FUZZY TOPSIS MODEL BUILDING FOR MULTI ATTRIBUTE DECISION MAKING

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Abstract:
The purpose of this paper is to develop a novel method for Multi Attribute Decision Making (MADM) using fuzzy numbers. Off late, fuzzy numbers have been widely used to determine the degree of subjective importance of evaluation items. The model developed here uses fuzzy measures based upon linguistic levels and converts them into fuzzy numbers. The hypothesis of this paper is that fuzzy modeling and approximate reasoning can replicate the actual state of affairs in decision making. The proposed method can significantly reduce the ambiguity in data ranking and markedly enhance the versatile applicability of fuzzy evaluation in the modern competitive drift.

Key words: Multi Attribute Decision making, Linguistic levels

INTRODUCTION:
The only thing that doesn’t change in the current revolutionary world is change itself (Nour Mohammad Yaghoubi et al., 2011). Mass markets are continuously fragment as customer demands and expectations rise. These developments have caused a major reversion of business priorities and strategic vision (Seyyedhosini et al., 2010). Real world production management, planning and control problems are usually imprecise, complex and critically depend on human activities, making the environment non conducive for decision making managers (Mohammad H. Fazel Zarandi, et al., 2007). In practice, performance evaluation is usually a subjective criteria depending on one’s wisdom, experience, professional knowledge and information which is difficult to define or describe accurately. While analyzing incomplete data, a lot of uncertainties will arise and thus confuse not only the decision maker but also complicate decision making as it is made under unknown situations (Mahmod Othman et al., 2009).

Fuzzy logic provides an effective means of dealing with problems involving imprecise and vague phenomena, since it does not make any global assumptions regarding independence, exhaustiveness or exclusiveness. Fuzzy measures have been so far used to determine the degrees of subjective importance of evaluation items in numerous studies (Ting Yu chen., 2006). Doubtless that fuzzy logics have found significant applications in management decisions and fuzzy concepts enable assessors to use linguistic terms to assess indicators in natural language expressions, were each linguistic term is associated with a membership function (Dahmardeh and Pourshahabi, 2011).

AHP conversely is a commonly used tool for MADM problems urbanized by Saaty. One of the main advantages of this method is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can handle both qualitative and quantitative data involving principles of decomposition, pair wise comparisons and priority vector generation and synthetics (Ramaa. A et al., 2010).

Notable limitations of the MADM is the ranking abnormality, were the ranking of the attributes change when low ranking alternatives are removed from the candidature list, which makes the selection problem inefficient (Lahby Mohamed et al., 2012). To reduce the vagueness and to streamline efforts in MADM the Fuzzy evaluation is used on the basis of fuzzy logic systems in combination with fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Situation). The evaluation can be done by identifying the various attributes which can influence a situation and then by ranking the attributes to improve decision making. The framework of the fuzzy evaluation method involves the following steps.

1. Survey the attributes influencing a situation.
2. Calculate appropriate ratings and weights of attributes.
3. Use of linguistic levels for calculating the average ratings (Ri) and weights (Wi) (Chen-Tung Chen et al., 2006).
4. Tabulating Fuzzy Merit-Important Indexes (FMII) (Ri . Wi).
5. Calculate right and left scores using fuzzy TOPSIS method (Mir. B. Aryanezhad et al., 2011).
6. Finding the overall ranking score of attributes.

The major decision attributes can be listed based on the expert opinion to exactly focus on the given state of affairs and enhance decision making. This will also assist to obviate negative factors from the attribute list and assures better management decision making. The identified attributes may be listed for any problematic circumstance for which ranking scores will have to be calculated.

FUZZY EVALUATION MODEL:
The fuzzy evaluation is primarily used to support decision making in confused and ambiguous environments to find the negative factors in order to eliminate them. This can be done by requesting the evaluators to analyze the decision attributes and giving their corresponding rating and weights using Linguistic levels (Table1).

Considering the evaluation: Ej, representing evaluator j=1, 2,….n conducts the evaluation.

The rating denotes Ri (Table 2) and weights denotes Wj (Table 3), where i=1, 2,…,n conducts the evaluation.

The average rating, weights are calculated by equation (1), (2) and the corresponding FMII shall be calculated by equation (3) for the multiple attributes under focus. The average weights get deduced by [1,1,1,(-)Wj] in order to eliminate negativities.

FMII = Ri .(Wi )/[(1,1,1,-1)Wj]                                                        (3)

Ri = (E1+E2+……..En)/n
Wi = (E1+E2+……..En)/n

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Table 1. Linguistic levels

FOR RATINGS

<table>
<thead>
<tr>
<th>Linguistic variables</th>
<th>Fuzzy numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worst (W)</td>
<td>(0,0.05,0.15)</td>
</tr>
<tr>
<td>Very poor (VP)</td>
<td>(0.1,0.2,0.3)</td>
</tr>
<tr>
<td>Poor (P)</td>
<td>(0.2,0.35,0.5)</td>
</tr>
<tr>
<td>Fair (F)</td>
<td>(0.3,0.5,0.7)</td>
</tr>
<tr>
<td>Good (G)</td>
<td>(0.5,0.65,0.8)</td>
</tr>
<tr>
<td>Very good (VG)</td>
<td>(0.7,0.8,0.9)</td>
</tr>
<tr>
<td>Excellent (E)</td>
<td>(0.85,0.95,1.0)</td>
</tr>
</tbody>
</table>

FOR WEIGHTS

<table>
<thead>
<tr>
<th>Linguistic variables</th>
<th>Fuzzy numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low (VL)</td>
<td>(0,0.05,0.15)</td>
</tr>
<tr>
<td>Low (L)</td>
<td>(0.1,0.2,0.3)</td>
</tr>
<tr>
<td>Fairly low (FL)</td>
<td>(0.2,0.35,0.5)</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>(0.3,0.5,0.7)</td>
</tr>
<tr>
<td>Fairly high (FH)</td>
<td>(0.5,0.65,0.8)</td>
</tr>
<tr>
<td>High (H)</td>
<td>(0.7,0.8,0.9)</td>
</tr>
<tr>
<td>Very high (VH)</td>
<td>(0.85,0.95,1.0)</td>
</tr>
</tbody>
</table>

Table 2. Rating of attributes assigned by evaluators using Linguistic levels

<table>
<thead>
<tr>
<th>Decision Attribute</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA&lt;sub&gt;1&lt;/sub&gt;</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>(0.73,0.85,0.93)</td>
</tr>
<tr>
<td>DA&lt;sub&gt;2&lt;/sub&gt;</td>
<td>F</td>
<td>F</td>
<td>P</td>
<td>(0.43,0.6,0.76)</td>
</tr>
<tr>
<td>DA&lt;sub&gt;3&lt;/sub&gt;</td>
<td>E</td>
<td>G</td>
<td>VG</td>
<td>(0.68,0.8,0.9)</td>
</tr>
</tbody>
</table>

Table 3. Weights of attributes assigned by evaluators using Linguistic levels

<table>
<thead>
<tr>
<th>Decision Attribute</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA&lt;sub&gt;1&lt;/sub&gt;</td>
<td>VH</td>
<td>H</td>
<td>FH</td>
<td>(0.68,0.8,0.9)</td>
</tr>
<tr>
<td>DA&lt;sub&gt;2&lt;/sub&gt;</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>(0.56,0.7,0.83)</td>
</tr>
<tr>
<td>DA&lt;sub&gt;3&lt;/sub&gt;</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>(0.56,0.7,0.83)</td>
</tr>
</tbody>
</table>

\[
ul(FMI) = (\frac{b}{N-1}) + (a)N \quad \rightarrow (4)
\]

\[
ur(FMI) = (\frac{c}{N-1}) + (b)N \quad \rightarrow (5)
\]

\[
ur(FMI) = (\frac{c}{N-1}) + (b)N \quad \rightarrow (5)
\]

\[
ur(FMI) = (\frac{c}{N-1}) + (b)N \quad \rightarrow (5)
\]

Using fuzzy TOPSIS method, the left and right score are calculated from equation (4) and (5). Finally ranking scores are calculated using equation (6), the results of which are depicted (Table 4).

Table 4. FMII and Ranking scores of Decision attributes
RESULT DISCUSSIONS

An FMII which focuses on the application of linguistic approximation and fuzzy arithmetic has been designed for addressing the problems involved in decision making, stressing the multiplicity of meaning and ambiguity of attribute measurement. It is ardent from findings (Table 4) that the model can systematically identify weaknesses in decision making and provide means for managers to devise a comprehensive improvement plan. According to the model results, the priority is to start from DA1 and proceed to DA3 in order to reap better results after decision making. Although the subset portrayed in the built model has only 3 decision attributes, this methodology shall be extended to ‘n’ number of decision attributes. The model thus facilitates systematic continuous improvement over the full range of activities and processes and will prove handy when the number of attributes is copious.

CONCLUSIONS

Changes in market conditions, advancements in technology innovations and everchanging customer demands are significant challenges that must be overcome if a company wants to succeed in satisfying the continuously changing requirements of current and potential customers alike (Ching-torng lin and Chen-tung chen, 2004). MADM problems commonly adhere to imprecise and uncertain data for which fuzzy evaluation is a fit tool. In decision making process, usage of Linguistic variables is highly beneficial when performance measurement cannot be measured by means of numerical values. Decision makers experience, feel and subjective estimates may cause certain liabilities which can be partially overcome using fuzzy TOPSIS. Significantly, the proposed model provides a convincing objective solution to decision making. This systematic framework of decision making can be extended to other decision making problems within the broader periphery of Industrial engineering. (Chen-Tung Chen et al., 2006).

Although the effort demonstrates the usefulness of the model for managerial decision making, we believe that room still vestiges for future validation and improvement. Further research is necessary to improvise the proposed model in other fields and to compare its efficiency with similar models.

REFERENCES


AUTHORS

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