

Human Resource Recruitment using Fuzzy Decision Making Method

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Abstract— Traditional way of recruiting personnel was through a group decision making problem under multiple criteria containing subjectivity, imprecision and vagueness. In order to keep up with increasing competition of globalization and fast technological improvements and changes, Human resource field needs the best fit employee for a job vacancy. This paper proposes a Fuzzy Decision Making (FDM) method for recruitment process of Human Resource management, which is based on the Fuzzy set theory. Different criteria of human resource recruitment process will be given fuzzy linguistic terms such as absolutely low, extremely low, very low, low, medium, high, very high, extremely high, absolutely high depends upon the importance given by the Human Resource manager. Fuzzy Scaled Weight (FSW) will be calculated for all the criteria. Cumulative Fuzzy Value (CFV) is calculated for all the applicants from Fuzzy Scaled Weight values. Interview Fuzzy Value (IFV) is given by the human resource manager for all the applicants attending interviews. Final Fuzzy Value (FFV) will be calculated aggregating both Cumulative Fuzzy Value and Interview Fuzzy Value. Finally, all the applicant records are arranged in the order of FFV values. Then, Human resource manager can select the applicants easily from the arranged list. Fuzzy Decision Making method system is developed to illustrate the above FDM method for the Human Resource recruitment process.

Key words: Fuzzy Multi-Attribute Decision Making Method, Linguistic Variables, Fuzzy Numbers, Fuzzy Set

I. INTRODUCTION

Human resource field requires more strict selection to ensure the best human resource for their company. It is a big challenge to create a system that helps the human resource manager to make their work easier without missing an opportunity to get the best employee. In order to make work easier for Human resource managers, we proposed Fuzzy Decision Making method for Human Resource recruitment process in this paper. A human resource recruitment decision is always made based on the available data and information of applicants that are vague, imprecise and uncertain by nature. The decision making process in the recruitment of employees in human resource management is one of these typical occasions. The nature of vagueness, imprecision and uncertainty is fuzzy rather than random in the decision making process. Fuzziness comes from the lack of precise boundaries in some subsets of data and information considered in a given situation. The Fuzzy multi-attribute Decision Making method offers a possibility of handling these sorts of data and information involving the subjective characteristics of human nature in the decision making process, which is mostly true in real world.

The primary aim of this paper is to propose a Fuzzy Decision Making method applicable to the decision making of recruitment process that involves several ill-defined

decision criteria. In the method, two main key concepts are employed: linguistic variables and fuzzy numbers. Linguistic variables such as absolutely low, extremely low, very very low, very low, low, more or less low, medium, more or less high, high, very high, very very high, extremely high, absolutely high are used to represent the importance weights of the decision criteria under consideration. Then these linguistic variables are translated into the corresponding fuzzy triangular numbers to facilitate the arithmetic operation. Then, Fuzzy Scaled Weight (FSW) is calculated for all the decision criteria. To calculate Cumulative Fuzzy Value (CFV) from all the FSW values Equation (11) is applied. Aggregating both Interview Fuzzy Value (IFV) and Cumulative Fuzzy Value (CFV) for all the applicants, Final Fuzzy Value (FFV) is calculated using Equation (12). Then, Human Resource manager can select suitable applicants for his organization, by arranging all the applicants using FFV values. The rest of the paper is organized as follows. The review of literature is described in section 2. Section 3 describes the basic concepts of Fuzzy sets. Section 4 describes the steps in the Fuzzy Decision Making Method (FDM). Section 5 describes the human resource recruitment application using FDM. Section 6 illustrates FDM method for recruiting Sales Manager. Section 7 describes the Conclusion.

II. LITERATURE REVIEW

Petrovic-Lazarevic, 2001 used the hesitation margin to deal with vagueness in Human Resource recruitment process and assign different priority weights of each criteria and attributes. Ruskova, N.A., 2002 presents a Decision Support System (DSS) based on fuzzy logic model for Human Resources Appraisal and Selection. The proposed DSS can be used in Web-based human resource solutions. Aras Keropyan and Gil-Lafuente, 2011 demonstrate the effects of different decision styles on strategic decisions. They proposed the fuzzy methodology approach to examine the relations between decision making styles and strategic management processes when there is uncertainty. Gulcin Buyukozkan, Gizem Cifci, 2011 developed a novel approach based on fuzzy analytic network process within multi-person decision-making for supplier selection with incomplete information. They analyze the sustainability of a number of suppliers in a real-life problem to demonstrate the validity of the proposed evaluation model. Ghodrattollah Talaei, 2012 proposed the Fuzzy logic approach in human resources management to make decisions meaningfully. He demonstrated the human resource recruitment process using the Fuzzy-TOPSY method. Sabina Nobari et al, 2012 introduced a model of fuzzy decision support systems for Iran Khodro Company to improve the human resource recruitment process. Ramadan Krebish et al, 2013 developed a decision making and evaluating system for employee recruitment using fuzzy analytic hierarchy process. The proposed system retrieves only important data such as age,

gender, education, work experience, and desired salary. It retrieves the condition of desired employee from human resource department. Finally, their proposed human resource system provides the fittest applicant to the available job vacancy.

III. BASIC CONCEPTS OF A FUZZY SETS

The theory of fuzzy sets was proposed by Zadeh in 1965 (Zadeh L.A., 1965). Let U be the universe of discourse, $U = \{u_1, u_2, \dots, u_n\}$. A fuzzy set N in the universe of discourse U can be represented by

$$N = \{u_i, f_N(u_i) \mid u_i \in U\} \quad (1)$$

Let N and L be two fuzzy sets of the universe of discourse U , $U = \{u_1, u_2, \dots, u_n\}$ and let f_N and f_L be the membership functions of the fuzzy sets N and L , respectively, where $f_N : U \rightarrow [0,1]$,

$f_L : U \rightarrow [0,1]$, $N = \{u_i, f_N(u_i) \mid u_i \in U\}$, and $L = \{u_i, f_L(u_i) \mid u_i \in U\}$. The union of the fuzzy sets N and L , denoted as $N \cup L$, is defined by

$$N \cup L = \{u_i, f_{N \cup L}(u_i) \mid f_{N \cup L}(u_i) = \text{Max}(f_N(u_i), f_L(u_i)), u_i \in U\} \quad (2)$$

The intersection of the fuzzy sets N and L , denoted as $N \cap L$, is defined by

$$N \cap L = \{u_i, f_{N \cap L}(u_i) \mid f_{N \cap L}(u_i) = \text{Min}(f_N(u_i), f_L(u_i)), u_i \in U\} \quad (3)$$

The cardinality $|N|$ of the fuzzy set N is defined by

$$|N| = \sum_{i=1}^n f_N(u_i) \quad (4)$$

A fuzzy number is a fuzzy subset in the universe of discourse U that is both convex and normal. The simplified arithmetic operations of triangular fuzzy numbers are described here:

Let E and L be two triangular fuzzy numbers, where

$$E = (a_1, b_1, c_1) \\ L = (a_2, b_2, c_2)$$

1) Fuzzy Numbers Addition \oplus :

$$E \oplus L = (a_1, b_1, c_1) \oplus (a_2, b_2, c_2) \\ = (a_1 + a_2, b_1 + b_2, c_1 + c_2) \quad (5)$$

2) Fuzzy Numbers Subtraction

$$E \ominus L = (a_1, b_1, c_1) \ominus (a_2, b_2, c_2) \\ = (a_1 - c_2, b_1 - b_2, c_1 - a_2) \quad (6)$$

3) Fuzzy Numbers Multiplication \otimes :

$$E \otimes L = (a_1, b_1, c_1) \otimes (a_2, b_2, c_2) \\ = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2) \quad (7)$$

4) Fuzzy Numbers Division \oslash :

$$E \oslash L = (a_1, b_1, c_1) \oslash (a_2, b_2, c_2) \\ = (a_1/c_2, b_1/b_2, c_1/a_2) \quad (8)$$

IV. FUZZY DECISION MAKING METHOD

The Fuzzy Decision Making method consists of two main steps: 1) representation of the decision problem, 2) Fuzzy set evaluation of the decision criteria.

A. Representation of the Decision Problem

The starting point to solve a decision problem is to define the problem. The proposed Fuzzy Decision Making Method consists of 3 activities as follows: 1) identifying the decision goal; 2) identifying a set of the decision criteria.

The goal is for what post in the organisation the HR manager will apply Fuzzy multi-attribute Decision Making method. If n decision criteria are identified, the set of the criteria is defined as follows: $C = \{C_t \mid t = 1, 2, \dots, n\}$.

B. Fuzzy Set Evaluation of the Decision Criteria

This step consists of 3 activities: 1) choosing sets of the preference weights using linguistic variables for the importance of the decision criteria; and 2) evaluating the importance weights of the criteria and 3) aggregating the weights of the decision criteria. In general, the sets of the preference ratings consist of 3 elements: the linguistic variable x representing the importance weights of the decision criteria under consideration; term set $G(x)$ representing the ratings of linguistic variables; and membership function corresponding to each element of the term set. As an example, the preference ratings for the importance weights of the decision criteria can be defined as follows: $G(\text{importance}) = \{ \text{Absolutely Low, Extremely Low, Very Very Low, Very Low, Low, More or Less Low, Medium, More or Less High, High, Very High, Very Very High, Extremely High, Absolutely High} \}$

Using the sets of the preference ratings, certain ratings are assigned to the decision criteria respectively by the decision-maker. After the assignment of the ratings, the membership function will be matched to each rating for the fuzzy arithmetic operation. (Li Li, Ze-Shui Xu, 2006). The triangular fuzzy numbers are used as membership functions corresponding to the elements in term set. The reason of using triangular fuzzy number is that it is easy to be used by the decision-maker. The triangular fuzzy number is denoted as follows:

$$f_M(x) = \begin{cases} \frac{(x-a)}{(b-a)}, & a \leq x \leq b, \\ \frac{(x-c)}{(b-c)}, & b \leq x \leq c, \\ 0, & \text{otherwise} \end{cases} \quad (9)$$

Let W_t be the triangular fuzzy number of the decision criterion C_t , F_t be the fuzzy membership value of the decision criterion C_t , and X_t be the Fuzzy Scaled Weight (FSW) of the decision criterion C_t that is obtained by fuzzy multiplication of F_t and W_t . I have applied the fuzzy arithmetic operations to calculate the Fuzzy Scaled Weight (FSW) value for all the criteria considered and calculate Cumulative Fuzzy Value (CFV). (Fuzzy arithmetic operations are discussed in section 2).

Let say Fuzzy triangular number weight of the criterion C_1 be (a_1, b_1, c_1) and Fuzzy membership set for the criterion C_1 be (F_i, F_b, F_c) of any applicant, FSW value X_i for the criterion C_1 is calculated as the following:

$$X_i = \frac{((a_1, b_1, c_1) \otimes (F_i, F_b, F_c))}{(a_1, b_1, c_1)} \quad (10)$$

For finding out the Cumulative Fuzzy Value (CFV) for n criteria, the following formula can be applied

$$CFV = \frac{\sum_{i=1}^n F_i \cdot W_i}{\sum_{i=1}^n W_i} \quad (11)$$

Substituting F_i and W_i with triangular fuzzy numbers, we can calculate Cumulative Fuzzy Value (CFV) triangular value all the applicants for the particular post they applied. After calculating Cumulative Fuzzy Value (CFV) triangular values for all the applicants, Final Fuzzy Value (FFV) is calculated aggregating both Interview Fuzzy Value (IFV) and Cumulative Fuzzy Value (CFV) triangular values depends upon the weights assigned respectively by the HR manager using the following formula. (Li Li, Ze-Shui Xu,2006)

$$FFV = \frac{(CFV \otimes W_1) \oplus (IFV \otimes W_2)}{(W_1 \oplus W_2)} \quad (12)$$

Assume that Cumulative Fuzzy Value (CFV) and Interview Fuzzy Value (IFV) are (0.9,0.9,0.9), (0.3,0.3,0.3) respectively. By applying fuzzy multiplication, we will obtain the following result :

$$\begin{aligned} K &= (0.9,0.9,0.9) \otimes W_1 \oplus (0.3,0.3,0.3) \otimes W_2 \\ &= (0.9,0.9,0.9) \otimes (a_1,b_1,c_1) \oplus (0.3,0.3,0.3) \otimes (a_2,b_2,c_2) \\ &= (0.9 a_1, 0.9 b_1, 0.9 c_1) \oplus (0.3 a_2, 0.3 b_2, 0.3 c_2) \\ &= (0.9 a_1 + 0.3 a_2, 0.9 b_1 + 0.3 b_2, 0.9 c_1 + 0.3 c_2) \end{aligned}$$

Then, we can use a defuzzification method to defuzzify the triangular fuzzy number K into a crisp value. Assume that K is a triangular fuzzy number, $K=(x,y,z)$ and $DEF(K)$ denotes the defuzzified value of the triangular fuzzy number K , then

$$DEF(K) = \frac{(x+2y+z)}{4} \quad (13)$$

Finally, HR manager can pick up the suitable applicants by arranging FFV values in the descending order.

V. APPLICATION

As a case study, the proposed method is applied for selecting the most suitable applicants who applied for the post of sales manager. It should be noted that all the assignments in this section are for illustrative purpose only. The actual steps taken in this study are summarized as follows:

A. Step 1: Representation of the Decision Problem

The decision goal is to select the most suitable applicants for the post of sales manager. Seven decision criteria are identified as follows: $C = \{C_1, C_2, C_3, C_4, C_5, C_6, C_7\}$, where $C_1 =$ age, $C_2 =$ qualification, $C_3 =$ experience, $C_4 =$ languages known, $C_5 =$ IT skills, $C_6 =$ Expected and Current Salary. The decision criteria are defined as follows: $C = \{Age, Qualification, Experience, Languages Known, IT Skills, Expected and current salary, Vehicle Owned\}$. Decision making method is illustrated in the figure 2.

B. Step 2: Fuzzy Set Evaluation of the Decision Criteria:

The linguistic variables represent the weights of the decision criteria. $W = \{AL, EL, VVL, VL, L, MLL, M, MLH, H, VH, VVH, EH, AH\}$, where AL = Absolutely Low, EL = Extremely Low, VVL = Very Very Low, VL = Very Low, L = Low, MLL = More or Less Low, M = Medium, MLH = More or Less High, H = High, VH = Very High, VVH = Very Very High, EH = Extremely High, AH = Absolutely High. The triangular fuzzy numbers for the above linguistic variables are defined in Table 1.

Linguistic Variable	Triangular Fuzzy Number
Absolutely Low (AL)	(0.0,0.0,0.0)

Extremely Low (EL)	(0.0,0.0,0.1)
Very Very Low (VVL)	(0.0,0.1,0.2)
Very Low (VL)	(0.1,0.2,0.3)
Low (L)	(0.2,0.3,0.4)
More or Less Low (MLL)	(0.3,0.4,0.5)
Medium (M)	(0.4,0.5,0.6)
More or Less High (MLH)	(0.5,0.6,0.7)
High (H)	(0.6,0.7,0.8)
Very High (VH)	(0.7,0.8,0.9)
Very Very High (VVH)	(0.8,0.9,1.0)
Extremely High (EH)	(0.9,1.0,1.0)
Absolutely High (AH)	(1.0,1.0,1.0)

Table 1: Triangular Fuzzy Number corresponding to each Linguistic Value

Substituting the triangular fuzzy numbers corresponding to each linguistic variable assigned to each decision criterion into Equation (11) and Equation (12), the fuzzy appropriate values will be obtained.

Criterion	Importance Rating
Age	EH
Qualification	VH
Experience	VVH
Language Skills	VH
IT Skills	M
Expected & Current Salary	VL
Vehicle Owned	VVL

Table 2: Importance Rating for Each Decision Making Criterion

VI. ILLUSTRATION OF FDM METHOD FOR RECRUITING SALES MANAGER

In the FDM model, first all the applicant records are retrieved from the database those who satisfy strict requirements set by HR manager. Strict requirements such as Qualification should be Master Degree and age should be between 30 and 40, etc.. Then Fuzzy weight terms such as AH,EH,VH,VVH,VH,M,VL,VVL will be assigned to all criteria.(Table 1 and Table 2).

Then Fuzzy triangular values will be calculated for all the criteria of applicants. Then Cumulative Fuzzy Value (CFV) is calculated for all the applicants. According to Cumulative Fuzzy Value (CFV) values, HR manager will select applicants for attending interview. After the applicants have attended interview, Interview Fuzzy Value (IFV) value will be calculated for all the applicants. Then, Final Fuzzy Value(FFV) triangular values will be calculated from the aggregation of Cumulative Fuzzy Value (CFV) and Interview Fuzzy Value (IFV) values using Equation (12). Then FFV triangular values will be defuzzified by Equation (13). Finally, all the applicants are arranged according to FFV values. All the above steps are illustrated in the Figure 1.

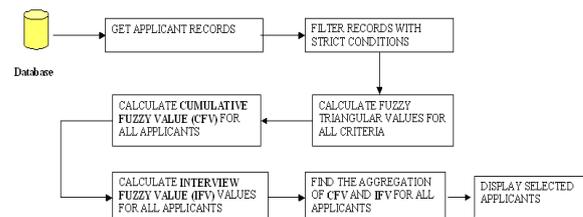


Fig. 1: Fuzzy multi-attribute Decision Making method model

A. Implementation of FDM System

HR manager will key-in all the details of the applicants applied for the post of sales manager, as the Table 3. FDM

Applicant Id	Name	Age	Qualification	Experience (in Years)	IT Skills	Expected Salary
1001	Joshua	31	M.B.A	3.2	MS-Office,Tally	10000
1002	Kumar	30	B.Sc	4.4	MS-Office,VB	8000
1003	David	31	B.Sc	5	MS-Office,Java	9000
1004	Raja	41	B.B.A	6	MS-Office	7000
1005	Jones	38	M.Com	3	MS-office,Tally	8000

Table 3: Applicant details for Sales Manager Post

ApplicantID	AGE	Qualification	IT Skills	Expected Salary
1001	1	0.6	0.8	0.4
1002	0.92	0.6	0.5	0.9

system will calculate Fuzzy value for all the criteria set by the HR manager. Then, the control will go to screen as shown in Table 4.

1003	0.27	0.5	0.5	0.8
1004	1	0.5	0.4	0.83
1005	0.72	0.7	0.8	0.84

Table 4: Fuzzy Criteria Value of Applicants

Applicantid	Triangle Cumulative Fuzzy Value (Cfv)	Interview Result For 10	Interview Fuzzy Value (Ifv)	Triangle Final Fuzzy Value (Ffv)	Final Fuzzy Value(Ffv)
1005	(0.9,0.9,0.9)	7.5	0.75	(0.82,0.81,0.85)	0.83
1001	(0.72,0.68,0.63)	3.8	0.48	(0.6,0.72,0.78)	0.74
1004	(0.64,0.61,0.59)	5.8	0.58	(0.59,0.58,0.56)	0.57
1002	(0.49,0.52,0.51)	4.5	0.45	(0.53,0.49,0.51)	0.52
1003	(0.44,0.43,0.42)	4.2	0.42	(0.47,0.48,0.42)	0.46

Table 5: Final Applicant Selection List

Table 4 shows the Fuzzy value for all the criteria for all the applicants. As shown in Table 5, HR manager can key-in interview result values for all the applicants. Then Interview Fuzzy Value, Triangular Final Fuzzy Value and Final Fuzzy Value (FFV) values are calculated for all the applicants and at the same time all the applicants' records will be arranged by FFV values in the descending order. Finally, HR manager will pick up the applicants from the system-arranged list.

B. Screenshots of FDM System

HR manager will key-in all the details of the applicants applied for the post of sales manager, as the screen shown in Figure 4. When he clicks "Calculate Fuzzy Criteria Values" button, FDM system will calculate Fuzzy value for all the criteria set by the HR manager. Then, the control will go to screen as shown in Figure 2.

Figure 3 will display the Fuzzy value for all the criteria for all the applicants. When "Calculate Fuzzy Final Triangular Value" button is clicked, control will go to Screen as shown in Figure 4.

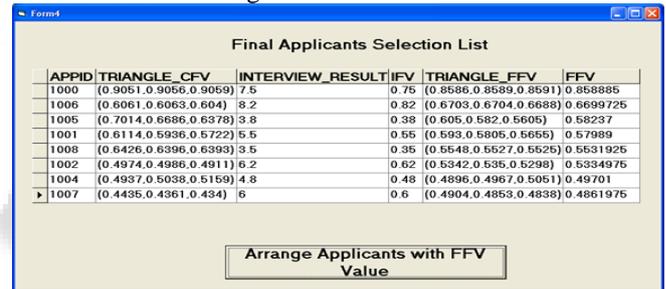


Fig. 4: Suitable Applicants according to Final Fuzzy Value

In the screen as shown in Figure 4, HR manager can key-in interview result values for all the applicants. When he clicks "Arrange Applicants with FFV Value" button, Interview Fuzzy Value(IFV) and Final Fuzzy Value (FFV) are calculated for all the applicants and at the same time all the applicants' records will be arranged by FFV values in the descending order. Finally, HR manager will pick up the applicants from the Fuzzy Decision Making System arranged list.

VII. CONCLUSION

In this paper, a simple and easy-to-use method based on the fuzzy set theory is proposed to aid the evaluation of the several decision criteria. The applicability of this method was demonstrated through the Fuzzy Decision Making model to select the most suitable sales managers for the organization. In this proposed FDM system, there is no limit on the number of the decision criteria and the complexity of the analysis is not greatly affected by the numbers of the decision criteria. Moreover, evaluation of the decision criteria is generally easier than other method since the linguistic variables that are similar to everyday words are used. A reasonable solution for recruitment of sales manager with various mutually conflicting criteria can be obtained;



Fig. 2: Screen for Applicant Details for Sales Manager Post

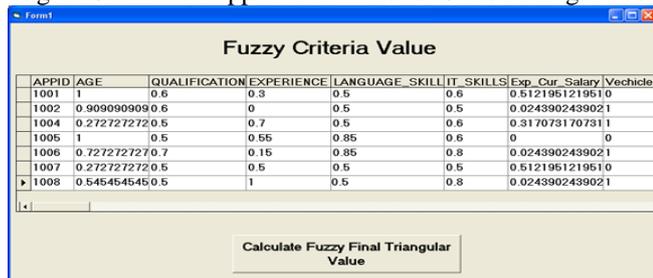


Fig. 3: Fuzzy Values for Salesman Attributes

and the foundations behind the decision are visualized to allow an easy re-examination and adjustment for better consensus formulation.

REFERENCES

- [1] Aras Keropyan and Ana Maria Gil-Lafuente, "A fuzzy-based decision model application on strategic management, *African Journal of Business Management* Vol. 5, Issue 15, pp. 6586-6590, 2011
- [2] Gulcin Buyukozkan, Gizem Cifci, "A novel fuzzy multi-criteria decision framework for sustainable supplier selection with incomplete information", *Elsevier Journal of Computers in Industry*, Vol 62, Issue 2, February 2011, pp 164–174.
- [3] Ghodrattollah Talaei, "Using Fuzzy Decision Support Systems in Human Resource Management", *Journal of Basic and Applied Scientific Research*, Vol 2, Issue 2, 2012.
- [4] Li Li, Ze-Shui Xu, "Approaches Based on Linear Goal programming models to Fuzzy multi-attribute decision making problems", *Proceedings of the Fourth International Conference on Machine Learning and Cybernetics*, Guang Zhou, August 2006.
- [5] Petrovic-Lazarevic, S., "Personnel Selection Fuzzy Model", *International Transactions in Operational Research*, Vol.8, Issue 1, pp 89-105, 2001.
- [6] Ramadan Krebish, Ablhamid ,Budi Santoso , M. Aziz Muslim, "Decision Making and Evaluation System for Employee Recruitment Using Fuzzy Analytic Hierarchy Process", *International Refereed Journal of Engineering and Science*, Vol.2, Issue 7, July 2013.
- [7] Ruskova, N.A., "Decision support system for human resources appraisal and selection", *IEEE International symposium on Intelligent Systems*, 2002,
- [8] Sabina Nobari, Zarifa Jabrailova and Shockrollah Ghadyani, "Using Model of Fuzzy Decision Support Systems in Iran Khodro Company's Recruitment and Selection Systems", *International Conference on Innovation and Information Management*, Singapore, 2012
- [9] Zadeh L.A., *Fuzzy Sets, Information and Control*, Vol.8, pp. 338-353, 1965.