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COMPARATIVE STUDY OF BIPOLAR FUZZY SOFT CATEGORY ACTION FOR ASSISTANT PROFESSOR RECRUITMENT IN GOVERNMENT SECTORS

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ABSTRACT

The Bipolar fuzzy soft techniques represent the recruitment of Assistant Professor as a multi-criteria group decision making process which involves subjectivity, imprecision and fuzziness. Here we have applied the score and accuracy functions, the hybrid score accuracy functions of bipolar fuzzy soft numbers (BFSNS) and ranking method for BFSNS. To rank the alternatives and recruit the most desirable professors, we use the overall evaluation formula of the weighted hybrid score accuracy functions for each alternative. To illustrate the effectiveness of the proposed model, the education problem for assistant professor selection is provided. Therefore we compare this result with TOPGREY Algorithm.

Keywords: *Soft set, bipolar Fuzzy soft set (BFSS), bipolar fuzzy soft number (BFSN), Decision making, hybrid score and accuracy function.*

1. INTRODUCTION

Recruitment process can be regarded as a multi-criteria group decision making (MCGDM) problem that generally consists of the selection of the most desirable alternative from all the feasible alternatives. Classical MCGDM approaches [1, 5, 9] deal with non fuzzy numbers that is the ratings and the weights of criteria are measured by crisp numbers. However, to present the information by crisp numbers is not always possible. The fuzzy sets introduce by Zadeh in 1965 [18] can be used in order to deal this situation. Compared to a fuzzy set a bipolar approach is more general and suitable way to deal with imprecise information, Bosc and Pivert [3] said that "Bipolarity refers to the propensity of the human mind to reason and make decisions on the basis of positive and negative effects and the positive information states what is possible, satisfactory, permitted, desired or considered as being acceptable. Whereas the negative statements express what is impossible, rejected or forbidden. Thus, Lee [12, 13] has introduced the concept of bipolar fuzzy sets which is a generalization of the fuzzy sets. At recent times, many authors or algebraic structures study the bipolar fuzzy models. J.Chen *et.al* [4] has studied the m-polar fuzzy set and has illustrated how many concepts have been defined on bipolar fuzzy sets. Many results have been examined, related to these concepts which can be generalized to the case of m-polar fuzzy set and illustrates how many results which are related to these concepts which can be generalized to the case of m-polar fuzzy sets. To show how to apply m-polar fuzzy sets in real world problems, numerical examples are also being proposed. P.Bosc and O.Pivert [3] has introduced a study called the bipolar fuzzy relations where each tuple associates with a pair of satisfactory degrees, bipolar value fuzzy [1, 2] – ideal and bipolar valued fuzzy ideal. M.Zhou and S.Li[17] has introduced a new frame work of bipolar fuzzy set semi rings and bipolar fuzzy ideals which is a generalization of the fuzzy set semi rings and the bipolar fuzzy ideals in semi rings and bipolar fuzzy ideals, respectively and the related properties are being examined by the authors. Assistant professor Recruitment process for higher education is regarded as a special case of personnel selection. Liang and M.J.Wang [11] study about the fuzzy multi criteria decision making (MCDM) algorithm for the purpose of personnel selection.

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Karsak [10] has presented the fuzzy MCDM approach based on the ideal and the anti ideal solutions for the selection of the most suitable candidate Z.Gunor [8] has developed the analytical hierarchy process (AHP) for the sake of personnel selection. M.DagDeviren[6] has studied about the hybrid model based on the analytical network process (ANP) and has modified the technique for order preference by similarity to ideal solution for supporting the personnel selection process in the manufacturing systems. M.Sursun and E.E.Karsak [7] discusses the fuzzy MCDM approach by using Topsis with Tuples for the process of personnel selections. IT. Robinson and B.Smith [16] investigate the role of top analysis, the contemporary models of work performance, and the set of criteria which has been employed in the personnel selection process.

In this paper, we use the score functions, accuracy functions and the hybrid score accuracy functions of bipolar fuzzy soft numbers (BFSNS) and ranking method for BFSNS. Also we analyze to the degree of grey relations among all professors and $BF\alpha IS$ (Bipolar fuzzy α ideal solution) and $BF\beta IS$ (Bipolar fuzzy β ideal solution) is calculated. Comparison is also evaluated for effectiveness of the appointment.

2. SOME BASIC CONCEPTS OF BIPOLAR FUZZY SOFT SETS

Definition 2.1: A bipolar fuzzy subset (briefly, BF-subset), A in a non-empty set X is an object having the form

$$A = \{(x, \mu_A^+(x), \mu_A^-(x)) / x \in X\} \text{where } \mu_A^+ : X \to [0, 1] \text{ and } \mu_A^- : X \to [-1, 0]$$

The positive membership degree μ_A^+ denote the satisfaction of an element x to the property corresponding to a BF – subset A and the negative membership degree μ_A^- denotes the satisfaction degree of X to some implicit counter property of BF – subset A. Bipolar fuzzy sets and Intuitmistic fuzzy set look similar to each other. However, they are different from each other.

Definition 2.2: Suppose that U is an initial Universe set and E is a set of parameters. Let P(U) denotes the power set of U. A pair (F, E) is called a soft set over U where F is a mapping given by F: E →P(U). Clearly, a soft set is a mapping from parameters to P(U) and it is not a set, but a parameterized family of subsets of the universe.

Definition 2.3: Let U be an initial Universe Set and E be the set of parameters. Let A⊂E. A pair (F, A) is called fuzzy soft set over U where F is a mapping given by F: $A \to I^U$. Where I^U denotes the collection of all fuzzy subsets of U.

Definition 2.4: Let U be an initial Universe and E be the set of parameters. Suppose that A is subset of E. Define F: A→BFU, where BFU is the collection of all bipolar fuzzy subset of U, then (F, A) is said to be a bipolar fuzzy of soft set over U and it is denoted by

$$(F, A) = A = \{(x, \mu_e^+(x), \mu_e^-(x)) / x \in U \text{ and } e \in A\}$$

Example: Let U= $\{c_1, c_2, c_3\}$ be the set of 3 objects under consideration and E=$\{e_1$=high, e_2=Low, e_3=Medium$\}$ be the set of parameters. Suppose that A= $\{e_1, e_2, e_3\}$ is subset of E. Then

$$(F, A) = \left\{\begin{array}{l} F(e_1) = \{(c_1,0.3,-0.7), (c_2,0.4,-0.3), (c_3,0.2,-0.5)\} \\ F(e_2) = \{(c_1,0.3,-0.2), (c_2,0.7,-0.2), (c_3,-0.4,-0.3)\} \\ F(e_3) = \{(c_1,-0.7,-0.3), (c_2,0.4,-0.6), (c_3,0.3,-0.2)\} \end{array}\right\}$$

Definition 2.5: Let U be a Universe and E a set of attributes. Then (U, E) is the collection of all bipolar fuzzy soft sets on U with attributes from E and is said to be bipolar fuzzy soft class.

Definition 2.6: A bipolar fuzzy soft set (F, A) is said to be a null bipolar fuzzy soft set denoted by ϕ, if for all e∈A, F(e) = ϕ

Definition 2.7: A bipolar fuzzy soft set (F, A) is said to be an absolute bipolar fuzzy soft set, if for all e∈A, F(e)= BFU.

3. RANKING METHODS FOR BFSNS

In this subsection, we define the score function, accuracy function and hybrid score accuracy function of a BFSN and the ranking method for BFSNS.

Definition 3.1: [Score function and accuracy function]

Let x = <P(x), N(x)> be a BFSN. Then the score function and accuracy function of the BFSN can be presented respectively as follows.

Score function $$S(x) = \frac{1+P(x)-N(x)}{2}, \quad \text{for } S(x) \in [-1,1] \tag{1}$$

Accuracy function $$h(x) = \frac{2+P(x)-N(x)}{3}, \quad \text{for } h(x) \in [-1,1] \tag{2}$$

Based on score and accuracy functions for BFSNS, two remarks are stated below.

Remark 1: For any two BFSNS x_1 and x_2, if $x_1 > x_2$, then $S(x_1) > S(x_2)$

Remark 2: For any two BFSNS x_1 and x_2, if $S(x_1) = S(x_2)$ and $x_1 \geq x_2$, then $h(x_1) \geq h(x_2)$

Based on Remarks 1 and 2, a ranking method between BFSNS can be given by the following definition.

Definition 3.2: Let x_1 and x_2 is two BFSNS. Then the ranking method can be defined as follows. (i) if $S(x_1) > S(x_2)$, then $x_1 > x_2$, (ii) if $S(x_1) = S(x_2)$ and $h(x_1) \geq h(x_2)$, then $x_1 \geq x_2$.

4. IMPORTANT PARAMETERS OF THE TERM STATED IN THE PROBLEM

- **(i) Academic performance:** This implies the percentage of marks (if grades are given, transform it into marks) obtained in post graduate examinations.
- **(ii) Teaching Aptitude:** Degree of knowledge in strategies of institution and information communication technology.
- **(iii) Subject Knowledge:** Degree of knowledge of a person in his/her respective field of study to be delivered during his/her instruction.
- **(iv) Research experience:** Research experience of a person implies his/her contribution of new knowledge in the form of publication is reputed peer reviewed journals with highly impact factor.
- **(v) Leadership quality:** A leadership quality of a person to maintain and control the team members and giving effectiveness through their academic.

5. GROUP DECISION MAKING METHOD IN BIPOLAR FUZZY SOFT SETTING

In a multi criteria group decision making problem, let $A = \{A_1, A_2,...,A_m\}$ be a set of alternatives and $C=\{c_1, c_2,...,c_n\}$ be a set of attributes. In the group decision process under bipolar fuzzy soft environment if a group of t decision makers or experts is required in the evaluation process, then the k^{th} decision maker can provide the evaluation information of the alternative A_i (i=1, 2,...,m) on the attribute c_j (j=1,2,...,n) which is represented by the form of a BFSNS

$$A_i^k = \{<c_j\ P_{Ai}^k(c_j),\ N_{Ai}^k(c_j)> / c_j \in C\}$$

When $P_{Ai}^k(c_j) \in [0,1]$ and $N_{Ai}^k(c_j) \in [-1,0]$ for k = 1, 2,...,t, j=1, 2,...,n, i=1,2,...,m for convenience, $X_{ij}^k = <P_{ij,}^k N_{ij}^k>$ is denoted as BFSNS A_i^k(k = 1, 2,...,t, j=1,2,...,n, i=1,2,...,m), therefore, we can get the k^{th} Bipolar fuzzy soft decision matrix $D^k = (A_{ij}^k)_{mxn}$(k = 1,2,...,t), then the group decision making method is described as follows.

ALGORITHM-1

Step-1: Calculate hybrid score accuracy matrix: The hybrid score accuracy matrix $Y^k = (Y_{ij}^k)_{m\times n}$(k = 1,2,...,t, j=1,2,...,n, i=1,2,...,m), is obtained from the decision matrix D^k by the following formula.

$$(Y_{ij}^k) = \frac{1}{2}\alpha\ (1+ P_{ij}^k - N_{ij}^k) + \frac{1}{3}(1-\alpha)\ (2+ P_{ij}^k - N_{ij}^k) \tag{3}$$

Step-2: Calculate the average matrix: From step-1, the average matrix $Y^* = (Y_{ij}^*)_{m\times n}$ (k = 1,2,...,t, j=1,2,...,n, i=1,2,...,m), is calculated by

$$Y_{ij}^* = \frac{1}{t}\sum_{k=1}^{t}(Y_{ij}^k) \tag{4}$$

Step-3: The collection correlation coefficient between Y^k (k=1, 2,...,t) and Y represents as follows

$$\rho_k = \sum_{i=1}^{m}\frac{\sum_{j=1}^{n} Y_{ij}^k Y_{ij}^*}{\sqrt{\sum_{j=1}^{n}(Y_{ij}^k)^2}\sqrt{\sum_{j=1}^{n}(Y_{ij}^*)^2}} \tag{5}$$

Step-4: Determination of Decision makers weights: The weight model for decision makers can be defined as:

$$\lambda_k = \frac{\rho_k}{\sum_{k=1}^{t-1} \rho_k} \tag{6}$$

Where $0 \leq \lambda_k \leq 1, and \sum_{k=1}^{t} \lambda_k = 1$ for k =1, 2,...,t

Step-5: Calculate collective hybrid score accuracy matrix: For the weight vector $\lambda = (\lambda_1, \lambda_2, \lambda_3,...,\lambda_k)$ of decision makers obtained from step-4, we collect all the individual hybrid score accuracy matrices of $Y^k = \left(Y_{ij}^k\right)_{m\times n}$ (k = 1,2,...,t,j=1,2,...,n,i=1,2,…,m), in to a collective hybrid score accuracy matrix $Y = \left(Y_{ij}\right)_{m\times n}$by the following formula

$$Y_{ij} = \sum_{k=1}^{t} \lambda_k Y_{ij}^k \tag{7}$$

Step-6: Weight model for attributes: To determine the weight vector of the attributes J.Ye [14, 15], introduced the following optimization method

$$\text{Max } W = \frac{1}{m} \sum_{j=1}^{n} \sum_{i=1}^{m} W_j Y_{ij}$$

$$\text{Subject to } \sum_{j=1}^{n} W_j = 1 \text{ and } Wj > 0 \tag{8}$$

This is a linear programming problem which can be easily solved to determine the weight vector of the attributes $W = (W_1, W_2, W_3, ...,W_n)^T$.

Step-7: Ranking alternatives : To rank alternative, we can sum all values is each row of the collective hybrid score accuracy matrix corresponding to the attributes weights by the overall weighted hybrid score accuracy value of each alternative A_i (i=1,2,…,m)

$$M(A_i) = \sum_{j=1}^{n} W_j Y_{ij} \tag{9}$$

According to the overall hybrid score accuracy values of M (A_i) (i=1,2,…,m). We can rank alternative A_i (i=1, 2,….,m) in descending order and choose the best one.

6. NUMERICAL EXAMPLE

Suppose that a Manonmaniam Sundaranar University is going to recruit in the post of Assistant Professors for a particular subject. After initial screening, five candidates (that is alternatives) A_1, A_2, A_3, A_4, A_5 remain for further evaluation.

A committee of four decision makers or exports D_1, D_2, D_3, D_4 has been formed to conduct the interview and select the most appropriate candidate, five criteria obtained from expert opinions, namely, Academic performance - (C_1), Subject knowledge - (C_2), Teaching aptitude - (C_3), Research Experience- (C_4), Leadership Quality- (C_5) are considered for recruitment criteria of four experts are required in the evaluation process, then the five possible alternatives A_i (i=1,2,...,5) are evaluated by the form of BFSNS. Under the five attributes on the fuzzy concept **"Excellence"** thus the four bipolar valued fuzzy soft decision matrices can be obtained from the four experts and expressed respectively as follows
(See table 1, 2, 3, 4).

Table – 1: Bipolar valued fuzzy soft decision matrix (D_1)

	C_1	C_2	C_3	C_4	C_5
A_1	[0.8, -0.4]	[0.6, -0.3]	[0.7, -0.2]	[0.5, -0.3]	[0.4, -0.3]
A_2	[0.8,-0.6]	[0.6, -0.5]	[0.7, -0.4]	[0.5, -0.2]	[0.4, -0.2]
A_3	[0.8, -0.3]	[0.6, -0.4]	[0.7, -0.1]	[0.5, -0.1]	[0.4, -0.1]
A_4	[0.8, -0.1]	[0.6, -0.2]	[0.7, -0.3]	[0.5, -0.4]	[0.4, -0.4]
A_5	[0.8, -0.2]	[0.6, -0.1]	[0.7, -0.1]	[0.5, -0.3]	[0.4, -0.3]

Table – 2: Bipolar valued fuzzy soft decision matrix (D_2)

	C_1	C_2	C_3	C_4	C_5
A_1	[0.6, -0.4]	[0.7, -0.4]	[0.5, -0.3]	[0.4, -0.3]	[0.6, -0.5]
A_2	[0.6, -0.3]	[0.7, -0.5]	[0.5, -0.4]	[0.4, -0.2]	[0.6, -0.4]
A_3	[0.6, -0.2]	[0.7, -0.3]	[0.5, -0.3]	[0.4, -0.1]	[0.6, -0.3]
A_4	[0.6, -0.1]	[0.7, -0.1]	[0.5, -0.1]	[0.4, -0.2]	[0.6, -0.2]
A_5	[0.6, -0.1]	[0.7, -0.2]	[0.5, -0.2]	[0.4, -0.1]	[0.6, -0.1]

Table – 3: Bipolar valued fuzzy soft decision matrix (D_3)

	C_1	C_2	C_3	C_4	C_5
A_1	[0.4, -0.2]	[0.5, -0.4]	[0.6, -0.5]	[0.7, -0.6]	[0.8, -0.5]
A_2	[0.4, -0.1]	[0.5, -0.3]	[0.6, -0.3]	[0.7, -0.5]	[0.8, -0.6]
A_3	[0.4, -0.3]	[0.5, -0.2]	[0.6, -0.2]	[0.7, -0.4]	[0.8, -0.5]
A_4	[0.4, -0.2]	[0.5, -0.1]	[0.6, -0.1]	[0.7, -0.3]	[0.8, -0.4]
A_5	[0.4, -0.1]	[0.5, -0.3]	[0.6, -0.5]	[0.7, -0.2]	[0.8, -0.3]

Table – 4: Bipolar valued fuzzy soft decision matrix (D_4)

	C_1	C_2	C_3	C_4	C_5
A_1	[0.6, -0.5]	[0.7, -0.6]	[0.8, -0.6]	[0.5, -0.4]	[0.4, -0.1]
A_2	[0.6, -0.4]	[0.7, -0.5]	[0.8, -0.5]	[0.5, -0.3]	[0.4, -0.3]
A_3	[0.6, -0.3]	[0.7, -0.4]	[0.8, -0.6]	[0.5, -0.2]	[0.4, -0.2]
A_4	[0.6, -0.4]	[0.7, -0.3]	[0.8, -0.5]	[0.5, -0.1]	[0.4, -0.3]
A_5	[0.6, -0.5]	[0.7, -0.2]	[0.8, -0.4]	[0.5, -0.3]	[0.4, -0.1]

Step -1: Form the Hybrid Score Accuracy Matrix for D_1

Table – 5: Form the Hybrid Score Accuracy Matrix for D_1

	C_1	C_2	C_3	C_4	C_5
A_1	1.083	0.958	0.958	0.916	0.875
A_2	1.166	1.066	1.041	0.875	0.833
A_3	1.0416	1.000	0.9166	0.833	0.7916
A_4	0.958	0.916	1.000	0.958	0.875
A_5	1.000	0.875	1.008	0.916	0.833

Table – 6: Form the Hybrid Score Accuracy Matrix for D_2

	C_1	C_2	C_3	C_4	C_5
A_1	1.0416	0.916	1.041	0.875	1.166
A_2	1.083	0.875	0.958	0.833	1.125
A_3	1.000	0.958	1.000	0.791	1.083
A_4	0.958	0.916	0.916	0.875	1.041
A_5	0.916	0.875	0.875	0.791	1.000

Table –7: Form the Hybrid Score Accuracy Matrix for D_3

	C_1	C_2	C_3	C_4	C_5
A_1	0.833	0.958	1.041	1.125	1.125
A_2	0.791	0.916	0.958	1.083	1.166
A_3	0.875	0.875	0.916	1.041	1.125
A_4	0.833	0.833	0.875	1.000	1.083
A_5	0.791	0.916	1.041	0.958	1.0.41

Table – 8: Form the Hybrid Score Accuracy Matrix for D_4

	C_1	C_2	C_3	C_4	C_5
A_1	1.041	1.125	1.166	0.958	0.791
A_2	1.000	1.083	1.125	0.916	0.875
A_3	0.958	1.041	1.166	0.875	0.833
A_4	1.000	1.000	1.125	0.833	0.875
A_5	1.041	0.958	1.083	1.000	0.916

Step-2: Calculate the average matrix: From Step 2 of algorithm 1, we can calculate the average matrix by using the formula

$$Y_{ij}^{*} = \frac{1}{t}\sum_{k=1}^{t}\left(Y_{ij}^{k}\right)$$

Table Calculation

	C_1	C_2	C_3	C_4
A_1	0.958	1.007	1.016	1.016
A_2	0.996	0.974	0.982	0.999
A_3	0.916	0.966	0.966	0.974
A_4	0.941	0.941	0.924	0.966
A_5	0.926	0.891	0.949	0.999

Step-3: Collection of Correlation Coefficient: The Correlation coefficient

$$\rho_k = \sum_{i=1}^{m}\frac{\sum_{j=1}^{n} Y_{ij}^{k} Y_{ij}^{*}}{\sqrt{\sum_{j=1}^{n}(Y_{ij}^{k})^2}\sqrt{\sum_{j=1}^{n}(Y_{ij}^{*})^2}}$$

Using this formula we obtain the values of

$\rho_1 = 4.981$, $\rho_2 = 4.979$, $\rho_3 = 4.981$, $\rho_4 = 4.958$

Step-4: Determination of Decision makers weights

$$\lambda_k = \frac{\rho_k}{\sum_{k=1}^{t-1}\rho_k}$$

In this Equation we determine the weight decision four makers as follows.

$\lambda_1 = 0.2507$, $\lambda_2 = 0.2501$, $\lambda_3 = 0.2503$ $\lambda_4 = 0.2491$

Step-5: Calculate collective hybrid score – accuracy matrix

$$Y_{ij} = \sum_{k=1}^{t}\lambda_k Y_{ij}^{k}$$

Using this formula we can obtain the hybrid score accuracy matrix.

	C_1	C_2	C_3	C_4	C_5
A_1	0.998	0.9892	1.0515	0.9687	0.9896
A_2	1.0103	0.9851	1.0206	0.9269	1.000
A_3	0.9689	0.9686	0.9996	0.8852	0.9584
A_4	0.9374	0.9163	0.9063	0.9168	0.9688
A_5	0.9374	0.9061	1.001	0.9163	0.9476

Step-6: Weight model for attributes: Assume that The information above attributes weights is incompletely known weight vectors $0.1 \le w_1 \le 0.2$, $0.1 \le w_2 \le 0.2$, $0.1 \le w_3 \le 0.2$, $0.1 \le w_4 \le 0.2$, which is given decision makers. By linear programming model in equation (8) we can obtained the weight vectors W = [0.2, 0.2, 0.2, 0.2, 0.2]

Step-7: Ranking Alternative: From The above weighted vectors the ranking alternatives is given by M (A_i), (i=1,2,...,5) as follows $M(A_1) = 0.9997$, $M(A_2) = 0.9885$, $M(A_3) = 0.9554$, $M(A_4) = 0.9291$, $M(A_5) = 0.9414$. The preference for ranking order of alternatives are $A_1 > A_2 > A_3 > A_5 > A_4$. Hence A_1 is the best assistant professor for the selection in Government sectors. By similar computation procedures, we can get various different ways for different α values.

7. TOPGREY ANALYSIS METHOD

In this section we have presented a new method namely top grey. This is the extension of the idea of new types of Grey Relation based on techniques of order preference by simplifying ideal solution (TOPSIS) for selection of best Assistant Professor recruitment and it appears to be more appropriate. Also we analyze the degree of grey relation among every professors and $BF\alpha IS$ and $BF\beta IS$ is calculated. In Grey Relational analysis, its coefficient $\xi - \left(R_{ij}\right)$ can be expressed as follows

$$\left(R_{ij}\right) = \xi = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{x_i(k)} + \rho\Delta_{\max}} \tag{10}$$

Here ρ to be fixed value between 0 and 1.For simplicity of representation $\left|H^{\alpha}(j) - H_i(j)\right|$ and $\left|H^{\beta}(j) - H_i(j)\right|$ will be represented Δ_i^{α} and Δ_i^{β} respectively. After evaluating ξ of equation (10), separation measurements will be calculated according to the following formula

$$M_i^{\alpha} = \frac{1}{n}\sum_{j=1}^{n} R_{ij}^{\alpha}, \quad for\ i = 1, 2, 3, ..., m.$$

$$M_i^{\beta} = \frac{1}{n}\sum_{j=1}^{n} R_{ij}^{\beta}, \quad for\ i = 1, 2, 3, ..., m.$$

Now we will give the operations of proposed method. The main procedure of this method is presented in the following steps.

TOPGREY RELATION ALGORITHAM-2:

Step-1: Let us choose the problem

Step-2: By choosing Linguistic Rooting values, from the weighted bipolar fuzzy parameter matrix D.

Step-3: Form weighted normalized bipolar fuzzy parameter matrix P and construct Weighted Vector

$$W = \left(w_1, w_2, w_3, ..., w_n\right).$$

Step-4: Construct bipolar fuzzy decision matrices D_k for each decision makers and find bipolar fuzzy average decision matrix.

Step-5: Build of weighted bipolar fuzzy decision matrix R.

Step-6: Finding bipolar fuzzy valued α -ideal solution$\left(BF\alpha IS\right)$ and bipolar fuzzy valued β -ideal solution$\left(BF\beta IS\right)$.

Step-7: Evaluating of the Measurement $\left(M_i^{\alpha}, M_i^{\beta}\right)$ for each parameter.

Step-8: Finding the relative closeness C_i^{α} of alternative to the ideal solution by using the formula

$$C_i^{\alpha} = \frac{M_i^{\alpha}}{M_i^{\alpha} + M_i^{\beta}}$$

Step-9: Arrange the Ranking preference order.

Step-1: In the same previous Numerical Example (section 6), we apply the given topgrey algorithm.

Step-2: In this problem we have same Linguistic terms such as.

LINGUISTIC TERM FOR EVALUATION OF PARAMETER:

Linguistic term	Bipolar fuzzy values
High(H)	[0.81 , - 0.4]
Very High(VH)	[0.90 , - 0.6]
Low(L)	[0.60 , - 0.3]
Very Low(VL)	[0.40 , - 0.2]
Medium(M)	[0.50 , - 0.4]

Step-3: Construct a weighted bipolar fuzzy parameter matrix P is as follows:

$$P = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & C_4 & C_5 \end{array} \\ \begin{bmatrix} [0.6,-0.3] & [0.4,-0.2] & [0.9,-0.6] & [0.81,-0.4] & [0.5,-0.4] \\ [0.9,-0.6] & [0.81,-0.4] & [0.5,-0.4] & [0.6,-0.2] & [0.4,-0.2] \\ [0.5,-0.4] & [0.6,-0.3] & [0.81,-0.2] & [0.4,-0.2] & [0.9,-0.6] \\ [0.4,-0.2] & [0.9,-0.6] & [0.6,-0.3] & [0.5,-0.4] & [0.81,-0.4] \\ [0.81,-0.4] & [0.5,-0.4] & [0.4,-0.2] & [0.9,-0.6] & [0.6,-0.3] \end{bmatrix} \end{array}$$

And the weighted vector W= (0.4, -0.2, 0.41, -0.112, 0.51)

Step-4: Bipolar valued fuzzy soft decision matrices D_1, D_2, D_3 and D_4 (Table) refer Section 6 from the problem. The average weighted bipolar fuzzy decision matrix is given by

$$V = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} [0.6,-0.375] & [0.625,-0.425] & [0.65,-0.40] & [0.525,-0.40] & [0.55,-0.350] \\ [0.6,-0.350] & [0.625,-0.450] & [0.65,-0.40] & [0.525,-0.30] & [0.55,-0.375] \\ [0.6,-0.270] & [0.625,-0.325] & [0.65,-0.30] & [0.525,-0.20] & [0.55,-0.275] \\ [0.6,-0.200] & [0.625,-0.175] & [0.65,-0.25] & [0.525,-0.25] & [0.55,-0.325] \\ [0.6,-0.220] & [0.625,-0.200] & [0.65,-0.30] & [0.525,-0.225] & [0.55,-0.200] \end{bmatrix} \end{array}$$

Step-5: We construct Weighted Bipolar fuzzy decision matrix R as follows

$$R = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} [0.13,-0.02] & [0.15,-0.06] & [0.21,-0.07] & [0.43,-0.02] & [0.41,-0.08] \\ [0.14,-0.03] & [0.22,-0.05] & [0.26,-0.03] & [0.31,-0.03] & [0.36,-0.07] \\ [0.15,-0.01] & [0.17,-0.07] & [0.16,-0.04] & [0.21,-0.07] & [0.39,-0.06] \\ [0.03,-0.05] & [0.21,-0.04] & [0.24,-0.06] & [0.11,-0.04] & [0.47,-0.05] \\ [0.12,-0.04] & [0.25,-0.03] & [0.22,-0.05] & [0.17,-0.05] & [0.29,-0.09] \end{bmatrix} \end{array}$$

Step-6: Bipolar fuzzy valued α -ideal solution $(BF\alpha IS)$ and bipolar fuzzy valued β -ideal solution $(BF\beta IS)$ is as follows

$$H^{\alpha} = H^{\alpha}(1) = 0.15, H^{\alpha}(2) = 0.25, H^{\alpha}(3) = 0.26, H^{\alpha}(4) = 0.43, H^{\alpha}(5) = 0.47,$$
$$H^{\beta}(1) = -0.03, H^{\beta}(2) = -0.03, H^{\beta}(3) = -0.03, H^{\beta}(4) = -0.02, H^{\beta}(5) = -0.05.$$

Table: Construction as $BF\alpha IS$

(0.02,-0.03)	(0.1,-0.03)	(0.05,-0.04)	(0, 0)	(0.06,-0.03)
(0.01,-0.02)	(0.03,-0.02)	(0, 0)	(0.12,-0.01)	(0.11,-0.02)
(0, 0)	(0.08,-0.04)	(0.1,-0.01)	(0.22,-0.05)	(0.08,-0.01)
(0.12,-0.04)	(0.04,-0.01)	(0.02,-0.03)	(0.32,-0.02)	(0, 0)
(0.03,-0.03)	(0, 0)	(0.04,-0.02)	(0.26,-0.03)	(0.2,-0.04)

Step-7: The separation measurement individual measurement $\left(M_i^{\alpha}, M_i^{\beta}\right)$ for each parameter is obtained as follows. Grey Relation values of (GRV) each alternative to the α-ideal $I\left(H_{ij}{}^{\alpha}, H_i(j)\right)$ and β-ideal $I\left(H_{ij}{}^{\beta}, H_i(j)\right)$, $I\left(H^{\alpha}(j), H_i(j)\right)$, $I\left(H^{\beta}(j), H_i(j)\right)$ solution can be followed as below

$l = GLB\ \Delta_i^{\alpha}$, $m = GLB\ \Delta_i^{\beta}$, $L = LUB\ \Delta_i^{\alpha}$, $M = LUB\ \Delta_i^{\beta}$, $l^* = GLB\left\{\ GLB\ \Delta_i^{\alpha}\right\}$,
$m^* = GLB\left\{\ GLB\ \Delta_i^{\beta}\right\}$, $L^* = LUB\left\{\ LUB\ \Delta_i^{\alpha}\right\}$, $M^* = LUB\left\{\ LUB\ \Delta_i^{\beta}\right\}$. Also grey Relational coefficient R_{ij} is obtained by equation (1)

$$\left(R_{ij}\right) = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{x_i(k)} + \rho\Delta_{\max}}$$

By choosing ρ =0.5, we have

	C_1	C_2	C_3	C_4	C_5	l	L
A_1	0.75	0.333	0.5	1	0.478	**0.333**	1
A_2	0.857	0.666	1	0.571	0.352	**0.352**	1
A_3	1	0.578	0.523	0.421	0.578	**0.421**	1
A_4	0.571	0.8	0.88	0.33	1	**0.33**	1
A_5	0.812	1	0.764	0.38	0.393	**0.38**	1
l^*						**0.33**	
L^*							1

Also we have the ideal solution is calculated as

Table calculation (2)

	C_1	C_2	C_3	C_4	C_5
A_1	0.01	0.4	0.3	1	0.66
A_2	0.5	0.5	1	0.714	0.453
A_3	1	0.384	0.66	0.33	0.714
A_4	0.33	0.66	0.4	0.55	1
A_5	0.4	1	0.5	0.454	0.33

After calculative, equation (1) separation measurements M_i^{α} and M_i^{β} will be calculated from the i^{th} requirement, $(i = 1,2,3,4,5)$.

$$M_1^{\alpha} = 0.6116,\ M_2^{\alpha} = 0.6890,\ M_3^{\alpha} = 0.6200,\ M_4^{\alpha} = 0.7160,\ M_5^{\alpha} = 0.6690$$
$$M_1^{\beta} = 0.480,\ M_2^{\beta} = 0.633,\ M_3^{\beta} = 0.6177,\ M_4^{\beta} = 0.588,\ M_5^{\beta} = 0.536$$

Step-8: Now we calculate according to relative closeness C_i^α formula

$$C_i^\alpha = \frac{M_i^\alpha}{M_i^\alpha + M_i^\beta}$$

$$C_1^\alpha = 0.56002,\ C_2^\alpha = 0.5211,\ C_3^\alpha = 0.5012,\ C_4^\alpha = 0.549,\ C_5^\alpha = 0.555.$$

Step-9: Ranking alternative: Arrange the ranking reference order from step (8) is given by

$$C_1^\alpha > C_5^\alpha > C_4^\alpha > C_2^\alpha > C_3^\alpha$$

$$A_1 > A_5 > A_4 > A_3 > A_2$$

Hence A_1 is the best Assistant Professor using TOPGREY Analysis method. Comparing these two algorithms, we have come to one conclusion, both algorithm, gives the same solution.

CONCLUSION

In this paper we employ the score and accuracy function, hybrid score accuracy functions of BFSNS to recruit best professor for higher education, under bipolar fuzzy soft Environment, where the weights of decision makers are completely unknown and the weights of attributes are incompletely known. Also comparatively algorithm has to be verified with the help of TOPGREY analysis and obtain the best way of selecting professors.

SCOPE FOR FURTHER RESEARCH

In future, one can obtain the extension and application of the methods to other domains, such as best row material selection for industries.

REFERENCES

1. R. D. Arvey, and J. E. Campion. the employment interviews: A summary and review of recent research, personnel psychology, 35(2) (1982), 281-322.
2. K Atanassov, Intuitionistic Fuzzy sets, Fuzzy sets and systems 20(1986), 87-96.
3. P.Bosc, O.Pivert, on a fuzzy by polar relational algebra, Information sciences, 219 (2013), 1-16.
4. J.Chen, S.Liu, Ma and X.Wong, m-polar fuzzy sets, An extension of Bipolar fuzzy sets, the scientific world journal (2014).
5. M.A.campion, E.D.pursell and B.K.Brown, structured interviewing, raising the psychometric properties of the employment interview, personnel psychology, 41(1) (1988), 25-42.
6. M.Dagdeviren, A hybrid multi criteria decision making model for personnel selection in manufacturing system. Journal of intelligent manufacturing, 21 (2010), 451 -460.
7. M. Dursun, E.E. Karsak, A fuzzy MCDM approach for personnel selection, Expert systems with applications, 37 (2010), 4324 – 4330.
8. Z.Gunor, G.Serhadliongu and S.E.Kesen, A fuzzy Attribute approach to personnel selection problem, Applied soft computing, 9 (2009), 641-646.
9. L.Hwang and M.J.Lin, Group decision making under multiple criteria, methods and application Springer verlog, Heidelberg, 1987.
10. E.E. Karsak, personnel selection using a fuzzy MCDM approach based on ideal and anti-ideal solutions, lecture notes in Economics and Mathematical systems, 507 (2001), 393-402.
11. S.L.Liang and M.J.wang, personnel selection using fuzzy MCDMalgorithm, European journal of operational Research, 78(1994), 22-23.
12. K.M.Lee, Bi-polar valued fuzzy sets and their operations Proc.Int.Conf.Intel.Tech. Bengkokthailand, (2000), 307-312.
13. K.M.Lee, comparison of inter valued fuzzy sets, Intuitionistic Fuzzy sets and bipolar valued fuzzy sets, J.Korean institute of intelligence system (412) (2004), 125-129.
14. J.Ye. Multiple attribute group decision making methods with unknown weights based on hybrid score accuracy function under simplified neutrosophic environment unpublished work.
15. J.Ye. Multiple attribute group decision making methods with unknown weights in Intuitionistic Fuzzy sets and in travel valued Intuitionistic Fuzzy sets international journal of General system 42 (5), (2013), 489-502.
16. I.T. Robinson and B.Smith personnel selection, journal of Occupational and organizational, psychology, 74 (2001), 441-472.

17. M.Zhou, S.Li Application of Bipolar fuzzy sets in semi-rings, journal of mathematical research and application. Vol. 34, 1 (2014), 61-72.
18. L.A.Zadeh, Fuzzy sets Information and control 8 (1965), 338-353.
19. P.K.Maji, R.Biswos and A.R.Roy, Fuzzy soft sets J.FuzzyMaths 9 (3) (2001) 589-602.
20. D.A.Molodtsov, Soft set theory, First Result, Computational mathematical application. 37 (1999), 19-31.

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