A combined approach for supplier selection: Fuzzy AHP and Fuzzy VIKOR

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AHP  
Fuzzy set

Abstract  
The aim of this study is applying a new integrated method for supplier selection. In this paper, the weights of each criterion are calculated using Fuzzy AHP method. After that, Fuzzy VIKOR is utilized to rank the alternatives. Then we select the best supplier based on these results. The outcome of this research is ranking and selecting supplier with the help of Fuzzy AHP and Fuzzy VIKOR techniques. This paper offers a new integrated method for supplier selection.

1. Introduction


2. Fuzzy Sets and Fuzzy Numbers

Fuzzy set theory, which was introduced by Zadeh (1965) to deal with problems in which a source of vagueness is involved, has been utilized for incorporating imprecise data into the decision framework. A fuzzy set $\mathbf{A}$ can be defined mathematically by a membership function $\mu_{\mathbf{A}}(x)$, which assigns each element $x$ in the universe of discourse $X$ a real number in the interval $[0,1]$. A triangular fuzzy number $\mathbf{A}$ can be defined by a triplet $(a, b, c)$ as illustrated in Figure 1.

The membership function $\mu_{\mathbf{A}}(X)$ is defined as

$$
\mu_{\mathbf{A}}(X) = \begin{cases} 
\frac{x-a}{b-a} & a \leq x \leq b \\
\frac{x-b}{b-c} & b \leq x \leq c \\
0 & \text{otherwise}
\end{cases} \quad (1)
$$
Basic arithmetic operations on triangular fuzzy numbers $\tilde{A}_i = (a_i, b_i, c_i)$, where $a_i \leq b_i \leq c_i$, and $\tilde{A}_2 = (a_2, b_2, c_2)$, can be shown as follows:

Addition: $\tilde{A}_1 \oplus \tilde{A}_2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$  

Subtraction: $\tilde{A}_1 \ominus \tilde{A}_2 = (a_1 - c_2, b_1 - b_2, c_1 - a_2)$  

Multiplication: if $k$ is a scalar

\[
\tilde{A}_1 \otimes k = \begin{cases} 
(ka_1, kb_1, kc_1), & k > 0 \\
(ka_1, kb_1, ka_1), & k < 0 
\end{cases}
\]

\[
\tilde{A}_1 \otimes \tilde{A}_2 \approx (a_1a_2, b_1b_2, c_1c_2), \text{ if } a_1 \geq 0, a_2 \geq 0
\]

Division: $\tilde{A}_1 \oslash \tilde{A}_2 \approx \left(\frac{a_1}{c_2}, \frac{b_1}{b_2}, \frac{c_1}{a_2}\right)$,

if $a_1 \geq 0, a_2 \geq 0$

Although multiplication and division operations on triangular fuzzy numbers do not necessarily yield a triangular fuzzy number, triangular fuzzy number approximations can be used for many practical applications (Kaufmann et al. 1988). Triangular fuzzy numbers are appropriate for quantifying the vague information about most decision problems including personnel selection (e.g. rating for creativity, personality, leadership, etc.). The primary reason for using triangular fuzzy numbers can be stated as their intuitive and computational-efficiency representation (Karsak, 2002). A linguistic variable is defined as a variable whose values are not numbers, but words or sentences in natural or artificial language. The concept of a linguistic variable appears as a useful means for providing approximate characterization of phenomena that are too complex or ill-defined to be described in conventional quantitative terms (Zadeh, 1975).

3. Research Methodology

In this paper, the weights of each criterion are calculated using FAHP method. After that, Fuzzy VIKOR is utilized to rank the alternatives. Finally, we select the best Supplier based on these results.

3.1. Fuzzy Analytic Hierarchy Process

First proposed by Thomas L. Saaty (1980), the analytic hierarchy process (AHP) is a widely used multiple criteria decision-making tool. The analytic hierarchy process, since its invention, has been a tool at the hands of decision makers and researchers, becoming one of the most widely used multiple criteria decision-making tools (Vaidya et al. 2006). Although the purpose of AHP is to capture the expert’s knowledge, the traditional AHP still cannot really reflect the human thinking style (Kahraman et al. 2003). The traditional AHP method is problematic in that it uses an exact value to express the decision maker’s opinion in a comparison of alternatives (Wang et al. 2007). And AHP method is often criticized, due to its use of unbalanced scale of judgments and its inability to adequately handle the inherent uncertainty and imprecision in the pairwise comparison process (Deng 1999). To overcome all these shortcomings, fuzzy analytical hierarchy process was developed for solving the hierarchical problems. Decision-makers usually find that it is more accurate to give interval judgments than fixed value judgments. This is because usually he/she is unable to make his/her preference explicitly about the fuzzy nature of the comparison process (Kahraman et al. 2003). The first study of fuzzy AHP is proposed by Van Laarhoven and Pedrycz (1983), which compared fuzzy ratios described by triangular fuzzy numbers. Buckley (1985) initiated trapezoidal fuzzy numbers to express the decision maker’s evaluation on alternatives with respect to each criterion Chang (1996) introduced a new approach for handling fuzzy AHP, with the use of triangular fuzzy numbers for pair-wise comparison scale of fuzzy AHP, and the use of the extent analysis method for the synthetic extent values of the pair-wise comparisons. Fuzzy AHP method is a popular approach for multiple criteria decision-making. In this study the extent fuzzy AHP is utilized, which was originally introduced by Chang (1996). Let $X = \{x_1, x_2, x_3, \ldots, x_n\}$ be an object set, and $G = \{g_1, g_2, g_3, \ldots, g_m\}$ be a goal set. Then, each object is taken and extent analysis for each goal is performed, respectively. Therefore, $m$ extent analysis values for each object can be obtained, with the following signs:

\[
\tilde{M}_{g_i}^1, \tilde{M}_{g_i}^2, \ldots, \tilde{M}_{g_i}^m, \quad i = 1, 2, \ldots n
\]

where $\tilde{M}_{g_i}^i (i = 1, 2, 3, \ldots, m)$ are all triangular fuzzy numbers. The steps of the Chang’s (1996) extent analysis can be summarized as follows:
Step 1: The value of fuzzy synthetic extent with respect to the ith object is defined as:

\[ S_i = \sum_{j=1}^{m} \tilde{S}_{ij} \odot \left[ \sum_{j=1}^{n} \sum_{i=1}^{m} \tilde{S}_{ij} \right]^{-1} \]  

(6)

Where \( \odot \) denotes the extended multiplication of two fuzzy numbers. In order to obtain \( \sum_{j=1}^{m} \tilde{S}_{ij} \), we perform the addition of m extent analysis values for a particular matrix such that,

\[ \sum_{j=1}^{m} \tilde{S}_{ij} = \left( \sum_{j=1}^{m} l_j \cdot \sum_{j=1}^{m} m_j \cdot \sum_{j=1}^{m} u_j \right) \]  

(7)

And to obtain \( \left[ \sum_{j=1}^{n} \sum_{i=1}^{m} \tilde{S}_{ij} \right]^{-1} \), we perform the fuzzy addition operation of \( \tilde{S}_{ij} \) (j = 1, 2, ..., m) values such that,

\[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{S}_{ij} = \left( \sum_{i=1}^{n} 1 \cdot \sum_{i=1}^{n} m_i \cdot \sum_{i=1}^{n} u_i \right) \]  

(8)

Then, the inverse of the vector is computed as,

\[ \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{S}_{ij} \right]^{-1} = \left( \frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \]  

(9)

Where \( u_i \), \( m_i \), \( l_i > 0 \)

Finally, to obtain the \( S_p \), we perform the following multiplication:

\[ S_p = \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{S}_{ij} \odot \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{S}_{ij} \right]^{-1} \]  

= \( \left( \sum_{i=1}^{n} l_j \cdot \sum_{j=1}^{m} m_j \cdot \sum_{j=1}^{m} u_j \right) \odot \left( \sum_{i=1}^{n} m_i \cdot \sum_{i=1}^{n} u_i \right) \)  

(10)

Step 2: The degree of possibility of \( \tilde{M}_2 \geq \tilde{M}_1 \) is defined as

\[ V(\tilde{M}_2 \geq \tilde{M}_1) = \sup \{ \min (\tilde{M}_1(x), \tilde{M}_2(y)) \} \]  

(11)

This can be equivalently expressed as,

\[ V(\tilde{M}_2 \geq \tilde{M}_1) = \| \tilde{M}_1 \cap \tilde{M}_2 \| = \tilde{M}_2(d) = \left\{ \begin{array}{ll} 1 & \text{if } m_2 \geq m_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \frac{1-u_2}{l_1-u_2} & \text{otherwise} \end{array} \right. \]  

(12)

Figure 2 illustrates \( V(\tilde{M}_2 \geq \tilde{M}_1) \) for the case \( d \) for the case \( m_1 < l_1 < u_2 < m_1 \), where \( d \) is the abscissa value corresponding to the highest crossover point \( D \) between \( \tilde{M}_1 \) and \( \tilde{M}_2 \). To compare \( \tilde{M}_1 \) and \( \tilde{M}_2 \), we need both of the values \( V(\tilde{M}_1 \geq \tilde{M}_2) \) and \( V(\tilde{M}_2 \geq \tilde{M}_1) \).

![Figure 2](image)

Step 3: The degree of possibility for a convex fuzzy number to be greater than \( k \) convex fuzzy numbers \( M_i \) (i = 1, 2, ..., k) is defined as

\[ V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, ..., \tilde{M}_k) = \min V(\tilde{M} \geq \tilde{M}_i), \text{ i = 1, 2, ..., k} \]

Step 4: Finally, \( W = (\min V(\tilde{M} \geq s_1), \min V(\tilde{M} \geq s_2), ..., \min V(\tilde{M} \geq s_k)) \), is the weight vector for \( k = 1, ..., n \).

3.2. The Fuzzy VIKOR Method

The optimum in multi-criteria decision-making is the process to decide the compromise ranking in the ensured rules. In reality, there is no avoidance of the coexistence of qualitative and quantitative data, and they are often full of fuzziness and uncertainty. So, the optimum is often the noninferior solutions or compromise solutions depend on the decision-maker. The concepts of compromise solutions were first initiated by Yu et al (1973). The compromise solutions will be presented by comparing the degree of closeness to the ideal alternative. The method of
VIKOR initiated by Opricovic (1998), works on the principle that each alternative can be evaluated by each criterion function; the compromise ranking will be presented by comparing the degree of closeness to the ideal alternative. To solve fuzzy multi-criteria decision-making problems with a best solution and compromise solution in reality confirmed situation, Fuzzy VIKOR was described by Wang et al (2005). The following was the stages in Fuzzy VIKOR.

**Step 1:** Form a group of decision-makers (denoted in n), then determine the evaluation criteria (denoted in k) and feasible alternatives (denoted in m).

**Step 2:** Identify the appropriate linguistic variables for the importance weight of criteria, and the rating for alternatives with regard to each criterion (as shown in Table 1 and Table 2). The membership degree of fuzzy numbers in the weight of criteria and the rating of alternatives will be presented in Figure 3 and Figure 4.

![Figure 3. The Membership Degree of Fuzzy Numbers in the Weight of Criteria](image)

**Table 1. Linguistic Variables for the Weight of Criteria**

<table>
<thead>
<tr>
<th>Linguistic Variables</th>
<th>Fuzzy Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low (VL)</td>
<td>(0.00,0.00,0.25)</td>
</tr>
<tr>
<td>Low (L)</td>
<td>(0.00,0.25,0.50)</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>(0.25,0.50,0.75)</td>
</tr>
<tr>
<td>High (H)</td>
<td>(0.50,0.75,1.00)</td>
</tr>
<tr>
<td>Very High (VH)</td>
<td>(0.75,1.00,1.00)</td>
</tr>
</tbody>
</table>

![Figure 4. The Membership Degree of Fuzzy Numbers in the Rating of Alternative](image)

**Table 2. Linguistic Variables for the Rating of Alternative**

<table>
<thead>
<tr>
<th>Linguistic Variables</th>
<th>Fuzzy Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst (W)</td>
<td>(0.0,0,2.5)</td>
</tr>
<tr>
<td>Poor (P)</td>
<td>(0.0,2.5,5.0)</td>
</tr>
<tr>
<td>Fair (F)</td>
<td>(2.5,5.0,7.5)</td>
</tr>
<tr>
<td>Good (G)</td>
<td>(5.0,7.5,10)</td>
</tr>
<tr>
<td>Best (B)</td>
<td>(7.5,10,10)</td>
</tr>
</tbody>
</table>

**Step 3:** Pull the decision makers’ opinions to get the aggregated fuzzy weight of criteria, and aggregated fuzzy rating of alternatives. If there are n persons in a decision committee, the importance weight of each criterion and rating of each alternative can be measured by:

\[
\bar{W}_j = \frac{1}{k} \left[ \bar{W}_j^1 \oplus \bar{W}_j^2 \oplus \ldots \oplus \bar{W}_j^k \right]
\]

\[
\bar{x}_{ij} = \frac{1}{k} \left[ \bar{x}_{ij}^1 \oplus \bar{x}_{ij}^2 \oplus \ldots \bar{x}_{ij}^k \right]
\]

**Step 4:** Construct a fuzzy decision matrix. Formally, a typical fuzzy multicriteria decision making problem can be expressed in matrix format as:
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\[
\tilde{D} = \left( \frac{\tilde{x}_{i1}}{M_i} \land \frac{\tilde{x}_{in}}{M_n} \right), \quad i=1,2,\ldots,m; \quad j=1,2,\ldots,n
\]  

(15)

\[
\tilde{W} = [\tilde{W}_1, \tilde{W}_2, \ldots, \tilde{W}_n], \quad j = 1,2,\ldots,n
\]  

(16)

where \( \tilde{x}_{ij} \) is the rating of alternative A, with respect to C, \( \tilde{w}_j \) the importance weight of the j th criterion holds, \( \tilde{x}_{ij} \) and \( \tilde{w}_j \) are linguistic variables denoted by triangular fuzzy numbers.

Step 5: Determine the fuzzy best value (FBV, \( \tilde{f}_j^+ \)) and fuzzy worst value (FWV, \( \tilde{f}_j^- \)) of all criterion functions.

\[
\tilde{f}_j^+ = \max_i \tilde{x}_{ij}, \quad j \in B; \quad \tilde{f}_j^- = \min_i \tilde{x}_{ij}, \quad j \in C
\]  

(17)

Step 6: Compute the values \( \tilde{S}_i \) and \( \tilde{R}_i \):

\[
\tilde{S}_i = \sum_{j=1}^{n} \tilde{W}_j \left[ \frac{\tilde{f}_j^+ - \tilde{x}_{ij}}{\tilde{f}_j^+ - \tilde{f}_j^-} \right]
\]  

(18)

\[
\tilde{R}_i = \max_j \left\{ \frac{\tilde{W}_j (\tilde{f}_j^- - \tilde{x}_{ij})}{\tilde{f}_j^+ - \tilde{f}_j^-} \right\}
\]  

(19)

where \( \tilde{S}_i \) refers to the separation measure of A, from the fuzzy best value, similarly, \( \tilde{R}_i \) is the separation measure of A, from the fuzzy worst value.

Step 7: Calculate the value \( S^*, S^-, R^*, R^- \) and \( \tilde{Q}_i \):

\[
S^* = \min_i \tilde{S}_i, \quad S^- = \max_i \tilde{S}_i
\]  

(20)

\[
R^* = \min_i \tilde{R}_i, \quad R^- = \max_i \tilde{R}_i
\]  

\[
\tilde{Q}_i = \frac{v(\tilde{S}_i - S^*)}{S^- - S^*} + \frac{(1 - v)(\tilde{R}_i - R^*)}{R^- - R^*}
\]  

(21)

The index \( \min_i \tilde{S}_i \) is with a maximum majority rule, and \( \min_i \tilde{R}_i \) is with a minimum individual regret of an opponent strategy. As well, v is introduced as weight of the strategy of the maximum group utility, usually v = 0.5.

Step 8: Defuzzify triangular fuzzy number \( \tilde{Q}_i \) and rank the alternatives by the index \( Q_r \).

The process converting a fuzzy number into a crisp value is called defuzzify. Various defuzzification strategies were suggested, in this paper, Chen’s (1985) method of maximizing set and minimizing set is applied. The maximizing set is defined as:

\[
R = \{(x, f_R(x)) x \in R\}, \text{ with the membership function}
\]

\[
f_R(x) = \begin{cases} 
(x - x_1)/(x_2 - x_1), & x_1 \leq x \leq x_2 \\
0, & \text{Otherwise}
\end{cases}
\]  

(22)

Similarly, the minimizing set is defined as:

\[
L = \{(x, f_L(x)) x \in R\}, \text{ with membership function:}
\]

\[
f_L(x) = \begin{cases} 
(x - x_2)/(x_1 - x_2), & x_1 \leq x \leq x_2 \\
0, & \text{Otherwise}
\end{cases}
\]  

(23)

Then the right utility \( U_R(\tilde{Q}_i) \) and left utility \( U_L(\tilde{Q}_i) \) can be denoted as:

\[
U_R(F_i) = \sup_x (f_{R_i}(x) \land f_{R}(x))
\]  

(24)

\[
U_L(F_i) = \sup_x (f_{L_i}(x) \land f_{L}(x))
\]  

(25)
As a result, the crisp value can be obtained by combining the right and left utilities.

\[ U_p(F_r) = \frac{|U_p(F_r') + 1 - U_p(F_r'')|}{2} \]  

(26)

The index Q, implies the separation measure of \( A_i \) from the best alternative. That is, the smaller the value, the better the alternative.

**Step 9:** To determine a compromise solution \((a')\) by the index Q in double conditions. To fit in with below double conditions, we should point out \( a' \) is our compromise solution.

[Condition 1] Acceptable advantage:

\[ Q(a') - Q(a'') \geq DQ \]

\[ DQ = \frac{1}{m-1} \] (DQ=0.33 if \( m=3 \))

(27)

[Condition 2] Acceptable stability in decision making:

\[ Q(a') \text{ must in } S(a') \text{ or/and } R(a') \text{, } a' \text{ is the alternative with second position ranked by index Q. If condition 1 is not satisfied, and } Q(a'^m) - Q(a') < DQ. \]

\[ a', a'', K, a^m \text{ are compromise solutions in the same. If condition 2 is not satisfied, } a' \text{ and } a'' \text{ are compromise solutions in the same.} \]

**Step 10:** Determine the best alternative.

The best alternative is \( Q(a') \), which is one with the minimum of \( Q_i \).

### 4. A Numerical Example

In this section, we presented a numerical example to demonstrate the application of proposed method. The alternative of this example including \( A_1, A_2 \) and \( A_3 \). In this paper criteria are taken from Mohaghar et al (2013). These criteria include Capacity \((C_1)\), Availability of Raw materials \((C_2)\), Geographic Location \((C_3)\), and Cost \((C_4)\). In this paper, the weights of criteria are calculated using Fuzzy AHP, and these calculated weight values are used as Fuzzy VIKOR inputs. Then, after Fuzzy VIKOR calculations, evaluation of the alternatives and selection of best supplier is realized.

**Fuzzy AHP:**

In Fuzzy AHP method, we determine the weights of each factor by utilizing pair-wise comparison matrixes. We compare each factor with respect to other factors. You can see the pair-wise comparison matrix for ranking of these factors in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>( C_1 )</th>
<th>( C_2 )</th>
<th>( C_3 )</th>
<th>( C_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_1 )</td>
<td>(1.00,1.00,1.00)</td>
<td>(1.00,2.00,3.00)</td>
<td>(1.00,2.00,3.00)</td>
<td>(0.33,0.50,1.00)</td>
</tr>
<tr>
<td>( C_2 )</td>
<td>(0.33,0.50,1.00)</td>
<td>(1.00,1.00,1.00)</td>
<td>(1.00,2.00,3.00)</td>
<td>(2.00,3.00,4.00)</td>
</tr>
<tr>
<td>( C_3 )</td>
<td>(0.33,0.50,1.00)</td>
<td>(0.33,0.50,1.00)</td>
<td>(1.00,1.00,1.00)</td>
<td>(0.33,0.50,1.00)</td>
</tr>
<tr>
<td>( C_4 )</td>
<td>(1.00,2.00,3.00)</td>
<td>(0.25,0.33,0.50)</td>
<td>(2.00,3.00,4.00)</td>
<td>(1.00,1.00,1.00)</td>
</tr>
</tbody>
</table>

After forming fuzzy pair-wise comparison matrix, we calculate the weight of criteria. The weight calculation details are given below. The value of fuzzy synthetic extent with respect to the \( i \)th object \((i = 1,2,3,4)\) is calculated as

\[ S_i = (3.33, 5.50, 8.00) \otimes (0.03, 0.05, 0.07) = (0.11, 0.26, 0.57) \]

\[ S_i = (4.33, 6.50, 9.00) \otimes (0.03, 0.05, 0.07) = (0.15, 0.31, 0.65) \]

\[ S_i = (2.00, 2.50, 4.00) \otimes (0.03, 0.05, 0.07) = (0.07, 0.12, 0.29) \]

\[ S_i = (4.25, 6.33, 8.50) \otimes (0.03, 0.05, 0.07) = (0.14, 0.30, 0.61) \]

Then the V values calculated using these vectors are shown in Table 4.

<table>
<thead>
<tr>
<th>V</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>0.899151</td>
<td>1</td>
<td>0.915035</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>0.547782</td>
<td>0.422613</td>
<td>0.437923</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td>1</td>
<td>0.983047</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Thus, the weight vector from Table 4 is calculated and normalized as

$$W^* = (0.2720, 0.3025, 0.1278, 0.2974)$$

**Fuzzy VIKOR:**
The weights of criteria are calculated by fuzzy AHP up to now, and then these values can be used in Fuzzy VIKOR. According to Fuzzy VIKOR methodology, we obtained weighted normalized decision matrix that can be seen in Table 5.

<table>
<thead>
<tr>
<th></th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>$C_3$</th>
<th>$C_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>(4.15, 6.67, 9.17)</td>
<td>(3.33, 5.83, 8.33)</td>
<td>(5.83, 8.33, 9.17)</td>
<td>(70.0, 73.0, 78.0)</td>
</tr>
<tr>
<td>$A_2$</td>
<td>(3.33, 5.50, 8.33)</td>
<td>(6.67, 9.17, 10.0)</td>
<td>(3.33, 5.83, 8.33)</td>
<td>(70.0, 75.0, 80.0)</td>
</tr>
<tr>
<td>$A_3$</td>
<td>(5.00, 7.50, 8.33)</td>
<td>(4.17, 6.67, 9.17)</td>
<td>(4.17, 6.67, 9.17)</td>
<td>(75.0, 79.0, 81.0)</td>
</tr>
</tbody>
</table>

By following Fuzzy VIKOR procedure steps and calculations, the ranking of suppliers are gained. The results and final ranking are shown in Table 6.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>$Q$</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>(0.61, 0.50, 0.50)</td>
<td>2</td>
</tr>
<tr>
<td>$A_2$</td>
<td>(0.00, 0.16, 0.36)</td>
<td>1</td>
</tr>
<tr>
<td>$A_3$</td>
<td>(0.88, 0.90, 0.75)</td>
<td>3</td>
</tr>
</tbody>
</table>

According to Table 6, $A_2$ is the best Supplier among other Suppliers and other Suppliers ranked as follow: $A_2 > A_1 > A_3$.

5. **Conclusions**
Supplier selection is one of the most important decision making problems including both qualitative and quantitative factors to identify Suppliers with the highest potential for meeting a firm’s needs consistently and at an acceptable cost and plays a key role in supply chain management. The objective of Supplier selection is to identify Suppliers with the highest potential for meeting a company’s needs consistently and at an acceptable cost. Selection is a broad comparison of Suppliers based on a common set of criteria and measures. However, the level of details used for examining potential Suppliers may vary depending on a company’s needs. The overall goal of selection is to identify high potential Suppliers and their quota allocations. An effective and appropriate Supplier assessment method is therefore crucial to the competitiveness of companies. In this paper, fuzzy AHP and fuzzy VIKOR are combined that fuzzy VIKOR uses fuzzy AHP result weights as input. According to result, $A_2$ is the best Supplier among other Suppliers.

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**References**


