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 to 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 used 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.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Relative Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equally important</td>
<td>1</td>
</tr>
<tr>
<td>Moderately more important</td>
<td>3</td>
</tr>
<tr>
<td>Strongly more important</td>
<td>5</td>
</tr>
<tr>
<td>Very strongly more important</td>
<td>7</td>
</tr>
<tr>
<td>Absolutely more important</td>
<td>9</td>
</tr>
<tr>
<td>Intermediate values</td>
<td>2, 4, 6, 8</td>
</tr>
</tbody>
</table>

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 \( a_{ij} \in [1,9] \) into \( p_{ij} \in [0,1] \) through (1).

\[
p_{ij} = \frac{1}{2} \times (1 + \log_9 a_{ij}) \quad (1)
\]

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

\[
p_{ij} + p_{ji} = 1 \quad (2)
\]

\[
p_{ji} = \frac{j-i+1}{2} - \pi(i+1) - \pi(i+2) - \cdots - \pi(j-1) \quad (3)
\]

\[
p_{ij} + p_{jk} + p_{ki} = \frac{3}{2} \quad (4)
\]

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).

\[
f(p_{ij}) = \frac{p_{ij} + a}{1 + 2a} \quad (5)
\]
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 $m$.

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

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.

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

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

$$w = \frac{1}{n} \sum_{j=1}^{n} h_{ij} \quad (8)$$

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.

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.

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

### Table 2. Criteria of personnel selection.

<table>
<thead>
<tr>
<th>Main Criteria</th>
<th>Sub-criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1 Activity</td>
<td>SC11 Productive Activity</td>
</tr>
<tr>
<td>MC2 FEE</td>
<td>SC12 Auxiliary Activity</td>
</tr>
<tr>
<td>MC3 Education</td>
<td>SC13 Inefficient Activity</td>
</tr>
<tr>
<td>MC4 Internal Factors</td>
<td>SC41 Self-Confidence</td>
</tr>
<tr>
<td>MC5 Business Factors</td>
<td>SC42 Take Initiative</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>MC1</th>
<th>MC2</th>
<th>MC3</th>
<th>MC4</th>
<th>MC5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1</td>
<td>1</td>
<td>5</td>
<td>0.33</td>
<td>1</td>
</tr>
<tr>
<td>MC2</td>
<td>1</td>
<td>1</td>
<td>0.50</td>
<td>1</td>
</tr>
<tr>
<td>MC3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>SC11</th>
<th>SC12</th>
<th>SC13</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC11</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>SC12</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>SC13</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>MC1</th>
<th>MC2</th>
<th>MC3</th>
<th>MC4</th>
<th>MC5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1</td>
<td>0.5</td>
<td>0.86624338</td>
<td>0.61624338</td>
<td>0.45851094</td>
</tr>
<tr>
<td>MC2</td>
<td>0.13375662</td>
<td>0.5</td>
<td>0.25</td>
<td>0.09226756</td>
</tr>
<tr>
<td>MC3</td>
<td>0.38375662</td>
<td>0.75</td>
<td>0.5</td>
<td>0.34226756</td>
</tr>
<tr>
<td>MC4</td>
<td>0.54148906</td>
<td>0.90773244</td>
<td>0.65773244</td>
<td>0.5</td>
</tr>
<tr>
<td>MC5</td>
<td>0.29148906</td>
<td>0.65773244</td>
<td>0.40773244</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Preference values transformed by transformation function for main and sub-criteria are obtained by (5) (Table 7, 8).

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.

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.

The importance weights for each set of sub-criteria are calculated by using (7) (Table 11, 12).

The normalized fuzzy preference relation matrices for main and 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.
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 > 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.

### References


