

Application of Fuzzy Multiple Attribute Decision Marking method to Evaluate Customer Satisfaction

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Abstract

In discussing quality characteristics in conventional quality management (QM), most researches tend to adopt the binary differentiation that quality, which is not good, is considered poor quality. But the quality characteristics are fuzzy attribution. This study presents a fuzzy multiple attribute decision marking method (FMADM) to Evaluate customer satisfaction (CS) from various customer services. The attributes weights are initially obtain from some experts. Then, the values of attribute are determined, along with linguistic terms designed for each value to measure the appropriateness of the attribute. Next, the total integral value based on the aggregated utilities is then used to determine the ranking order. FMADM proposed herein can support the decision of the CS evaluation.

Keyword: fuzzy multiple attribute decision marking method, total integral value, Quality Management

1.Introduction

Decision marking is essential in management problems. Evaluation must be from a finite number of alternative actions available to us. A decision-making often involves confronting high degree of fuzziness and uncertainty (yu, 1984). A fuzzy technique has been applied vague data in approximate reasoning, decision marking, optimization, control, and so on (Zimmerman, 1991). In these fields the ranking of fuzzy values is an important issue.

Decision – marking frequently encounter a lack of precise information to assess a set of alternatives in an uncertain environment. Imprecise evaluations might be attributed to incomplete, no obtainable and part ignorance information (Chen and Hwang, 1992). Incorporating fuzziness and uncertainty into decision marking problems can generally generate promising alternatives (Liang, 1991). In MADM, evaluating the alternative is determined on the basis of various attributes and, then, the ranking of these alternatives can obtained using the summarized evaluation results of these attributes. There are two

approaches to these ranking methods (Lee et al., 1994). (1) Defining a ranking function, which maps fuzzy value into a real value where a nature order exists. The ranking function leads to total order among fuzzy values (Kim, 1990; Lious and Wang, 1992). (2) Obtaining a fuzzy set of optimal alternatives, where the membership function indicates the degree to which the corresponding alternative may be considered the optimal one.

The fuzzy set is constructed on the basis of the comparison indices of each pair of fuzzy values corresponding to the alternatives (Dubois, 1983). For example, Liang and Wang (1991) developed a facility sit selection algorithm by applying the fuzzy set theory and hierarchical structure analysis to integrate various linguistic assessments and weights to evaluate facility sit suitability and determine the optimal solution. Wilhelm and Parsaei (1991) applied fuzzy linguistic approach to facilitate decision marking in the phased implementation a strategy for computer-integrated manufacturing. Ibrahim and Ayyub (1992) presented a ranking methodology which uncertainty evaluation; propagation was developed for developing inspection strategies. Knosala and pefrycz (1992) proposed a novel means of evaluating alternatives in mechanical engineering. Maeda and Murakami (1993) use a fuzzy decision-marking method for multiple objective problems for computer system choice. Wang and Chang (1995) use FMADM method to help select the appropriate tool stell materials. Liao (1996) developed a FMADM method to support material selection decisions in engineering design application.

Although many methods for ranking fuzzy values have been suggested in literature, there is yet no method which can always give satisfactory solution to every situation; some of use only the local information fuzzy values; some produces different ranking for the some situation.

For these reasons, we proposed a ranking method which in intuitively acceptable and considers the global information of fuzzy values as well as one that produces coherent ranking. In order to provide an alternative evaluation approach, this paper is organized as follows: first,

the proposed approach are reviewed and discussed in Section 2. In Section 3, presents a numerical example of customer satisfaction (CS) evaluation. Conclusions are finally made in Section 4.

2. Proposed approach

Figure 1 presents the complete structure of proposed approach that contains six distinct Steps. Step 1 and step 2, we determine the attributes applicability the proposed approach, their values represented by linguistic terms and weight to evaluate. Additionally in Step 3, the experts individually evaluate each alternative with respect to their attribute. Step 4, we use linguistic terms to evaluate the performance rating.

The procedure is as follows:

- Step 1: Determine a set of important attributes to assess the alternative performance. For performing the evaluation of services quality, some important attributes, cited from Parasuraman et al. (1985 and 1988) are used herein for various business firms. These attributes contain Reliability, Responsiveness, Competence, Access, Courtesy, Communication, Credibility, Security, Understanding the customer, Tangible, Assurance and Empathy.
- Step 2: Set the type of each attribute's value and the corresponding linguistic term. A set of linguistic terms denoting the appropriation of as attribute is determined therein as (VL, L, M, H, VH) in which each means 'Very Low', 'Low', 'Medium', 'High', and 'High Low', respectively. Triangular fuzzy numbers in Figure 2 are used to define each linguistic term.
- Step 3: Determine the weight to denote an importance of each attribute. Experts respond to a questionnaire to obtain each attributes weight. First, five kinds of importance level are defined: "extremely important", "important", "fairly important", "slightly important" and "unimportant". Each level is assigned a score from 5 decreasing to 1. Next, the average (h_i) of scores of each attribute is calculated by

$$h_i = \sum_{j=1}^n \frac{S_{ij}}{n} \quad i=1, \dots, m \quad (1)$$

where S_{ij} denotes the score of the i th attribute provided by the j th expert. Finally, the weight of each attribute (w_i) is determined by normalizing the

average to be a real number in $[0, 1]$ by

$$w_i = h_i / \sum_{k=1}^m h_k \quad i=1, \dots, m \quad (2)$$

- Step 4: Use linguistic terms to evaluate the performance rating of an alternative
- Step 5: Calculate the aggregate utilities of p alternative by aggregating the weights and performance rating of an alternative. The aggregate utilities are defined by

$$\tilde{F}_j = \sum_{i=1}^m w_i \otimes \tilde{f}_{ij} \quad j=1, 2, \dots, p \quad (3)$$

Where \otimes denotes the fuzzy multiplication and f_{ij} represents the i th performance rating for the j th alternative.

- Step 6: Determine the ranking order based on total values of aggregated utilities, which is calculating the total integral values (Lliou and Wang, 1992). The total integral values are described as follows:

If A is a fuzzy number with membership function $f_A(x)$, then the left, right and total integral value with index of optimism μ are defined by the equations from (4) to (6), respectively, as follows:

$$I_L(\tilde{A}) = \int g_A^L(y) dy \quad (4)$$

$$I_R(\tilde{A}) = \int g_A^R(y) dy \quad (5)$$

$$I_R^\mu(\tilde{A}) = \mu I_L(\tilde{A}) + (1-\mu) I_R(\tilde{A}) \quad (6)$$

Where $g_A^L(y)$ and $g_A^R(y)$ are the inverse functions of the left and right functions of $f_A(x)$, respectively, and the index of optimism μ represents a decision-maker's optimistic or pessimistic attitude.

3. Illustrative example

This section presents an illustrative example of restaurants evaluate to demonstrate the feasibility of the proposed approach. Each attribute's types of values and the corresponding linguistic terms are determined and list in table 1. For specifying an attribute's weight to realize its importance, this study designs a questionnaire to accumulate information from experts familiar with the performance of service quality.

In the questionnaire, respondents use a score from 0 to 7 to rank each performance based on their experiences. To collect a sufficient amount of information, several research assistants visit these experienced engineers and help them complete the questionnaire. Finally, attributes' weights are determined by applying Eqs. (1) And (2). The Aggregated utilities of alternatives are then obtained by aggregating the weights and performance rating using EQ. (3). Table 2 lists the aggregated utilities of the restaurants to be evaluated in terms of triangular fuzzy numbers.

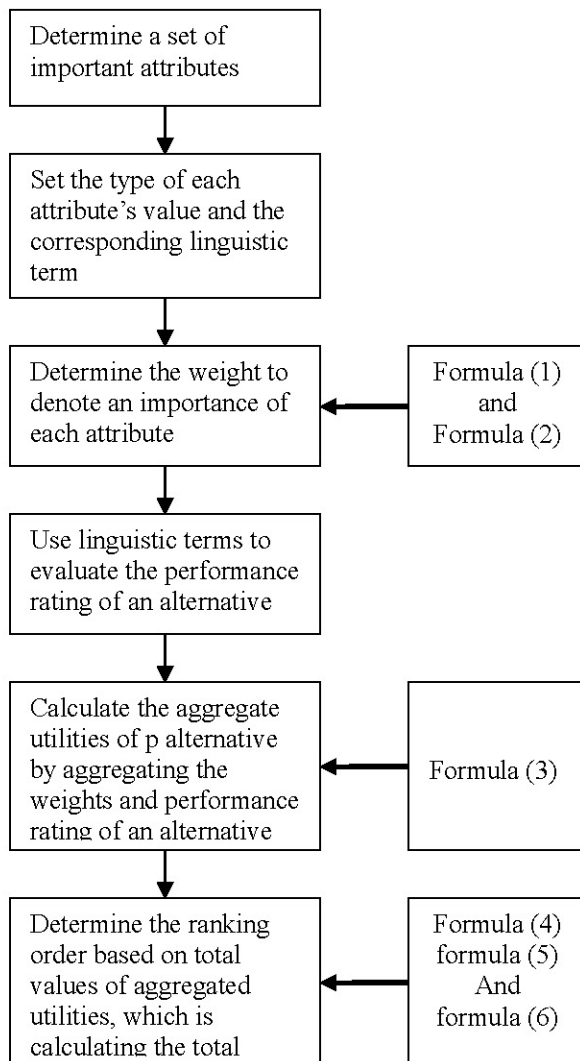


Figure 1: View of the proposed order selection decision model and methodology

Based on the aggregated utilities obtain herein, the total integral value of each restaurants is known by specifying the optimism index as 0.5 in Lious and Wang (1992) and is listed in table 3 in descending order. For comparison, this table

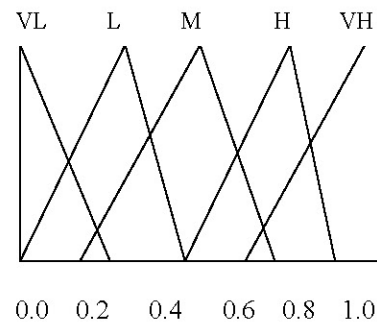


Figure 2. Membership functions denoting the appropriateness of an attribute

also contains the average score of each restaurant, as provided by experienced engineering through questionnaires.

Table 1. Attributes' weights

Attribute	Weight
Reliability	0.093
Responsiveness	0.087
Competence	0.084
Access	0.083
Courtesy	0.084
Communication	0.085
Credibility	0.085
Security	0.085
Understanding the customer	0.087
Tangible	0.080
Assurance	0.075
Empathy	0.072

Table 2. Aggregated utilities of various restaurants

Restaurants	Aggregated utilities
A	(0.361, 0.5367, 0.7455)
B	(0.1343, 0.2609, 0.4940)
C	(0.4815, 0.7565, 0.9326)
D	(0.3311, 0.5872, 0.7978)
E	(0.6421, 0.9349, 0.9826)
F	(0.4829, 0.7566, 0.9342)
G	(0.30001, 0.5454, 0.7618)
H	(0.1703, 0.3160, 0.5968)
I	(0.4241, 0.6400, 0.7906)

Table 3. The final evaluation results for Restaurants

Restaurants	Integral value	Ranking order	Average score	Expert's ranking
E	1.7432	1	6.32	1
F	1.4648	2	3.32	5
C	1.4633	3	2.25	6
I	1.2470	4	3.45	4
D	1.1515	5	5.95	2
G	1.0731	6	0.98	7
A	1.0615	7	0.620	8
H	0.7012	8	3.68	3
B	0.5720	9	0.58	9

4. Conclusions

This study presents a novel approach to evaluate Restaurants. Attributes are initially determined to evaluate Restaurants. These attributes' types of values and corresponding linguistics term are then developed based on performance of Restaurants. Each attribute's importance is also considered in terms of weights supported by experienced experts. Evaluating performance rating of an alternative with respect to each attribute using linguistic terms, allows us to weights and performance ratings to obtain the aggregated utilities of alternatives. Finally the ranking order is determined by the total integral values on the basis of the aggregated utilities.

In order to demonstrating the feasibility of this approach, this study also perform

In order to demonstrate the feasibility of the approach, this study also performs experts' decisions. According to those results, two methods have a consistent conclusion. This finding suggests the fuzzy multiple attribute decision-marking method proposed herein can support the decision on which Restaurants to evaluate. This proposed method can provided quality engineering with effective means of evaluating a customer satisfaction.

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