*Journal of Learning and Teaching in Digital Age, 2019,* ***4***(1), 1-14
ISSN: 2458-8350 (online)
**Research Paper**

# A New Integrated Fuzzy Multicriteria Approach Towards Evaluation And Selection of Instructor Candidates to Military Schools

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Received 29 April 2018, Revised 29 June 2018, Accepted 09 July 2018

**ABSTRACT**

Personnel selection is a critical process for organizations and both quantitative and qualitative factors are used in the decision phase. The criteria should be unique to the organization and the best alternative should be chosen to satisfy requirements. This paper researches the instructor selection process for military academics. The criteria are weighted with fuzzy Analytic Hierarchy Process (AHP) by experts and candidates are ranked by using fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Method. The purpose of Fuzzy TOPSIS method, which is one of Multiple Criteria Decision Making (MCDM) methods, is to allow group decision-making in a fuzzy environment. It involves the calculation of the closeness coefficients by means of Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS). Alternatives are ranked according to the calculated closeness coefficients. In the study, candidates were assessed by three DM's in accordance with seven decision criteria. The decision makers carried out assessments with linguistic variables, and subsequently these variables were transformed into positive trapezoidal fuzzy numbers. The study shows that as a decision tool, the Fuzzy TOPSIS method integrated with Fuzzy AHP is extremely well suited to evaluation and selection decisions regarding candidates for position of instructor.

***Keywords:*** *personnel selection, military schools, fuzzy AHP, fuzzy TOPSIS, triangular and trapezoidal fuzzy numbers*

## INTRODUCTION

In organizations, one of the most important and serious issues confronting human resources divisions is the selection and recruitment of personnel. To finalize the process successfully, the accurate definition of organization needs and evaluation of candidates is crucial. One of the cornerstones of success in the organizations is the quality of the workforce. Due to the fact that changing human character through education is very difficult and even impossible spending time and money on finding candidates with proper qualifications and skills is assumed as a profitable investment (Churchill, Ford, & Walker, 1990). Selection of eligible persons with desired qualifications depends on selection process which is as far as possible correctly configured and comprised of objective criteria. Successful configuration of this process will minimize risks in areas such as effectiveness, workforce loss, low motivation and lack of dedication stemming from improper personnel selection. Additionally, selection of the most suitable person for a particular job will result in a decrease in the personnel turn over (Olorunsola, 2000; Adomi, 2006), and therefore selection costs. In majority of cases no single alternative is the optimum solution for all criteria. In this case, the solution is achieved by taking into consideration predefined needs and criteria which are consistent with selection problem. Instructor selection is a group decision made under multiple criteria. Thus, the problem arises from the fact; there are several interviewers as decision maker during selection process, and evaluation of multiple candidates with multiple decision criteria, therefore a solution to the problem involves using multiple criteria decision making methods. The fuzzy Analytic Hierarchy Process (AHP) and fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods, developed using linguistic terms for evaluation, are two multi criteria decision making methods which make group decisions in fuzzy environments possible. The fundamental feature of fuzzy AHP is the pairwise comparison using fuzzy numbers. The fundamental

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feature of fuzzy TOPSIS method is that selected alternative is the closest to positive ideal solution and the farthest from the negative solution. In many cases, quantitative values may lack a reflection real life. Human opinions and judgments are often vague and it may not be possible to express individual preferences using terms such as present/absent or yes/no. In such a case, a person can use linguistic terms to reflect his opinions and judgments. In evaluations made using linguistic terms, fuzzy TOPSIS method assigns membership function with the help of fuzzy numbers and makes calculations with the help of its algorithm.

In this study, the necessary qualifications and capabilities for a potential instructor at the military school primarily are determined by applying experts' opinions. As a result of interviews with these experts, the criteria are weighted with Fuzzy AHP. The candidates are evaluated using fuzzy TOPSIS, and candidates are ranked in terms of their scores.

The paper is organized as follows. Section 2 provides a review of the literature on personnel selection and techniques used in this study. Section 3 gives explains the role of an academic personnel in military schools while Sections 4 and 5 are give information about fuzzy numbers and linguistic variables, the proposed method, respectively. The proposed method for academic personnel selection is applied in section 6. Finally, Section 7 sums up our conclusion and sets future study directions.

## LITERATURE REVIEW

In literature, the TOPSIS and fuzzy TOPSIS methods applications can be seen in different type of selection studies such as Chen (2000), Parkan and Wu (1999), Yurdakul and İç (2005), Yurdakul and Çoğun (2003), Güngör, Serhadlıoğlu, & Kesen (2009), Dağdeviren, Yavuz, & Kılınç (2009), Sun (2010), Sánchez-Lozano, García-Cascales, & Lamata (2018), Banaeian, Mobli, Fahimnia, Nielsen & Omid (2018). Chen (2001) attempted to solve place selection problem by using an approach similar to fuzzy TOPSIS, but with different algorithm. Here, unlike fuzzy TOPSIS assigning values to linguistic variables, regular numbers such as population are used together with fuzzy triangular values.

Chu and Lin (2003) applied a fuzzy TOPSIS method for robot selection and Dağdeviren, Yavuz, and Kılınç (2009) for the selection of optimal weapon. Byun and Lee (2004) developed a decision support system for a fast prototype process selection using fuzzy TOPSIS. Additionally, Chen (2000) produced a study explaining the fuzzy TOPSIS method in the decision making processes. Cochran and Chen (2005) studied a fuzzy multiple criteria decision making problem of simulation software selection. This was needed for production system analysis and evaluated the criteria without pair wise comparison. Sánchez-Lozano, García-Cascales and Lamata (2018) used fuzzy AHP for selection of military training aircrafts. To obtain the weights of the criteria that influence the decision are both qualitative and quantitative combined with fuzzy logic through the design and development of a survey to experts in the field of military training aircraft.

Kahraman, Ruan, and Doğan (2003) resolved the facility location selection problem using fuzzy group decision. He used qualitative and quantitative criteria, reviewed with a numerical example. Sergaki (2002) developed a method with fuzzy bases for the maintenance planning of electrical power system. Linguistic terms were used for evaluation of criteria and the study was based on a prepared data base. De Korvin, Shipley, & Kleyle (2002) studied team selection problems in multiple stage projects, by taking advantage of the fuzzy compatibility of capability clusters. The aim of this study was the selection of teams with the abilities required by the project. Rasmy, Lee, El-Wahed, Ragab, & El-Sherbiny (2002) developed an expert system for a multiple criteria decision making problems where fuzzy linguistic priorities and goal programming were applied. Teodorović, & Lučić (1998) attempted to find a solution to a route problem by using fuzzy clusters. The study was seen as an assignment problem which aimed to match routes with personnel attending daily.

Celik, Kandakoglu, & Er (2009) developed a systematic decision aid mechanism which could be integrated into the official recruitment procedures of academic administrations. Hence, their paper proposes a fuzzy integrated multi-staged evaluation model (FIMEM) under multiple criteria in order to manage the academic personnel selection and development processes in Maritime Education and Training (MET) institutions. The diversity of evaluation attributes requires an assessment via both fuzzy and crisp values. Consequently, their paper suggested utilization of FIMEM as a recruitment toolkit in MET institutions in order to prevent possible conflicts and manipulations in the evaluation process of candidates for different academic positions.

Galinec and Vidović (2006) used a fuzzy approach and fuzzy logic to identify the importance of each individual for a project team work. As a method for soft-computing and as input values, fuzzy logic employs data with the features of uncertainty and partial verity and indistinctive borders among particular categories. Fuzzy evaluation systems have been designed to reduce evaluation subjectivity.

Majozi (2005) presents the application of fuzzy set theory (FST) within the context of integrated planning and scheduling. Canós, & Liern (2008) are interested in the problem of personnel selection problem and have developed a flexible decision support system to assist managers in decision-making functions. The DSS simulates experts' evaluations using ordered weighted average (OWA) aggregation operators, which assign different weights to different selection criteria. Moreover, they use an aggregation model based on efficiency analysis to rank the candidates.

Güngör, Serhadlıoğlu, & Kesen (2009) proposed a personnel selection system for the most adequate person based on fuzzy AHP. De Korvin, Shipley, & Kleyle (2002) developed a model for the selection of personnel for a multiple phase project which takes into account the match between the skills possessed by each individual and those needed for each phase within flexible budget considerations. Sun (2010) developed a performance evaluation model based on the fuzzy AHP and fuzzy TOPSIS to help the industrial practitioners. Petrovic-Lazarevic, (2001) presented a two-level personnel selection fuzzy model for short list and hiring decisions. The model is an attempt to minimize subjective judgment in the process of distinguishing between appropriate and inappropriate potential employees. Compared to the traditional way of selecting an appropriate short-listed job applicant, the model minimizes individual judgment at both the short-list and hiring decision levels.

Beheshti and Lollar (2008) provide a simple-to-use fuzzy logic model for establishing a more meaningful evaluation system. They seek to describe the development of the fuzzy logic model approach to decision making and its value for managers by illustrating its application to employee performance appraisals. The flexibility of the model allows the decision maker to introduce vagueness, uncertainty, and subjectivity into the evaluation system. Their research calls attention to an alternative method of the performance evaluation system as opposed to the traditional quantitative methods. In their study, Alliger, Feinzig, & Janak (1993) suggested fuzzy cluster theory for personnel selection problem solving. Liang and Wang (1994) developed an algorithm which uses fuzzy cluster theory for the same purpose. In this method subjective criteria such as personality, leadership, experience, and objective criteria including capability, work knowledge, analytic thinking ability are used. Karsak (2001) constructed a model at personnel selection process using fuzzy multiple criteria programming. In his model, using membership functions, quantitative and qualitative factors are evaluated together. Other personnel selection methods in the literature based on multiple criteria analysis can be listed as follows: Bohanec, Urh, & Rajkovič (1992), Timmermans and Vlek (1992, 1996), Gardiner and Armstrong-Wright (2000), Spyridakos, Siskos, Yannacopoulos, & Skouris (2001) and Jessop (2004).

## THE ROLE OF AN ACADEMIC PERSONNEL IN MILITARY SCHOOLS

Scientists studying education as a social system state that there are three basic elements shaping and directing education system; student, instructor and education programs (Bossing, 1955; Oğuzkan, 1981). Among these three elements, importance of the relation between instructor and students is higher than the education programs themselves because the student is part of an interaction between instructor and the environment. An instructor should have qualifications that enable innovation in educations in order to meet the students' needs, an understanding of the new developments in knowledge and technology, and the ability to plan and arrange the education system accordingly. The students sitting in front of the instructor should not be seen as someone merely sitting, listening and writing, but as someone knowing what to learn, searching for knowledge, being able to think creatively and express himself or herself (Senge, 1991). Instructors should meet these needs. Being proficient and knowledgeable in front of the class can affect success but they are not in themselves enough. For this reason, the instructor must be eager and diligent and be able to create team spirit in the class. Steps of process are described by Cafoğlu (1995) as:

Instructors should;

- Work constantly to improve classes,
- Improve and apply their listening skills,
- Encourage everybody to share opinions,
- Build team spirit and confidence,
- Support student effort,
- Learn constantly,
- Encourage positive behavior,
- Meet students' needs,
- Support other instructors,
- Be satisfied and content at work.

Although, military schools are education institutions, they are different from the others in terms of curriculum and expectations of graduates. Due to this reason, instructors working in military school are expected to have special qualities in addition to general ones. They may be summarized as below:

- Leadership perception,
- Discipline,
- Initiative,
- The ability to take on different roles regarding students,
- To prepare students for missions in times of conflict and peace.

Even though there are studies present for academic personnel selection in literature, no studies relating to military school's instructors could be found. As a result of interviews with experts the desired qualifications of a military school instructor is shown in Table 1. The necessary qualifications in terms of self-confidence are physical, personal, and professional self-belief, the ability to defend oneself physically and intellectually and belief in one's own success. In terms of physical appearance, desirable qualities include certain height, weight and external appearance features. (Churchill, Ford, and Walker, 1990).

**Table 1.** Academic Personnel Selection Criteria for Military School

| |
|---|
| C1-Personal Factors |
| C2-Cognitive Ability |
| C3-Leadership Perception |
| C4-Discipline |
| C5-Family&social aspect |
| C6-Psychological Factors |
| C7-Academic Performance |

## FUZZY NUMBERS AND LINGUISTIC VARIABLES

In this section, a number of basic definitions of fuzzy sets, fuzzy numbers and linguistic variables are reviewed from Buckley (1985), Kaufmann and Gupta (1991), Negi (1989), Zadeh (1975). The basic definitions and notations below will be used throughout this paper unless otherwise stated.

*Definition1*. A fuzzy set $\tilde{A}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{A}}$ which associates with each element x in X a real number in the interval [0,1]. The function value $\mu_{\tilde{A}}$ is termed the grade of membership of x in $\tilde{A}$ (Kaufmann and Gupta, 1991).

*Definition 2*. A fuzzy set $\tilde{A}$ in the universe of discourse X is convex if and only if

$$\mu_{\tilde{A}}\left(\lambda x_1 + (1-\lambda)x_2\right) \geq \min\left(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\right) \quad (1)$$

for all $x_1$; $x_2$ in X and all $\lambda \in [0,1]$,where min denotes the minimum operator (Klir and Yuan,1995).

*Definition 3*. The height of a fuzzy set is the largest membership grade attained by any element in that set. A fuzzy set $\tilde{A}$ in the universe of discourse X is called normalized when the height of $\tilde{A}$ is equal to 1 (Klir and Yuan, 1995).

*Definition 4*. A fuzzy number is a fuzzy subset in the universe of discourse X that is both convex and normal.

*Definition 5*. The $\alpha$-cut of fuzzy number $\tilde{n}$ is defined as

$$\tilde{n}^{\alpha} = \{x_i : \mu_{\tilde{n}}(x_i) \geq \alpha, x_i \in X\} \quad (2)$$

where $\alpha \in [0,1]$.

The symbol $\tilde{n}^{\alpha}$ represents a non-empty bounded interval contained in X, which can be denoted by $\tilde{n}^{\alpha} = [\tilde{n}_l^{\alpha}, \tilde{n}_u^{\alpha}]$, $\tilde{n}_l^{\alpha}$ and $\tilde{n}_u^{\alpha}$ are the lower and upper bounds of the closed interval, respectively (Kaufmann and Gupta, 1991; Zimmermann, 1991).

For a fuzzy number $\tilde{n}$, if $\tilde{n}_l^{\alpha} \rangle 0$ and $\tilde{n}_u^{\alpha} \leq 1$ for all $\alpha \in [0,1]$, then $\tilde{n}$ is called a standardized (normalized) positive fuzzy number (Negi, 1989).

*Definition 6*. A positive trapezoidal fuzzy number (PTFN) $\tilde{n}$ can be defined as (n1, n2, n3, n4) shown in Fig. 1. The membership function, $\mu_{\tilde{n}}$ is defined as (Kaufmann and Gupta, 1991)

$$\mu_{\tilde{n}} = \begin{cases} 0, & x<n1 \\ (x-n1)/(n2-n1), & n1 \leq x \leq n2 \\ 1, & n2 \leq x \leq n3 \\ (x-n4)/(n3-n4), & n3 \leq x \leq n4 \\ 1, & x>n4 \end{cases}$$

For a trapezoidal fuzzy number $\tilde{n}$ = (n1, n2, n3, n4), if n2=n3, then $\tilde{n}$ is called a triangular fuzzy number. A non-fuzzy number r can be expressed as (r, r, r, r).

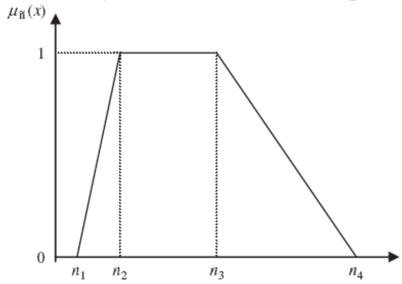


**Figure 1.** Trapezoidal fuzzy number $\tilde{n}$

By the extension principle (Dubois and Prade, 1980), the fuzzy sum $\oplus$ and fuzzy subtraction $\Theta$ of any two trapezoidal fuzzy numbers are also trapezoidal fuzzy numbers; but the multiplication $\otimes$ of any two trapezoidal fuzzy numbers is only an approximate trapezoidal fuzzy number.

Given any two positive trapezoidal fuzzy numbers, $\tilde{m}$ =(m1,m2,m3,m4), $\tilde{n}$ =(n1,n2,n3,n4) and a positive real number r, some main operations of fuzzy numbers $\tilde{m}$ and $\tilde{n}$ can be expressed as follows:

$\tilde{m} \oplus \tilde{n} =$ [m1+n1, m2+n2, m3+n3, m4+n4], (4)

$\tilde{m} \Theta \tilde{n} =$ [m1-n4, m2-n3, m3-n2, m4-n1], (5)

$\tilde{m} \otimes \tilde{n} =$ [m1/n4, m2/n3, m3/n2, m4/n1], (6)

$\tilde{m} \otimes \tilde{n} =$ [m1n1, m2n2, m3n3, m4n4], (7)

*Definition 7.* A matrix $\tilde{D}$ is called a fuzzy matrix if at least one element is a fuzzy number (Buckley,1985).

*Definition 8.* A linguistic variable is one whose values are expressed in linguistic terms (Zimmermann, 1991). The concept of a linguistic variable is very useful in dealing with situations which are too complex or not sufficiently well defined to be reasonably described in conventional quantitative expressions (Zimmermann, 1991). For example, ''weight'' is a linguistic variable whose values are very low, low, medium, high, very high, etc. Fuzzy numbers can also represent these linguistic values.

Let $\tilde{m}$ = (m1, m2, m3, m4) and $\tilde{n}$ = (n1, n2, n3, n4) be two trapezoidal fuzzy numbers. Then the distance between them can be calculated by using the vertex method as (Chen, 2000).

$$d_v(\tilde{m},\tilde{n}) = \sqrt{1/4[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2+(m_4-n_4)^2]} \quad (8)$$

Let $\tilde{m}$ = (m1, m2, m3) and $\tilde{n}$ = (n1, n2, n3) be two triangular fuzzy numbers. Then the distance between them can be calculated by using the vertex method as (Chen, 2000).

$$d_v(\tilde{m},\tilde{n}) = \sqrt{1/3[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2]} \quad (9)$$

The vertex method is an effective and simple method to calculate the distance between two trapezoidal fuzzy numbers. According to the vertex method, two trapezoidal fuzzy numbers $\tilde{m}$ and $\tilde{n}$ are identical if and only if $d_v(\tilde{m},\tilde{n}) =$ 0. Let $\tilde{m}$ and $\tilde{n}$ and $\tilde{p}$ be three trapezoidal fuzzy numbers. Fuzzy number $\tilde{n}$ is closer to fuzzy number $\tilde{m}$ than the other fuzzy number $\tilde{p}$ , if and only if $d_v(\tilde{m},\tilde{n}) < d_v(\tilde{m},\tilde{p}) =$ (Chen, 2000).

## THE PROPOSED METHOD

The theoretical background of the proposed method is summarized in three sections as, fuzzy sets-fuzzy AHP, extent analysis and fuzzy TOPSIS.

### Fuzzy Sets Theory and Fuzzy AHP

To deal with vagueness of human thought, Zadeh, in 1965, first introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the fuzzy domain. A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function, which assigns to each object a grade of membership ranging between zero and one. A tilde "~" will be placed above a symbol if the symbol represents a fuzzy set.

Therefore, $\tilde{P}$ , $\tilde{r}$ , $\tilde{n}$ are all fuzzy sets. The membership functions for these fuzzy sets will be denoted by $\mu$ ( $x|\tilde{p}$ ) and $\mu$ ( $x|\tilde{n}$ ) respectively. A triangular fuzzy number (TFN), $\tilde{M}$ , is shown in Fig. 2.

A TFN is denoted simply as ( $\frac{m_1}{m_2}$ , $\frac{m_2}{m_3}$ ) or (m1, m2, m3).

The parameters m1, m2 and m3 respectively denote the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event (Kahraman, Ruan, and Doğan, 2003).

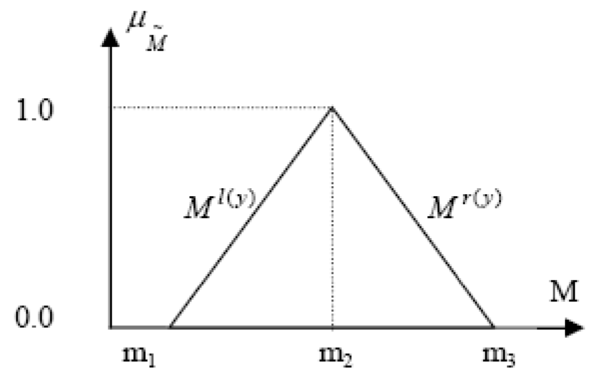


**Figure 2.** A triangular fuzzy number

The AHP is one of the extensively used multi-criteria decision-making methods. One of the main advantages of this method is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can effectively handle both qualitative and quantitative data. The use of AHP does not involve cumbersome mathematics. AHP involves the principles of decomposition, pairwise comparisons, and priority vector generation and synthesis. Though the purpose of AHP is to capture the expert's knowledge, the conventional AHP still cannot reflect the human thinking style. Therefore, fuzzy AHP, a fuzzy extension of AHP, was developed to solve the hierarchical fuzzy problems.

In the fuzzy-AHP procedure, the pairwise comparisons in the judgment matrix are fuzzy numbers that are modified by the designer's emphasis (Kahraman, Ruan, and Doğan, 2003).

**Extent Analysis Method on Fuzzy AHP**

In the following, first the outlines of the extent analysis method on fuzzy AHP are given and then the method is applied to a supplier selection problem. Let

X = {x1, x2,….,xn} (10)

be an object set, and

U = {u1, u2,….,un} (11)

be a goal set.

According to the method of Chang's (1992), extent analysis, each object is taken and extent analysis for each goal is performed respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs:

$$M^1_{g_i},\ M^2_{g_i},\ \ldots,\ M^m_{g_i} \quad i = 1,2,...,n \qquad (12)$$

where all the $M^j_{g_i}$ ( j 1,2,...,m) are triangular fuzzy numbers. The value of fuzzy synthetic extent with respect to ith object is defined as:

$$S_i = \sum_{j=1}^{m} M^j_{g_i} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M^j_{g_i}\right]^{-1} \qquad (13)$$

The degree of possibility of M1 ≥ M2 is defined as:

$$V(M1 \geq M2) = \sup_{x \geq y} [\min(\mu_{M1}(x), \mu_{M2}(y))] \qquad (13)$$

When a pair (x, y) exists such that x ≥ y and $\mu$ M1 (x) = $\mu$ M2 (y),

then we have V (M1 ≥ M2) =1.

Since M1 and M2 are convex fuzzy numbers we have that:

V (M1 ≥ M2) =1 if m1 ≥ m2 (14)

V (M1 ≥ M2) = hgt (M1 ∩ M2) = $\mu$ M1 (d) (15)

where d is the ordinate of the highest intersection point D between $\mu$ M1 and $\mu$ M2 .

When M1 = (l1,m1,u1) and M2 = (l2,m2,u2), the ordinate of D is given by equation (8):

V (M2 ≥ M1) = hgt (M1 ∩ M2)

$$= \frac{l_1 - u_1}{(m_2 - u_2) - (m_1 - u_1)} \qquad (16)$$

To compare M1 and M2, we need both the values of V (M1 ≥ M2) and V (M2 ≥ M1).

The degree possibility for a convex fuzzy number to be greater than k convex fuzzy numbers Mi (i= 1,2,...,k) can be defined by:

V (M ≥ M1 ,M2 ,……,Mk ) = V (M ≥ M1)

and V (M ≥ M2) and…and V (M ≥ Mk) (17)

=min V (M ≥ Mi), i=1,2,….,k

Assume that:

d'(Ai) = min V (Si ≥ Sk) (18)

For k =1,2,...,n; k ≠ i . Then the weight vector is given by:

W '= (d' (A1), d' (A2),,..., d' (An))T (19)

where Ai (i=1,2,...,n) are n elements. Via normalization, the normalized weight vectors are:

W = (d (A1), d (A2),,..., d (An))T (20)

where W is a nonfuzzy number.

**Fuzzy TOPSIS**

A systematic approach to extend the TOPSIS is proposed to solve the alternative-selection problem under a fuzzy environment in this section. In this paper, the importance weights of various criteria and the ratings of qualitative criteria are considered as linguistic variables. Because linguistic assessments merely approximate the subjective judgment of decision-makers, we can consider linear trapezoidal membership functions to be adequate for capturing the vagueness of these linguistic assessments (Delgado, Herrera, Herrera-Viedma, & Martinez, 1998; Herrera, & Herrera-Viedma, 1996; Herrera and Herrera-Viedma, 2000). These linguistic variables can be expressed in positive trapezoidal fuzzy numbers, as in Figure 3 and 4. The importance weight of each criterion can be either directly or indirectly assigned using pair wise comparison (Cook, 1992). It is suggested in this paper that Fuzzy AHP is used in evaluation and weighting of criteria through extent analysis. However, in classical Fuzzy TOPSIS for evaluation and weighting of the criteria following linguistic variables and Equations (20) -(25) can be used. In the Fuzzy TOPSIS with respect to qualitative criteria the decision-makers may use the linguistic variables shown in Fig. 3 and 4 to evaluate the importance of the criteria and the ratings of alternatives. For example, the linguistic variable ‘‘Medium High (MH)’’ can be represented as (0.5, 0.6, 0.7, 0.8) the membership function of

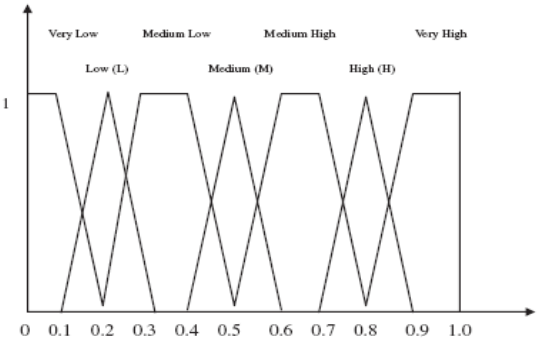


**Figure 3.** Linguistic variables for importance weight of each criterion.

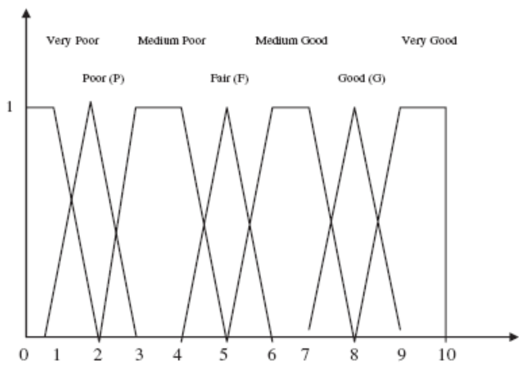


**Figure 4**. Linguistic variables for ratings.

which is,

$$\mu_{MediumHigh}(x) = \begin{cases} 0, & x<0.5 \\ (x-0.5)/(0.6-0.5), & 0.5 \le x \le 0.6 \\ 1, & 0.6 \le x \le 0.7 \\ (x-0.8)/(0.7-0.8), & 0.7 \le x \le 0.8 \\ 0, & x>0.8 \end{cases} \quad (21)$$

The linguistic variable ‘‘Very Good (VG)’’ can be represented as (8,9,9,10), the membership function of which is

$$\mu_{VeryGood}(x) = \begin{cases} 0, & x<8 \\ (x-8)/(9-8), & 8 \le x \le 9 \\ 1, & 9 \le x \le 10 \end{cases} \quad (22)$$

In fact, academic personnel selection is a group multiple-criteria decision-making (GMCDM) problem, which may be described by means of the following sets:

(i) a set of K decision-makers called E= $\{D_1, D_2, ...., D_k\}$;

(ii) a set of m possible alternatives called A= $\{A_1, A_2, ...., A_m\}$;

(iii) a set of n criteria, C= $\{C_1, C_2, ...., C_k\}$;, with which alternative performances are measured;

(iv) a set of performance ratings of Ai (i=1,2,….m); with respect to criteria Cj (j=1,2,….n); called X= $\{x_{ij}, i = 1,2,....m, j = 1,2,......n\}$.

Assume that a decision group has K decision makers, and the fuzzy rating of each decision maker, Dk(k=1,2,…,K); can be represented as a positive trapezoidal fuzzy number $\tilde{R}_k$ (k=1,2,…,K); with membership function $\mu_{\tilde{R}_k}$ (x). A good aggregation method should consider the range of fuzzy rating of each decision-maker. This means that the range of aggregated fuzzy rating must include the ranges of all decision-makers' fuzzy ratings. Let the fuzzy ratings of all decision makers be trapezoidal fuzzy numbers $\tilde{R}_k$ (ak,bk,ck,dk) k=1,2,…,K. Then the aggregated fuzzy rating can be defined as

$$\tilde{R} = (a,b,c,d), \; k=1,2,…,K \quad (23)$$

where,

$a = \min_k\{a_k\}$, $b = \frac{1}{K}\sum_{k=1}^{K} b_k$, $c = \frac{1}{K}\sum_{k=1}^{K} c_k$, $d = \max_k\{d_k\}$

Let the fuzzy rating and importance weight of the kth decision maker be $\tilde{x}_{ijk} = (a_{ijk}, b_{ijk}, c_{ijk}, d_{ijk})$ and

$\tilde{w}_{ijk} = (w_{jk1}, w_{jk2}, w_{jk3}, w_{jk4})$
$\{i = 1,2,....m, j = 1,2,......n\}$ respectively.

Hence, the aggregated fuzzy ratings ( $\tilde{x}_{ij}$ ) of alternatives with respect to each criterion can be calculated as

$$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}, d_{ij}) \tag{24}$$

$$a_{ij} = \min_k \{a_{ijk}\}, \quad b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}, \quad c_{ij} = \frac{1}{K}\sum_{k=1}^{K} c_{ijk}, \quad d_{ij} = \max_k \{d_{ijk}\}$$

The aggregated fuzzy weights ( $\tilde{x}_{ij}$ ) of each criterion can be calculated as

$$\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3}, w_{j4}) \tag{25}$$

where

$$w_{j1} = \min_k \{w_{jk1}\}, \quad w_{j2} = \frac{1}{K}\sum_{k=1}^{K} b_{jk2}, \quad w_{j3} = \frac{1}{K}\sum_{k=1}^{K} w_{jk3}, \quad w_{j4} = \max_k \{w_{jk4}\}$$

As stated above, a personnel-selection problem can be concisely expressed in matrix format as follows:

$$\tilde{\mathbf{D}} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}$$

$$\tilde{W} = [w_1, w_2, ......, w_n]$$

where $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}, d_{ij})$ and $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3}, w_{j4})$; $\{i = 1,2,....m, j = 1,2,......n\}$ can be approximated by positive trapezoidal fuzzy numbers.

To avoid the complexity of mathematical operations in the decision process, the linear scale transformation is used here to transform the various criteria scales into comparable scales. The set of criteria can be divided into benefit criteria (the larger the rating, the greater the preference) and cost criteria (the smaller the rating, the greater the preference). Therefore, the normalized fuzzy-decision matrix can be represented as

$$\tilde{R} = [\tilde{r}_{ij}]_{mxn} \tag{26}$$

where B and C are the sets of benefit criteria and cost criteria, respectively, and

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{d_j^*}, \frac{b_{ij}}{d_j^*}, \frac{c_{ij}}{d_j^*}, \frac{d_{ij}}{d_j^*}\right), \quad j \in B,$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{d_{ij}}, \frac{b_j^-}{d_{ij}}, \frac{c_j^-}{d_{ij}}, \frac{d_j^-}{d_{ij}}\right), \quad j \in C,$$

$$d_j^* = \max_i d_{ij}, \quad j \in B,$$

$$a_j^- = \min_i a_{ij}, \quad j \in C,$$

The normalization method mentioned above is designed to preserve the property in which the elements $\tilde{r}_{ij}, \forall i, j$ are standardized (normalized) trapezoidal fuzzy numbers. Considering the different importance of each criterion, the weighted normalized fuzzy-decision matrix is constructed as

$$\tilde{V} = \left[\tilde{v}_{ij}\right]_{mxn}, \quad \{i = 1,2,....m, j = 1,2,......n\} \tag{27}$$

where

$$\tilde{v}_{ij} = \tilde{r}_{ij}(.)\tilde{w}_j$$

According to the weighted normalized fuzzy decision matrix, normalized positive trapezoidal fuzzy numbers can also approximate the elements $\tilde{v}_{ij}, \forall i, j$. Then, the fuzzy positive-ideal solution (FPIS, $A^*$ ) and fuzzy negative-ideal solution (FNIS, $A^-$) can be defined as

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, ...., \tilde{v}_n^*) \tag{28}$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, ...., \tilde{v}_n^-) \tag{29}$$

where

$$\tilde{v}_j^* = \max_i \{v_{ij4}\} \quad \text{and} \quad \tilde{v}_j^- = \min_i \{v_{ij1}\},$$
$$\{i = 1,2,....m, j = 1,2,......n\}$$

The distance of each alternative from $A^*$ and $A^-$ can be currently calculated as

$$d_i^* = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^*\right), \quad \{i = 1,2,....m\} \tag{30}$$

$$d_i^- = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), \quad \{i = 1,2,....m\} \tag{31}$$

where $d_v$ (.,.) is the distance measurement between two fuzzy numbers.

A closeness coefficient is defined to determine the ranking order of all possible alternatives once $d_i^*$ and $d_i^-$ of each alternative $A_i (i = 1,2,...,m)$ has been calculated. The closeness coefficient represents the distances to the fuzzy positive-ideal solution ( $A^*$ ) and the fuzzy negative-ideal solution ( $A^-$ ) simultaneously by taking the relative closeness to the fuzzy positive-ideal solution. The closeness coefficient (CCi) of each alternative is calculated as

$$CCi = \frac{d_i^-}{d_i^- + d_i^*}, \{i = 1,2,....m\} \quad (32)$$

It is clear that CCi =1 if $A_i = A^*$ and CCi = 0 if $A_i = A^-$. In other words, alternative $A_i$ is closer to the FPIS ( $A^*$ ) and farther from FNIS ( $A^-$ ) as CCi approaches to 1. According to the descending order of CCi, we can determine the ranking order of all alternatives and select the best from among a set of feasible alternatives.

## APPLICATION OF FUZZY TOPSIS IN ACADEMIC PERSONNEL SELECTION

The steps of the methodology used in this study can be listed as:

1. The list of criteria which will be used in the study is stated through a literature study. The seven main criteria for instructor selection to a military school are given in Table 1.
2. The military school concept has a number of different aspects, compared to classical instructor selection. To take into account the unique nature of the problem, to weight the criteria Fuzzy AHP is conducted on 53 potential experts who may take a part in the selection process.
3. Triangular numbers are used in the linguistic fuzzy variables of Fuzzy AHP in order to increase easiness of decisions taking place in the evaluation phase of decision makers. The list of fuzzy linguistic variables for evaluation of criteria and evaluation of alternatives are shown in Table 2.
4. Fuzzy TOPSIS is conducted with the real selection committee which is composed of three experts. The trapezoidal fuzzy numbers are used in linguistic fuzzy variables in Fuzzy TOPSIS instead of triangular numbers in order to increase the flexibility of decisions taking place in the evaluation phase of alternatives. The list of fuzzy linguistic variables for evaluation of alternatives is shown in Table 3.
5. Fuzzy weights of the criteria are calculated with respect to Fuzzy AHP and Equations (10) -(20) and shown in Table 5.
6. Normalized fuzzy decision matrix is prepared according to Equation (26) and shown in Table 6 and weighted normalized fuzzy decision matrix is prepared according to Equation (27) and shown in Table 7.
7. Fuzzy positive and negative solutions are stated according to Equation (28)-(29) and distances to ideal solutions and the distance of each alternative from $A^*$ and $A^-$ are calculated according to Equation (30)-(31) and shown respectively in Table 8-9-10.
8. The closeness coefficients for each alternative are calculated with respect to Equation (32) and shown in Table 11.

**Table 2.** Fuzzy Linguistic Variables Used in the Evaluation of Criteria and Corresponding Values

| | | l | m | u |
|---|---|---|---|---|
| Very important | VI | 4 | 5 | 5 |
| Important | I | 2 | 3 | 4 |
| Equal | E | 1 | 1 | 1 |
| Unimportant | UI | 1/4 | 1/3 | 1/2 |
| Very unimportant | VUI | 1/5 | 1/5 | 1/4 |

**Table 3.** Fuzzy Linguistic Variables Used in the Evaluation of Alternatives and Corresponding Values

| Very good | VG | 8 | 9 | 10 | 10 |
|---|---|---|---|---|---|
| Good | G | 7 | 8 | 8 | 9 |
| Moderate good | MG | 5 | 6 | 7 | 8 |
| Moderate | M | 4 | 5 | 5 | 6 |
| Moderate bad | MB | 2 | 3 | 4 | 5 |
| Bad | B | 0 | 2 | 2 | 3 |
| Very bad | VB | 0 | 0 | 1 | 2 |

**Table 4.** Pair wise Comparison of Criteria in Fuzzy AHP

| | C1 | | | C2 | | | C3 | | | C4 | | | C5 | | | C6 | | | C7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 1,00 | 1,00 | 1,00 | 0,83 | 1,00 | 1,20 | 1,20 | 1,60 | 1,90 | 1,40 | 1,70 | 1,90 | 1,30 | 1,70 | 2,00 | 1,10 | 1,40 | 1,60 | 0,63 | 0,71 | 0,83 |
| C2 | 0,83 | 1,00 | 1,20 | 1,00 | 1,00 | 1,00 | 1,50 | 1,90 | 2,30 | 1,80 | 2,30 | 2,80 | 1,60 | 2,10 | 2,60 | 1,10 | 1,40 | 1,70 | 0,91 | 1,10 | 1,20 |
| C3 | 0,53 | 0,63 | 0,83 | 0,43 | 0,53 | 0,67 | 1,00 | 1,00 | 1,00 | 1,30 | 1,60 | 1,80 | 1,20 | 1,40 | 1,70 | 0,71 | 0,83 | 1,00 | 0,45 | 0,56 | 0,71 |
| C4 | 0,53 | 0,59 | 0,71 | 0,36 | 0,43 | 0,56 | 0,56 | 0,63 | 0,77 | 1,00 | 1,00 | 1,00 | 0,83 | 1,10 | 1,30 | 0,59 | 0,67 | 0,77 | 0,40 | 0,45 | 0,59 |
| C5 | 0,50 | 0,59 | 0,77 | 0,38 | 0,48 | 0,63 | 0,59 | 0,71 | 0,83 | 0,77 | 0,91 | 1,20 | 1,00 | 1,00 | 1,00 | 0,59 | 0,71 | 0,83 | 0,42 | 0,50 | 0,67 |
| C6 | 0,63 | 0,71 | 0,91 | 0,59 | 0,71 | 0,91 | 1,00 | 1,20 | 1,40 | 1,30 | 1,50 | 1,70 | 1,20 | 1,40 | 1,70 | 1,00 | 1,00 | 1,00 | 0,56 | 0,67 | 0,83 |
| C7 | 1,20 | 1,40 | 1,60 | 0,83 | 0,91 | 1,10 | 1,40 | 1,80 | 2,20 | 1,70 | 2,20 | 2,50 | 1,50 | 2,00 | 2,40 | 1,20 | 1,50 | 1,80 | 1,00 | 1,00 | 1,00 |

**Table 5.** Weights of the Criteria

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 0,2263 | C2 | 0,3058 | C3 | 0,0887 | C4 | 0,0275 | C5 | 0,0459 | C6 | 0,1284 | C7 | 0,1774 |

**Table 6.** Normalized Fuzzy Decision Matrix

| | C1 | | | | C2 | | | | C3 | | | | C4 | | | | C5 | | | | C6 | | | | C7 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 0,70 | 0,87 | 0,93 | 1,00 | 0,80 | 0,90 | 1,00 | 1,00 | 0,70 | 0,80 | 0,80 | 0,90 | 0,80 | 0,90 | 1,00 | 1,00 | 0,00 | 0,63 | 0,67 | 1,00 | 0,50 | 0,73 | 0,77 | 0,90 | 0,50 | 0,60 | 0,70 | 0,80 |
| A2 | 0,50 | 0,80 | 0,90 | 1,00 | 0,70 | 0,87 | 0,93 | 1,00 | 0,40 | 0,63 | 0,67 | 1,00 | 0,50 | 0,60 | 0,70 | 0,80 | 0,80 | 0,90 | 1,00 | 1,00 | 0,70 | 0,83 | 0,87 | 1,00 | 0,50 | 0,67 | 0,73 | 0,90 |
| A3 | 0,70 | 0,80 | 0,80 | 0,90 | 0,70 | 0,83 | 0,87 | 1,00 | 0,40 | 0,63 | 0,67 | 0,90 | 0,40 | 0,70 | 0,70 | 0,90 | 0,50 | 0,73 | 0,77 | 0,90 | 0,50 | 0,67 | 0,73 | 0,90 | 0,70 | 0,83 | 0,87 | 1,00 |
| A4 | 0,70 | 0,80 | 0,80 | 0,90 | 0,50 | 0,77 | 0,83 | 1,00 | 0,70 | 0,83 | 0,87 | 1,00 | 0,70 | 0,80 | 0,80 | 0,90 | 0,70 | 0,80 | 0,80 | 0,90 | 0,50 | 0,77 | 0,83 | 1,00 | 0,70 | 0,80 | 0,80 | 0,90 |
| A5 | 0,50 | 0,60 | 0,70 | 0,80 | 0,00 | 0,53 | 0,57 | 0,90 | 0,40 | 0,73 | 0,77 | 1,00 | 0,70 | 0,83 | 0,90 | 1,00 | 0,50 | 0,80 | 0,90 | 1,00 | 0,00 | 0,53 | 0,57 | 0,90 | 0,50 | 0,60 | 0,70 | 0,80 |
| A6 | 0,50 | 0,67 | 0,73 | 0,90 | 0,50 | 0,70 | 0,80 | 1,00 | 0,40 | 0,63 | 0,67 | 0,90 | 0,20 | 0,63 | 0,67 | 0,90 | 0,70 | 0,80 | 0,80 | 0,90 | 0,50 | 0,77 | 0,83 | 1,00 | 0,70 | 0,83 | 0,87 | 1,00 |

**Table 7.** Weighted Normalized Fuzzy Decision Matrix

| | C1 | | | | C2 | | | | C3 | | | | C4 | | | | C5 | | | | C6 | | | | C7 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 0,16 | 0,20 | 0,21 | 0,23 | 0,24 | 0,28 | 0,31 | 0,31 | 0,06 | 0,07 | 0,07 | 0,08 | 0,02 | 0,02 | 0,03 | 0,03 | 0,00 | 0,03 | 0,03 | 0,05 | 0,06 | 0,09 | 0,10 | 0,12 | 0,09 | 0,11 | 0,12 | 0,14 |
| A2 | 0,11 | 0,18 | 0,20 | 0,23 | 0,21 | 0,27 | 0,29 | 0,31 | 0,04 | 0,06 | 0,06 | 0,09 | 0,01 | 0,02 | 0,02 | 0,02 | 0,04 | 0,04 | 0,05 | 0,05 | 0,09 | 0,11 | 0,11 | 0,13 | 0,09 | 0,12 | 0,13 | 0,16 |
| A3 | 0,16 | 0,18 | 0,18 | 0,20 | 0,21 | 0,25 | 0,27 | 0,31 | 0,04 | 0,06 | 0,06 | 0,08 | 0,01 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,04 | 0,04 | 0,06 | 0,09 | 0,09 | 0,12 | 0,12 | 0,15 | 0,15 | 0,18 |
| A4 | 0,16 | 0,18 | 0,18 | 0,20 | 0,15 | 0,23 | 0,25 | 0,31 | 0,06 | 0,07 | 0,08 | 0,09 | 0,02 | 0,02 | 0,02 | 0,02 | 0,03 | 0,04 | 0,04 | 0,04 | 0,06 | 0,10 | 0,11 | 0,13 | 0,12 | 0,14 | 0,14 | 0,16 |
| A5 | 0,11 | 0,14 | 0,16 | 0,18 | 0,00 | 0,16 | 0,17 | 0,28 | 0,04 | 0,07 | 0,07 | 0,09 | 0,02 | 0,02 | 0,02 | 0,03 | 0,02 | 0,04 | 0,04 | 0,05 | 0,00 | 0,07 | 0,07 | 0,12 | 0,09 | 0,11 | 0,12 | 0,14 |
| A6 | 0,11 | 0,15 | 0,17 | 0,20 | 0,15 | 0,21 | 0,24 | 0,31 | 0,04 | 0,06 | 0,06 | 0,08 | 0,01 | 0,02 | 0,02 | 0,02 | 0,03 | 0,04 | 0,04 | 0,04 | 0,06 | 0,10 | 0,11 | 0,13 | 0,12 | 0,15 | 0,15 | 0,18 |

**Table 8.** Fuzzy Positive and Negative Ideal Solutions

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A*= | 0,23 | 0,23 | 0,23 | 0,23 | 0,31 | 0,31 | 0,31 | 0,31 | 0,09 | 0,09 | 0,09 | 0,09 | 0,03 | 0,03 | 0,03 | 0,03 | 0,05 | 0,05 | 0,05 | 0,05 | 0,13 | 0,13 | 0,13 | 0,13 | 0,18 | 0,18 | 0,18 | 0,18 |
| A-= | 0,11 | 0,11 | 0,11 | 0,11 | 0,00 | 0,00 | 0,00 | 0,00 | 0,04 | 0,04 | 0,04 | 0,04 | 0,01 | 0,01 | 0,01 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,09 | 0,09 | 0,09 | 0,09 |

**Table 9.** The Distance to Ideal Solutions of Each Alternative From $A^*$

| | | | | | | | | di* |
|---|---|---|---|---|---|---|---|---|
| A1 | 0,04 | 0,03 | 0,02 | 0,00 | 0,03 | 0,04 | 0,07 | 0,22 |
| A2 | 0,06 | 0,05 | 0,03 | 0,01 | 0,01 | 0,02 | 0,06 | 0,25 |
| A3 | 0,05 | 0,06 | 0,03 | 0,01 | 0,01 | 0,04 | 0,03 | 0,24 |
| A4 | 0,05 | 0,09 | 0,02 | 0,01 | 0,01 | 0,04 | 0,04 | 0,24 |
| A5 | 0,08 | 0,18 | 0,03 | 0,00 | 0,01 | 0,08 | 0,07 | 0,46 |
| A6 | 0,08 | 0,09 | 0,03 | 0,01 | 0,01 | 0,04 | 0,03 | 0,30 |

**Table 10.** The Distance to Ideal Solutions of Each Alternative From $A^-$

| | | | | | | | | di- |
|---|---|---|---|---|---|---|---|---|
| A1 | 0,09 | 0,28 | 0,04 | 0,02 | 0,03 | 0,09 | 0,03 | 0,59 |
| A2 | 0,08 | 0,27 | 0,03 | 0,01 | 0,04 | 0,11 | 0,04 | 0,59 |
| A3 | 0,07 | 0,26 | 0,03 | 0,01 | 0,03 | 0,09 | 0,06 | 0,56 |
| A4 | 0,07 | 0,24 | 0,04 | 0,02 | 0,04 | 0,10 | 0,05 | 0,56 |
| A5 | 0,04 | 0,18 | 0,03 | 0,02 | 0,04 | 0,08 | 0,03 | 0,42 |
| A6 | 0,06 | 0,24 | 0,03 | 0,01 | 0,04 | 0,10 | 0,06 | 0,54 |

**Table 11.** The Closeness Coefficients and Ranking

| Alternative | The closeness coefficients | Ranking |
|---|---|---|
| A1 | 0,724 | 1 |
| A2 | 0,706 | 2 |
| A3 | 0,702 | 3 |
| A4 | 0,699 | 4 |
| A5 | 0,483 | 6 |
| A6 | 0,644 | 5 |

As seen in the ranking, even though Alternative 1 does not have a high score in family & social aspect, however the high scores from cognitive and discipline criteria place Alternative 1 at the top.

## CONCLUSION

A selection technique is required for academic institutions to sustain the instructor selection and employment process which is aligned with the strategy of the institutions and protects the process from personal and external pressures and influences. This technique should be easy to apply; however, at the same time, is justified as to its analytical background, should also be capable of reflecting the real world aspects and should provide a high degree of flexibility to experts in the evaluation phase. Fuzzy TOPSIS is applied in the study, assuring the quantitative and qualitative combination in the same technique and by allowing experts to conduct evaluations using the flexibility of fuzzy concept. The study has been conducted in a military school with the aim of the selection of an instructor from six alternatives. The criteria are not limited to only academic performance, but also include leadership, discipline, family and social aspects. The criteria are weighted with experts using Fuzzy AHP which provides a flexible approach for criteria weighting. The unique properties of this study can be summed up as:

- providing a road map for the instructor selection to the military schools
- a new approach for criteria weighting in Fuzzy TOPSIS
- combining two different MCDM methods (Fuzzy AHP and Fuzzy TOPSIS) into a single method
- enabling experts to evaluate the criteria and the alternatives according to the fuzzy linguistic variables,
- allowing experts to carry out a more flexible and realistic evaluation.

As it can be seen at Table 5, the most important criterion is cognitive ability and the second one is C1. Cognitive abilities are needed to carry out any task from the simplest to the most complex. Because instructors are role models for students in military schools, they should use these skills during education years and must teach how the students will use these abilities in their professional years. So, cognitive ability and personnel factors of instructors are required during the education years. In summary, the importance degrees of the criteria are sensible for military academic personnel.

It is projected that future studies can focus on different MCDM techniques and in various higher education institutions such as medicine and architecture where instructor selection requires complex analysis as military schools.

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