Selection of Logistics Personnel by Using and Hybrid Fuzzy DEMATEL and Fuzzy ANP

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ABSTRACT: Today, companies act in an environment which is known with the feature of uncertainty. In this environment, companies have a strategy based on present the quality services and products to their customers. To do so, logistics plays an important role to create value for customers. Selection of logistics personnel is a kind of multi-criteria decision making problem which includes consideration of different factors. On the other hand, there is a problem with encountering to crisp criteria in selection of optimized candidate. This research presents a hybrid structured methodology by integrating MCDM methods for solving the problem based on Fuzzy approach. Delphi method is applied to select effective criteria, a Fuzzy DEMATEL is applied for defining the direction and relationships between criteria and Fuzzy ANP is used for selection of optimized candidate. A case study in vehicle industry is presented at the end.

Keywords: Logistics Personnel Selection, Delphi Method (DM), Fuzzy Decision Making Trial and Evaluation Laboratory (FDEMATEL), Fuzzy Analytic Network Process (FANP).

INTRODUCTION

In the current operational environment which is due to behavior of human, uncertainty is one of the most important features managers encountered. Changes in the customer’s needs are growing, markets are developing out of countries and global markets are shaping. In this environment, the companies will be survived which have defined their strategies based on creation of value to the customers and world-class performance by continuous improvement (Kumar & Kumar, 2005; Gungor et al., 2009). Logistics managers are inevitable for investing on their performance and capabilities (Bashiri et al., 2011) in terms of personnel and equipment cost, quality, quick servicing and flexibility (Karsak & Toulga, 2001), so that customers need to the quality product with minimum price or cost (Wang & Lee, 2007). To do so, employee or personnel performances such as knowledge, capability, skill and other abilities play an important role in the success of logistics organizations. So, selection of the appropriate logistics personnel based on supply chain conditions puts more emphasis and pressure on personnel selection process. Logistics personnel selection increasingly affects the quality of services and products which companies produce (Chien & Chen, 2008). Based on this approach, Organizations differ from attaining to the process and budgets allocated for recruiting, selecting, and orienting people (Karsak, 2001; Karsak et al., 2003).

Personnel selection process should provide reliable and valid information about candidates. There are some traditional techniques used in this process, mainly, completion of application forms, initial interview, employment test and background investigation (Robertson & Smith, 2001). These traditional methods generally come to a conclusion on the basis of the subjective judgment of decision makers, which makes the accuracy of the results highly questionable. In order to select the most suitable personnel to perform the defined job,
combining the subjective judgment and the objective analysis methods to develop effective selection approaches is very critical (Zhang and Liu, 2011).

Logistics personnel selection is a kind of multi-criteria decision making problem which needs a huge and variety of criteria for comparing. On the other hand, there are different mathematical techniques for evaluation of maintenance alternatives, there are some researches by different techniques about selection of personnel (McDaniel, 2009; Gungor et al., 2009; Lin, 2010; Dursun and Karsak, 2010; Gutman, 2009; Kelemenis and Askounis, 2010; Zhang and Liu, 2011; Kabak et al., 2012) in literature which have considered the criteria of this problem independently while logistics personnel selection is a kind of problem with dependent criteria. So, the current research focuses on the relationships between criteria which can be handled by ANP. The ANP deals with all kinds of dependencies. The ANP has been successfully implemented in many areas (Agarwal & Shankar, 2002; Chung et al., 2005; Coulter & Sarkis, 2005; Kahraman et al., 2006; Karsak et al., 2003; Lee & Kim, 2001; Meade & Presley, 2002; Niemira & Saaty, 2004; Partovi, 2001; Partovi & Corredoira, 2002; Partovi, 2006; Shang et al., 2004; Tesfamariam & Lindberg, 2005; Yurdakul, 2004). This study also applies DEMATEL technique for finding the relationships between criteria. Also, we cannot ignore that human being is integrated to fuzzy approach. Therefore, fuzzy logic is used for comparisons. Briefly, fuzzy DEMATEL are applied by different researchers, but there is no research about combining these three methods in logistics personnel selection. This research also uses Delphi method for reaching to the suitable criteria. Vehicle industry of Iran is selected as the preferred case study. The rest of this paper is organized as follows. In Section 2, a literature review is presented, In Section 3, the proposed methodology is reviewed. In Section 4, a numerical example in vehicle industry as the case study of this research is illustrated. Finally, according to the findings of this research, conclusions and suggestions are depicted.

Literature review

The term “selection” is used to determine the totally assessment of candidates who have filled and sent the applications for organization and choosing the best one. In all of these applications, the overall assessment rating is used as a measure of competence to be successful in some new assignment (Thornton & Gibson, 2009). Personnel selection is one of the most important functions of human resource management. So, human resource management departments, in all private and public organizations, are responsible for finding the probable candidates and selecting the best one for a defined job. Based on this performance, personnel selection is defined as the process of choosing the best one among the candidates for a defined job in the company, the ones who have the pre-qualifications needed to perform the job in the best way (Zhang and Liu, 2011).

Based on many researches, there are different aspects in the process which organizations apply for personnel selection (e.g., Beckers & Bsat, 2002; Hough & Oswald, 2000; Liao, 2003; Robertson & Smith, 2001). The first aspect is about the criteria, and second is the method which organizations use for personnel selection. Rothstein and Goffin (2006) believe that personality by an adding value procedure measures the process of personnel selection. Simultaneous to progressions and growing in information technology tools, many studies have emphasized the development of information systems usage and making decisions based on informational support systems like expert systems, executive support systems and other technological equipment for improving the quality of decisions about personnel selection (Hooper et al., 1998; Mehrabad & Brojeny, 2007; Shih et al., 2005). MCDM methods like what have mentioned before are applicable techniques in which combine information usage and expert’s knowledge in the personnel selection field. To do so, Chien and Chen (2008) proposed a data mining framework based on a decision tree and association rules to generate 30 meaningful rules for recruitment strategies. The personnel profile data and long-term work behavior records are collected to support this method. Kelemenis and Askounis (2010) developed a Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) based multi-criteria approach which incorporates the veto threshold for the ranking of the alternatives. In their approach, the ultimate decision criterion is not the similarity to the ideal solution but the distance of the alternatives from the veto set by the decision-makers. Dursun and Karsak (2010) argued that many individual attributes considered for personnel selection such as organizing ability, creativity, personality, and leadership exhibit vagueness and imprecision.

METHODOLOGY

This study proposes a hybrid Structured MCDM methods based on Delphi, Fuzzy DEMATEL, and fuzzy ANP, as a structured methodology to assist in logistics strategic decision makers. The general view of the proposed structured evaluation methodology is shown in Fig. 1. Based on these steps, we firstly mention about the proposed techniques.
Figure 1. The proposed structure hybrid methodology of research.

**Fuzzy DEMATEL:** The Battelle Memorial Institute was introduced a DEMATEL method project through its Geneva Research Centre. This is an analytical method which visualizes the relationships between criteria. DEMATEL is a comprehensive method for illustration of casual relationship between criteria which shows the systematic relations (Chen and Kishor, 2005). There are different statistical and MCDM methods for clarifying the relationships. DEMATEL is one of strong MCDM methods for explanation of relationships between criteria where there is a need for applying expert’s idea. Despite effective usage of this method for solving problems, there is the problem of crisp values and facing to uncertain factors. Thus, fuzzy theory is applied to the DEMATEL method for solving such a MCDM problem. Fuzzy DEMATEL is done by a questioner which asks decision makers to compare the variable affection by fuzzy numbers. Base on this method, an expert decides which criteria effects on the other criteria. It is an expert who decides about the volume and degree of affection by his/her knowledge, experiment etc. this research applies five linguistic terms (Very high, High, Low, Very low and No) and directs decision makers to triangular fuzzy numbers (Lin and Wu, 2004) as table 1. The pair wise comparison between criteria will result in a matrix which in shown by $\mathbf{Z}^P$ and called Assessment Data Fuzzy Matrix (Jassbi et al., 2011). The same table will be filled out by all experts. Indeed, there are $p$ fuzzy matrices which $p = \{1, 2, \ldots, k\}$ is the number of experts which participate in research. In the next step, the average of preferences calculates by Eq. (1) (Lin & Wu, 2004).

$$\hat{Z} = \frac{1}{p} \sum_{i=1}^{p} Z_i$$

(1)

Then, fuzzy matrix is as bellow:

$$\hat{Z} = \begin{bmatrix}
\hat{Z}_{12} & \cdots & \hat{Z}_{1n} \\
\tilde{Z}_{21} & 0 & \hat{Z}_{2n} \\
\tilde{Z}_{n1} & \tilde{Z}_{n2} & 0 \\
\end{bmatrix}$$

(2)

Which is called direct-relation fuzzy matrix. In this matrix, $\hat{Z}_{ij} = (l_{ij}, m_{ij}, u_{ij})$ are triangular fuzzy members and $\tilde{Z}_{ij}(i = 1, 2, \ldots, n)$ refers to triangular fuzzy number ($0, 0, 0$). Then, normalized primary direct-relation fuzzy matrix results in normalized direct-relation fuzzy matrix $\tilde{X}$ by:

$$\bar{X} = \begin{bmatrix}
\bar{X}_{12} & \cdots & \bar{X}_{1n} \\
\bar{X}_{21} & \tilde{X}_{21} & \bar{X}_{2n} \\
\vdots & \vdots & \vdots \\
\end{bmatrix}$$

(3)
\[ \hat{x}_{n1}\hat{x}_{n2}\hat{x}_{nm} \]

Where:

\[ \hat{x}_{ij} = \frac{r_{ij}}{r} = \left( \frac{1}{r} \right) \]

And

\[ r = \max_{1 \leq i \leq n} \left( \sum_{j=1}^{n} u_{ij} \right) \]

It is assumed at least one \( l \) such that \( \sum_{j=1}^{n} u_{ij} < r \)

| Table 1. The linguistics terms and values for FDEMATEL. |
|---------------------------------|---------------------------|
| **Linguistic terms** | **Linguistic values** |
| Very High Influence (VH) | \((0.75, 1.0, 1.0)\) |
| High Influence (H) | \((0.5, 0.75, 1.0)\) |
| Low Influence (L) | \((0.25, 0.5, 0.75)\) |
| Very Low Influence (VL) | \((0, 0.25, 0.5)\) |
| No Influence (No) | \((0, 0, 0.25)\) |

As Lin and Wu (2004), after computing the above matrices, the total-relation fuzzy matrix \( \hat{T} \) is computed.

\[
\hat{T} = \lim_{k \to \infty} \left( \hat{x}^1 + \hat{x}^2 + \cdots + \hat{x}^k \right) \quad \text{(6)}
\]

then:

\[
\hat{T} = \begin{pmatrix}
\hat{t}_{11} & \hat{t}_{12} & \cdots & \hat{t}_{1n} \\
\hat{t}_{21} & \hat{t}_{22} & \cdots & \hat{t}_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
\hat{t}_{n1} & \hat{t}_{n2} & \cdots & \hat{t}_{nn}
\end{pmatrix} \quad \text{(7)}
\]

In which \( \hat{t}_{ij} = \left( t_{ij}^{m}, m_{ij}^{m}, u_{ij}^{m} \right) \)

\[
\left[ t_{ij}^{m} \right] = X_i \times (I - X_i)^{-1}, \left[ m_{ij}^{m} \right] = X_i \times (I - X_i)^{-1}, \left[ u_{ij}^{m} \right] = X_i \times (I - X_i)^{-1}
\]

The defined threshold by defuzzification of matrix \( \hat{T} \) shows the cause and effects relationships. The numbers which are higher than threshold are cause and vice versa. The threshold is defined as the arithmetic average of matrix \( \hat{T} \) (Aghaee and Fazli, 2012).

**Fuzzy ANP:** The basis for all two methods is pair wise comparisons, but there are differences among them. ANP method applies an in-linear structure while AHP is a linear method with a goal on the top level and alternatives on the down level. The ANP refers then to the systems of which a level may both dominate and be dominated, directly or indirectly, by other decision attributes and levels (Onut et al., 2011). ANP handles independencies between elements. It develops a super matrix which is a matrix of relationships between network elements and obtains from preference vectors of the relationships. This matrix provides a structure for defining the relative importance of alternatives. Human judgment is together with vagueness. So, it cannot be described by definite numbers. Fuzzy approach uses a triangular fuzzy number (TFN) instead of 1-9 discrete scale. This scale is illustrated in table.2. The pair-wise comparisons by decision maker can be denoted as in Eq. (9).

\[
\hat{A} = \begin{pmatrix}
(a_{11}, a_{12}, a_{13}) & (a_{21}, a_{22}, a_{23}) & \cdots & (a_{n1}, a_{n2}, a_{n3}) \\
(a_{12}, a_{13}, a_{14}) & (a_{22}, a_{23}, a_{24}) & \cdots & (a_{n2}, a_{n3}, a_{n4}) \\
\vdots & \vdots & \ddots & \vdots \\
(a_{1n}, a_{1n+1}, a_{1n+2}) & (a_{2n}, a_{2n+1}, a_{2n+2}) & \cdots & (a_{nn}, a_{nn+1}, a_{nn+2})
\end{pmatrix}
\]

The item \( a_{mn} \) in \( (a_{11}, a_{12}, a_{13}) \) describes the comparison of the item \( m \) with item \( n \). based on fuzzy number laws, the matrix \( \hat{A} \) can be rewritten as Eq. (10) by replacing \( a_{mn} \) with the corresponding reciprocal values.
Table 2. Definition of TFN-linguistic scale for importance.

<table>
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<tr>
<th>TFN</th>
<th>Linguistic scale for importance</th>
<th>Triangular fuzzy number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally preferred</td>
<td>(1,1,1)</td>
</tr>
<tr>
<td>2</td>
<td>Equally to moderately preferred</td>
<td>(1,3/2,3/2)</td>
</tr>
<tr>
<td>3</td>
<td>Moderately preferred</td>
<td>(1,2,2)</td>
</tr>
<tr>
<td>4</td>
<td>Moderately to strongly preferred</td>
<td>(3,7/2,4)</td>
</tr>
<tr>
<td>5</td>
<td>Strongly preferred</td>
<td>(3,4,9/2)</td>
</tr>
<tr>
<td>6</td>
<td>Strongly to very strongly preferred</td>
<td>(3,4,9/2)</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly preferred</td>
<td>(5,11/2,6)</td>
</tr>
<tr>
<td>8</td>
<td>Very strongly to extremely preferred</td>
<td>(5,6,7)</td>
</tr>
</tbody>
</table>

$\bar{A}$ is a triangular fuzzy comparison matrix. To compute the estimates of fuzzy preferences $\bar{w}_i$, where $\bar{w}_i = (w^1_i, w^m_i, w^u_i)$, $i = 1, 2, \ldots, n$, by means of judgment matrix which approximates the fuzzy ratios $\tilde{a}_{ij}$ so that $\tilde{a}_{ij} \approx \bar{w}_i / \bar{w}_j$. The logarithmic least squared method is the most effective and efficient one and was used in our study. In this way, the triangular fuzzy weights for the relative importance of the factors, the feed-back of the factors, and alternatives according to the individual factors can be calculated. To compute the triangular fuzzy numbers, the logarithmic least squares method is used as described in Eqs, (11) and (12).

$\bar{w}_k = (w^1_k, w^m_k, w^u_k), k = 1, 2, \ldots, n$  

\[ w^s_k = \frac{\sum_{k=1}^{n} \bar{a}^{s}_{ij}}{\sum_{k=1}^{n} (\bar{a}^{s}_{ij})^{1/n}}, \quad s \in \{l, m, u\} \]

RESULTS

Numerical example in petrochemical industry

Vehicle production industry is one of the growing industries in the world because of the increasing in the vehicle demand. So, many countries have invested in production of this strategic high-tech product. Iran vehicle production industry have established in 1950s with assembling of Peykan which was a Britain vehicle. This company developed 1980 to 1990 as three phases. The main strategy of industry was based on self-sufficiency in vehicle production field as production of automobile and work vehicle products. Iran’s vehicle industry encompasses different complexes such Iran Khodro, Iran Khodro Diesel, Saipa, Saipa Diesel, Pars Khodroetc. These companies produce more than 1,500,000 automobile in a year. In this section, an empirical study in Iran vehicle industry is presented to illustrate the application of the proposed solution for evaluating and selecting logistics personnel. The proposed hybrid structured methodology findings are summarized as the following steps:

Step1: effective factor selection: Delphi method is one of strong methods for selecting criteria. A questioner presented to logistics experts and asked them to define the factors affecting on logistics personnel selection. After two times Delphi method implementation, the following criteria were defined: University degree related to logistics major (C1), requested wage (C2), job experience in logistics department (C3), and familiarity to logistics software (C4)

Step 2: In this step, for obtaining the relative influence between elements, 10 experts from logistics department were asked for. The members of committee were asked to respond through a series of pair-wise comparisons. The initial direct-relation matrix $\tilde{Z}$ (Table 3) can be obtained; hereby total relationship fuzzy matrix $\tilde{F}$ (Table 4) can be acquired by using the FDEMATEL. The threshold by arithmetic average of matrix $\tilde{F}$ is calculated 0.218. So, each number which is higher than 0.218 is effective and each is lesser is imprissible. The diagram of cause and effects is as figure 2. Based on this diagram, C1 effects on C2 and C4, C2 effects on C1, C3 and C4, C3 effects on C2 and C4.
Step 3: the ANP model formed by criteria determined in the first step. As illustrated in figure 3, The ANP model is composed of three stages. A committee with 10 experts followed the proposed solution with the three-phase procedure. First, they defined the decision goal for selecting a favorable logistics personnel candidate. In phase 2, after conducting the literature review and a profound discussion, three evaluation clusters were used to select optimized logistics personnel. Specifically, the “Purposes” cluster involved one purpose of optimized maintenance alternative (P); the “Criteria” cluster contained four criteria based on Delphi method as bellow: University degree related to logistics major (C1), requested wage (C2), job experience in logistics department (C3), and familiarity to logistics software (C4); and the “Alternatives” cluster comprised six candidate: (A1), (A2), (A3), (A4), (A5) and (A6) and then the decision structure (Fig. 3) was shaped for evaluating optimized logistics candidate. Briefly, the first step includes the objective of model, determined as “optimized logistics candidate selection”. The second step includes the criterions to be used in selection of logistics candidates. The third step deals with local weights of criterions participated in second step. Pair-wise comparison matrices for local weights of factors are formed by the experts by using the scale given in table 2.

Figure 2. The cause and effects diagram.

Figure 3. Decision structure for the optimized maintenance alternative selection.
Table 5 presents the un-weighted super matrices constructed to determine local priorities. In the next stage, the limiting super matrix (table 6) is obtained by multiplying the weighted super matrix by itself until each column of the super matrix reaches the same value. The final set of pairwise comparisons is made for the relative importance of each of the criteria so as to determine the overall prioritization of the alternatives. As indicated by the final priorities in Table 6, the criteria (C1, C2, C3, C4) and the alternatives (A1, A2, A3, A4, A5, A6) are respectively (0.212, 0.092, 0.241, 0.180) and (0.131,0.152,0.187,0.251, 0.234, 0.388). The rankings are C3, C1, C4, C2 and A6, A4, A5, A3, A2, A1. The results identify “job experience in logistics department” as the top criterion. The A6 candidate with the highest priority is the best candidate.

Table 5. The un-weighted super matrix.

<table>
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<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
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Table 6. The limit matrix.

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**CONCLUSION**

In the current logistics environment characterized by uncertainty, the logistics organizations are competing in the global markets and they are increasingly trying to find the competitive advantages for surviving. To do so, human resource as practical and soft investment of organizations plays an important role in the successfulness. Based on this approach, personnel selection as an important function of human resource management is defined as a process for finding the best person from probable candidates. So, this research deals with presentation of a hybrid structured methodology for selection and evaluation of logistics personnel. Hence, Iran’s vehicle industry as a pioneer industry in the world was selected as case study of this research. Logistics personnel selection and evaluation is a kind of multi-criteria decision making problem which needs consideration of several criteria and candidates. There are different methods for evaluation of alternatives in which has its weakness and strength. The main weakness is the pre-assumption of independency between levels and criteria while logistics personnel evaluation faces to interdependencies between criteria and levels. So, this research proposes ANP as a MCDM method which it deals with interdependencies between criteria. On the other hand, DEMATEL method is applied to detection of relationships between criteria. Moreover, Delphi was used for detection of final criteria in selection and evaluation of logistics personnel. Regarding to or researches, no previous work investigated such a methodology for evaluation and selection of logistics personnel. In future, this methodology might be applied to other MCDM problems.
Conflict of interest
The authors declare no conflict of interest

REFERENCES


