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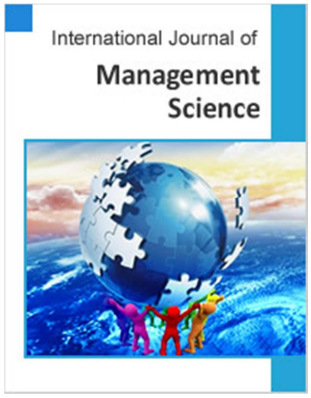

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Evaluation of Personnel Selection Criteria Using Consistent Fuzzy Preference Relations

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Abstract

The quality and productivity of personnel is determined by personnel selection. Therefore, personnel selection is crucial in today's competitive business world and also a very important issue for both academicians and industrialists. Selecting personnel or determining the selection criteria can be handled as a Multi Criteria Decision Making (MCDM) problem. The aim of this paper is to determine personnel selection criteria and to prioritize these criteria by using one of the MCDM techniques, Consistent Fuzzy Preference Relations (CFPR). In order to prioritize, 22 sub-criteria were identified and they were categorized under 5 main criteria. According to these criteria, employees have the opportunity to improve themselves; on the other hand, managers/human resources department can easily predict how they can evaluate employees.

1. Introduction

In professional personnel selection, to allocate time and spend money is more important than having to pay training costs to develop incorrectly positioned employees later. Choosing the right employee for the right position is one of the most decisive factors in a company's success. The success of many organizations depends on several factors. Personnel abilities such as knowledge, skill and experience are some of the main factors.

Personnel selection increases the possibility of being treated fairly when hiring decisions are made. Moreover, personnel selection decreases the possibility of hiring "insufficient" employees and reduces discrimination. Personnel selection process can determine which criteria are the basis of the assessment for the job positions. Also each criteria, which have different importance levels, must be prioritized.

Main and sub-criteria are crucial factors for a valid personnel selection procedure. Some of the criteria for personnel selection in the literature are: interpersonal skill, experience, negotiation, language, ability to follow orders, cognitive ability, adaptation to environment, adaptation to company, emotion, loyalty, attitude, and response [1], written / oral communication skill, general aptitude, general culture, past experience, knowledge of foreign language, computer knowledge, planning, team player, works independently, decisiveness, leadership, self-confidence, comprehension, driver's license, willingness to travel, references [2], creativity/innovation, problem solving/decision making, conflict management/negotiation, empowerment/delegation, strategic planning, specific presentation skills, communication skill, team management, diversity management, self-management, professional experience, educational background [3], personal skills, enthusiasm, dependability, job stress, pay [4], etc.

Selecting or prioritizing alternatives from a set of available alternatives with respect to multiple criteria is often referred as multi-criteria decision-making (MCDM). MCDM is a well-known branch of a general class of operation research models which deal with decision problems in the presence of a number of decision criteria. This class is further divided into multi-objective decision-making (MODM) and multi-attribute decision-making (MADM). There are several methods in each of the above categories. Priority-based, outranking, distance-based and mixed methods are also applied to various problems. Each method has its own characteristics and such methods can also be classified as deterministic, stochastic and fuzzy methods [5].

Most decision processes are based on preference relations which are usual in decision making. To design good decision making models, preference relations are very important for verifying the properties. One of the most significant properties is the so-called consistency property. In decision making, the lack of consistency can cause results to become inconsistent. So it is crucial to study conditions under which consistency is satisfied [6].

Many studies have been done about personnel selection in the literature. Rouyendegh and Erkan examined a Fuzzy Analytic Hierarchy Process (FAHP) using triangular fuzzy numbers for selecting the most suitable academic staff [7]. Md Saad et al. proposed an approach by using Hamming distance method with subjective and objective weights (HDMSOW's) for personnel selection problem [8]. Aggarwal proposed a methodology based on Delphi method as well as Fuzzy Analytic Hierarchy Process to prioritize various human capital indicators for personnel selection [9]. Violeta and Turskis developed a fuzzy multi-criteria decision making (MCDM) algorithm for selection of a chief accounting officer [10]. Karabasevic et al. established an MCDM model for the evaluation and selection of candidates in the process of the recruitment and selection of personnel by using the SWARA and the ARAS methods [11].

The aim of this paper is to determine personnel selection criteria and to prioritize the criteria by using one of the Multi Criteria Decision Making (MCDM) techniques, Consistent Fuzzy Preference Relations (CFPR). The lack of consistency in decision making can lead to inconsistent conclusions. In order to prioritize, 22 sub-criteria were identified and they were categorized under 5 main criteria by 3 experts from academia and industry.

The rest of this paper is organized as follows: In Section 2, Consistent Fuzzy Preference Relations (CFPR) methodology is presented. In Section 3, an application about determining and prioritizing the criteria that used for personnel selection is shown. Also, computational results and evaluation of the results are given in this section. Finally, the results are summarized and future research directions are discussed in Section 4, which concludes the paper.

2. Consistent Fuzzy Preference Relations (CFPR)

Consistent fuzzy preference relations (CFPR) proposed by [6] simplifies the pairwise comparison. It only requires $n-1$ judgments for a preference matrix with n elements. Moreover, CFPR provides better consistency, because it reduces judgment times. CFPR determines the relative importance of main criteria and sub-criteria by computational procedure discussed in [12-13].

The steps of CFPR are as shown below [14]:

Step 1: Risk identification. Main criteria and sub-criteria are determined.

Step 2: Degree of preference. Linguistic terms and corresponding numbers are presented in Table 1 and they are used to obtain pairwise comparisons.

Table 1. *Linguistic scale.*

Definition	Relative Importance
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Absolutely more important	9
Intermediate values	2, 4, 6, 8

Step 3: Comparison. Build pairwise comparison matrices amongst the criteria $(C_i, i=1,\ldots,n)$. Pairwise comparisons for a set of $n-1$ preference values are provided by the decision makers.

Step 4: Transformation. Transform the preference value $a_{ij} \in \left[\frac{1}{9}, 9\right]$ into $p_{ij} \in [0,1]$ through (1).

$$p_{ij} = \frac{1}{2} \times (1 + \log_9 a_{ij}) \tag{1}$$

Then, calculate the remaining p_{ij}^k by using (2), (3) and (4).

$$p_{ij} + p_{ji} = 1 \tag{2}$$

$$p_{ji} = \frac{j-i+1}{2} - p_{i(i+1)} - p_{i+1(i+2)} - \cdots - p_{j-1(j)} \tag{3}$$

$$p_{ij} + p_{jk} + p_{ki} = \frac{3}{2} \tag{4}$$

This preference matrix can contain values included in the interval $[-a, 1+a]$ rather than in the interval $[0,1]$. In this situation, to preserve reciprocity, a transformation function is used. The transformation is obtained by (5).

$$f(p_{ij}) = \frac{p_{ij} + a}{1 + 2a} \tag{5}$$

Here a indicates the absolute value of the minimum in this preference matrix. Likewise, the fuzzy preference relation matrices for all decision makers are calculated.

Step 5: Aggregation. Aggregate the fuzzy preference relation matrices to obtain the importance weights of the selection criteria. Let p_{ij}^{k} denote the transformed fuzzy preference value of the k-th decision maker for criteria i and criteria j. The average value method (6) is used to integrate the judgments of m decision makers. The total number of decision makers is denoted as m.

$$p_{ij} = \frac{1}{m}(p_{ij}^{1} + p_{ij}^{2} + \ldots + p_{ij}^{m}), \quad k = 1, 2, \ldots, m \tag{6}$$

Step 6: Normalization. Normalize the aggregated fuzzy preference relation matrices. h_{ij} is used to indicate the normalized fuzzy preference value of each criteria in (7) and the normalized fuzzy preference relation matrix is obtained.

$$h_{ij} = \frac{p_{ij}}{\sum_{i=1}^{n} p_{ij}} \quad i, j = 1, 2, \ldots, n \tag{7}$$

Step 7: Prioritization. Calculate the importance weight of each criteria (8).

$$w = \frac{1}{n} \sum_{j=1}^{n} h_{ij} \tag{8}$$

3. Application: Determining and Prioritizing the Criteria

In this paper, personnel selection criteria are studied and prioritizing the criteria using one of the Multi Criteria Decision Making (MCDM) techniques, Consistent Fuzzy Preference Relations (CFPR) is aimed. In order to prioritize, 22 sub-criteria were identified and they were categorized under 5 main criteria by 3 experts from academia and industry as can be seen from Table 2.

Table 2. *Criteria of personnel selection.*

Main Criteria		Sub-criteria	
MC1	Activity	SC11	Productive Activity
		SC12	Auxiliary Activity
		SC13	Inefficient Activity
MC2	FEE	SC21	Fee Paid
		SC22	Payable Fee
		SC23	Requested Fee
MC3	Education	SC31	Education Status
		SC32	Foreign Languages
		SC33	Certificates
		SC34	Job Experience
		SC35	Technology Usage
		SC36	Lifelong Learning
MC4	Internal Factors	SC41	Self-Confidence
		SC42	Take Initiative
		SC43	Analytic Thinking
		SC44	Leadership
		SC45	Productivity
		SC46	Decision Making / Problem Solving
MC5	Business Factors	SC51	Compatible with the Team / Communication
		SC52	Teamwork Skills
		SC53	Finishing Work on Time
		SC54	Business Discipline

All experts were asked to determine the importance of different main criteria and sub-criteria based on Table 1. The pairwise comparison matrices for the main criteria and sub-criteria (MC1) were provided by decision maker 1 are shown in Table 3 and Table 4, respectively.

Table 3. *Fuzzy preference pairwise comparison matrix of decision maker 1 for main criteria.*

	MC1	MC2	MC3	MC4	MC5
MC1	1	5			
MC2		1	0.33		
MC3			1	0.50	
MC4				1	3
MC5					1

Table 4. *Fuzzy preference pairwise comparison matrix of decision maker 1 for sub-criteria (MC1).*

	SC11	SC12	SC13
SC11	1	5	
SC12		1	3
SC13			1

Then, the remaining p_{ij}^{k} for main and sub-criteria are calculated by using (1), (2), (3) and (4) (Table 5, 6).

Table 5. *Transformed fuzzy preference values of decision maker 1 for main criteria.*

	MC1	MC2	MC3	MC4	MC5
MC1	0.5	0.86624338	0.61624338	0.45851094	0.70851094
MC2	0.13375662	0.5	0.25	0.09226756	0.34226756
MC3	0.38375662	0.75	0.5	0.34226756	0.59226756
MC4	0.54148906	0.90773244	0.65773244	0.5	0.75
MC5	0.29148906	0.65773244	0.40773244	0.25	0.5

Table 6. *Transformed fuzzy preference values of decision maker 1 for sub-criteria.*

	SC11	SC12	SC13
SC11	0.5	0.86624338	1.11624338
SC12	0.13375662	0.5	0.75
SC13	-0.1162434	0.25	0.5

Preference values transformed by transformation function for main and sub-criteria are obtained by (5) (Table 7, 8).

Table 7. *Preference values transformed by transformation function for main criteria.*

	MC1	MC2	MC3	MC4	MC5
MC1	0.5	0.80918744	0.59813418	0.4649744	0.67602766
MC2	0.19081256	0.5	0.28894674	0.15578696	0.36684022
MC3	0.40186582	0.71105326	0.5	0.36684022	0.57789348
MC4	0.5350256	0.84421304	0.63315978	0.5	0.71105326
MC5	0.32397234	0.63315978	0.42210652	0.28894674	0.5

Table 8. *Preference values transformed by transformation function for sub-criteria.*

	SC11	SC12	SC13
SC11	0.5	0.79715806	1
SC12	0.20284194	0.5	0.70284194
SC13	0	0.29715806	0.5

Likewise, the fuzzy preference relation matrices of the other 2 decision makers for all main and sub-criteria are calculated by using above computational procedure.

To integrate the judgments of 3 decision makers, (6) is used and the aggregated pairwise comparison matrices for main and sub-criteria are shown in Table 9 and Table 10, respectively.

Table 9. *Aggregated pairwise comparison matrix of 3 decision makers for main criteria.*

	MC1	MC2	MC3	MC4	MC5
MC1	1.5	2.443981	2.260465	1.74247	2.67602766
MC2	0.55601911	1.5	1.316484	0.798489	1.73204677
MC3	0.73953522	1.683516	1.5	0.982005	1.91556287
MC4	1.25752996	2.201511	2.017995	1.5	2.43355762
MC5	0.32397234	1.267953	1.084437	0.566442	1.5

Table 10. *Aggregated pairwise comparison matrix of 3 decision makers for sub-criteria.*

	SC11	SC12	SC13
SC11	1.5	1.727439	2
SC12	1.27256083	1.5	1.772561
SC13	1	1.227439	1.5

The normalized fuzzy preference relation matrices for main and sub-criteria are calculated by using (7) (Table 11, 12).

Table 11. *Normalized fuzzy preference relation matrix for main criteria.*

	MC1	MC2	MC3	MC4	MC5
MC1	0.34269605	0.268659	0.276361	0.311745	0.26089274
MC2	0.12703037	0.16489	0.160952	0.142858	0.16886164
MC3	0.1689572	0.185064	0.183388	0.17569	0.18675309
MC4	0.28730036	0.242005	0.246717	0.268365	0.23725372
MC5	0.07401603	0.139382	0.132582	0.101342	0.14623881

Table 12. *Normalized fuzzy preference relation matrix for sub-criteria.*

	SC11	SC12	SC13
SC11	0.3976079	0.387763	0.379322
SC12	0.33732016	0.33671	0.336186
SC13	0.26507194	0.275527	0.284492

Finally, the importance weight of main criteria and sub-criteria determined by three decision makers using (8) can be seen from Table 13 and Table 14, respectively.

Table 13. *Importance weight of main criteria.*

	Importance weight
MC1	0.292070853
MC2	0.152918273
MC3	0.179970451
MC4	0.256328253
MC5	0.11871217

Table 14. *Importance weight of sub-criteria.*

	Importance weight
SC11	0.388231
SC12	0.336739
SC13	0.27503

The importance weights for each set of sub-criteria are calculated by using above computational procedure. The importance weight and the ranking for each set of sub-criteria are shown in Table 15.

Table 15. *Importance weight of sub-criteria.*

Main criteria	Weight	Sub-criteria	Local weight	Global weight	Rank
MC1	0.292070853	SC11	0.388231237	0.113391029	1
		SC12	0.336738545	0.098351514	2
		SC13	0.275030218	0.080328311	3
MC2	0.152918273	SC21	0.287925359	0.044029048	8
		SC22	0.346211523	0.052942068	6
		SC23	0.365863118	0.055947156	5
MC3	0.179970451	SC31	0.196629422	0.035387486	13
		SC32	0.208357378	0.037498171	12
		SC33	0.11636891	0.020942965	21
		SC34	0.182892491	0.032915244	16
		SC35	0.137716919	0.024784976	19
		SC36	0.158034879	0.028441608	18
MC4	0.256328253	SC41	0.095832804	0.024564655	20
		SC42	0.167024432	0.042813081	10
		SC43	0.23378479	0.059925647	4
		SC44	0.155065959	0.039747786	11
		SC45	0.167356491	0.042898197	9
		SC46	0.180935524	0.046378887	7
MC5	0.11871217	SC51	0.287085644	0.03408056	15
		SC52	0.288847693	0.034289736	14
		SC53	0.148462136	0.017624262	22
		SC54	0.275604526	0.032717611	17

According to the results in Table 15, the ranking for main criteria is obtained as MC1 > MC4 > MC3 > MC2 > MC5 (Activity > Internal Factors > Education > Fee > Business Factors). Also the ranking for sub-criteria is obtained as SC11 > SC12 > SC13 > SC43 > SC23 > SC22 > SC46 > SC21 > SC45 > SC42 > SC44 > SC32 > SC31 > SC52 > SC51 > SC34 > SC54 > SC36 > SC35 > SC41 > SC33 > SC53 (Productive Activity > Auxiliary Activity > Inefficient Activity > Analytic Thinking > Requested Fee > Payable Fee > Decision Making / Problem Solving > Fee Paid > Productivity > Take Initiative > Leadership > Foreign Languages > Education Status > Teamwork Skills > Compatible with the Team / Communication > Job Experience > Business Discipline > Lifelong Learning > Technology Usage > Self-Confidence > Certificates > Finishing Work on Time).

4. Conclusion

Determining the criteria that is used for personnel selection is crucial for business life. According to these criteria, employees have the opportunity to improve themselves; on the other hand, managers/human resources department can easily predict how they can evaluate employees. The aim of this paper is to determine personnel selection criteria and to prioritize these criteria by using one of the Multi Criteria Decision Making (MCDM) techniques, Consistent Fuzzy Preference Relations (CFPR). In order to prioritize, 22 sub-criteria were identified and they were categorized under 5 main criteria.

As a result of the evaluation process, the ranking for main criteria is obtained as MC1 > MC4 > MC3 > MC2 > MC5 (Activity > Internal Factors > Education > Fee > Business Factors); the global ranking for sub-criteria is obtained as SC11 > SC12 > SC13 > SC43 > SC23 (Productive Activity > Auxiliary Activity > Inefficient Activity > Analytic Thinking > Requested Fee).

For future researches, the problem could be solved by other MCDM techniques. Also these prioritized criteria can be used for selecting employee of the month, selecting employee to be promoted or upgraded, evaluation of the personnel (for both academicians and industrialists), etc. Other than that, the employees can better understand which criteria are more important for their promotion and they can improve themselves on these criteria.

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