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DESIGN OF FUZZY DECISION SUPPORT SYSTEM (FDSS) IN TECHNICAL EMPLOYEE RECRUITMENT

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Abstract:**Now-a-days employee recruitment is one of the most important assets of any companies. The aim of study is developing a fuzzy decision support system (FDSS) to select appropriate employee in technical field by taking some qualitative judgments of decision makers into consideration. Proposed approach is based on Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. FAHP method is used in determining the weights of the criteria by decision makers and then rankings of the technical employee are determined by TOPSIS method.**

Key words: employee recruitment, Fuzzy Decision Support System, Fuzzy Analytic Hierarchy Process, Fuzzy TOPSIS.

I. INTRODUCTION

Today, the most important human resource factor and its unique role as the strategic recourse in the organization become more tangible than the past time. Finding the best possible candidate who can fit within the culture and contribute in an organization is a challenge and an opportunity. Keeping the best candidate, once we find them, is easy if we do the right things right. These specific actions will help for recruiting and retaining all the talent company need. Employee or personnel performances such as capability, knowledge, skill, and other abilities play an important role in the success of an organization. Numerous topics have been addressed by researchers and a large number of studies have been published in this regard [7, 9, 12 and 13]. The objective of all paper is a selection process which depends mainly on assessing the differences among candidates and predicting the future performance. The selection of qualified candidates for certain posts is one of the most difficult tasks either in larger or smaller companies and requires an organized system.

Indeed, one of the major concerns of Human resource managers is the subject of technical employee recruitment. In the past, organizations had considerably stressed on the employment test. Under many conditions, crisp data are inadequate to model real-life situations. Since human judgment including preferences are often vague and cannot estimate his preference with an exact numerical value. A more realistic approach may be to use linguistic assessments instead of numerical values. With this respect, fuzzy logic gets a position at human resource. As it is mentioned most dimensions of human resource are qualitative variables. Chuu [3] develops fuzzy multiple attribute decision making applied in group decision making to improve the advanced manufacturing technology selection process.The decision support system (DSS) is a computer-based information system that combines models and data in an attempt to solve unstructured problems with extensive user involvement through a friendly user's interface (Laudon,2006). An integrated Fuzzy TOPSIS (FTOPSIS) method is proposed to improve the quality of decision making for ranking alternatives by Ding [6]. FAHP, FTOPSIS methods are used by various researchers [2, 7, 9, 10, 12 and 13] in different selection processes. Nezhad and Damghani [11] proposed an algorithm based on TOPSIS approach and an efficient fuzzy distance measurement for a Fuzzy Multiple Criteria Group Decision-Making Problem which has efficiently been applied in assessment of traffic police centers. Das et. al. [5] presented FTOPSIS in comparing technical institutes. Haldar et. al. [8] presented a simplified Fuzzy TOPSIS method for selecting resilient suppliers. In this paper we are planning to develop a generic fuzzy decision support system which removes the weakness of employment test. Then fuzzy TOPSIS is used to develop a fuzzy decision support system (FDSS). By comparison of conclusion of two mentioned methods, we approved the reliability and validity of FDSS. The remainder of the paper is organized as follows: Section II depicts model design of technical employee recruitment.

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Section III depicts AHP and TOPSIS methodology In the Section IV, V, VI and VII fuzzy multiple criteria decision making (MCDM) methods are discussed. Section VIII and IX depicts the methodology of this research work and problem solving steps. In the last section discussion and conclusion is given.

II. MODEL DESIGN OF TECHNICAL EMPLOYEE RECRUITMENT

In the present work, researchers tried the best to design the framework for technical employee recruitment contrasting the traditional importance of the common employee tests methods. Table 1 shows some of major test criteria which are common in employee recruitment in technical field in an organization. The criteria and sub criteria are adopted from those tests.

Table 1: Major test criteria for technical employee recruitment

Assessment Test	Bio-graphical Test	Integrity Test	Personality Test	Job Knowledge Test
➢ Interpersonal Skill, ➢ Communication Skill, ➢ Planning and Organizing, ➢ Analytical Skill	➢ Education, ➢ Training, ➢ Work experience, ➢ Team work, ➢ Gender, ➢ Age limit	➢ Person honesty, ➢ Dependability, ➢ Reliability, ➢ Pro-social behavior	➢ Optimism, Agreeableness, ➢ Service Orientation, ➢ Stress tolerance, ➢ Emotional stability, ➢ Initiative, ➢ Interpersonal interaction	➢ Technical Expertise, ➢ Professional expertise, ➢ Knowledge for job

III. ANALYTIC HIERARCHY PROCESS (AHP)

The concept of Analytic Hierarchy Process (AHP), was introduced by Saaty (1988), AHP is a robust, multi-criteria decision analysis tool for dealing with complex, unstructured multi-criteria decisions. Subjective weights are determined only according to the preference of decision makers. The comparisons are recorded in a square and reciprocal matrix. The basic steps of AHP are:

(i) Describing a complex decision-making problem as a hierarchy;
(ii) Developing Pair-wise comparison Matrix (PWCM);
(iii) Estimating relative weights of the PWCM elements;
(iv) Checking the consistency of decision variables;

Determination of the Consistency Ratio (C.R.)

An eigen-vector (λ) for each row alternative is computed to determine the Consistency Index (C.I.)

$C.I. = (\lambda_{max} - N) / (N - 1)$……………..(1)

where, 'N' is the dimension of the matrix and 'λ' is the eigen-value. The C.R. for each of the matrices is checked using the following relation:

$C.R. = C.I. / R.I.$…………………….. (2)

where, R.I. is the Random Consistency Index, which depends on the number of alternatives (Ref. Table 2).

Table 2: Random Consistency Index corresponding to order of the matrix

Dimension, n	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The consistency of the pair wise comparison matrix can be measured by calculating a consistency ratio. A consistency ratio of less than 0.1 should be obtained otherwise it should be re-evaluated. However AHP is unable to handle uncertainty decisions in a comparison of the attributes.

IV. FUZZY MULTIPLE CRITERIA DECISION MAKING (MCDM) WITH LINGUISTIC TERMS

The decision problem for selecting a technical employee can be described as a complex, multi-objective task, based on uncertain test, in which the alternatives are the candidates to be selected and the criteria are those attributes under consideration. In traditional MCDM,alternative ratings and weights are measured in crisp numbers that depend on decision makers' judgments. Linguistic variables are used to describe the degrees of a criterion specifically as crisp data are inadequate to model real life situations in MCDM. In practice, alternative ratings and criteria weights cannot be assessed precisely for various reasons, such as: (1) unquantifiable information, (2) unobtainable information, (3) partial ignorance, and (4) incomplete information. Fuzzy MCDM approaches are proposed to deal with the inherent vagueness and imprecision in our study. Bellman and Zadeh [1, 14] first introduced fuzzy set theory into MCDM as an approach for dealing effectively with the inherent imprecision, vagueness and ambiguity of the human decision making process. Fuzzy tools provide a simplified platform where the development and analysis

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of models require reduced development time compared with other approaches. As a result, fuzzy tools are easy to implement and modify.

A linguistic variable is a variable that applies words or sentences in natural or artificial language to describe degrees of value, and we use this kind of expression to compare each criterion by linguistic variables in a fuzzy environment with respect to a seven level fuzzy scale. Triangular fuzzy numbers are used to represent approximate values for selection criteria and are denoted as (a1, b1, c1) where 0≤ a1≤ b1≤ c1≤10. Tables 3 define the linguistic terms and show the membership functions of these linguistic terms as triangular fuzzy numbers.

V. TRIANGULAR FUZZY NUMBER

In applications it is often convenient to work with triangular fuzzy numbers (TFNs) because of their computational simplicity, and they are useful in promoting representation and information processing in a fuzzy environment. A triangular fuzzy number, M is shown in Fig 2:

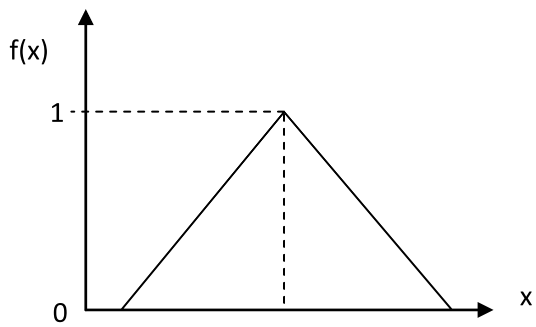

Fig 2. A Triangular fuzzy number, M

Triangular fuzzy numbers form a special class of fuzzy numbers whose membership is defined by three real numbers, expressed as (a, b, c) with membership function given below:

$f_A(x)=(x-a) / (b-a)$ for $a \le x \le b$,

$=(x-c) / (b-c)$ for $b \le x \le c$, $=0$ otherwise (3)

(a) Triangular fuzzy numbers are used in the interval [0,10] for defining the linguistic variables for the importance weight of each criterion.

(b) Linguistic variables used in the interval [0, 10] for defining the linguistic variables for the importance weight of each criterion are shown in Table 3.

Table 3. Linguistic variables and membership in the interval [0,10].

Importance	Abbreviation	Fuzzy number
Very Poor	VP	(0,0,2)
Poor	P	(0.5,2,3.5)
Medium– Poor	MP	(2,3.5,5)
Fair	F	(3.5,5,6.5)
Medium–Good	MG	(5,6.5,8)
Good	G	(6.5,8,9.5)
Very Good	VG	(8,10,10)

VI.SIMPLE AGGREGATE METHOD USING TRIANGULAR FUZZY NUMBER

Assuming a decision group has K persons, the importance of the criteria and the rating of alternative candidates with respect to each criterion can be calculated as:

$$\tilde{\ }_j = \frac{1}{K} [illegible]$$

Where, x_{ij}^{k} and w_j^{K} are the simple aggregate ratings of alternatives and the importance weights of the k^{th} decision maker. (+) indicates the fuzzy arithmetic summation function.

VII. FUZZY TOPSIS USING TRIANGULAR FUZZY NUMBERS

Technical employee recruitment model 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 = {DM1; DM2;…; DMK};
II. A set of m applicants called F = {A; B; C; . . . }
III. A set of n criteria, C = {C1; C2; . . . ; Cn}
IV. A set of s Sub criteria, S = {C11; C12; . . . ; C21; C22;….; C31; C32….}

Step 1: *A fuzzy multi-criteria group decision-making problem can be concisely expressed in matrix format as:*

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} ....(5)$$

$$\tilde{W} = [illegible]$$

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The importance weight of each criterion can be obtained by assigning either directly or indirectly using pairwise comparisons. Decision makers used the linguistic variables shown in Tables 3 to evaluate the importance of the criteria and the ratings of alternatives with respect to various criteria.

Step 2: *The normalized fuzzy decision matrix is formed using Equations (8), (9), (10) and (11) and it is denoted by R:*

$$R_{ij} = [r_{ij}]_{m \times n} ....(7)$$

Where, B and C are the set of benefit criteria and cost criteria, respectively, and

$$\tilde{r}_{ij} \ldots c_j \ldots c_j, \frac{c_{ij}}{c_j^*}), j \in B; ....(8)$$

$$\tilde{r}_{ij} \ldots, \frac{a_j^-}{a_{ij}}), j \in C; ....(9)$$

$$c_j^* = \max_i \; c_{ij}, if \;\; j \in B; ....(10)$$

$$a_j^- = \min_i \; a_{ij}, if \;\; j \in C; ....(11)$$

Step 3: *Now the weighted normalized decision matrix is formed using Equations (12) and (13):*

$$\tilde{V} \ldots [\ldots]_{m \times n} \ldots 1,2,....,n \cdots$$

$$\ldots ....$$

Step 4: Sorting of the fuzzy positive ideal solution (FPIS), A^+ and the fuzzy negative ideal solutions (FNIS), A- are determined using Equations (14) and (15):

$$A^+ = (\ldots) \cdots$$

$$A^- = (\ldots) \cdots$$

Step 5: *Calculation of the separation measure.*

Calculate the distance of each alternative from the positive ideal solution and the negative ideal solution. According to Dalah, et. al., [4] the distance between two triangular fuzzy numbers $A_1 = (a_1,b_1,c_1)$ and $A_2 = (a_2,b_2,c_2)$ is calculated using (16), as:

$$d(A_1, A_2) = \sqrt{\frac{1}{3}(a_1 - a_2) + (b_1 - b_2)^2 + (c_1 - c_2)^2} \cdots$$

$$d_i^+ = \sum_{j=1}^{k} d(\ldots) \quad 2,....,m \quad \cdots\cdots$$

$$d_i^- = \sum_{j=1}^{k} d(\ldots) \quad 2,....,m \quad \cdots\cdots$$

Step 6: *The closeness coefficient (CC_i) for each of the candidate alternatives is determined using equation (17):*

$$CC_i = \frac{d_i^-}{d_i^- + d_i^+}, \quad i = 1, 2, ..., m \quad \cdots$$

VIII. METHODOLOGY

In designing a Fuzzy Decision Support System in Technical Employee Recruitment, the steps are as follows

Step1: Eliminate insignificant Sub-criteria

Step2: Weights of the criteria are determined using AHP.

Step3: Determination of combined weights of the Sub-criteria.

Step4: Determination of Aggregated Fuzzy Weights (AFW) of the alternatives with respect to each sub-criterion.

Step5: Determination of Normalized AFW of alternativeswith respect to each sub-criterion.

Step6: Normalized fuzzy weight of the each sub-criterion.

Step7: Apply Fuzzy TOPSIS to rank candidate alternatives.

Step8: Ranking of the candidate alternatives.

IX. PROBLEM SOLVING

Step1: Reduce the Sub-criteria using AHP

Base on findings, we develop the technical employee recruitment model. By studies of tests, we found five major criteria and twenty three sub-criteria which are shown in Table 1. These criteria and sub-criteria are most emphasized factors at different organization. AHP is used in determining the preference weights of each sub-criterion.We identified the insignificant sub-criteria which has the preference weight less than a cut-off value and removed concerned insignificant sub-criteria. An elimination process of the sub-criteria under Bio-graphical test is demonstrated below:

As the value of preference weight of sub-criteria: Gender, Training, Team Work are very low i.e. less than the predefined cut-off value (0.1), so these three sub-criteria are considered as insignificant. So, the revised preference weights are calculated as:

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Table 5: Revised sub-criteria and corresponding PWCM

Criteria	C1	C2	C3	C4	C5	Preference Weight
C1	1	1/5	1/3	1/4	4	0.08807
C2	5	1	2	2	8	0.40473
C3	3	1/2	1	1/2	4	0.18322
C4	4	1/2	2	1	7	0.28570
C5	1/4	1/8	1/4	1/7	1	0.03826

	Education	Age limit	Work exp.	Pref. wt
Education	1	1/2	3	0.319618
Age limit	2	1	4	0.558425
Work exp.	1/3	1/4	1	0.121957

Those sub-criteria which exceed the cut-off value of preference weight are considered as qualifying sub-criteria for Technical Employee Recruitment designing process.The reduced number of sub-criteria led to nineteen and is shown in Fig 1, in the hierarchical structure of Technical Employee Recruitment Model.

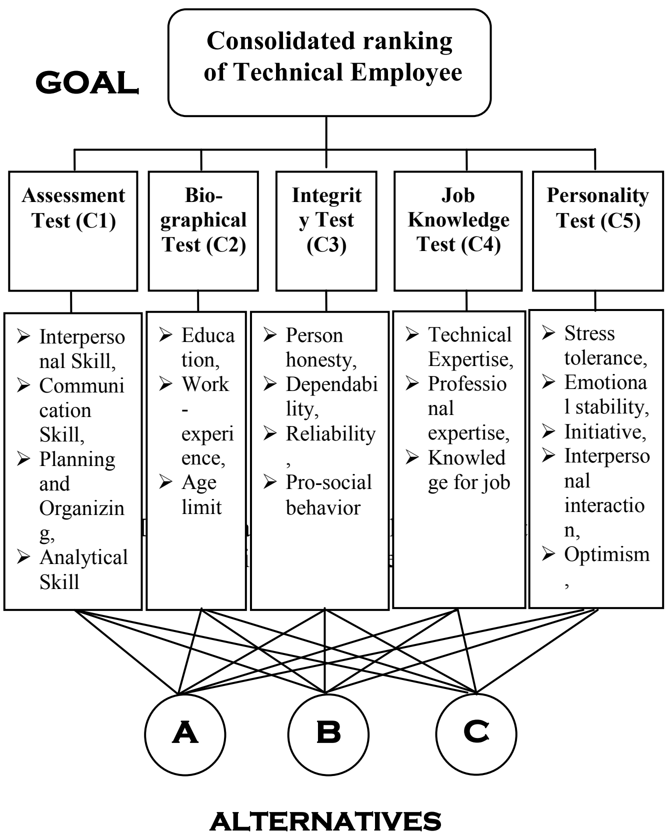

Fig 1: Hierarchical Structure of Finalized Criteria and Sub-criteria

Step2: Determination ofweights of the criteria

The preference weights of selection criterion is calculated using Analytical Hierarchy Process (AHP) and are shown in Table 6.

Table 6: Preference weight of selection criterion

	Education	Age limit	Work exp.	Gender	Training	Team work	Pref. wt
Education	1	2	3	6	6	5	0.376515
Age limit	1/2	1	3	6	6	5	0.299208
Work exp	1/3	1/3	1	4	4	3	0.154769
Gender	1/6	1/6	1/4	1	2	1/2	0.050253
Training	1/6	1/6	1/4	1/2	1	1/4	0.037125
Team work	1/5	1/5	1/3	2	4	1	0.082128

Step3: Combined weights of the Sub-criteria are determined using AHP.

Now preference weights of the sub-criteria are determined using AHP and tabulated in Table 7. The product of criteria weight & sub-criteria weight produces the combined weight of each sub-criterion.

Table 7: Combined preference weight of sub-criterion

Criteria	Sub-Criteria	Weight of criteria	Weight of sub-criteria	Combined weight of each sub-criteria
C1	C11	0.08807	0.11587	0.01020
	C12		0.24685	0.02174
	C13		0.06001	0.00528
	C14		0.57726	0.05083
C2	C21	0.40473	0.31961	0.12935
	C22		0.55842	0.22600
	C23		0.12195	0.04935
C3	C31	0.18322	0.086	0.01575
	C32		0.496	0.09087
	C33		0.289	0.05295
	C34		0.130	0.02381
C4	C41	0.28570	0.5076	0.14502
	C42		0.11326	0.03235
	C43		0.37912	0.10831
C5	C51	0.03826	0.13243	0.00501
	C52		0.23828	0.00911
	C53		0.14534	0.00556
	C54		0.44268	0.01693
	C55		0.04124	0.00157

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Step4: Aggregate Fuzzy Weights of the alternatives with respect to each sub-criterion is determined.

Each DM rates each alternative with respect to each sub-criterion and the results are tabulated in Table 8. DMs recommendations are applied in fuzzy linguistic terms which are converted in fuzzy numbers using Table 3. By applying equations (4) and (5), the aggregate fuzzy weights for DMs (AFW) for each alternative are determined with respect to each sub-criterion and shown in Table 9.

Step5: Normalized AFW of alternativeswith respect to each sub-criterion.
Normalized AFW of each alternativewith respect to each sub-criterion are determined using equation (7) and (9) and tabulated in column 5 of Table 9.

Step6: Normalized fuzzy weight of the each sub-criterion.
Normalized fuzzy weight of the each sub-criterion is determined and is tabulated in column 6 of Table 9.

Step7: Apply Fuzzy TOPSIS to rank candidates.
Now weighted normalized decision matrix is formed using equation (15). As shown in column 7 of Table 9. Table 10 shows Fuzzy weight of applicants comparable to sub-criteria.Fuzzy positive ideal solution (FPIS), A^+ and the fuzzy negative ideal solutions (FNIS), A- are determined using Equations (13) and (14). The separation measure is computed using equation (15), (16) and (17) and shown in Table 11.

Step8: Ranking of the candidate alternatives.
Ranking of the candidate alternatives is done on the basis of closeness coefficient (CC_i) of each of the alternatives are computed using equation (18) which results the ranking of the alternatives.

Table 8: Linguistic terms for each criterion weight and aggregate Fuzzy weight (AFW) of each criterion.

Criteria	Sub Criteria	Alternatives	DM1	DM2	DM3	DM4
C1	C11	A	VP	VG	F	G
		B	G	F	P	VG
		C	MG	G	VG	VP
	C12	A	F	VP	G	P
		B	P	VG	F	G
		C	F	MG	VP	P
	C13	A	VP	F	MG	MP
		B	MP	P	MP	VP
		C	G	F	VP	VG
	C14	A	VP	MP	G	F
		B	F	VP	MP	MG
		C	VG	MP	G	VP
C2	C21	A	MG	G	VP	F
		B	VP	MP	G	G
		C	P	VP	VG	VP
	C22	A	VG	G	F	P
		B	MP	VP	G	VG
		C	F	VG	MG	MP
	C23	A	G	F	VP	VG
		B	P	G	VG	F
		C	MP	VP	P	G
C3	C31	A	VG	VP	G	MG
		B	F	G	MP	VP
		C	VP	MG	VG	F
	C32	A	VG	P	G	VG
		B	MP	G	P	VG
		C	VP	P	VG	P
	C33	A	G	P	MG	P
		B	VG	VP	G	VG
		C	F	MG	P	G
	C34	A	MP	G	VP	MG
		B	G	F	MP	P
		C	VP	VG	F	G
C4	C41	A	F	F	VG	VP
		B	G	MP	P	VG
		C	MG	VP	MP	G
	C42	A	F	MG	G	VP
		B	VP	F	VG	P
		C	F	VG	F	P
	C43	A	F	P	VP	MG
		B	G	MP	P	VP
		C	F	VP	VG	F
C5	C51	A	F	MG	MP	MG
		B	VP	VG	G	VG
		C	VG	F	VP	VG
	C52	A	G	VP	P	F
		B	VG	MP	VP	VG
		C	P	G	MP	VP
	C53	A	F	MG	VG	P
		B	MP	VP	G	F
		C	P	F	VP	MP
	C54	A	VP	P	G	VG
		B	F	MP	P	VP
		C	MG	VP	P	MG
	C55	A	P	F	VG	G
		B	F	P	VP	MP
		C	VP	VG	MG	F

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Table 9: Aggregate value of fuzzy triangular number [0, 10] for each candidate by assessment of decision makerCriteria	Sub Criteria	Alternatives	DM1	DM2	DM3	DM4	AFW of alternatives
C1	C11	A	(0,0,2)	(8,10,10)	(3.5,5,6.5)	(6.5,8,9.5)	(4.5,5.75,7)
		B	(6.5,8,9.5)	(3.5,5,6.5)	(0.5,2,3.5)	(8,10,10)	(4.625,6.25,7.375)
		C	(5,6.5,8)	(6.5,8,9.5)	(8,10,10)	(0,0,2)	(4.875,6.125,7.375)
	C12	A	(3.5,5,6.5)	(0,0,2)	(6.5,8,9.5)	(0.5,2,3.5)	(2.625,3.75,5.375)
		B	(0.5,2,3.5)	(8,10,10)	(3.5,5,6.5)	(6.5,8,9.5)	(4.625,6.25,7.375)
		C	(3.5,5,6.5)	(5,6.5,8)	(0,0,2)	(0.5,2,3.5)	(2.25,3.375,5)
	C13	A	(0,0,2)	(3.5,5,6.5)	(5,6.5,8)	(2,3.5,5)	(2.625,3.75,5.375)
		B	(2,3.5,5)	(0.5,2,3.5)	(2,3.5,5)	(0,0,2)	(1.125,2.25,3.875)
		C	(6.5,8,9.5)	(3.5,5,6.5)	(0,0,2)	(8,10,10)	(4.5,5.75,7)
	C14	A	(0,0,2)	(2,3.5,5)	(6.5,8,9.5)	(3.5,5,6.5)	(3,4.125,5.75)
		B	(3.5,5,6.5	(0,0,2)	(2,3.5,5)	(5,6.5,8)	(2.625,3.75,5.375)
		C	(8,10,10)	(2,3.5,5)	(6.5,8,9.5)	(0,0,2)	(4.125,5.375,6.625)
C2	C21	A	(5,6.5,8)	(6.5,8,9.5)	(0,0,2)	(3.5,5,6.5)	(3.75,4.875,6.5)
		B	(0,0,2)	(2,3.5,5)	(6.5,8,9.5)	(6.5,8,9.5)	(3.75,4.875,6.5)
		C	(0.5,2,3.5)	(0,0,2)	(8,10,10)	(0,0,2)	(2.125,3,4.375)
	C22	A	(8,10,10)	(6.5,8,9.5)	(3.5,5,6.5)	(0.5,2,3.5)	(4.625,6.25,7.375)
		B	(2,3.5,5)	(0,0,2)	(6.5,8,9.5)	(8,10,10)	(4.125,5.375,6.625)
		C	(3.5,5,6.5)	(8,10,10)	(5,6.5,8)	(2,3.5,5)	(4.625,6.25,7.375)
	C23	A	(6.5,8,9.5)	(3.5,5,6.5)	(0,0,2)	(8,10,10)	(4.5,5.75,7)
		B	(0.5,2,3.5)	(6.5,8,9.5)	(8,10,10)	(3.5,5,6.5)	(4.625,6.25,7.375)
		C	(2,3.5,5)	(0,0,2)	(0.5,2,3.5)	(6.5,8,9.5)	(2.25,3.375,5)
C3	C31	A	(8,10,10)	(0,0,2)	(6.5,8,9.5)	(5,6.5,8)	(4.875,6.125,7.375)
		B	(3.5,5,6.5)	(6.5,8,9.5)	(2,3.5,5)	(0,0,2)	(3,4.125,5.75)
		C	(0,0,2)	(5,6.5,8)	(8,10,10)	(3.5,5,6.5)	(4.125,5.375,6.625)
	C32	A	(8,10,10)	(0.5,2,3.5)	(6.5,8,9.5)	(8,10,10)	(5.75,7.5,8.25)
		B	(2,3.5,5)	(6.5,8,9.5)	(0.5,2,3.5)	(8,10,10)	(4.25,5.875,7)
		C	(0,0,2)	(0.5,2,3.5)	(8,10,10)	(0.5,2,3.5)	(2.25,3.5,4.75)
	C33	A	(6.5,8,9.5)	(0.5,2,3.5)	(5,6.5,8)	(0.5,2,3.5)	(3.125,4.625,6.125)
		B	(8,10,10)	(0,0,2)	(6.5,8,9.5)	(8,10,10)	(5.625,7,7.875)
		C	(3.5,5,6.5)	(5,6.5,8)	(0.5,2,3.5)	(6.5,8,9.5)	(3.875,5.375,6.875)
	C34	A	(2,3.5,5)	(6.5,8,9.5)	(0,0,2)	(5,6.5,8)	(3.375,4.5,6.125)
		B	(6.5,8,9.5)	(3.5,5,6.5)	(2,3.5,5)	(0.5,2,3.5)	(3.125,4.625,6.125)
		C	(0,0,2)	(8,10,10)	(3.5,5,6.5)	(6.5,8,9.5)	(4.5,5.75,7)
C4	C41	A	(3.5,5,6.5)	(3.5,5,6.5)	(8,10,10)	(0,0,2)	(3.75,5,6.25)
		B	(6.5,8,9.5)	(2,3.5,5)	(0.5,2,3.5)	(8,10,10)	(4.25,5.875,7)
		C	(5,6.5,8)	(0,0,2)	(2,3.5,5)	(6.5,8,9.5)	(3.375,4.5,6.125)
	C42	A	(3.5,5,6.5)	(5,6.5,8)	(6.5,8,9.5)	(0,0,2)	(3.75,4.875,6.5)
		B	(0,0,2)	(3.5,5,6.5)	(8,10,10)	(0.5,2,3.5)	(3,4.25,5.5)
		C	(3.5,5,6.5)	(8,10,10)	(3.5,5,6.5)	(0.5,2,3.5)	(3.875,5.5,6.625)
	C43	A	(3.5,5,6.5)	(0.5,2,3.5)	(0,0,2)	(5,6.5,8)	(2.25,3.375,5)
		B	(6.5,8,9.5)	(2,3.5,5)	(0.5,2,3.5)	(0,0,2)	(2.25,3.375,5)
		C	(3.5,5,6.5)	(0,0,2)	(8,10,10)	(3.5,5,6.5)	(3.75,5,6.25)

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C5	C51	A	(3.5,5,6.5)	(5,6.5,8)	(2,3.5,5)	(5,6.5,8)	3.875,5.375,6.875)
		B	(0,0,2)	(8,10,10)	(6.5,8,9.5)	(8,10,10)	(5.625,7,7.875)
		C	(8,10,10)	(3.5,5,6.5)	(0,0,2)	(8,10,10)	(4.875,6.25,7.125)
	C52	A	(6.5,8,9.5)	(0,0,2)	(0.5,2,3.5)	(3.5,5,6.5)	(2.625,3.75,5.375)
		B	(8,10,10)	(2,3.5,5)	(0,0,2)	(8,10,10)	(4.5,5.875,6.75)
		C	(0.5,2,3.5)	(6.5,8,9.5)	(2,3.5,5)	(0,0,2)	(2.25,3.375,5)
	C53	A	(3.5,5,6.5)	(5,6.5,8)	(8,10,10)	(0.5,2,3.5)	(4.25,5.875,7)
		B	(2,3.5,5)	(0,0,2)	(6.5,8,9.5)	(3.5,5,6.5)	(3,4.125,5.75)
		C	(0.5,2,3.5)	(3.5,5,6.5)	(0,0,2)	(2,3.5,5)	(1.5,2.625,4.25)
	C54	A	(0,0,2)	(0.5,2,3.5)	(6.5,8,9.5)	(8,10,10)	(3.75,5,6.25)
		B	(3.5,5,6.5)	(2,3.5,5)	(0.5,2,3.5)	(0,0,2)	(1.5,2.625,4.25)
		C	(5,6.5,8)	(0,0,2)	(0.5,2,3.5)	(5,6.5,8)	(2.625,3.75,5.375)
	C55	A	(0.5,2,3.5)	(3.5,5,6.5)	(8,10,10)	(6.5,8,9.5)	(4.625,6.25,7.375)
		B	(3.5,5,6.5)	(0.5,2,3.5)	(0,0,2)	(2,3.5,5)	(1.5,2.625,4.25)
		C	(0,0,2)	(8,10,10)	(5,6.5,8)	(3.5,5,6.5)	(4.125,5.375,6.625)

Table 10: Fuzzy weight of applicants comparable to sub-criteria

Criteria	Sub Criteria	Alternatives	AFW of alternatives	Normalized AFW of alternatives (NAFW)	Normalized weight of Sub-criteria (NWSC)	Multiplication of NAFW and NWSC
C1	C11	A	(4.5,5.75,7)	(0.610169, 0.779661, 0.949153)	(0.0102, 0.0102,0.0102)	(0.006224,0.007953,0.009681)
		B	(4.625,6.25,7.375)	(0.627119, 0.847458, 1)		(0.006397,0.008644,0.0102)
		C	(4.875,6.125,7.375)	(0.661017,0.830508,1)		(0.006742,0.008471,0.0102)
	C12	A	(2.625,3.75,5.375)	(0.355932,0.508475,0.728814)	(0.0217, 0.0217, 0.0217)	(0.007724,0.011034,0.015815)
		B	(4.625,6.25,7.375)	(0.627119,0.847458,1)		(0.013608,0.01839,0.0217)
		C	(2.25,3.375,5)	(0.305085,0.457627,0.677966)		(0.00662,0.009931,0.014712)
	C13	A	(2.625,3.75,5.375)	(0.375,0.535714,0.767857)	(0.0052, 0.0052, 0.0052)	(0.00195,0.002786,0.003993)
		B	(1.125,2.25,3.875)	(0.160714,0.321429,0.553571)		(0.000836,0.001671,0.002879)
		C	(4.5,5.75,7)	(0.642857,0.821429,1)		(0.003343,0.004271,0.0052)
	C14	A	(3,4.125,5.75)	(0.45283,0.622642,0.867925)	(0.0508, 0.0508, 0.0508)	(0.023004,0.03163,0.044091)
		B	(2.625,3.75,5.375)	(0.396226,0.566038,0.811321)		(0.020128,0.028755,0.041215)
		C	(4.125,5.375,6.625)	(0.622642,0.811321,1)		(0.03163,0.041215,0.0508)
C2	C21	A	(3.75,4.875,6.5)	(0.576923,0.75,1)	(0.1293, 0.1293, 0.1293)	(0.074596,0.096975,0.1293)
		B	(3.75,4.875,6.5)	(0.576923,0.75,1)		(0.074596,0.096975,0.1293)
		C	(2.125,3,4.375)	(0.326923,0.461538,0.673077)		(0.042271,0.059677,0.087029)
	C22	A	(4.625,6.25,7.375)	(0.627119,0.847458,1)	(0.226, 0.226, 0.226)	(0.141729,0.191525,0.226)
		B	(4.125,5.375,6.625)	(0.559322,0.728814,0.898305)		(0.126407,0.164712,0.203017)
		C	(4.625,6.25,7.375)	(0.627119,0.847458,1)		(0.141729,0.191525,0.226)
	C23	A	(4.5,5.75,7)	(0.610169,0.779661,0.949153)	(0.0493, 0.0493, 0.0493)	(0.030081,0.038437,0.046793)
		B	(4.625,6.25,7.375)	(0.627119,0.847458,1)		(0.030917,0.04178,0.0493)
		C	(2.25,3.375,5)	(0.305085,0.457627,0.677966)		(0.015041,0.022561,0.033424)
C3	C31	A	(4.875,6.125,7.375)	(0.709091,0.890909,1)	(0.0157, 0.0157, 0.0157)	(0.011133,0.013987,0.0157)
		B	(3,4.125,5.75)	(0.436364,0.6,0.836364)		(0.006851,0.00942,0.013131)
		C	(4.125,5.375,6.625)	(0.6,0.781818,0.963636)		(0.00942,0.012275,0.015129)
	C32	A	(5.75,7.5,8.25)	(0.69697,0.909091,1)	(0.0908, 0.0908, 0.0908)	(0.063285,0.082545,0.0908)
		B	(4.25,5.875,7)	(0.515152,0.712121,0.848485)		(0.046776,0.064661,0.077042)
		C	(2.25,3.5,4.75)	(0.272727,0.424242,0.575758)		(0.024764,0.038521,0.052279)
	C33	A	(3.125,4.625,6.125)	(0.396825,0.587302,0.777778)	(0.0529, 0.0529, 0.0529)	(0.020992,0.031068,0.041144)
		B	(5.625,7,7.875)	(0.714286,0.888889,1)		(0.037786,0.047022,0.0529)
		C	(3.875,5.375,6.875)	(0.492063,0.68254,0.873016)		(0.02603,0.036106,0.046183)
	C34	A	(3.375,4.5,6.125)	(0.482143,0.642857,0.875)	(0.0238, 0.0238, 0.0238)	(0.011475,0.0153,0.020825)
		B	(3.125,4.625,6.125)	(0.446429,0.660714,0.875)		(0.010625,0.015725,0.020825)
		C	(4.5,5.75,7)	(0.642857,0.821429,1)		(0.0153,0.01955,0.0238)
C4	C41	A	(3.75,5,6.25)	(0.535714,0.714286,0.892857)	(0.145, 0.145,	(0.077679,0.103571,0.129464)

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		B	(4.25,5.875,7)	(0.607143,0.839286,1)	0.145)	(0.088036,0.121696,0.145)
		C	(3.375,4.5,6.125)	(0.482143,0.642857,0.875)		(0.069911,0.093214,0.126875)
	C42	A	(3.75,4.875,6.5)	(0.566038,0.735849,0.981132)	(0.0323, 0.0323, 0.0323)	(0.018283,0.023768,0.031691)
		B	(3,4.25,5.5)	(0.45283,0.641509,0.830189)		(0.014626,0.020721,0.026815)
		C	(3.875,5.5,6.625)	(0.584906,0.830189,1)		(0.018892,0.026815,0.0323)
	C43	A	(2.25,3.375,5)	(0.36,0.54,0.8)	(0.1083, 0.1083, 0.1083)	(0.038988,0.058482,0.08664)
		B	(2.25,3.375,5)	(0.36,0.54,0.8)		(0.038988,0.058482,0.08664)
		C	(3.75,5,6.25)	(0.6,0.8,1)		(0.06498,0.08664,0.1083)
C5	C51	A	3.875,5.375,6.875)	(0.492063,0.68254,0.873016)	(0.005, 0.005, 0.005)	(0.00246,0.003413,0.004365)
		B	(5.625,7,7.875)	(0.714286,0.888889,1)		(0.003571,0.004444,0.005)
		C	(4.875,6.25,7.125)	(0.619048,0.793651,0.904762)		(0.003095,0.003968,0.004524)
	C52	A	(2.625,3.75,5.375)	(0.388889,0.555556,0.796296)	(0.0091, 0.0091, 0.0091)	(0.003539,0.005056,0.007246)
		B	(4.5,5.875,6.75)	(0.666667,0.87037,1)		(0.0060670.00792,0.0091)
		C	(2.25,3.375,5)	(0.333333,0.5,0.740741)		(0.003033,0.00455,0.006741)
	C53	A	(4.25,5.875,7)	(0.607143,0.839286,1)	(0.0055, 0.0055, 0.0055)	(0.003339,0.004616,0.0055)
		B	(3,4.125,5.75)	(0.428571,0.589286,0.821429)		(0.002357,0.003241,0.004518)
		C	(1.5,2.625,4.25)	(0.214286,0.375,0.607143)		(0.001179,0.002063,0.003339)
	C54	A	(3.75,5,6.25)	(0.6,0.8,1)	(0.0169, 0.0169, 0.0169)	(0.01014,0.01352,0.0169)
		B	(1.5,2.625,4.25)	(0.24,0.42,0.68)		(0.004056,0.007098,0.011492)
		C	(2.625,3.75,5.375)	(0.42,0.6,0.86)		(0.007098,0.01014,0.014534)
	C55	A	(4.625,6.25,7.375)	(0.627119,0.847458,1)	(0.0015, 0.0015, 0.0015)	(0.000941,0.001271,0.0015)
		B	(1.5,2.625,4.25)	(0.20339,0.355932,0.576271)		(0.000305,0.000534,0.000864)
		C	(4.125,5.375,6.625)	(0.559322,0.728814,0.898305)		(0.000839,0.001093,0.001347)

Table 11: Determining separation measure (FPIS and FNIS)

Table 12: Computations of $\sum d^+$, $\sum d^-$ and CC_i

Alternatives	$\sum d^+$	$\sum d^-$	$\sum d^+ + \sum d^-$	CC_i	Rank
A	0.1182	0.1452	0.2635	0.5512	1
B	0.1380	0.1300	0.2681	0.4850	2
C	0.1509	0.0825	0.2334	0.3535	3

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X. CONCLUSION

This paper introduced TOPSIS in a fuzzy environment for evaluating the candidates of technical employee recruitment process. Using fuzzy theory, measuring the importance of technical employees for a company can reduce ambiguities and uncertainties that are inherent in the performance measurement procedure of traditional approaches. In this hybrid approach, a triangular fuzzy number is used for evaluating the employee on the basis of technical attributes possessed by the candidates. The distance of each fuzzy number from both the Fuzzy Positive Ideal Solution (FPIS) and the Fuzzy Negative Ideal Solution (FNIS) are calculated. Then, the ranking orders of the candidates for the technical attributes are measured on the basis of closeness ratio (CR_i).

Criteria	Sub-Criteria	FPIS(A+)	FNIS(A-)
C1	C11	(0.0067, 0.0086, 0.0102)	(0.0062, 0.0079, 0.0096)
	C12	(0.0136, 0.0183, 0.0217)	(0.0066, 0.0099, 0.0147)
	C13	(0.0033, 0.0042 ,0.0052)	(0.0019, 0.0016, 0.0028)
	C14	(0.0316, 0.0412, 0.0508)	(0.0201, 0.0287, 0.0412)
C2	C21	(0.0745, 0.0969, 0.1293)	(0.0422, 0.0596, 0.0870)
	C22	(0.1417, 0.1915, 0.226)	(0.1264, 0.1647, 0.2030)
	C23	(0.0014, 0.0018, 0.0023)	(0.0150, 0.0225, 0.0334)
C3	C31	(0.0111, 0.0139, 0.0157)	(0.0068, 0.0094, 0.0131)
	C32	(0.0632, 0.0825, 0.0908)	(0.0247, 0.0385, 0.0522)
	C33	(0.0377 ,0.0470, 0.0529)	(0.0209, 0.0310, 0.0411)
	C34	(0.0153, 0.0195, 0.0238)	(0.0106, 0.0153, 0.0208)
C4	C41	(0.0880, 0.1216, 0.145)	(0.0699, 0.0932, 0.1268)
	C42	(0.0188, 0.0268, 0.0323)	(0.0146, 0.0207, 0.0268)
	C43	(0.0649, 0.0866, 0.1083)	(0.0389, 0.0584, 0.0866)
C5	C51	(0.0035, 0.0044, 0.005)	(0.0024, 0.0034, 0.0043)
	C52	(0.0060, 0.0079, 0.0091)	(0.0030, 0.0045, 0.0067)
	C53	(0.0033, 0.0046, 0.0055)	(0.0011, 0.0020, 0.0033)
	C54	(0.0101, 0.0135, 0.0169)	(0.0040, 0.0070, 0.0114)
	C55	(0.0009, 0.0012, 0.0015)	(0.0003, 0.0005, 0.0008)

For evaluating the weights of each criterion, the ratings of each alternative are made in linguistic terms by decision makers, represented as triangular fuzzy numbers. The process contradicts the traditional evaluation process by considering the flexibility in rating the importance of alternatives in the evaluation process. The methodology adopted here is a sound alternative in a conflicting, unstructured, multi-criteria environment. However, thorough investigation is required to improve this methodology as both frameworks and criteria for decision making may deviate widely depending on the context.

References

[1] Bellman, R. E., and Zadeh, L. A., Decision-making in a fuzzy environment management. Science, 17, pp. 141–164, 1970.

[2] Chang, C.W., Wu, C.R. and Lin, H.L., Applying fuzzy hierarchy multiple attributes to construct an expert decision making process, Expert Systems with Applications, 36, pp. 7363–7368, 2009.

[3] Chuu, S. J., Selecting the advanced manufacturing technology using fuzzy multiple attributes group decision making with multiple fuzzy information. Computers & Industrial Engineering, 57, pp. 1033–1042, 2009.

[4] Dalah, D., Hayajneh, M., & Bateieha, F., A fuzzy multicriteria decision making model for supplier selection. Expert Systems with Applications, 38, pp. 8384–8391, 2011.

[5] Das, M.C., Sarkar, B. and Ray, S., Comparative evaluation of Indian technical institutions using distance based approach method", Benchmarking: An International Journal, 20(5), pp. 568 – 587, 2013.

[6] Ding, J. F., An integrated fuzzy TOPSIS method for ranking alternatives and its application. Journal of Marine Science and Technology, 19 (4), pp. 341–352, 2011.

[7] Gungor, Z., Serhadlıoglu, G. and Kesen, S. E., A fuzzy AHP approach to personnel selection problem, Applied Soft Computing 9, pp. 641–646, 2009.

[8] Haldar A., Ray A., Banerjee D. and Ghosh S., Resilient supplier selection under a fuzzy environment, International Journal of Management Science and Engineering Management, 9(2), pp. 147-156, 2014.

[9] Kilincci, O. and Onal, A.S., Fuzzy AHP approach for supplier selection in a washing machine company, Expert Systems with Applications 38, pp. 9656–9664, 2011.

[10] Naghadehi, M.Z., Mikaeil, R. and Ataei, M., The application of fuzzy analytic hierarchy process (FAHP) approach to selection of optimum underground mining method for Jajarm Bauxite Mine, Iran, Expert Systems with Applications 36, pp. 8218–8226, 2009.

[11] Nezhad, S.S., Damghani, K.K., Application of a fuzzy TOPSIS method base on modified preference ratio and fuzzy distance measurement in assessment of traffic police centers performance, Applied Soft Computing, 10 (4), pp. 1028–1039, 2010.

[12] Nobari, S. M., Design of Fuzzy Decision Support System (FDSS) in employee recruitment, J. Basic. Appl. Sci. Res., 1(11) pp. 1891-1903, 2011.

[13] Wang, W.P., A fuzzy linguistic computing approach to supplier evaluation, Applied Mathematical Modelling, 34, pp. 3130–3141, 2010.

[14] Zadeh, L. A., The concept of linguistic variable and its application to approximate reasoning, Information Science, 8, pp. 199–249, 1975.