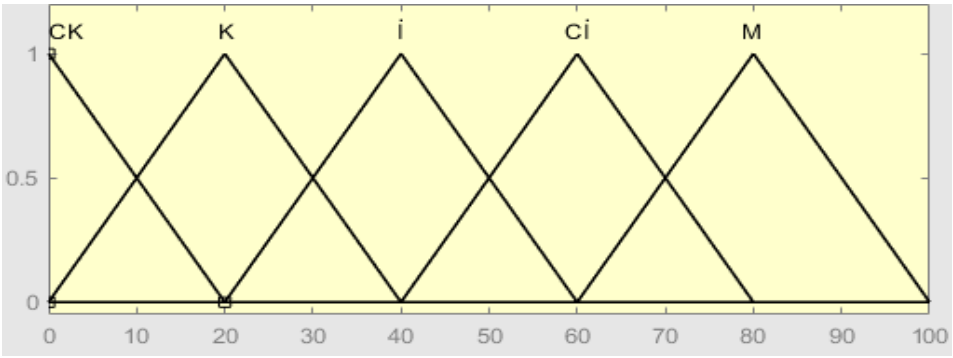

Figure 1: Input Membership Functions

The naming of output membership functions is abbreviated as follows in Figure 2. In the evaluation of one by one, the output membership functions vary according to the rules given by the management.

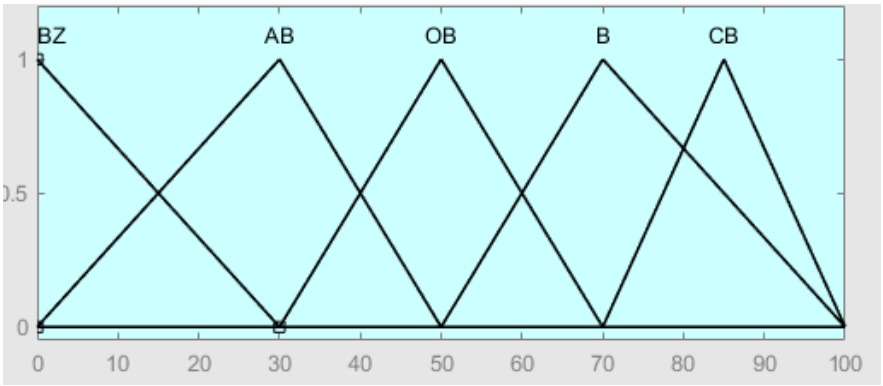

Figure 2: Output Membership Functions

Failed: BZ
Less Successful: AB
Medium Successful: OB
Successful: B
Very Successful: CK

4.2 Rule Base

The rule table created according to the management's criteria is below. The survey consists of 10 different groups, each group will be evaluated individually and then a joint evaluation will be made. There is 1 input (input) and 1 output (output) for each group. The total scores obtained from each group will be processed according to the following rules while creating separate membership functions and performing the blurring process.

FAILED if it scores between 0-20 points in the overall assessment.

LESS SUCCESSFUL if it scores between 20-40 points in the overall assessment.

MEDIUM SUCCESSFUL if it scores between 40-60 points in the overall assessment.

SUCCESSFUL if it scores between 60-80 points in the overall assessment.

VERY SUCCESSFUL if it scores between 80-100 points in the general evaluation.

4.3 Matlab Application

In Matlab, there are 1 input and 1 output, as seen in Figure 3 below, for fuzzification and defuzzification processes using the Mamdani method. The center of gravity was chosen for the fuzzification process. According to the data from the input, the result will be output consistent with the center of gravity as a result of Mamdani.

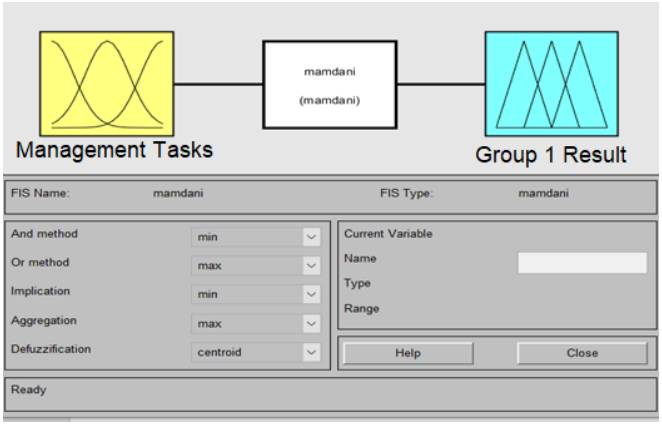

Figure 3: Mamdani System

In order to measure the performance of the person with the Mamdani inference method for the survey scores, it is necessary to apply the following steps.

Input membership functions are abbreviated as follows.

0-20➔ Very Bad: CK

20-40➔ Bad: K

40-60 ➔ Good: I

60-80 ➔ Very Good: CI

80-100➔ Perfect: M

4.4 Evaluation of Groups with the Mamdani Method

Inputs that will be included in the system and will determine the performance of the person will be evaluated one by one. The success of the score obtained by the person participating in the survey from each question group will be determined. Among the 60 people who were included in the last system, the people with the best scores from each group will be determined. The people who have the worst scores will also be determined. 10 groups will be evaluated one by one as follows. As an example, only the first group, the “Management Tasks” group evaluation is shared here.

The rule base must first be created for the Management Tasks group.

FAILED if it scores between 0-20 points in the overall assessment.

LESS SUCCESSFUL if it scores between 20-40 points in the overall assessment.

MEDIUM SUCCESSFUL if it scores between 40-60 points in the overall assessment.

SUCCESSFUL if it scores between 60-80 points in the overall assessment.

VERY SUCCESSFUL if it scores between 80-100 points in the general evaluation.

After the rule base is created, membership functions must be created. Management tasks input membership functions are as in Figure 4. For each membership function, a result will be drawn according to the center of gravity of the score it gets from the group it belongs to.

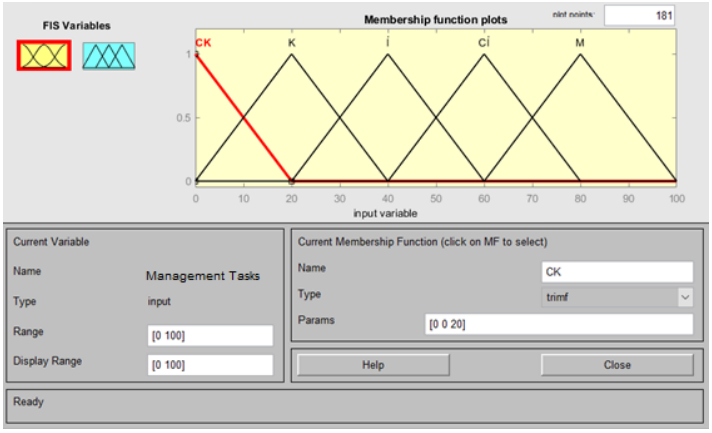

Figure 4: Management Tasks Input Membership Function

The input values in the system are fuzzified, and then the membership degrees of these membership functions are determined according to the rule base. The defuzzification process is performed according to the center of gravity of the functions whose membership degree is determined.

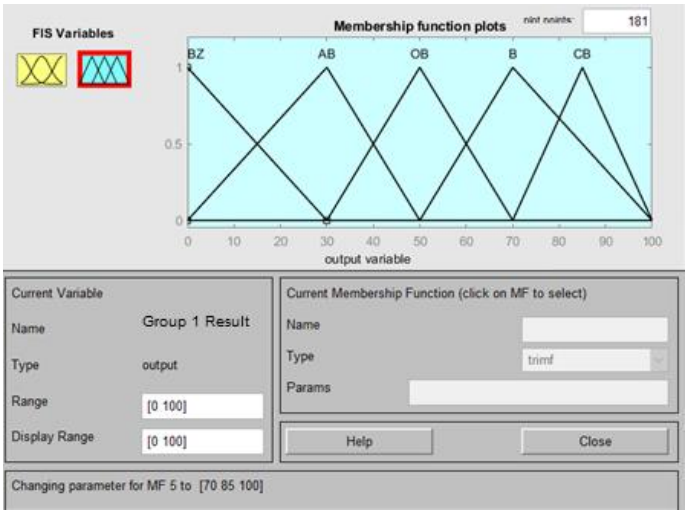

Figure 5: Management Tasks Output Membership Function

The value obtained after the defuzzification process is evaluated according to which result set it is close to. The resulting membership functions are shown in Figure 5.

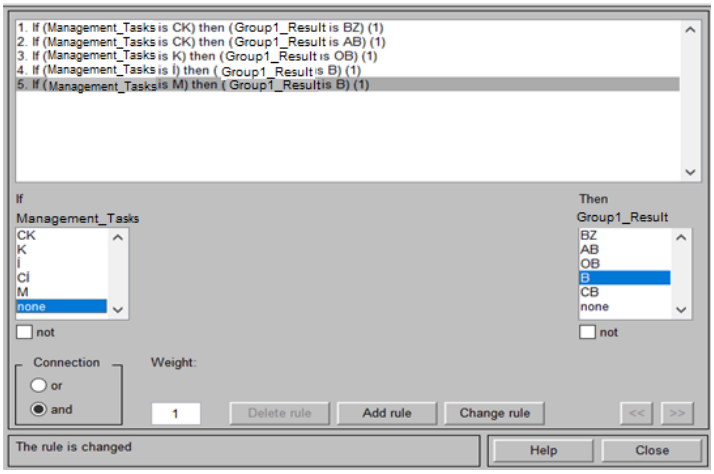

Figure 6: Management Tasks Rule Base

The rule table to be used in the management tasks group is as in Figure 6. Each group has a different rule base among themselves. Common assessment has a single rule base.

Let's include the first questionnaire answered in the application in the evaluation. A total of 10 points were obtained from management tasks according to the 1st column shown in Table 1 so our input value is 10.

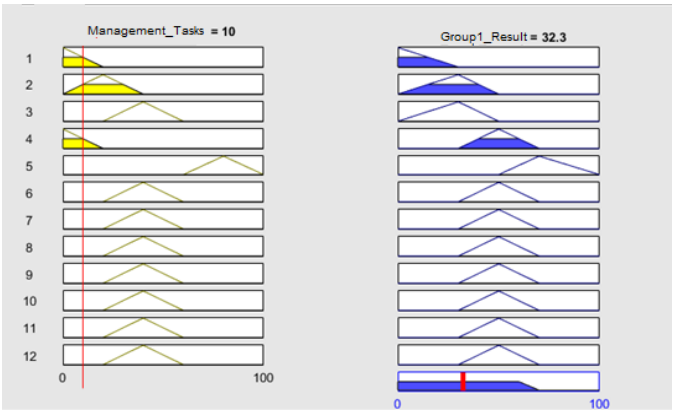

Figure 7: Management Tasks Performance Result Output

As shown in Figure 14, the score 32,3 is obtained for 10 points entered. Since it has a value between 20-40, it was evaluated as MEDIUM SUCCESSFUL. The remaining 9 groups were evaluated using the Mamdani method, just like the Management Tasks group shown above.

4.5 Joint Evaluation

The scores obtained from all groups were fuzzified separately within each of them and a result was obtained. In order to reach a general conclusion, a joint evaluation should be made. There are several ways to reach a consensus. One of them is max-min (largest among the smallest) and the other is min-max (smallest among the largest). Whichever is appropriate according to the circumstances of the case or the problem should be used. The scores obtained from all groups will be included in the system as input and fuzzification will be done. After the fuzzification process, the inputs draw the performance result of the person according to their membership degrees. The result should then be evaluated against

the rule base. Since the survey consists of 10 groups, there are 10 inputs included in the system. The rule base to be used in the evaluation of the result is below.

FAILED if it scores between 0-20 points in the overall assessment.

LESS SUCCESSFUL if it scores between 20-40 points in the overall assessment.

MEDIUM SUCCESSFUL if it scores between 40-60 points in the overall assessment.

SUCCESSFUL if it scores between 60-80 points in the overall assessment.

VERY SUCCESSFUL if it scores between 80-100 points in the general evaluation.

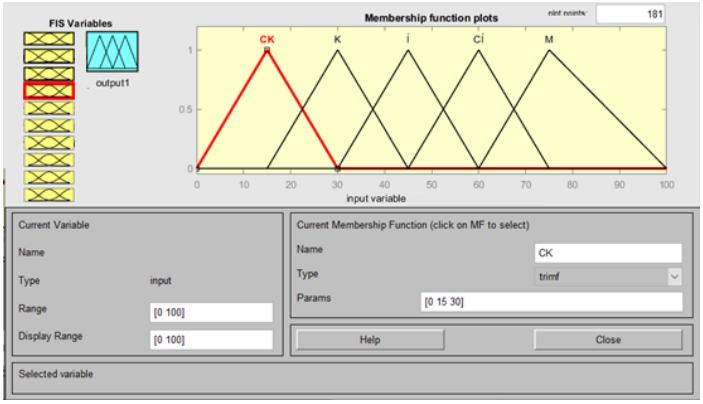

Figure 8: General Evaluation Input Membership Function

Membership functions of the education and training task, which is one of the input values, are shown in Figure 8 as an example. Membership functions of each group in the survey were formed in this way.

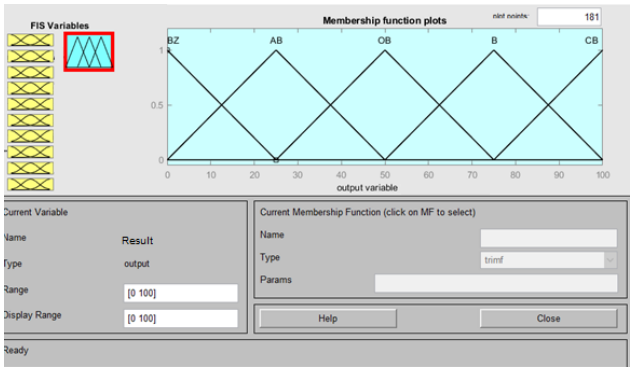

Figure 9: General Evaluation Output Membership Function

As shown in Figure 9, membership functions are created in the result. According to the center of gravity, the results will be obtained by performing the min-max process. The rule base then is created for all entries as defined above.

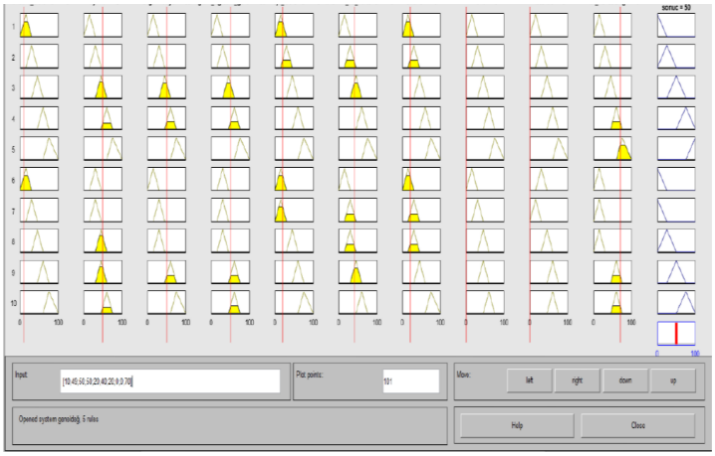

Figure 10: General Evaluation Performance Output

According to the questions answered by this person in the questionnaire, 50 points were obtained in the Mamdani system shown in Fig. 10 above. Since it is between 40-60 points, the performance of the person is MEDIUM SUCCESSFUL.

The performance of 60 academicians included in the survey was evaluated in this way. Performance results will be evaluated in the conclusion and discussion section.

4.6 Evaluation of New Employees

People who start a new job will be asked to fill in the same questionnaire according to the information in the previous institution. The survey information entered will be evaluated using the fuzzy logic method, and according to the result, people with suitable performance will be hired, and those who are not suitable will not be hired. Before coming to the institution for the first evaluation, the person must fill out the questionnaire from the questionnaire link sent. Unsuccessful and less successful people in the system will not be hired. This rule may vary from institution to institution.

As shown in Table 2 below, a person's scores for answers to the questionnaire are displayed. The scores he gets will be evaluated by joint evaluation using fuzzy logic.

Table 2. Survey Score of the New Employee

Groups	Scores
Management Tasks	30
Publications	78
Organizational Tasks	50
Educational and Teaching Tasks	50
Project Tasks	40
Refereeing and Editorial	60
Awards	30
Citations	10
Patents	50
Thesis Management	70

As in the evaluation above, the scores obtained from all groups will be included in the system as input and fuzzification will be done. After the fuzzification process, the entries show the performance result of the person according to the membership degrees. The result should then be evaluated against the rule base. The rule base is the same as the ones mentioned above. Since the survey consists of 10 groups, there are 10 inputs included in the system. Then the overall performance result was calculated. As shown in Figure 11, according to the questions answered by a person in the questionnaire, 60 points were obtained in the Mamdani system. Since the person's performance is between 60-80 points, the person's performance is considered SUCCESSFUL. That's why this person can be hired.

Figure 11: Performance result of the new employee

5. CONCLUSION

Performance evaluations are very important in the decision-making mechanism of managers in an organization. Managers ensure that employees are supported to develop themselves and improve their skills by receiving the necessary training through performance evaluation. Human resources management aims to use human resources most efficiently by evaluating performance in terms of providing added value to the organization. This assessment is critical in business planning.

In order to stay ahead or survive in the competitive environment, organizations should determine their strategy and apply the latest technologies as they move towards their goals. This research aims to examine the use of the fuzzy logic approach in decision-making processes in human resources management by using the latest technology artificial intelligence techniques and to propose a decision-making mechanism that considers various performance evaluation criteria of employees in a company using fuzzy logic.

The data obtained as a result of the questionnaire applied to the engineering academicians of Maltepe University were processed with the help of fuzzy logic and many results were obtained. The question groups were analyzed and the percentages of success they got from the questions are shown in Table 3.

Table 3. Analysis of Question Groups

Groups	**Failed (# of people and %)**	**Less Successful (# of people and %)**	**Medium Successful (# of people and %)**	**Successful (# of people and %)**	**Very Successful (# of people and %)**
Management Tasks	32 %53,33	16 %26,66	8 %13,33	3 %5	1 %1,66

Publications	5 %8,33	8 %13,33	24 %40	16 %26,66	7 %11,66
Organizational Tasks	6 %10	12 %20	28 %46	8 %13,33	6 %10
Educational and Teaching Tasks	1 %1,66	5 %8,33	22 %36,66	18 %30	14 %23,33
Project Tasks	3 %5	8 %13,33	24 %40	15 %25	10 %16,66
Refereeing and Editorial	10 %16,66	12 %20	23 %38,33	12 %20	3 %5
Awards	9 %15	17 %28,33	26 %48,33	5 %8,33	1 %1,66
Citations	6 %10	11 %18,33	25 %41,66	16 %26,66	2 %3,33
Patents	12 %20	16 %26,66	28 %46,66	4 %6,66	0 %0
Thesis Management	8 %13,33	12 %20	26 %48,33	6 %10	8 %13,33

The number of people who answered all questions and participated in the survey was 60 people. As shown in Table 5, most people failed in management duties with a rate of 53.33%. In the publications group, the majority was moderately successful with 40%. In the organization group, the majority was moderately successful with 46%. In the education and training task group, the majority was moderately successful with a rate of 36.66%. 40% of the project tasks are moderately successful. The majority were moderately successful with a rate of 38.33% from the refereeing and editorial group. Most were moderately successful with 48.33% from the awards group. The majority was moderately successful with a rate of 41.66% from the citations group. A majority with a rate of 46.66% from the patents group were moderately successful. Most were moderately successful with a rate of 48.33% from the thesis management group. When we examine the performance values of the academic staff according to the

groups, the majority were moderately successful. As a result of the analysis, it was evaluated that the institution was at a moderately successful level for the Engineering Faculty.

Out of the 60 respondents, the first person with the best performance scored 88, the second person 80, the third person 78, the fourth person 75 and the fifth person 72 points. Those who are in the top 5 with the best performance should be rewarded for their successes. The worst 10 of the 60 people who participated in the survey will both be warned and supported to be more motivated. If there is no progress, their jobs should be terminated. The worst-performing person's output is 8 points. The person has been assessed as FAILED.

In the joint evaluation, 7% of the individuals were unsuccessful, 12% were less successful, 60% were moderately successful, 18% were successful and 3% were very successful. Academic staff working in the institution are generally moderately successful in both individual evaluation and joint evaluation. It was decided that 3 of the candidates to be recruited would start the job because they met the required criteria.

Performances were evaluated using the fuzzy logic method on new employees and existing employees. Institutions that prefer this method will be able to increase their success by moving themselves to better levels. At the same time, companies using this decision-making mechanism will enable them to get ahead of other companies in the competitive environment. Since the decision is made according to the fuzzy logic system, measures will be taken against injustices. Human errors will be prevented. Persons who are qualified to meet the demands of the managers of the institution will be determined by the system. Awards will be given to increase the achievements of working people. As a suggestion to the study, institutions should combine the Matlab and the survey applications into a single application. When the survey results of the person are entered into the system, the success score and level should be displayed on the main screen at once.

The limitations of this research are, that is assumed, that privileges such as being acquainted, being a relative, etc. will not be considered for the personnel. It is assumed that managers answer the survey questions that they need to score for current employees, honestly and impartially. In such an environment, it is assumed that the fuzzy logic decision-making mechanism will be largely successful. Also, this decision support system may not be suitable if there are people with more specific qualifications within the institution. For example, if a company considers different ethnicity as a criterion for a position, it may want to have someone of different descent as a staff member. For this reason, this decision support system takes general data into account.

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