Puritoning suppliers of a petrochemical unit considering fuzzy approach (Case study: Mobin Petrochemical unit)

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ABSTRACT

Human reasoning and judgments have an important role in determining score of suppliers' performance. Therefore, the more interaction a decision has with human resources as well as complex systems, the more domination fuzzy phenomenon find over explanations of such issues. Although AHP method has some advantages for evaluating suppliers rather than other methods, it has some weaknesses. These weaknesses can be minimized using FIS approach. The aim of this research is to prioritize suppliers for a petrochemical unit. Case study of this research is Mobin petrochemical unit in that fuzzy AHP method was used to rank suppliers of petrochemical unit after identifying and collecting paired comparison of indicators. MATLAB software was applied for operating the calculations due to high volume of calculations of AHP method. Results from MATLAB along with information obtained from experts showed that supplier number 3 had the highest priority with the highest score and the rest were suppliers number 1, 2, and 4, respectively. Doing this research, management can select suppliers of unit with lower risk and in more transparent atmosphere.

INTRODUCTION

Nowadays, in the highly competitive environment identified as low benefit, high expectations of customers for quality products and short expectation time of delivery, companies have to take advantage of all opportunities in order to optimum their work processes. To reach this goal, those involved have reached the following result: For a company to stay competitive, it needs to work with chain-supplier partners [1]. According to this, nowadays, companies, instead of competing each other, consider themselves as a part of supply chain competing other supply chains [10]. Among this, selecting supplier has gained growing importance according to being supply-chain processes and influencing all departments of an organization [1]. Weber and his colleagues (1991) indicate that decisions relevant to selecting supplier are highly complicated because of considering various criteria. Furthermore, different approaches can be used for this selection. Analysis of these two subjects (Criteria and selection method of supplier) has attracted attention of researchers and those involved in purchase process from 1960s onward [19]. A considerable number of factors can affect efficiency of suppliers including quality, delivery, goods history, guarantee, price, technical capability, financial condition to name a few. Thus, the issue of selecting suppliers is a multi-criteria one involving sensible and insensible features considering the fact that some are contradictory. Basically, there are two ways of selecting suppliers. In the first way of selecting a supplier, a supplier can provide all necessary needs in which the management needs to select by a definite decision. In the second way, not each of suppliers have the capability of meeting all needs of management. Management divides orders among suppliers in this type of situation [16]. Powerful analysis models and decision-logistic tools in order to enable creating balance between multi mental and visual criteria are necessary to select an effective supplier [3]. In a comprehensive review conducted by Weber and his colleagues, it was obvious that almost all organizations face more than a criterion for selecting their suppliers [17]. Therefore, decision making about selecting a supplier is naturally a multi-criteria issue and it is an important strategic one for organizations [6].

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AHP method which is one of MCDM methods was used to select the supplier in this research. This method is for selecting and deciding one choice among frequent choices. This method was invented and presented by Thomas Sati in 1980. AHP is the reflection of natural behavior as well as human thought. This technique investigates complex issues according to their mutual effects, simplify them, and solve them. This method includes four steps for final selection: 1. Modeling 2. Collecting data and forming paired-comparison matrix 3. Calculating relative weight 4. Calculating final weights and selection [11]. We are facing uncertainty since, in this research, mangers and experts give their verbal opinions. Fuzzy logic is used for accuracy and making results realistic. Theory of fuzzy collections and fuzzy logic are highly useful and they are efficient tools for this purpose. Theory of fuzzy collections is a mathematical theory which has been designed for mathematical modeling of ambiguity in identifying processes [9]. Application domain of this theory covers a great deal of areas such as natural and biological sciences, social science, engineering, computer science, systematic and management sciences, planning and decision making [7].

2. Methodology:
2.1 selecting indicators for assessing suppliers:

The purpose of selection is to identify suppliers with the highest potentials to meet company’s needs agreeably and affordable expense [12].

Generally, two issues have particular importance in terms of decisions for selecting supplier. The first one is what criterion to use and the other is what methods ought to be used for comparing suppliers. Analysis of these two issues for selecting supplier has attracted attention of managers and lecturers since 1960s. The first research was done by Dickson in 1962. He presented 23 criteria for assessing suppliers and prioritized them. Results have been listed in the following table:

<table>
<thead>
<tr>
<th>Table 1: Table of indicators</th>
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</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
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<td>S1</td>
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<td>S2</td>
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<td>S3</td>
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<td>S4</td>
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<td>S5</td>
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<td>S6</td>
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<td>S21</td>
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<tr>
<td>S22</td>
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<tr>
<td>S23</td>
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</tbody>
</table>

Since 1994, new criteria have been presented in terms of articles related to selecting suppliers in that some are development of early criteria of Dickson’s and some others have been created as a result of development of management philosophy in which two criteria of delivery and quality have been selected as important ones [5].

2.2 elements of fuzzy collection:

In classic or definite collections, one element of reference collection in a given collection has membership or not. Membership in a definite collection, F can be defined with a membership function for each member of X from the reference collection as following:

$$\mu_F(x) = \begin{cases} 1 & x \in F \\ 0 & x \notin F \end{cases}$$

Fuzzy numbers: each fuzzy function is defined by a membership function. The concept of membership function in theory of fuzzy collection has highly got importance. The first point of view is using experts’ knowledge because fuzzy collections are being used for formulating human knowledge. In the second point of view, collected data by various sensors are used to determine membership function [18].
Triangular fuzzy numbers: The triangular fuzzy number of A or, simply, triangular number with membership function of $\mu_A(x)$ on $\mathbb{R}$ is defined as follows:

$$
\mu_A(x) = \begin{cases} 
\frac{x-a}{b-a}, & a \leq x \leq b; \\
\frac{c-x}{c-b}, & b \leq x \leq c; \\
0, & x < a \text{ or } x > c.
\end{cases}
$$

Where $[a, b]$ is support span and the point of $(b, 1)$ is the head.

Fuzzy logic has provided a natural technique tool for investigating this phenomena and affairs due to the fact that it has the capability of competing with artificial intelligence and systematic approach in investigating the conditions and ambiguous situations which are not effective in ordinary mathematics [2]. Fuzzy theory and logic is a scientific tool which has created a possibility and permission for simulation of dynamism of a system without long mathematical description using qualitative and quantity data [13].

In analysis of group and multi-criteria decision making, fuzzy model has been identified as the most common method for explaining and investigating uncertainties. Fuzzy logic has removed the gap between scientific and organized assessment and measurement considering simultaneous social goals and it has provided a method for converting vast spectrum of information, visual data, quantity information, mental opinions and judgments, and social needs in to a natural language for explaining effects of environment [15,8].

2.2.1 Fuzzy AHP:

Assume that $X=\{x_1, x_2, x_n\}$ is a collection of items and $G=\{g_1, g_2, g_n\}$ is a collection of goals. According to Chang method, the maximum is obtained from analysis of each item [14] and maximum analysis of each goal has been done respectively, therefore, maximum values of analysis $m$ for each item can be obtained from the following signs:

$$M_{gi}^1, M_{gi}^2, ..., M_{gi}^m$$

Steps of maximum for Chang analysis is as following:

First step:
The maximum value of combined fuzzy is defined as following according to ith item:

$$S_i = \sum_{j=1}^{m} M_{gi}^j \otimes \left[ \sum_{j=1}^{m} M_{gi}^j \right]^{-1}$$

Calculating the fuzzy sum, maximum value of analysis for a particular matrix is obtained where:

$$\sum_{j=1}^{m} M_{gi}^j = \left[ \sum_{j=1}^{m} L_j, \sum_{j=1}^{m} M_j, \sum_{j=1}^{m} U_j \right]$$

Calculating fuzzy sum, the value of $M_{gi}$ is obtained:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j = \left[ \sum_{j=1}^{m} L_j, \sum_{j=1}^{m} M_j, \sum_{j=1}^{m} U_j \right]$$

And then we obtain the inversion of above vector:

$$\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right]^{-1} = \left[ \frac{1}{\sum_{j=1}^{m} U_j}, \frac{1}{\sum_{j=1}^{m} M_j}, \frac{1}{\sum_{j=1}^{m} L_j} \right]$$
Second step:
We define two triangular fuzzy numbers with probability degree:
\[ v(\tilde{R}_2 \geq \tilde{R}_1) = \sup_{x \in [0,1]} \min(\mu_{\tilde{R}_1}(x), \mu_{\tilde{R}_2}(y)) \]
And we can explain it as follows:

Third step:
If probability degree for a fuzzy curved number is more than \( k \), fuzzy curved numbers of \( M= (i=1,2,k) \) can be defined as follows:
\[ v(M \geq M_1, M_2, M_3, ..., M_k) = V[M \geq M_1) \land (M \geq M_2) \land ... \land (M \geq M_k)] \]

Fourth step:
Normal weight vectors are as follows using normalization:
\[ W = (d(A_1), d(A_2), ..., d(A_n))^T \]
Where \( W \) is not fuzzy [14].

2.3. Implementing the research:
In this research, FAHP has been used for selecting suppliers. The general issues of research is as following:

Table 2: General Table

As it can be seen from table (2), the first activity in this research is to identify potential suppliers. This means that suppliers need to be selected in that they can meet the needs of unified management. Since this petrochemical unit had some restrictions to disclose the name of suppliers, we number them from one to four. Identifying indicators is the step after identifying suppliers. It was mentioned that these indicators were clarified and prioritized generally by Dickson. Now, we use AHP method for selecting the best supplier using criteria. Picture (1)
Since each company or petrochemical unit has particular and unique priorities for indicators and criteria in order to select suppliers, table of paired comparison was used for determining the weight of each of indicators.

Table 3: Table of paired comparison

<table>
<thead>
<tr>
<th>S1</th>
<th>Supplier 1</th>
<th>Supplier 2</th>
<th>Supplier 3</th>
<th>Supplier 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier 1</td>
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<td></td>
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<tr>
<td>Supplier 2</td>
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<td></td>
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<tr>
<td>Supplier 3</td>
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<tr>
<td>Supplier 4</td>
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</tbody>
</table>

2.4 Data analysis:
Using variables with definite values makes it difficult for experts to give their opinions. So, it is clear that qualitative variables gives more freedom to experts. Using some qualitative variables such as “low”, “medium”, and “high” will somewhat solve the problems. Peoples’ opinions toward qualitative variables such as low or high are not similar. Since experts have various characteristics, they will have different opinions as well. If they answer these questions according to different opinions, the analysis will not be valuable. Although, they will answer with the same ideas defining domain of qualitative variables, qualitative variables are defined using fuzzy numbers [4]. In this article, verbal variables of $X=\{\text{extremely more important, highly more important, More important, relatively more important, the same importance, relatively unimportant, unimportant, highly more unimportant and extremely more unimportant}\}$ were used. Table(4).
After doing these steps and determining mutual importance weight with ambiguous qualitative words (not accurate), we use fuzzy logic to make correct and close- to-real decision. MATLAB software is used to reach the answer considering the fact that fuzzy calculations are too long with high possibility of error in that we write the steps of reaching the answer in the form of order (computer programming), in MATLAB software, after determining importance weight with fuzzy words and consequently, we reach the answer. The following results, as table 5, were obtained after operations in this research:

Table 5: final table

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Supplier 1</th>
<th>Supplier 2</th>
<th>Supplier 3</th>
<th>Supplier 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking</td>
<td>0.244</td>
<td>0.214</td>
<td>0.314</td>
<td>0.197</td>
</tr>
</tbody>
</table>

Conclusion:
Selecting supplier is the most important and vital issue in supply-chain management. The more transparent with lower risk the decision making environment is, the easier, more comfortable and more accurate the management can select the supplier. Human reasoning and judgments have an important role in determining score of suppliers’ performance. Therefore, the more interaction a decision has with human resources as well as complex systems, the more domination fuzzy phenomenon find over explanations of such issues. In this research, the results, after following mentioned steps, are in this way using MATLAB software and according to FAHP method: Supplier number 3 rated the first obtaining the score of 0.314 and suppliers number 1, 2, and 4 ranked the next positions with scores of 0.244, 0.214, and 0.197, respectively.

REFERENCES


