





complicated situation emerges. It is not remarkable that the Decision Maker selects the appropriate staff to meet all the requirements among the various criteria. In addition, staff selection is a Multiple Criteria Decision-Making problem that is impacted by many contradictory aspects and performed based on qualitative as well as quantitative aspects. (Kelemenis and Askounis 2010) Quantitative criteria for personnel selection have been taken into account in many MCDM models in the literature. Over the past few years, researchers' interest in qualified worker recruitment has risen up noticeably [29].

Since globalization strengthens, human capital turns out to be a key factor for the success of enterprises. Furthermore, successful recruitment is crucial for economic growth in many countries on account of the lack of personnel [26].

Written and oral exams are among the techniques implemented in staff recruitment and assessment process in the literature. Despite the fact that applying paper and oral exams as a way of the applicants examination is significant when hiring the employees required by a company, it is not solely enough. Therefore, both generating criteria and assessing based on these criteria are essential [28].

Ray Gibney and Jennifer Shang provide explanation of the use of AHP in the dean selection process to the university in the article "Decision Making in Academia - A Case of the Dean Selection Process". In the analysis, the results of the two processes were compared in terms of the group interview and AHP practices. Subsequently, he concluded that AHP is a valuable tool and should be included in the staff selection processes in the academy [8].

M. Moayeri et al. compared the Fuzzy Topsis and Fuzzy AHP method in their article named "Comparison of Fuzzy AHP and Fuzzy Topsis Methods for Math Teachers Selection". Since the choice of mathematics teachers is a multi-criteria assessment decision and it has a strategic importance for academic institutions, traditional methods used in the selection of teachers are insufficient to deal with the

imprecise or ambiguous nature of linguistic evaluation [6].

Daniel and Friday explained the Fuzzy AHP model that he applied to the university in Nigeria in the "A Fuzzy AHP Model for Selection of University Academic Staff" article by using Chang's scope analysis model [2]. The AHP technique can make the best selection decision using the weighting process for a number of alternatives only through binary comparison [3]. Considering a set of criteria and a set of goals, each criterion is taken and Chang's scope analysis is performed for each goal, respectively [4].

Sarfaraz et al. used the Fuzzy Analytical Hierarchy Process (FAHP) together with Quality Function Deployment to determine the best management alternative among possible options in order to maximize the performance of employees in their study named "Application of Fuzzy Analytical Hierarchy Process and Quality Function Deployment (FAHP-QFD) Technique in Improving Employee Performance" [24].

The key factor in the development of the Zang and Chen Petroleum industry is that the enterprise depends upon its ability to maintain high quality security management eventually. The article suggests a comprehensive safety performance assessment model based on human factors, FAHP and FCE. The weight ranking can also help leaders and managers with security strategies [27].

Ema Carnia, Zenia Amarti, Asep K Supriatna present a discussion on the ranking of the academic staff performance at an Indonesian University in their article named "Analytical Hierarchy Process (AHP) and the ranking of academic performance using TOPSIS methods." [30].

There are many examples of fuzzy AHP applications in the literature. Evaluation of service quality in determining the marketing strategy of companies, applications in total production planning, facility location selection and other similar applications can be enumerated [23, 21, 14, 22].

### 3. Fuzzy AHP

AHP method utilizes real numbers when making binary comparisons. However, it is not possible to use real numbers at all times. When decision makers intend to express their mind verbally, they find themselves in predicament while using real numbers. Therefore, BAHP, which also uses fuzzy numbers, has been suggested. Weights are determined by making binary comparison with fuzzy numbers. These weights are normalized afterwards [16].

The scope analysis of Chang's Fuzzy AHP is determined by the extend of likelihood of each criterion. In accordance with the answers provided by the decision maker, the corresponding triangle Fuzzy values are figured out for each criterion [20]. For a certain level on this hierarchy, a binary comparison matrix has been created. Subtotals are calculated for each row of the matrix and new set (a, b, c) is obtained, then to get the Fuzzy values of the general triangular numbers for each criterion,  $a_i / \sum a_i, b_i / \sum b_i, c_i / \sum c_i, (i = 1, 2, \dots, n)$  values are found and used as the last  $M_i$  ( $a_i, b_i, c_i$ ) determined for the  $M_i$  criterion for the rest of the process [17].

The scope analysis method is applied to determine the scope of an object to be satisfied for the purpose, that is, the satisfactory scope. In this method, "scope" is measured using a fuzzy number [13]. Based on Fuzzy values for the scope analysis of each object, a Fuzzy synthetic degree value defined as follows can be obtained [19].

The steps of Chang's scope analysis can be listed hereafter:

$$M_{gi}^1, M_{gi}^2, \dots, M_{gi}^m \quad i = 1, 2, \dots, n \quad (1)$$

Here all  $M_{gi}^j$  ( $j = 1, 2, \dots, m$ ) are triangular Fuzzy numbers.

Step 1. Fuzzy synthetic expansion value in accordance with I object is obtained as below;

$$S_i = \sum_{j=1}^m M^j g_i \otimes \left[ \sum_{i=1}^n \sum_{j=1}^m M^j g_i \right]^{-1} \quad (2)$$

Subsequently, Fuzzy addition is applied for a specific matrix to identify  $g_i$  value of  $\sum_{j=1}^m M^j$  (Varmazyar and Nouri, 2014: 30).

$$\sum_{j=1}^m M^j g_i = (\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j) \quad (3)$$

Step 2. Probability level  $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$  and Likelihood ratio V are obtained.

$$V(M_2 \geq M_1) = \sup [\min (\mu_{M_1}(X), \mu_{M_2}(y)), (4)$$

In the meantime, this can be equally expressed as follows:  $V(M_2 \geq M_1) = \text{highest}$

$$\begin{aligned} (M_1 \cap M_2) &= \mu_{M_2}(d) \\ &\left\{ \begin{array}{l} 1, \\ 0, \end{array} \right. \\ M_2 \geq M_1 & \\ D = & \\ l_1 \geq u_2 & (5) \end{aligned}$$

$\frac{l_1 - \mu_2}{(m_2 - \mu_2) - (m_1 - l_1)}$  in other cases

The highest intersection point between  $\mu_{M_1}$  and  $\mu_{M_2}$  is the coordinate of D.

Step 3: The probability that the Convex Fuzzy number is greater than the k Convex Fuzzy number can be defined by  $M_i$  ( $i = 1, 2, \dots, k$ ).

$$V(M \geq M_{(1)}, M_{(2)}, \dots, M_{(k)}) = V[(M \geq M_{(1)}), (M \geq M_{(2)}), \dots, (M \geq M_{(k)})] = \min V(M \geq M_{(i)}), i = 1, 2, \dots, k$$

In this situation,  $d'(A_i) = \min V(S_i \geq S_k)$ .

When  $k = 1, 2, \dots, n; k \neq i$ , in this case,  $\mu$  is the weight priority vector.

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T, \quad (6)$$

Here  $A_i$  ( $i = 1, 2, \dots, n$ ) comprises of n element.

When the weight vector is normalized:

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T,$$

W loses its fuzzy feature, and this provides the priority weights of one alternative over another [18].

#### 4. Research Method

The research was carried out by referring to the results of the survey conducted with the people who recruit personnel at Azerbaijan University of Technology. In the research, a questionnaire was conducted to the HRM specialist, HRM associate and quality control specialist of the university. Before the questionnaire was made, the opinions of academicians working at the university were addressed and it was intended to specify which criteria were significant for academic selection. Studies on this subject were subjected to review and it was noticed that evaluations were made on subjects such as education level, experience, and publication research by a majority. Furthermore, it was projected by academics that other criteria would be also essential in academic selection. The results of the survey were converted into Chang's linguistic variables and analyzed in Excel with the fuzzy AHP method. Only the opinions of HR manager and Quality Control specialist are included in this article while evaluating the results, as the evaluations of HR manager and HR associate are similar in many ways. Although it was evaluated by Chang's method, since the majority sub-criteria values in some of the main criteria yielded the result of zero, the Fuzzy Analytical Hierarchy Process and the Fuzzy Analytical Process were addressed and evaluated in the study. The level of importance used in the study is depicted in table 1.

Tablo. 1 Chang's fuzzy inguistic scale

Linguistic variables	Fuzzy Scale	Response Scale
Equally important	1, 1, 1,	1, 1, 1,
Moderately important	2/3, 1, 3/2,	2/3, 1, 3/2,
Important	3/2, 2,	2/5, 1/2,

	5/2	2/3,
Very important	5/2, 3, 7/2,	2/7, 1/3, 2/5,
Much more important	7/2, 4, 9/2,	2/9, 1/4, 2/7,

**Source:** Aytekin Bal. 2014. "Prioritizing Performance Criteria with Fuzzy Ahp Method: An Application in the Automotive Sector" Numerical Examples.

In the research analysis section, it was first evaluated by Chang's method, but the result in which some strategies are zero in the analysis section is shown in the example below. Table 2 gives an overview of the sub criteria of the Education main criterion. Fuzzy synthetic values were obtained with linguistic expressions of these criteria. After these values were collected, in Table 3, the weighting of the strategies and the weight vector was achieved with the Chang method.

Table 2. Synthetic Value of Education Level Sub Criteria

Sub Criteria of Education Main Criterion	L	M	U
Overseas University Graduate	0,22431	0,30379	0,40183
Local University Graduate	0,14445	0,16455	0,18828
Grade Point Average	0,28712	0,37974	0,49770
Certificates in Academic Term	0,12561	0,15189	0,19173

Table 3. Significance Weights of Strategies Using Chang Method

	Comparison of the S1 Strategy	Values Obtained	Selecting the smallest value  When $l_1 \geq u_2$ and $M_2 \geq M_1$ are not provided	
Overseas University Graduate	S1 > S2	1		W'=0.375
	S1 > S3	0.601	0.601	
	S1 > S4	1		
	Comparison of the S2 Strategy	Values Obtained	Selecting the smallest value  $l_1 \geq u_2$	
Local University Graduate	S2 > S1	0		W'=0
	S2 > S3	0	0	
	S2 > S4	1		
	Comparison of the S3 Strategy	Values Obtained	Selecting the smallest value  $M_2 \geq M_1$	
Grade Point Average	S3 > S1	1		W'=0.625
	S3 > S2	1	1	
	S3 > S4	1		
	Comparison of the S4 Strategy	Values Obtained	Selecting the smallest value  $l_1 \geq u_2$	
Certificates in Academic Term	S4 > S1	0		W'=0
	S4 > S2	0.394	0	
	S4 > S3	0		

Weights were found by comparing the strategies or criteria as follows.

When S1 > S2 is compared, it is evaluated as 1 because M value of S1 strategy which is 0.3037 is greater than M value of S2 strategy which is 0.1645. When we compare S1 > S3,

since  $l_1 \geq u_2$  ve  $M_2 \geq M_1$  is not provided, it is found as hereinbelow.

$$L3-U1 / (M1-U1) - (M3 - L3) = 0.2871-0.4018 / (0.3037-0.4018) - (0.3797 - 0.2871) = 0.601$$

Comparing S2 > S1 in the criteria of the local university graduate, it is considered zero, as  $l_1 \geq u_2$ . The same situation gives zero while  $l_1 \geq u_4$  is contrasted in S4 > S1 criteria comparison.

The smallest values obtained by comparing the strategies are achieved while finding the weight vector using the formula in step 6. The weight vector is attained by dividing weights into the sum of the small values.

$$W' = (0.601, 0, 1, 0)^T$$

$$W' (S1) = 0.601 / 1.601,$$

$$W' (S2) = 0 / 1.601,$$

$$W' (S3) = 1 / 1.601,$$

$$W' (S4) = 0 / 1.601.$$

$$S1 = 3754$$

$$S1 = 3754$$

$$S2 = 0$$

$$S3 = 0.6246$$

$$S4 = 0$$

As can be inferred, it is concentrated on being graduated from overseas university and Grade Point Average in Chang's method. Although being a local university graduate and the certificates of achievement in the academic term do not show any importance as being zero, it has a weight when evaluated by the mean square method. Since Chang's method was insufficient in these cases, it was started to evaluate weights with the mean square method and obtain values using the following formula for the mean square method.

$$K (Sn) = \sqrt{\frac{l^2 + m^2 + u^2}{3}}$$

Therefore, the subsequent table analyzes the linguistic variables presented for Academic qualification in Table 4. The results achieved by the mean square method are described in Table 6. Although the criteria such as being a graduate of the local university and gaining the certificate during the university years are considered to be zero in Chang method, these criteria have a positive weight in the mean square method.

Table 4. Linguistic Expressions of the Quality Specialist Related to the Sub Criteria of Education Level

Sub Criteria of Education Main Criteria	Overseas U.G	Local U.G	Grade Point Average	Cert. in Academic Term
Overseas University Graduate	(1,1,1)	(1,1,1)	(3/2, 2, 5/2)	(3/2, 2, 5/2)
Local University Graduate	(1,1,1)	(1,1,1)	(2/9, 1/4, 2/7)	(1,1,1)
Grade Point Average	(2/5, 1/2, 2/3)	(7/2, 4, 9/2)	(1,1,1)	(3/2, 2, 5/2)
Certificates in Academic Term	(2/5, 1/2, 2/3)	(1,1,1)	(2/5, 1/2, 2/3)	(1,1,1)

Table 5. Significance weights according to the Quality Control Specialist's Mean Square Method

Sub Criteria of Education Level	Mean Square Method	Criteria Weight Vector %
Overseas University Graduate	0,1838	0,3057
Local University Graduate	0,0963	0,1601
Grade Point Average	0,2296	0,3818
Certificates in Academic Term	0,0917	0,1524

<b>Total</b>	<b>0.60132</b>	<b>1</b>
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Regarding the results obtained with the mean square method, local university graduates and certificates gained in university term have the same weight. These weights are calculated as zero in Chang method. For this reason, our research will be evaluated only by the Mean Square Method after these examples. Since the weights of HRM specialist and HRM associate are similar in the study, only the criteria weight average of HRM specialists are taken into consideration. Thus, Table 6 (Appendix 1) below shows the HRM specialist's opinion and Table 7 (Appendix 2) presents the importance weights of the Quality control specialist's opinion.

### 5. Conclusion and Evaluation

A detailed example demonstrating the application of the Fuzzy AHP model to a university teaching staff selection quandary is provided in this article. The AHP technique can make the best choice decision using the weighting process for a number of alternatives merely by the means of binary comparison. The fuzzy AHP approach proves to be a more functional tool for the solution of multi-criteria decision problems related to uncertainty and deviations in the decision-maker's views. Uncertainties in the human view were found and synthesized using Fuzzy numbers and Chang's scope analysis to determine the weight of each criterion. Weights represent the proportion of how much an alternative is more significant than another, relative to a higher proportion of goal or criterion. The alternatives are enumerated and the best candidate is identified with the highest normalized priority weight.

Considering the weights taken with the mean square method in the study, it was concluded that the main criteria such as the level of education, administrative factors and academic competence are of low importance, although the main criteria such as education level, administrative factors and academic

competence are of the greatest essence. When the sub-criteria of the important main criteria are evaluated, it is observed that the sub-criteria such as understanding and expression in academic proficiency, psychological resilience in psychological factors and education abroad at the level of education have significant weight. The reason why the significance of sub-criteria is in priority is that it provides awareness among academicians who have completed their education abroad, and all of them are psychologically resilient and do not experience burnout syndrome in terms of psychological factor.

It is summarized that the cases such as disabled students, gender minorities and racial minorities in Azerbaijan universities are of little importance, taking into account that the management of the disparity which is of less significance among other criteria. Regarding international level, although private lessons, seminars and various organizations for the disabled are provided for students with impairments abroad, this situation is rarely encountered in our country. Therefore, universities should be sensitive to disabled students and minorities. Although lifestyle is not very important in the selection of academic staff in countries such as the EU countries and the USA, the significance of cultural sensitivity in countries such as Azerbaijan has made the lifestyle an important factor. Although the main criterion of the lifestyle is of little significance, the frequency of alcohol use and smoking, which is its sub criterion, shows consequential weight. The reason for this is the cultural thoughts such as attention distribution during lesson hours and not being presented to students as a good example.

The publication and research, which are the sub-criteria of creativity and academic competence, were evaluated as high importance by the quality expert. A total of 1274 articles were published in the magazine named "Web of Science" in Azerbaijan within the Caucasian countries in 2018. Although this indicator is higher in Armenia and Georgia which are Caucasian countries, it is noticed

that research and publications are low on the whole.

In future research, Fuzzy Analytical Hierarchy Process and Topsis Vikor as well as ANP will be used to increase the reality of the research concurrently. At the same time, regression analysis applied to students after the selection of academic staff is important in finding out the relevance of the recruited staff and performance level of academicians. It is possible to evaluate whether the right choice is made by comparing the performance of the candidates selected with the method. Doing this will enable to better select the staff selection and evaluate the performances of the selected candidates.

Consequently, although the academic staff selection of Azerbaijan was evaluated only in terms of one university in our research, this method and research can be used as a source for staff selection in other universities and sectors.

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### Appendix 1.

Table 6. Criterion Weights with HRM Specialist’s Mean Square Method

Main criteria	Main criterion weight	Sub Criteria	Sub criterion weights
Academic Competence	0,176406	Understanding and Expression	0,284136

		Foreign Language	0,202774
		Analytical Thinking	0,257815
		Computer Skills	0,06251
		Publication and Research	0,192766
Personal Factors	0,066071	Self-confidence	0,072612
		Objectivity and Neutrality	0,21529
		Valuing Knowledge	0,282743
		Willingness to be Enthusiastic	0,313777
		Physical Appearance	0,115578
Psychological Factors	0,054313	Maturity level	0,068296
		Social Conformity	0,220048
		Volunteerism	0,225491
		Extraversion	0,215211
		Psychological Resilience	0,270954
Administrative Factors	0,142425	Taking Initiative and Decision Making	0,229605
		Human Relations and Communication	0,210547
		Work discipline	0,198189
		Being open to criticism	0,082817
		The ability to motivate	0,101414
		Making a Long-Term Plan	0,177428
Education level	0,175844	Overseas College Graduate	0,451001
		Local University Graduate	0,1351
		Grade Point Average	0,199367
		Certificates in University Term	0,214532
Experience	0,105259		-
Ability to Manage Diversity	0,042468	No Sexual Discrimination	0,402324
		Foreign Cultural Attitude	0,343263
		Attitude to Racial Minorities	0,254413

Reference	0,04734	Persons with Academic Titles	0,331753
		from Previous Workplace	0,668247
Lifestyle	0,096532	The age you feel	0,160878
		Participating in Entertainment	0,203099
		Doing Sports	0,174379
		Frequency of Alcohol Usage and Smoking	0,461645
Creativity	0,093342	Creative Idea	0,609093
		Imagination	0,134039
		Design	0,256868

## Appendix 2.

Table 7. Criterion Weights Using the Quality Control Sp's Mean Square Method

Main Criteria	Main Criterion Weight	Sub Criteria	Sub Criterion Weights
Academic Competence	<b>0,05623</b>	Understanding and Expression Skills	0,07501
		Foreign Language	0,2536
		Analytical Thinking	0,29274
		Computer Skills	0,0859
		Publication and Research	0,29274
Personal Factors	<b>0,05741</b>	Self-Confidence	0,11335
		Objectivity and Neutrality	0,1936
		Valuing Knowledge	0,28992

		Willingness to be Enthusiastic	0,28466
		Physical Appearance	0,11846
Psychological Factors	<b>0,10491</b>	Maturity Level	0,13102
		Social Conformity	0,13102
		Volunteerism	0,13379
		Extroversion	0,13379
		Psychological Resilience	0,47038
Administrative Factors	<b>0,12379</b>	Taking Initiative and Decision Making	0,08011
		Human Relations and Communication	0,10439
		Work Discipline	0,23505
		Being Open to Criticism	0,1118
		The Ability to Motivate	0,18983
		Making a Long-Term Plan	0,27881
Education Level	<b>0,15905</b>	Overseas College Graduate	0,30568
		Local University Graduate	0,16009
		Grade Point Average	0,38179
		Certificates in University Term	0,15243
Experience	<b>0,09978</b>	-----	0,09978
Ability to Manage Diversity	<b>0,07608</b>	No Sexual Discrimination	0,33777
		Foreign Cultural Attitude	0,33777
		Attitude to Racial Minorities	0,32447
Reference	<b>0,06375</b>	Persons With Academic	0,33175
		Titles From Previous Workplace	0,66825
Lifestyle	<b>0,07841</b>	The Age You Feel	0,12803
		Participating in Entertainment	0,15297
		Doing Sports	0,29419
		Frequency of Alcohol Usage and Smoking	0,42482
Creativity	<b>0,18059</b>	Creative Idea	0,45988

		Imagination	0,16542
		Design	0,3747