A FUZZY MULTI-ATTRIBUTE DECISION MAKING ALGORITM FOR PRODUCTION CONSUMER GOODS

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ABSTRACT : This article we provide an overview of the analysis a method of decision making system for consumer goods. Based on the definition of the positive ideal solution and negative ideal solution, this method selects the most appropriate one with the highest degree of membership belonging to the positive ideal solution. The use of this method is expected to help and provide the best decision in the selection of sale of consumer goods.

KEY WORDS : Fuzzy Sets, Decision making, Membership function, Linguistic quantifiers, Customer satisfaction level.

1. INTRODUCTION

This paper applies the fuzzy multi-attribute decision making approach to the process of products selection based on quality of product, wich can select the most appropriate one with the highest degree of membership belonging to the positive ideal soltion.

2. PRODUCTION CONSUMER GOODS QUALITY MODEL

The quality of goods produced is a generic term to determine the products that do not sell. In this article I thought four important quality criteria: production cost (shortly cost), time, form, popular. More quality requirements can reference [2],[5].

Cost. Given an operation *op* of a product *p*, the cost $q_{cost}(p,op)$ is the amount of money that a product company requester has to pay for executing the operation.

Time. Is a common measure of performance Suppose we have executed an operation *op* of a product *p*, the execution time $q_{time}(p,op)$ can be divided into $q_{time}(p,op)=T_{production}(p,op)+T_{sale}(p,op)$, where $T_{production}(p,op)$ is the actual time of manufacturing a product *p* and $T_{sale}(p,op)$ is the time of packaging and marketing the product *p*.

Form. It represents the company's skill to give a pleasant product. Form $q_{form}(p)=T(p)/\theta$, where $T(p)$ is the total time in which the product *p* is avaible during the last θ time.

Popular. The popularity $q_{pop}(p)$ of the product *p* is defined as the average rank given to de product by end users, i.e., $q_{pop}(p)=\sum_{i=1}^{n}\frac{R_i}{n}$, where *Ri* is the end user's rank on a product's popular, n is the number of times that the product has been graded.

Definition 1. [1] A quality criterion is defined as a tuple *(N,V,U)* where

- *N* is the name of a quality criterion.
- $V:N\longrightarrow V$ is the value of a quality criterion.
- $U:N\longrightarrow U$ is a function that gives the unit of measurement used for each quality criterion.

According to before notation we have thus:

$q(p)=(q_{cost}(p), q_{time}(p), q_{form}(p), q_{pop}(p)$

2. DESCRIPTION OF DECISION MAKING PROCESS

2.1. Presentation of the Problem

A consumer goods producer wants to determine the best product for a customer based on his preferences. The vendor objective is to define the product that is closest to the customer preference. The product was evaluated by considering the four features: F_1 – production cost, F_2 –time, F_3 – form, F_4 –popular. Suppose you want to sell (the function t) a specific range of products which means that we have a finite set of possibilities This returns to evaluate set $p(t)=\{p_1, p_2,..., p_n\}$ where n represents the number of products for the task (marketing) *t*. Each product s_i is assigned quality vector $q(s_i)=\{q_{\cost}(s_i), q_{weight}(s_i), q_{form}(s_i), q_{popular}(s_i)\}$ The process of product for a customer proposed in this paper uses fuzzy multi-attribute decision making approach [1], [3], [4], [6].

2.2. Decision Making Process for product Selection

Steps which I will follow are the following:

Step 1: Unifying unit. Once the quality vector of each product is derived, quality matrix $Q_{n,4}$ can be obtained where *i* row represents the quality vector of product p_i.

$$Q_{n,4}=\begin{pmatrix} q_{11} & q_{11} & q_{11} & q_{11} \\ q_{21} & q_{22} & q_{23} & q_{24} \\ \vdots & \vdots & \vdots & \vdots \\ q_{n1} & q_{n2} & q_{n3} & q_{n4} \end{pmatrix} \quad \textbf{(1)}$$

The quality of product can be advertised by the HACCP procedure called "customer satisfaction" is required to perform and record the level of any companies producing consumer goods. Data arising here lead us to obtain a matrix $Q'_{n,4}$ as follows, where each column vector has the same unit

$$Q'_{n,4}=\begin{pmatrix} q'_{11} & q'_{11} & q'_{11} & q'_{11} \\ q'_{21} & q'_{22} & q'_{23} & q'_{24} \\ \vdots & \vdots & \vdots & \vdots \\ q'_{n1} & q'_{n2} & q'_{n3} & q'_{n4} \end{pmatrix} \quad \textbf{(2)}$$

Step 2: Scaling phase. We consider positive criteria standard form and popularity, and shape their values representing higher quality. Equations 3 and 4 will be used for this criterion.

$$v_{ij}=\begin{cases} \dfrac{q'_{ij}-\min\limits_i q'_{ij}}{\max\limits_i q'_{ij}-\min\limits_i q'_{ij}} & if \quad \max\limits_i q'_{ij}\neq \min\limits_i q'_{ij} \\ 1 & if \quad \max\limits_i q'_{ij}= \min\limits_i q'_{ij} \end{cases}$$

$$1\le i\le n, j=3,4 \quad \textbf{(3)}$$

$$v_{ij}=\frac{q'_{ij}}{\max\limits_i q'_{ij}+\min\limits_i q'_{ij}}, 1\le i\le n, j=3,4 \quad \textbf{(4)}$$

For negative criteria such cost and time, the higher the value is, the lower the quality is. For negative criteria, values are scaled according to equation (5) or equation (6).

$$v_{ij}=\begin{cases} \dfrac{\max\limits_i q'_{ij}-q'_{ij}}{\max\limits_i q'_{ij}-\min\limits_i q'_{ij}} & if \quad \max\limits_i q'_{ij}\neq \min\limits_i q'_{ij} \\ 1 & if \quad \max\limits_i q'_{ij}= \min\limits_i q'_{ij} \\ 1\le i\le n, j=1,2 \end{cases} \quad \textbf{(5)}$$

$$v_{ij}=1-\frac{q'_{ij}}{\max\limits_i q'_{ij}+\min\limits_i q'_{ij}}, 1\le i\le n, j=1,2 \quad \textbf{(6)}$$

In the above equation, $\max\limits_i q'_{ij}$ is the maximum element of *j* column vector and $\min\limits_i q'_{ij}$ is the minimal element of *j* column vector. For a certain column in $Q'_{n,4}$, if the value of vector elements spans a wide interval, equations (3) and (5) is used, otherwise equations (4) and (6) is used.

After the above operations are done, the following matrix $Q''_{n,4}$ can be obtained:

$$Q''_{n,4}=\begin{pmatrix} v_{11} & v_{11} & v_{11} & v_{11} \\ v_{21} & v_{22} & v_{23} & v_{24} \\ \vdots & \vdots & \vdots & \vdots \\ v_{n1} & v_{n2} & v_{n3} & v_{n4} \end{pmatrix} \quad \textbf{(7)}$$

Row vector $v_i=\{v_{i1}, v_{i2}, v_{i3}, v_{i4}\}$ represents the relative quality of p_i to object.

Step 3: Computing weighted Hamming distance to the positive ideal solution and weighted Hamming distance to the negative ideal solution for alternatives. We give below a few definitions that we will use:

Definition 2. [6] Quality vector of the positive ideal solution denoted by g in $Q''_{n,4}$ is defined as:

$$g = \{g_1, g_2, g_3, g_4\} = \left(\max_i v_{i1}, \max_i v_{i2}, \max_i v_{i3}, \max_i v_{i4}\right) \quad \textbf{(8)}$$

1≤i≤n.

Definition 3. [6] Quality vector of the negative ideal solution denoted by *b* in $Q''_{n,4}$ is defined as:

$$b = \{b_1, b_2, b_3, b_4\} = \left(\min_i v_{i1}, \min_i v_{i2}, \min_i v_{i3}, \min_i v_{i4}\right) \quad \textbf{(9)}$$

1≤i≤n.

Definition 4. Weighted Hamming distance d_{ig} between product p_i and the positive ideal solution is defined as:

$$d_{ig} = \sum_{j=1}^{4} \left| g_j - v_{ij} \right|, 1 \le i \le n. \quad \textbf{(10)}$$

Definition 5. Weighted Hamming distance d_{ib} between product p_i and the negative ideal solution is defined as:

$$d_{ig} = \sum_{j=1}^{4} \left| v_{ij} - b_j \right|, 1 \le i \le n. \quad \textbf{(11)}$$

*Step 4***:** Calculating degree of membership of each product belonging to the positive ideal solution.

Definition 6. A membership function $\mu(v_i)$ which gives the degree of membership of v_i belonging to g is:

$$\mu(v_i) = \frac{1}{1 + \left(\frac{d_{ig}}{d_{ib}}\right)}, 1 \le i \le n. \quad \textbf{(12)}$$

$\mu(v_i)$ represents the degree of membership of product p_i belonging to the positive ideal solution *g*.

*Step 4***:** Select the final decision alternative. Sorting the vector *u*, and the final decision is the product with the maximum $\mu(v_i)$.

3. CONCLUSION

In this paper it has been analyzed that many decision making approach are limited with respect to the management of complexity of the decision situation. What I tried to present in this article is that by replacing the Euclidean distance with Hamming distance, no need to simplify calculations for determining an additional vector to norm equal to 1.

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