Dr. S. Durai raj et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Special Issue: Conscientious Computing Technologies, April 2018, pp. 302-306

Fuzzy In Multi Criteria - Decision Making

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Abstract- **A fuzzy approach for tackling qualitative MA problems in a simple straight forward manner presented. An empirical Illustration is given and compare the results with the conventional method and this new method proposed is found to be better.**

Key words: Multi criteria, Triangular fuzzy numbers, Extent Analysis and Fuzzy AHP.

INTRODUCTION

The application of fuzzy sets theory to multi-criteria Decision making (MCDM) models provides an effective way of dealing with the subjectiveness and vagueness of the decision making process for the general MCDM problem. By using the linguistic terms with fuzzy number representation, the Decision maker (DM) can effectively express his/her subjective assessments. The DM's preference in comparing alternatives or criteria can be better modeled.

Most of the fuzzy MCDM models are based on classical utility theory which involve two phases:
(i) the aggregation of the fuzzy assessment with respect to all criteria for each alternative, and (ii) the ranking of alternatives based on their aggregated overall assessments (fuzzy utilities). This ranking of comparing fuzzy utilities can be quite complex and may produce unreliable results. There is no best method for fuzzy utility comparison in all situations for which the method can be used satisfactorily even though quite a few ranking methods have been developed in the literature [2, 4].

To avoid the complex and unreliable process of fuzzy utilities ranking, we propose a new algorithm for solving the general fuzzy MCDM problem by using the □ - cut concept of fuzzy set theory. In corporated with the DM's attitude towards risk, an overall performance index is obtained for each alternative by applying the concept of the degree of similarity to the ideal solution using the vector matching function.

2. BASIC CONCEPTS IN FUZZY AHP

2.1. Triangular fuzzy numbers

(i) Let M ∈ F(R) be called a fuzzy number if:

1) there exists $x_0 \in R$ such that $\mu_m(x_0) = 1$
2) For any $\alpha \in [0, 1]$, $A_\alpha(x) > \alpha]$ is a closed interval. Here F(R) represents all fuzzy sets and R is the set of real numbers.

(ii) We define a fuzzy number M on R to be a triangular fuzzy number if its membership function $\mu_M(x) : R \to [0, 1]$ is equal to

$$\mu_m(x) = \left\{ \begin{array}{ll} \frac{x}{m-l} - \frac{l}{m-l}, & x \in [l, m] \\ \frac{x}{m-u} - \frac{u}{m-u}, & x \in [m, u] \\ 0 & , otherwise \end{array} \right\} \quad \ldots\ldots (2.1)$$

where $l \le m \le u$, l and u stand for the lower and upper value of the support of M respectively, and m for the modal value. The triangular fuzzy number can be denoted by (l_1, m_1, u_1) and $M_2 = (l_2, m_2, u_2)$. Their operational laws are as follows.

a) $(l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$ ……… (2.2)

b) $(l_1, m_1, u_1) \odot (l_2, m_2, u_2) \simeq (l_1 l_2, m_1 m_2, u_1 u_2)$ ……… (2.3)

c) $(\lambda, \lambda, \lambda) \odot (l_1, m_1, u_1) = (\lambda l_1, \lambda m_1, \lambda u_1)$ ……… (2.4)

$\lambda > 0, \lambda \in R$

d) $(l_1, m_1, u_1)^{-1} \simeq \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right)$ ………. (2.5)

e) $l_n (l, m, u) \simeq (l_{nl}, l_{nm}, l_{nu})$ ………. (2.6)

f) $\exp (l, m, u) \simeq (\exp l, \exp m, \exp u)$ ………. (2.7)

2.2. α - cut and strong α - cut

One of the most important concepts of fuzzy sets is the concept of an α-cut and its variant, a strong α - cut. Given a fuzzy set A defined on X and any number α ∈ [0, 1], the α - cut, $^{\alpha}A$, and the strong α - cut $^{\alpha+}A$, are the crisp sets

$$^{\alpha}A = \{x / A(x) \ge \alpha\} \quad \ldots\ldots\ldots (2.8)$$

$$^{\alpha+}A = \{x / A(x) > \alpha) \quad \ldots\ldots\ldots.. (2.9)$$

That is, α - cut (or the strong α-cut) of a fuzzy set A is the crisp set $^{\alpha}A$ (or the crisp set $^{\alpha+}A$) that contains all the elements of the universal set X whose membership grades in

A are greater than or equal (or only greater than) the specified value of α.

3. PROBLEM SETTING

Let A_i (i ∈{1, 2, ..., n} be a finite number of alternatives to be evaluated against a set of criteria C_j (j = 1, 2, …, m). Subjective assessments are to be given by the DM to determine

(a) the degree to which each alternative satisfies each criterion, represented as fuzzy matrix (referred to as the decision matrix)

(or)

(b) how much important each criteria is for the problem evaluated, represented as a fuzzy vector (referred to as the weighting vector)

To better model the subjectiveness and vagueness of the decision making process, linguistic terms which have been found intuitively easy to use [given below in Table 1] are used to represented the DM's subjective assessment. Triangular fuzzy numbers are used to represent the approximate value of the linguistic terms, denoted as (a_1, a_2, a_3), where $1 \le a_1 \le a_2 \le a_3 \le 9$.

Linguistic terms	Scores	Triangular fuzzy equivalent
Very poor (v.p) or least important (LTI)	1	(1, 2, 3)
Poor (p) or less important (LSI)	3	(2, 3, 4)
Fair (F) or Important (I)	5	(4, 5, 6)
Good (G) or more important (MEI)	7	(6, 7, 8)
Very Good (VG) or most important (MTI)	9	(8, 9, 10)

Table 1 : Linguistic terms, scores and the triangular fuzzy equivalents Expressed by the linguistic terms from a term set, the decision matrix for alternatives is given as

$$X = \begin{bmatrix} x_{11} & x_{12} & -- & x_{1m} \\ x_{21} & x_{22} & -- & x_{2m} \\ -- & -- & -- & -- \\ x_{n1} & x_{n2} & -- & x_{nm} \end{bmatrix} \quad \ldots\ldots 3.1$$

where x_{ij} represents the linguistic assessments of the performance rating of alternative A_i (i= 1, 2, …, n) with respect to criterion c_j (j = 1, 2, …, m), which are to be given by the DM.

The weighting vector for the evaluation criteria can be directly given by the DM or obtained by using pairwise comparison of the analytic hierarchy process (AHP). By using the linguistic terms from the term set, the weighting vector w for evaluation criteria represented.

$$W = (w_1, w_2, \ldots, w_m) \qquad \ldots\ldots. (3.2)$$

Where w_j is the fuzzy weight of criterion c_j (j = 1, 2, …, m). Given the decision matrix and the weighting vector, the problem is to rank all the alternatives by giving each of them an overall performance rating with respect to all the criteria.

4. CONSTRUCTION OF THE ALGORITHM

The algorithm begins with the generation of a performance matrix by multiplying the weighting vector by the decision matrix (given in (4.1) below). The arithmetic operations on these fuzzy numbers are based on interval arithmetic given in section 2.1.

$$Z = \begin{bmatrix} w_1x_{11} & w_2x_{12} & -- & w_mx_{1m} \\ w_1x_{21} & w_2x_{22} & -- & w_mx_{2m} \\ -- & -- & -- & -- \\ w_1x_{21} & w_2x_{22} & -- & w_mx_{nm} \end{bmatrix} \quad \ldots\ldots (4.1)$$

By using an □-cut on the performance matrix, an interval performance matrix is derived as in (4.2) below, where 0 □ □ □ 1. The value of □ represents the DM's degree of confidence in his/her fuzzy assessments. A larger □ value indicates a more confident DM, meaning that the DM's assessments are closer to the most probable value a2 of the triangular fuzzy numbers (a1, a2, a3), represented by the corresponding linguistic terms.

$$Z = \begin{bmatrix} [z^{\alpha}_{11\ell}, z^{\alpha}_{11r}] & [z^{\alpha}_{12\ell}, z^{\alpha}_{12\ell}] & -- & [z^{\alpha}_{1m\ell}, z^{\alpha}_{1mr}] \\ [z^{\alpha}_{21\ell}, z^{\alpha}_{21r}] & [z^{\alpha}_{22\ell}, z^{\alpha}_{22r}] & -- & [z^{\alpha}_{2ml}, z^{\alpha}_{2mr}] \\ -- & -- & -- & -- \\ [z^{\alpha}_{n1\ell}, z^{\alpha}_{n1r}] & [z^{\alpha}_{n2\ell}, z^{\alpha}_{n2r}] & -- & [z^{\alpha}_{nnl}, z^{\alpha}_{nmr}] \end{bmatrix} \quad \ldots\ldots (4.2)$$

Incorporated with the DM's attitude towards risk using an optimism index λ, on overall crisp performance matrix is calculated and presented below in (4.3) by using the transformation:

$$z^{\lambda}_{ij\alpha} = \lambda z^{\alpha}_{ijr} + (1-\lambda)\, z^{\alpha}_{ijl}, \lambda \in [0,1]$$

$$Z^{\lambda'}_{\alpha} = \begin{bmatrix} z^{\lambda'}_{11\alpha} & z^{\lambda'}_{12\alpha} & -- & z^{\lambda'}_{1mr} \\ z^{\lambda'}_{21\alpha} & z^{\lambda'}_{22\alpha} & -- & z^{\lambda'}_{2m\alpha} \\ -- & -- & -- & -- \\ z^{\lambda'}_{n1\alpha} & z^{\lambda'}_{n2\alpha} & -- & z^{\lambda'}_{nm\alpha} \end{bmatrix} \quad \ldots\ldots. (4.3)$$

In practical applications, λ = 1, λ = 0.5 and λ = 0 are used to indicate that the DM involved has an optimistic, moderate or pessimistic view respectively. An optimistic DM is apt to prefer higher values of his/her fuzzy assessments expressed in linguistic terms, while a pessimistic DM tends to favour lower values.

To facilitate the vector matching process, a normalization process with respect to each criterion is applied in (4.3) by using (4.4), the resulting is a normalized performance matrix given below in (4.5)

$$Z_{ij\alpha}^{\lambda} = \frac{z_{ij\alpha}^{\lambda'}}{\sqrt{\sum_{i=1}^{n}\left(z_{ij\alpha}^{\lambda'}\right)}} \quad \ldots\ldots. (4.4)$$

$$= \begin{bmatrix} z_{11\alpha}^{\lambda} & z_{12\alpha}^{\lambda} & -- & z_{1m\alpha}^{\lambda} \\ z_{21\alpha}^{\lambda} & z_{22\alpha}^{\lambda} & -- & z_{2m\alpha}^{\lambda} \\ -- & -- & -- & -- \\ z_{n1\alpha}^{\lambda} & z_{n2\alpha}^{\lambda} & -- & z_{nm\alpha}^{\lambda} \end{bmatrix} \quad \ldots\ldots (4.5)$$

The positive ideal solution $A_\alpha^{\lambda+}$ and the negative ideal solution $A_\alpha^{\lambda-}$ can be determined from (4.5) by selecting the maximum value and minimum value across all alternatives with respect to each criteria, given as in (4.6) and (4.7), which represent the best possible result and the worst possible result of the alternatives respectively.

$$A_\alpha^{\lambda+} = \left(z_{1\alpha}^{\lambda+}, z_{2\alpha}^{\pi+}, ..., z_{m\alpha}^{\lambda+}\right) \text{and}$$

$$A_\alpha^{\lambda-} = \left(z_{1\alpha}^{\lambda-}, z_{2\alpha}^{\lambda+}, ..., z_{m\alpha}^{\lambda-}\right) \quad \ldots\ldots. (4.6)$$

where

$$Z_{j\alpha}^{\lambda+} = \max\left(z_{1j\alpha}^{\lambda}, z_{2j\alpha}^{\lambda}, ..., z_{nj\alpha}^{\lambda}\right) \quad \text{and}$$

$$z_{j\alpha}^{\lambda-} = \min\left(z_{1j\alpha}^{\lambda}, z_{2j\alpha}^{\lambda}, ..., z_{nj\alpha}^{\lambda}\right) \quad \ldots\ldots. (4.7)$$

By applying the vector matching technique, the degree of similarity between each alternative and the positive ideal solution and the negative ideal solution can be calculated respectively by

$$S_{i\alpha}^{\lambda+} = \frac{A_{i\alpha}^{\lambda} A_{\alpha}^{\lambda+}}{\max\left(A_{i\alpha}^{\lambda} A_{i\alpha}^{\lambda}, A_{\alpha}^{\lambda+} A_{\alpha}^{\lambda+}\right)} \quad \ldots\ldots (4.8)$$

$$S_{i\alpha}^{\lambda-} = \frac{A_{i\alpha}^{\lambda} A_{\alpha}^{\lambda+}}{\max\left(A_{i\alpha}^{\lambda} A_{i\alpha}^{\lambda}, A_{\alpha}^{\lambda-} A_{\alpha}^{\lambda-}\right)} \quad \ldots\ldots. (4.9)$$

where $A_{i\alpha}^{\lambda} = \left(z_{i1\alpha}^{\lambda}, z_{i2\alpha}^{\lambda}, ..., z_{im\alpha}^{\lambda}\right)$ is the ith row of the overall performance matrix in (4.5), representing the corresponding performance of alternative A_i ($i \in \{1, 2, \ldots, n\}$) with regard to each criteria C_j ($j = 1, 2, \ldots, m$). The larger the value of $S_{i\alpha}^{\lambda+}$ and $S_{i\alpha}^{\lambda-}$, the higher the degree of similarly between each alternative and the positive ideal solution and the negative ideal solution respectively.

Based on the rationale that a preferred alternative should have a higher degree of similarity to the positive ideal solution and a lower degree of similarity to the negative ideal solution, hence an overall preference index for each alternative with the DM's α level of confidence in his/her assessments and λ degree of optimison towards risk is determined by (4.10) below. The larger the index value, the more preferred the alternative

$$P_{\alpha i}^{\lambda} = \frac{S_{i\alpha}^{\lambda+}}{S_{i\alpha}^{\lambda+} + S_{i\alpha}^{\lambda-}}, \; i = 1, 2, ..., n \quad \ldots\ldots (4.10)$$

Summarizing the above, the steps required to reach (4.10) are as given below

Step 1 : Compute the decision matrix as in (3.1)
Step 2 : Estimate the weighting vectors for each criteria using AHP and get (3.2)
Step 3 : Using (3.2) and (3.1) obtain the matrix (4.1)
Step 4 : Using an α - cut on the matrix in (4.1), obtain the interval performance matrix as in (4.2)
Step 5 : Compute the crisp performance matrix (4.3) by including the DM's attitude towards the risk which is represented by the optimison index λ.
Step 6 : Using (4.4) compute the normalized performance matrix given in (4.5)
Step 7 : Using (4.6) and (4.7) obtain the positive and negative ideal solutions.
Step 8 : Now compute, by using (4.8) and (4.9), the degree of similarity between each alternative and the positive and negative ideal solutions.
Step 9 : By using (4.10), obtain the overall preference index for each alternative
Step10 : Rank the alternatives in the descending order of their corresponding preference index.

5. ILLUSTRATION

Suppose a well recognized educational Institution is interested in the selection of a Head of the Department (HOD). The requirements are (c1) paper qualifications (c2) Research Ability (c3) good Teaching and (c4) Administrative ability. After getting the application of candidates, the initial scrutiny with experts are left with one three candidates A1, A2, A3. Now the Institution requested three experts to sit together and assess them with respect to each criteria and asked them to rank them. The expets resorted to used the fuzzy AHP in the selection process; accordingly they proceeded as follows.

In the first step they obtained the fuzzy pairwise for all the three with respect to each criteria, the results obtained are:

(i) For paper qualification C_1 =

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 9 \\ 1/3 & 1 & 5 \\ 1/9 & 1/5 & 1 \end{bmatrix} \end{array}$$

(ii) Research ability C_2 =

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array}\begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 1/5 \\ 1/3 & 1 & 9 \\ 5 & 1/9 & 1 \end{bmatrix} \end{array}$$

(iii) Teaching ability C_3 =

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array}\begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 1/9 & 7 \\ 9 & 1 & 1/3 \\ 1/7 & 3 & 1 \end{bmatrix} \end{array}$$

(iv) Administrative ability C_4 =

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array}\begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 1/7 & 3 \\ 7 & 1 & 9 \\ 1/3 & 1/9 & 1 \end{bmatrix} \end{array}$$

Now by using the fuzzy synthetic extent analysis [1] the performance rating (x_{ij}) of three candidates A_1, A_2, A_3 with respect to each criteria C_1, C_2, C_3, C_4 were calculated as

X1=

$$\left\{ \frac{1+3+9}{1+3+9+\frac{1}{3}+1+5+\frac{1}{9}+\frac{1}{5}+1}, \frac{\frac{1}{3}+1+5}{1+3+9+\frac{1}{3}+1+5+\frac{1}{9}+\frac{1}{5}+1}, \frac{\frac{1}{9}+\frac{1}{5}+1}{1+3+9+\frac{1}{3}+1+5+\frac{1}{9}+\frac{1}{5}+1} \right\}$$

X2=

$$\left\{ \frac{1+3+\frac{1}{5}}{1+3+\frac{1}{5}+\frac{1}{3}+1+9+5+\frac{1}{9}+1}, \frac{\frac{1}{3}+1+9}{1+3+\frac{1}{5}+\frac{1}{3}+1+9+5+\frac{1}{9}+1}, \frac{5+1/9+1}{1+3+\frac{1}{5}+\frac{1}{3}+1+9+5+\frac{1}{9}+1} \right\}$$

X3=

$$\left\{ \frac{1+\frac{1}{7}+3}{1+\frac{1}{7}+3+7+1+9+\frac{1}{3}+\frac{1}{9}+1}, \frac{7+1+9}{1+\frac{1}{7}+3+7+1+9+\frac{1}{3}+\frac{1}{9}+1}, \frac{\frac{1}{7}+3+1}{1+\frac{1}{9}+7+9+1+\frac{1}{3}+\frac{1}{7}+3+1} \right\}$$

X4=

$$\left\{ \frac{1+\frac{1}{7}+3}{1+\frac{1}{7}+3+7+1+9+\frac{1}{3}+\frac{1}{9}+1}, \frac{7+1+9}{1+\frac{1}{7}+3+7+1+9+\frac{1}{3}+\frac{1}{9}+1}, \frac{\frac{1}{3}+\frac{1}{9}+1}{1+\frac{1}{7}+3+7+1+9+\frac{1}{3}+\frac{1}{9}+1} \right\}$$

where $X_1 = (x_{11}, x_{21}, x_{31})$
$X_2 = (x_{12}, x_{22}, x_{32})$
$X_3 = (x_{13}, x_{23}, x_{33})$
$X_4 = (x_{14}, x_{24}, x_{34})$

By using the fuzzy arithmetic in [3], the decision matrix for the selection of a HOD is determined as

X=

$$\begin{bmatrix} (0.27,0.63,1.32) & (0.06,0.12,0.58) & (0.17,0.36,0.74) & (0.06,0.18,0.50) \\ (0.13,0.31,0.76) & (0.24,0.50,1.04) & (0.23,0.46,0.91) & (0.37,0.75,1.40) \\ (0.04,0.06,0.24) & (0.12,0.30,0.70) & (0.06,0.18,0.50) & (0.04,0.06,0.25) \end{bmatrix}$$

To determine the relative importance of the selection criteria, fuzzy pairwise comparison process is conducted, resul in a fuzzy reciprocal Judgement matrix (w) as

$$W = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \end{array}\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & C_3 & C_4 \end{array} \\ \begin{bmatrix} 1 & 3 & 7 & 5 \\ 1/3 & 1 & 9 & 3 \\ 1/7 & 1/9 & 1 & 1/3 \\ 1/5 & 1/3 & 3 & 1 \end{bmatrix} \end{array}$$

Using [1] as before, with the fuzzy extent analysis.

w1 = (0.17, 0.45, 1.05)
w2 = (0.16, 0.38, 0.87)
w3 = (0.02, 0.04, 0.19)
w4 = (0.04, 0.13, 0.41)

Using (3.3) the fuzzy performance matrix for the above problem is

Z=

$$\begin{bmatrix} (0.046,0.284,1.386) & (0.010,0.046,0.505) & (0.003,0.014,0.141) & (0.002,0.023,0.205) \\ (0.022,0.140,0.798) & (0.038,0.190,0.905) & (0.005,0.018,0.173) & (0.015,0.098,0.574) \\ (0.007,0.027,0.252) & (0.019,0.114,0.609) & (0.001,0.007,0.095) & (0.002,0.008,0.103) \end{bmatrix}$$

Let α = 0.5, λ = 0.5 (for a moderate DM). The performance index for each candidate and its corresponding ranking is determined by applying equations (2.1) to (4.10) Table 2 below shows the result. As shown the candidate A_1 is the best choice in this group.

Professors	Performance Index	Ranking
A_1	0.77	1
A_2	0.67	2
A_3	0.28	3

Table 2: Performance index and ranking of professors

6. COMPARISON WITH TRADITIONAL AHP METHOD

For the sake of comparison, we use the saaty's traditional AHP method to the same problem. The resulting pairwise comparison matrices for HOD performance with respect to each criterion and criteria importance were obtained individually as follows:

$$C1 = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 9 \\ 1/3 & 1 & 5 \\ 1/9 & 1/5 & 1 \end{bmatrix} \end{array}, \quad C2 = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 1/5 \\ 1/3 & 1 & 9 \\ 5 & 1/9 & 1 \end{bmatrix} \end{array},$$

$$C3 = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 1/9 & 7 \\ 9 & 1 & 1/3 \\ 1/7 & 3 & 1 \end{bmatrix} \end{array}, \quad C4 = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ \begin{bmatrix} 1 & 1/7 & 3 \\ 7 & 1 & 9 \\ 1/3 & 1/9 & 1 \end{bmatrix} \end{array}$$

$$\text{and } W = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & C_3 & C_4 \end{array} \\ \begin{bmatrix} 1 & 3 & 7 & 5 \\ 1/3 & 1 & 9 & 3 \\ 1/7 & 1/9 & 1 & 1/3 \\ 1/5 & 1/3 & 3 & 1 \end{bmatrix} \end{array}$$

The procedure of the AHP for solving these reciprocal matrices is well established [4, 5]. Here we give only the final result in Table 1. According to this also candidate A1 is the best choice.

Professors	Performance Index	Ranking
A_1	0.51	1
A_2	0.37	2
A_3	0.12	3

Table 3: Performance index and ranking of professors with the traditional AHP

7. CONCLUSIONS

The AHP is widely used for tackling multi criteria Analysis (MA) decision problems in real situations. Despite its simplicity in concept and efficiency in computation, it suffers from a few short comings. To improve the AHP method, this study presents and MA approach using the fuzzy pairwise comparison for effectively solving the general MA decision problem involving linguistic (qualitative) data.

The empirical study on the selection of a professor is done with the new approach. The results indicate that the MA problems involving qualitative data.

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