Integrating Decision Support System for Human Resource Selection Using TOPSIS Based Models

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Abstract

Among the responsibilities of Human Resource Department is selecting the right people for the available job. This task tends to be the most challenging due to necessity to make tough decisions under uncertainty. To minimize error occurrences and complexity of the selection process, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is adopted together with fuzzy TOPSIS and Fuzzy set theory to provide solutions to Multi-criteria decision making (MCDM) problems associated with human resource selection (HRS) process. The proposed framework of Integrated Decision Support System for Human Resource Selection using TOPSIS based models was constructed and presented in this paper.

Keywords: Human Resource Selection, Decision Support System, TOPSIS, Fuzzy TOPSIS, Fuzzy Set theory

1. Introduction

Human Resource Selection (HRS) is considered to be a process carried out by an organization to recruit new potential employees, thereby contributing greatly in achieving company’s objectives [1]. Every organization is defined according to
the services offered and the internal operational activities is usually segmented into departments, each responsible in accomplishing a particular task which when integrated shows directions towards mission and vision of that organization. These series of activities are being handled by humans so brought the issue of human resource selection i.e. process of selecting the right people for the available jobs. Human Resource Department (HRD) is responsible in matters pertaining with management and staff services. HRD is also responsible to recruit the best people for the organization.

HRD deals with the process of human resource selection that involves many phases beginning from a request for a vacant position from a department to the final stage of face-to-face interview. Based on the traditional approach, each panel will evaluate candidates according to a set of criteria agreed before the commencement of evaluation process. The results of the evaluation by the panels will be compared in order to sort out potential candidates to be recruited for the organizations.

Many studies have been carried out in the field of HRS aiming to find solutions to the problems faced by the panels (i.e the decision makers, DMs) during the recruitment process [2, 10, 18]. Dealing with hundreds of applications, and using the traditional method, causes problems because of the difficulty to compare individual applicant’s data which can lead to unfair judgment [2]. Judgment limitation also arises when DMs have to make preference in a fuzzy environment instead of crisp circumstances [3].

In order to ensure sustain success of HRS, Decision Support System (DSS) needs to be adopted in various phases of the selection process. Many decision analysis techniques are available, with their own unique features, hence needs to be properly selected for different situations.

Rule-based technique for the shortlisting of applicants guided by a set of criteria had been applied by [12]. Junalux et al. [18] also studies on facilitating Job recruitment process through job application support system. The system has three components which are electronic application form, electronic telephone interview and electronic interview but does not give much consideration to aptitude test [18].

In this study, a DSS for web-based environment will be explored. A design of a framework for DSS human resource selection is constructed by considering both subjective and objective aspects. A TOPSIS based models will be developed to ease decision making process by allowing DMs to assess each candidate despite
the fuzziness of data and hence, assuring transparency in final judgment results [4]. The proposed framework consists of a Fuzzy Set Theory, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [5] and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) [5, 6]. Those techniques are applied in various phases in the framework to ensure through evaluation and better decision making.

2. Decision Support System and TOPSIS based models

DSS is considered to be very effective tools used by corporate, executives, administrators and other senior officers in decision making [7]. In early 1970’s, the use of DSS increased tremendously due to its ability assistance in simplifying decision making process. Business industry has so much contribution in fast revolution of DSS as they make use of it in different aspect of their business decisions to meet international challenges. DSS integrates four components which are data management, knowledge management, model management, and user interface to support decision making process [8, 10]. An effective DSS should be user-friendly, capable of allowing decision making within reasonable price and less time consuming.

In designing of DSS, model base and database gain more priority because data’s entered via the interface needs to be processed and saved for future reference. Access to the database is through Graphical User Interface (GUI) using web-based platform. Standard design with user friendly features and accessibility regardless of the user’s location is important [9]. The previously mentioned features enable DMs to successfully conduct HRS evaluation process with minimal mistakes. Data can be retrieved any time and presented in a structured manner which can be used to finalize decisions.

TOPSIS

Technique for Order Preference by Similarity to an ideal solution (TOPSIS) was introduced by Hwang and Yoon (1981) [3]. In TOPSIS method, positive ideal solution maximizes benefit criteria and minimizes cost criteria. Negative ideal solution maximizes cost criteria and minimizes benefit criteria [5, 23]. Hence, alternatives should have shortest distance from positive ideal solution and farthest from negative ideal solution [22, 23].

Fuzzy Set Theory

Zadeh introduces fuzzy sets theory in 1965 aiming to represent uncertainty, vagueness and provide tools that can be used in dealing with imprecise problems [19]. Fuzzy sets where extended to fuzzy logic providing a theory that clearly shows
its mathematical strength in capturing uncertainties associated with human thinking and reasoning [19]. Since then, fuzzy set theory has been applied in different fields such as computer science, artificial intelligence, pattern recognition, expert systems, and robotics [17].

**Fuzzy TOPSIS**

Fuzzy TOPSIS is an extension of TOPSIS method coined by Chen CT (2000) to deal with crisp data that are inadequate to model real-life situation due to limitation in human judgment when preference is not clear and cannot estimate such circumstance with an exact numerical value [5]. The FTOPSIS method is also considered as a mathematical model used in processing convictions of experts as quantitative data. The fuzzy positive ideal solution (FPIS) maximizes benefit attribute and fuzzy negative ideal solution (FNIS) minimizes the cost attribute. Values in the decision metric are assigned using fuzzy numbers. The detailed description of FTOPSIS sourced from [24] is as follows:

Let us assume that a decision group has $K$ members. If the fuzzy rating and relative importance weight of $k$th decision maker of the $i$-th alternative and $j$-th criterion are:

$$
\tilde{x}_{ij}^k \equiv (a_{ij}^k, b_{ij}^k, c_{ij}^k) \quad \text{and} \quad \tilde{w}_j^k \equiv (w_{j1}^k, w_{j2}^k, w_{j3}^k) \quad \text{respectively, where } i = 1, 2, \ldots, m, \ j = 1, 2, \ldots, n, \text{then the aggregated fuzzy rating } \tilde{x}_{ij} \text{ of alternatives } (i) \text{ with respect to each criterion } (j) \text{ are given by } \tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}) \text{ such that:}
$$

$$
a_{ij} = \min_k \{a_{ij}^k\}, \quad b_{ij} = \frac{1}{K} \sum_{k=1}^{K} b_{ij}^k, \quad c_{ij} = \max_k \{c_{ij}^k\} \quad (1)
$$

The aggregated fuzzy weights $(\tilde{w}_{ij})$ of each criterion are calculated as $\tilde{w}_j^k = (w_{j1}^k, w_{j2}^k, w_{j3}^k)$ where:

$$
w_{j1} = \min_k \{w_{jk1}\}, w_{j2} = \frac{1}{K} \sum_{k=1}^{K} w_{jk2}, w_{j3} = \max_k \{w_{jk3}\} \quad (2)
$$

Matrix format for the fuzzy multi-criteria Group Decision Making problem is expressed as follows:

$$
\tilde{D} = \begin{pmatrix}
A_1 & A_2 & A_3 & \cdots & A_m \\
\tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} & \cdots & \tilde{x}_{1n} \\
\tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} & \cdots & \tilde{x}_{2n} \\
\tilde{x}_{31} & \tilde{x}_{32} & \tilde{x}_{33} & \cdots & \tilde{x}_{3n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
\tilde{x}_{m1} & \tilde{x}_{m2} & \tilde{x}_{m3} & \cdots & \tilde{x}_{mn}
\end{pmatrix} \quad (3)
$$
where \( \tilde{x}_{ij} \) and \( \tilde{w}_{j} \) \( i = 1, 2, \ldots, m; j = 1, 2, \ldots, n \) are linguistic variables assign by DM’s which can be expressed by using Triangular fuzzy numbers, \( \tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}) \) and \( \tilde{w}_{j} = (w_{j1}, w_{j2}, w_{j3}) \). The normalised decision matrix is calculated by:

\[
\tilde{R} = [\tilde{r}_{ij}]_{m \times n}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n
\]

where:

\[
\tilde{r}_{ij} = \left( \frac{a_{ij}}{c_{ij}} \right) \mbox{ and } c_{ij}^* = \max_i c_{ij} \quad \text{(benefit criteria)}
\]

\[
\tilde{r}_{ij} = \left( \frac{a_{ij}^-}{a_{ij}}, \frac{a_{ij}^+}{c_{ij}}, \frac{a_{ij}^*}{c_{ij}} \right) \mbox{ and } a_{ij}^- = \min_i a_{ij} \quad \text{(cost criteria)}
\]

The normalisation method above ensures that values of normalized triangular fuzzy satisfy the range \([0, 1]\). Weighted normalized decision matrix \( \tilde{V} \) is calculated by multiplying the weights \( \tilde{w}_{j} \) of evaluation criteria with the normalized fuzzy decision matrix \( \tilde{r}_{ij} \) as:

\[
\tilde{V} = [\tilde{v}_{ij}]_{m \times n}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n
\]

where \( \tilde{v}_{ij} = \tilde{r}_{ij}(\cdot)\tilde{w}_{j} \)

The fuzzy positive ideal solution and fuzzy negative ideal solution of the alternatives are defined as follows:

\[
A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \ldots, \tilde{v}_n^*) \mbox{ where } \tilde{v}_j^* = \max_k v_{ijk}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n
\]

\[
A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \ldots, \tilde{v}_n^-) \mbox{ where } \tilde{v}_j^* = \max_k v_{ijk}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n
\]

The distance \( d_i^* \) and \( d_i^- \) of each weighted alternative \( i = 1, 2, \ldots, m \) from FPIS and FNIS is calculated as follows.

\[
d_i^* = \sum_{n=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^*), i = 1, 2, \ldots, m
\]

\[
d_i^- = \sum_{n=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1, 2, \ldots, m
\]
Where \( d_{vp}(\tilde{a}, \tilde{b}) \) is the distance measurement between two fuzzy numbers \( \tilde{a} \) and \( \tilde{b} \). The closeness coefficient \( CC_i \) represents the distance to fuzzy positive idea solution, \( \text{A}^+ \), and the fuzzy negative ideal solution, \( \text{A}^- \) simultaneously. The closeness coefficient of each alternative is calculated as:

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

(12)

The alternatives are ranked according to the closeness coefficient \( CC_i \) in decreasing order. That is, the best alternative with highest \( CC_i \) indicates the closest to the fuzzy positive ideal solution (FPIS) and farthest from FNIS.

Hence, best alternative is identified based on having the shortest distance from FPIS and farthest distance from FNIS.

3. Human Resource Selection and the Proposed Framework

Zero mistake tolerance is always adopted when it comes to hiring new talent because the organizations future totally depends on perfect workforce. In Malaysia, the government has policies pertaining HRS that guide the civil service institutions and being monitored by the Ministry for Higher Education and Public Service Department of Malaysia. In this study, these policies are taken into consideration so that the DSS produced is adhere to the government requirements. In order to gather the requirements for the system, experts in the HRD from Universiti Sultan Zainal Abidin (UniSZA) and University Malaysia Terengganu (UMT) were interviewed. The criteria used in the HRS are identified and compared to the one used by the University of Melbourne resulting in four standardized criteria [17].

The proposed framework consists of four phases as shown in Figure 2. In the first phase of HRS, vacant positions are identified and request from various departments are forwarded to the HRD. Upon acceptance, the vacancy will be advertised either on newspapers or institution’s official website. Advertisement for the vacant positions will display the criteria that candidate must fulfill before applying for a particular position. The applicants will be shortlisted by the system and the candidates are invited for exams and only those who reach certain marks are invited to the face-to-face interview. Candidates’ individual performances are considered in order to select the most potential ones. The following describes the detailed phases in the framework:
Phase 1: This phase requires the system administrator to determine the positions that are available. The selection criteria are identified and their weights are assigned to be used in the shortlisting of candidates. The evaluation criteria considered are Qualification, Qualities (Intelligent Quotient, IQ and Emotional Quotient, EQ), Skills (soft skills and technical skills) and Knowledge (in the field) by which each applicant will be evaluated on. Also, the determinations of panel interviewers who are to participate in the HRS process are performed in this stage. The criteria weights in this phase can be assigned by the administrator/experts using a customized scale respecting the TOPSIS rule. On the side of applicants, they can access the system and select the job title which they are interested to apply. They need to fill in their particulars in the on-line form provided by the system.

An applicant has to provide personal information, educational background, work experience, and the skills in which the system will automatically generate identification number (ID) to be used throughout the evaluation process. Access to the system will be blocked after the closing date. Based on the job ID, the system will categorized the applicants according to applied positions.

Phase 2: Technique for Order Preference by Similarity to an ideal solution (TOPSIS) is adopted in this phase to automatically rank the shortlisted applicants who fulfill the evaluation criteria.

Phase 3: Certain number of shortlisted applicants identified during Phase 2 will be invited to seat for examination known as aptitude test. The test is basically divided into two categories; speed test and powered test designed to assess the capabilities of a candidate in terms of various aspects such as verbal and numeric ability, abstract reasoning, technical reasoning, and fault diagnosis. Certain amount of time is given in which applicants must complete the main key test questions within certain speed at which a candidate is able to reach correct
Figure 2. Proposed framework for IDSSHRS
answers. The aptitude result shows candidate level of competency to perform a certain type of task. Candidates are shortlisted again according to the pass marks defined earlier and are invited for the final phase i.e. interview session based on face-to-face with the panels.

**Phase 4:** In this phase, the interview evaluation criteria are selected or updated by the panels, followed by the assignment of weight to the criteria. Due to subjective nature of some of the criteria, Fuzzy numbers will be used by DMs to determine their relative importance. FTOPSIS will be deployed to deal with fuzziness of the data values during the interview assessment of applicants against the multi-criteria [5, 23, 24]. Lastly, FTOPSIS assures aggregation of the results and ranked the candidates in certain order. Candidate with the highest points proves potentiality to be recruited. Decision makers can now conclude final decision from the available result.

### 4. Conclusion

The evaluation of applicants during HRS is a vital process to any organization. Traditional method used in HRS tends to be tiring, time consuming and at the end poor judgment can occur which may lead to wrong selection of staff. IDSSHRS is a web-based application that allows DMs to evaluate applicants without stress and assuring proper judgment of candidates. The IDSSHRS utilizes TOPSIS, FTOPSIS and fuzzy set theory concepts to enable decision makers to perform their duties successfully within limited time and resources. Using TOPSIS algorithm, the proposed IDSSHRS will be able to generate decision matrix from submitted applications and automatically rank applicants. From the results, the employer can just decide to invite top candidates to proceed with the next phase. If the results do not meet the organization’s requirement, the list can be reselected from the system without repeating the whole process. Lastly, FTOPSIS aid the panels to deal with interview process. The integration of HRS procedures in one platform gives users the flexibility of shifting priority to their desired phase. The evaluation results are saved in the database which can be retrieved for references and further decision making.

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