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Research Article

A Study on the Decision Model of Retail Food Dealers Service Quality Based on UEOWA Operator

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Abstract: As an example of compare service quality of different retail food dealer, the article studies the problem with many decision-makers evaluate some of all schemes and provide a method to transform weighted certain language to uncertain language and then study main indexes to evaluate the service quality of retail food dealers and to analyze a case based on the UEOWA operator at last, the method can provide reference for this kinds of problems.

Keywords: Retail food dealer, service quality, UEOWA operator

INTRODUCTION

There are many Multi-Attribute Decision Making (MADM) problems in the national food tradition economic areas. Many experts studied these problems from different angles by uncertainty language. Suo (2003) studied the uncertain language multi-attribute group decision-making problems based the extended VIKOR decision-making method that the problem attribute weights and experts evaluation weights are in the form of language phrases. Wei (2010) studied the multi-attribute decision-making problems that attribute weights given in the form of real and attribute values given in the form of uncertain language variables. Liu and Wang (2012) studied the MADM problems and transformed uncertain language into binary contact numbers. Wang and Wu (2010) defines a new IGULOWC-OWA operator on the basis of the gray zone uncertainty language and then proposed a new decision-making method. Fang *et al*. (2009) combined rough sets and uncertain language MADM method and proposed a program evaluation model. Liu and Fan (2009) studied group decision-making problems with multi-granularity uncertain language information's. Not only the above literatures described the problem that many decision-makers assigned the attribute values of all programs and then to build models and ordered programs (Yang *et al*., 2012; Li and Li, 2013).

MATERIALS AND METHODS

Problem description: There are some decision-makers evaluated the each index of some programs but not all in practice. For example, there are many retail food sellers to sale the same brand foods, the consumers as the evaluators who have received services from some food retail food sellers to evaluate the service quality of them but not all. There are tourist in the evaluation of scenic spots so that government will get the results to compare the service quality between different scenic spots and so on. This kind of decision problems described as Fig. 1.

We use food service quality as an example to study such:

$$R = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1j} \\ p_{21} & p_{22} & \cdots & p_{2j} \\ \cdots & \cdots & \cdots & \cdots \\ p_{m1} & p_{m2} & \cdots & p_{mj} \end{bmatrix} \left(i = 1, 2 \ldots m \right);$$

issues in this study. Food mobile manufacturers need to supervise and manage the quality of service to its brand retail food stores, so they need to compare retail food sellers service quality scientific. Because of different sellers have different number of customers, the evaluation results are not deterministic language but the sum of weighted uncertainty language. For example, there are x customers for one seller, every one evaluate the index of service quality has different results, so we can't use the deterministic language to demonstrate the overall evaluation results for each index. The problem described as bellow: all of customers for one seller to evaluate the service quality, then combined all of results for different sellers to form the service quality evaluation matrix for all sellers. Assume that there are m sellers in market, for the i^{th} (i = 1, 2…m) seller, n_{ij}^{k} is the number of consumers who evaluate the j^{th} index value as s_k, so the evaluation result matrix for the i^{th} seller is.

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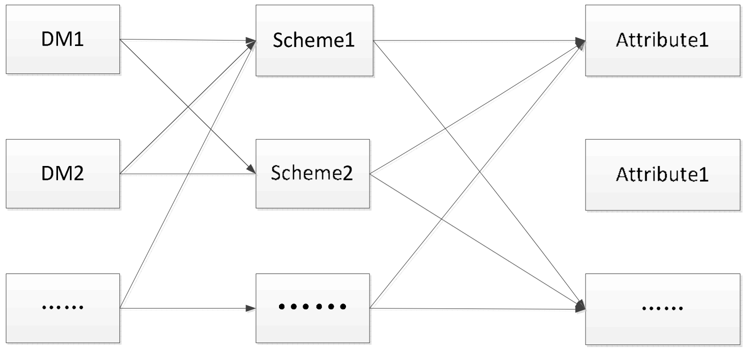

Fig. 1: Decision problems

So the evaluation results of j[th] index by all consumers record as the sum of weighted deterministic language as follow:

$$P_{ij} = n_{ij}^0 s_0 + n_{ij}^1 s_1 + n_{ij}^2 s_2 + n_{ij}^3 s_3 + \ldots + n_{ij}^k s_k$$

k is the number of index and the number of consumers is $n_i = n_{ij}^0 + n_{ij}^1 + \ldots\ldots + n_{ij}^k$; $p_{ij} = P_{ij}/n_i$; p_{ij} is the weighted mean of the j[th] index value that evaluate by all the consumers for i[th] seller, so we constructed the service quality evaluation matrix R of all the retail food sellers by consumers as follow.

$$\begin{bmatrix} n_{i1}^0 & n_{i2}^0 & \ldots & n_{ij}^0 \\ n_{i1}^1 & n_{i2}^1 & \ldots & n_{ij}^1 \\ \ldots & \ldots & \ldots & \\ n_{i1}^k & n_{i2}^k & \ldots & n_{ij}^k \end{bmatrix}$$

Basic knowledge: Two-tuple linguistic information is reprints by tuple group (s_k, α) that show the results for evaluation objects. s_k is the element of properties language assessment scale set.

S = {very bad, bad, few bad, normal, few good, good, very good }={ $s_1, s_2, s_3, s_4, s_5, s_6, s_7$}.

S has some properties as follows:

- Order: when i> = j, s_i> = s_j
- Inverse operator: Neg (s_i) = s_j, j = L-I, L+1 is the Element number of language set (S)
- Maximation operation and minimization operation: when s_i> = s_j, min {s_i, s_j} = s_j

In order to avoid loss decision-making information and calculation, we defined a extended scale $\bar{S}$ = {s_i|$s_1 \le s_i \le s_t$, t ∈ [1, t]}, which was based on original scale S = {s_i|i = 1, 2, 3 …q}. t is a sufficiently large positive number, if i ∈ {1, 2, 3 … q}, we called s_i is primitive term, otherwise, s_i is expand term. Decision makers use primitive term to evaluate programs usually, but use expand term in the procedure of calculation and order.

If $\bar{s}$ = [s_a, $s_β$], s_a, $s_β$ ∈ $\bar{S}$, s_a and $s_β$ showed lower limit and upper limit especially and defined $\bar{s}$ as the sets of all the uncertainty language variables.

Definition 1: On the basis of the ordering of language evaluation scale, if k consumers evaluation results is s_i, l:

Consumers evaluation results is s_j, so the total evaluation value of k+l consumers is $s_{(ki+lj)/(k+l)}$, it is between s_i and s_j, we assumed $ks_i + ls_j = s_{(ki+lj)/(k+l)}$, when j< = i, $j \le \frac{ki+lj}{k+l} \le i$.

Property 1: If k consumers evaluate one index value as s_i, so the overall index value is s_i and we can deem ks_i is equivalent to s_i, record as ks_i == s_i.

Property 2: Extended to the entire expand scale:

$$k_1 s_i + k_2 s_j + \ldots\ldots + k_x s_h == s_{\frac{k_1 s_i + k_2 s_j + \ldots\ldots + k_x s_h}{k_1 + k_2 + \ldots\ldots k_x}}$$

$$s_i, s_{j,} s_k \in \bar{S}$$

Definition 2: Order int is the rounding operator, int ($S_{\frac{k_1 s_i + k_2 s_j + \cdots + k_x s_h}{k_1 + k_2 + \cdots k_x}}$) is the integer part of $S_{\frac{k_1 s_i + k_2 s_j + \cdots + k_x s_h}{k_1 + k_2 + \cdots k_x}}$.

Definition 3: Assumed s_a is belong to extended scale and a is a real number between 1 and t. if a is a integer, s_a is expressed as uncertainty language [s_a, s_a]; but if a is not a integer, s_a is expressed as uncertainty language [int (a), int (a) +1] according to definition 2.

Definition 4: For any two uncertain linguistic variables:

$$\dot{u} = [s_a, s_b], \dot{v} = [s_c, s_d] \in \bar{S}, \beta, \beta_1, \beta_2 \in [0,1]$$

The operation rule was defined as follows:

- $\tilde{u} \oplus \tilde{v} = [s_a, s_b] \oplus [s_c, s_d] = [s_a \oplus s_c, s_b \oplus s_d] = [s_{a+c}, s_{b+d}]$;
- $\beta \tilde{u} = \beta[s_a, s_b] = [\beta s_a, \beta s_b] = [s_{\beta a}, s_{\beta b}]$;
- $\tilde{u} \oplus \tilde{v} = \tilde{v} \oplus \tilde{u}$;
- $\beta(\tilde{u} \oplus \tilde{v}) = \beta \tilde{u} \oplus \beta \tilde{v}$;
- $(\beta_1 + \beta_2)\tilde{u} = \beta_1 \tilde{u} \oplus \beta_2 \tilde{u}$

Definition 5: Assumed $\tilde{u} = [s_a, s_b], \tilde{v} = [s_c, s_d] \in \tilde{S}$ and defined the possible degree of the formula $l_{ab} = b - a, l_{cd} = d - c$ as follows:

when $\tilde{u} \geq \tilde{v}; p(\tilde{u} \geq \tilde{v}) = \max\{1 - \max(\frac{d-a}{l_{ab} + l_{cd}}, 0), 0\}$

when $\tilde{v} \geq \tilde{u}; p(\tilde{v} \geq \tilde{u}) = \max\{1 - \max(\frac{b-c}{l_{ab} + l_{cd}}, 0), 0\}$

Definition 6: Assumed $\tilde{u} = [s_a, s_b]$, $\tilde{v} = [s_c, s_d]$, $\tilde{\gamma} = [s_e, s_f] \in \bar{S}$ there are some conclusions according to definition 5 as follows:

- $0 \leq p(\tilde{u} \geq \tilde{v}) \leq 1, 0 \leq p(\tilde{v} \geq \tilde{u}) \leq 1$.
- When only d≤a, $p(\tilde{u} \geq \tilde{v}) = 0$ $p(\tilde{u} \geq \tilde{v}) = 1$
  When only b≤c, $p(\tilde{v} \geq \tilde{u}) = 1$
- When only b≤c; when only d≤a, $p(\tilde{v} \geq \tilde{u}) = 0$
- $p(\tilde{u} \geq \tilde{v}) + p(\tilde{v} \geq \tilde{u}) = 1, p(\tilde{u} \geq \tilde{u}) = 1/2$.
- When only a + b≥c + d, $p(\tilde{u} \geq \tilde{v}) \geq 1/2$
  When only a + b = c + d, $p(\tilde{u} \geq \tilde{v}) = 1/2$
- When $p(\tilde{u} \geq \tilde{v}) \geq 1/2$, $p(\tilde{v} \geq \tilde{\gamma}) \geq 1/2$, there is a result $p(\tilde{u} \geq \tilde{\gamma}) \geq 1/2$

Definition 7: Assumed a function UEOWA: $\bar{S}^n \rightarrow \bar{S}$ if $UEOWA_w(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n) = w_1 \tilde{v}_1 \oplus w_2 \tilde{v}_2 \oplus ...... \oplus w_n \tilde{v}_n$, w = ($w_1$, w_2,…, w_n) is the weighting vector associated with function UEOWA , $w_j \in [0,1] (j \in N), \sum_{j=1}^{n} w_j = 1, \tilde{u}_i \in \tilde{S}, \tilde{v}_i$ is a the j^{th} bigger element in the group of uncertain linguistic variables $(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n)$, we called function UEOWA operator is a uncertain EOWA operator.

Definition 8: In the sort vector $v_i = \frac{1}{n\,(n-1)}\,(\sum_1^n p_{ij} + n2 - 1)$, n is the order of possible degree matrix, p_{ij} is the element of the matrix.

RESULTS AND DISCUSSION

Evaluation indexes of retail food sellers service quality: This study from the consumers perspective to study most concerned factors When they accepting food dealers service, as index of the decision-making model.

The first index is Service Environment (SE) which is the rest place provided by food dealers who provide computers for customers to access entertainment and fine magazines and the place whether bring a relaxed atmosphere for customers will to enhance customers feeling because of the good service environment.

Second index is the Service Attitude (SA) refers to the workers have mild manners, respect and enthusiastic, active, etc. or not in the process of provide services to consumers, rather than passed individual negative emotions to customers. If service attitude is better, the customer will feel better and the possibility will greater for accept service again.

Third index is Maintenance Quality (MQ), after consumers receive the services, whether there will be some problems make customers feel the quality is not high, such as the consumers to shop for air cleaning work, they find the food air-conditioning still smell after the completion of the service. This situation will make consumers feel poor quality of service.

Fourth index is Service Professionalism (SP), the staff need explain the technology problem and questions to customers professional and easy to understand.

Fifth index is Work Efficiency (WE), it is refers to response time is or not fast when consumers need service for example, maintenance staff should arrive at the position when consumer's food broke down as soon as possible.

Sixth index is food Cleanliness (VC) that means after complete food mobile maintenance if the food exterior and interior are kept clean or cause damage.

The last index is Expense (E). Generally, the better the service, the costs are higher, but consumers want lower prices to get higher service levels in a competitive market, if the price is higher than the average too much, even if the dealer offers the best service will also affect consumers evaluation for the overall quality of service.

Algorithm steps:

Step 1: Construct a weighted matrix.

Step 2: According the definitions 1, 2, 3 and properties 1 and 2 to transfer the evaluation of the property value with certainty language to property value by uncertain language and then get a comprehensive decision matrix.

Step 3: According the definitions 5 to compare the property value between different objects and then build possible degree matrix.

Step 4: According the definitions 5 to calculate the ordering vector V of possible degree matrix.

Table 1: Transformed weighted certain language to extended term

	SE	SA	MQ	SP	WE	VC	E
A	$S_{2.698}$	$S_{1.061}$	$S_{3.753}$	$s_{4.061}$	$S_{2.239}$	$s_{5.342}$	$S_{1.164}$
B	$S_{3.027}$	$S_{4.027}$	$S_{3.481}$	$S_{4.518}$	$S_{3.472}$	$S_{5.083}$	$S_{3.407}$
C	$S_{2.990}$	$S_{3.995}$	$S_{5.296}$	$S_{3.990}$	$S_{4.228}$	$S_{5.631}$	$S_{1.587}$
D	$S_{4.437}$	$S_{2.772}$	$S_{4.727}$	$S_{5.545}$	$S_{3.852}$	$S_{5.056}$	$S_{2.965}$

Step 5: According the vector components to descend order by uncertain linguistic properties of each program in the decision matrix.

Step 6: According 7 to use UEOWA operator and weighted vector to assemble uncertain linguistic attribute values which was sorted and obtain a comprehensive attribute value of the scheme d:

$$\tilde{z}_d(w)(d \in N) : \tilde{z}_d(w) = UEOWA_w(\tilde{u}_1, \tilde{u}_2, ..., \tilde{u}_n)$$

Step 7: According definition 5 to reuse the possible degree formula to calculate the possible degree $\tilde{z}_d(w)$ between the comprehensive attribute value of different schemes and build complementarily matrix of possible degree.

Step 8: Get the vector of possible degree and sorted according definition 8, we get a result which object is best.

Case study: A food manufacture in order to assess the service quality of four different retail food dealers and collect some results that there are 146, 108, 206 and 176, respectively consumers to evaluate the quality in the same time period respectively, we accord step 1 and 2 to get Table 1 and a comprehensive matrix that described by uncertain language:

$$\begin{bmatrix} [s_2,s_3] & [s_1,s_2] & [s_3,s_4] & [s_4,s_5] & [s_2,s_3] & [s_5,s_6] & [s_1,s_2] \\ [s_3,s_4] & [s_4,s_5] & [s_3,s_4] & [s_4,s_5] & [s_3,s_4] & [s_5,s_6] & [s_3,s_4] \\ [s_2,s_3] & [s_3,s_4] & [s_5,s_6] & [s_3,s_4] & [s_4,s_5] & [s_5,s_6] & [s_1,s_2] \\ [s_4,s_5] & [s_2,s_3] & [s_4,s_5] & [s_5,s_6] & [s_3,s_4] & [s_5,s_6] & [s_2,s_3] \end{bmatrix}$$

According to step 3 and 4, we get ordering vectors of possible degree as follows:

V_1 = (0.131, 0.083, 0.166, 0.196, 0.107, 0.214, 0.083)

V_2 = (0.060, 0.179, 0.107, 0.179, 0.107, 0.214, 0.107)

V_3 = (0.095, 0.131, 0.202, 0.131, 0.166, 0.202, 0.071)

V_4 = (0.155, 0.083, 0.155, 0.202, 0.119, 0.202, 0.083)

Assumed weighted vector:

W = (0.10, 0.13, 0.19, 0.23, 0.15, 0.08, 0.12)

And according step 5 and 6 to calculate the comprehensive evaluation values of attributes for these four decision schemes, as follows:

$$\tilde{z}_A(w) = UEOWA_w(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n) = 0.1\times[s_5,s_6] \oplus 0.13\times[s_4,s_5]$$
$$\oplus 0.19\times[s_3,s_4] \oplus 0.23\times[s_2,s_3] \oplus 0.15\times[s_2,s_3] \oplus 0.08\times[s_1,s_2]$$
$$\oplus 0.12\times[s_1,s_2] = [s_{2.55}, s_{3.55}]$$

$$\tilde{z}_B(w) = UEOWA_w(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n) = 0.1\times[s_5,s_6] \oplus 0.13\times[s_4,s_5] \oplus$$
$$0.19\times[s_4,s_5] \oplus 0.23\times[s_3,s_4] \oplus 0.15\times[s_3,s_4] \oplus 0.08\times[s_3,s_4]$$
$$\oplus 0.12\times[s_3,s_4] = [s_{3.52}, s_{4.52}]$$

$$\tilde{z}_C(w) = UEOWA_w(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n) = 0.1\times[s_5,s_6] \oplus 0.13\times[s_5,s_6]$$
$$\oplus 0.19\times[s_4,s_5] \oplus 0.23\times[s_3,s_4] \oplus 0.15\times[s_3,s_4] \oplus 0.08\times[s_2,s_3]$$
$$\oplus 0.12\times[s_1,s_2] = [s_{3.33}, s_{4.33}]$$

$$\tilde{z}_D(w) = UEOWA_w(\tilde{u}_1, \tilde{u}_2 ..., \tilde{u}_n) = 0.1\times[s_5,s_6] \oplus 0.13\times[s_5,s_6]$$
$$\oplus 0.19\times[s_4,s_5] \oplus 0.23\times[s_4,s_5] \oplus 0.15\times[s_3,s_4] \oplus 0.08\times[s_2,s_3]$$
$$\oplus 0.12\times[s_2,s_3] = [s_{3.68}, s_{4.68}]$$

And then according step 7 to use the formula of possible degree to calculate the possible degree matrix between different attribute values of four schemes and get a result as follow:

$$\begin{bmatrix} 0.5 & 0.015 & 0.11 & 0 \\ 0.985 & 0.5 & 0.595 & 0.42 \\ 0.89 & 0.405 & 0.5 & 0.325 \\ 1 & 0.58 & 0.675 & 0.5 \end{bmatrix}$$

At last, according step 4 to calculate the ordering vector of possible degree V = (0.1354, 0.2917, 0.1767, 0.2296) and then get the result Bf Df Cf A, sorted by vector component, so the best one in these food dealers is B.

CONCLUSION

We accorded the practical problems that many decision makers are not to evaluate all schemes and there are different numbers of decision makers to evaluate each scheme and based on the certainty of attribute values that evaluated by decision makers, to expressed the attribute values of total schemes to the sum of weighted certain language and then raised a new method that transformed the weighted certain language to uncertain language and combined possible degree to compared the service quality between different retail food dealers that based on UEOWA operator and the method can be provided some consults for this kind of multiple attribute problems.

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