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Research Paper

CUSTOMER ORIENTED PRODUCT ATTRIBUTES RANKING USING FUZZY NORMALIZATION

Sachin Agarwal[1]*

*Corresponding Author: Sachin Agarwal, ✉ sachin.agrawal@sait.ac.in

The paper proposed a methodology to rank the attributes of any product which is beneficial in product design and development. The paper is accomplish with a survey which is conducted to know the required customer choice, attributes preferences in the products. Suggested methodology help the enterprise to know the market demand, according to which product is to be manufactured to satisfy a mass marketing segment. Design and development of the product should mainly focus on those attributes which are as per the ranking of customer's preferences. Changing requirement of the market, mass customization, timely response and customer satisfaction attributes are the main driving force for modularity concept. Fuzzy logic concept is used to address the uncertainty and imprecise decision in analysis of the attributes of the product. In order to meet the customer's satisfaction it is presumed that the enterprise should be flexible to meet the rapid changes of the market demand.

Keywords: Fuzzy logic, Customer preferences, Customer satisfaction, Normalization, Product attributes

INTRODUCTION

Customer satisfaction is the fulfillment of the need for any products or services desired. Satisfaction as a global evaluative judgement about product consumption (Hunt, 1977; and Westbrook, 1987) is a function of the closeness between expectation of customers and product perceived performance both technically and aesthetically. Several researches have been conducted to investigate the determinants of satisfaction. Customer satisfaction can be evaluated by subjective factors (feeling, emotion, customers need, demands) and objective factors (product and service feature including quality and reliability). Products attributes play an important role to satisfy customer's needs. According to (Aaker *et al.*,1992) an important attributes is one that offers desirable benefit towards the satisfaction of customer's needs.

[1] Department of Mechanical Engineering, SAIT, Indore, MP, India.

Luo and Homburg (2007) noted that customer satisfaction positively influences business profitability.

Customer preferences for product attributes are very crucial for the design and development of product. In order to meet the uncertain future needs, demands preferences of the customers, enterprise should be flexible enough for rapid changes in the design, which is the main driving force for modularity concept. As (Oliver, 1981) suggested that "the surprise or excitement of satisfaction evaluation is thought to be of finite duration". Conceptually, modularity can be understood as a way of building a complex product or process from smaller subsystems that can be designed independently and yet function together as a whole (Baldwin and Clark, 1997). It is common that performance ratings for different attribute are measured by different units. To transform performance ratings into a compatible measurement unit, normalization procedures are used. Further there is a vagueness in deciding the importance of attributes, hence Fuzzy logic as suggested by Zadeh can be used to determine the final outcome of all the attributes.

Fuzzy Logic was initiated in 1965 by Lofti A Zadeh, professor of computer science. Fuzzy Logic is a multivalued logic that allows intermediate values to be defined between conventional evaluation like true/false, yes/no, high/low. Fuzzy Logic provide a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise information by using membership function. Importance of fuzzy logic and fuzzy sets theory applied to the decision making process was proposed initially by (Hwang and Yoon, 1981). The multi criteria decision making problem with fuzzy sets was first introduced by (Bellman and Zadeh, 1970).

LITERATURE REVIEW

Customer satisfaction has been very relevant topic in marketing research since perceived by Cardozo's (1965). Oliver (1981), Churchill and Surprenant (1982), Tse and Wilton (1988), Yi (1990), Westbrook and Oliver (1991) and Fornell (1992) view that customer satisfaction is post purchase phenomenon and Customer satisfaction vary dramatically over time (Cote, *et al.*, 1989). Olander (1977) projects the different view that there are situation when a consumer determine satisfaction before purchase. To satisfy customer fully product attributes include both tangible (concrete) and intangible properties (abstract) (Peter and Olsen, 1994). Early researchers include only physical properties like price, brand name that were quantitatively and objectively measureable (Wu *et al.*, 1988). In recent year it expanded to subjective criteria like quality, style, benefits or value also (Grapetine, 1995; and Jamaml and Goode, 2001).

Customer ranks the different product on the basis of attributes satisfying their preferences and choice. Brian Thomas (2002) has mentioned that brand awareness plays an important role in consumer preferences. Blackwell *et al.* (2006) stated that decision rules strategies adopted by customer to select the product. Customer evaluate the score of each brand in consideration to the available attributes according to their satisfaction level (Hawki *et al.*, 1992; and Schiffman and Kanuk, 2007). Gary Knight (1984) has compared the consumer preferences for goods made abroad

and made in the home country by both home country and foreign firms and found that the country of manufacture and product quality strongly influence consumer decision making in globally available product categories.

Liu (1995) proposed models to evaluate customer satisfaction using the analytical hierarchy process and fuzzy set theory. Oyatoye (2011) point out that resources allocation, costing and pricing decision as a benchmark that balances customer expectation, satisfaction level with the optimum level of attributes. Zeenat Ismail *et al.* (2012) have compared global brand and local brand and revealed that most important factors that influence a consumer's final decision are the price and quality of the product. Ali Nasr Esfahair (2012) has analyzed the psychological factors on consumer's buying behavior.

Kotler and Armstrong (2006) addressed that product design and development department should think about the product at three levels: core product level, actual product level and augmented product level. Modularity in design has been investigated to reduce design process complexity (Ulrich and Eppinger, 1995; and Fujita, 2002). It can be defined as choosing the design boundaries of a product and of its components, i.e. on how to divide a system into modules, so that the design features and tasks are interdependent within and independent across modules (Huang and Kusiak, 1998; and Camuffo, 2001). Product modularity and determination of modular configuration involve design evaluation, which can be performed from different points of view: function, flexibility, cost-effect and environment (Bi and Zhang, 2001). In product oriented areas, to reduced design effort and time-to-market (Martin and Ishii, 2000) developed a dfV (design for Variety) methodology for developing a robust product platform architecture.

Normalization is used to transform performance ratings to a compatible unit scale. The four well known normalization procedures used in MADM are (a) vector normalization, (b) linear scale transformation (max-min method), (c) linear scale transformation (max method), and (d) linear scale transformation (sum method).

SUGGESTED METHODOLOGY

A_{ij}, value of the choice and preferences according to the customer requirement about the attribute of the individual product $i = 1, 2, \ldots, m$, m represent the number of attributes. $j = 1, 2, \ldots, c$, c represent no. of customer surveyed. Customers have always imprecise, fuzzy in the knowledge of the attributes therefore he has to give preference choice of the attributes in the value between 0 and 1. The value 1 indicates the fullest satisfaction level of the customer's about that attribute and 0 indicates that the given attribute is not important or does not satisfy needs.

$S_1, S_2, \ldots, S_m$ represent the sum of individual attribute of all the customer's choice.

$S_{1N}, S_{2N}, \ldots, S_{mN}$ represent the linear normalization of each attributes.

T represents the total summation of the preferences choice of all the attributes of all the customers.

The selected m attributes should be grouped in to three levels viz., Highly desirable, Desirable and Optional.

In the approach, suggested ranking of the first four or five attributes which contributed mostly in customer's satisfaction level should be grouped in to Highly desirable. Similarly, other are also grouped in to Desirable and Optional. Optional contribute least in satisfaction of customer's choice and preferences. The first priority of the enterprise in the product design and development is to incorporate the features of all those attributes grouped as Highly desirable to satisfies mass customization.

The steps to be followed in the methodology

1. First, decide the number of attributes on which data is collected for the individual product about the customer's choice and preferences.
2. Decide the sample size of the number of customer's to be surveyed using simple random sampling techniques.
3. Calculate the sum of all the individual attributes, i.e., S_1, S_2, …, S_m and total summation of the attributes of all customers.

$$S_1 = \sum_{j=1}^{c} A_{1j}\ ,\ S_2 = \sum_{j=1}^{c} A_{2j}\ ,\ \ldots,\ S_m = \sum_{j=1}^{c} A_{mj}$$

$$T = \sum_{i=1}^{m} S_i = S_1 + S_2 + \ldots\ldots\ldots\ldots\ldots + S_m$$

4. Arrange the attributes in descending order by sorting in excel sheet as shown in the Appendix 1.
5. Calculate the linear normalization of the attributes. Out of four normalization procedures used in MADM, we use here Linear Scale Transformation (sum method).

$$S_{1N} = \frac{S_1}{T}, \ldots,\ S_{mN} = \frac{S_m}{T}$$

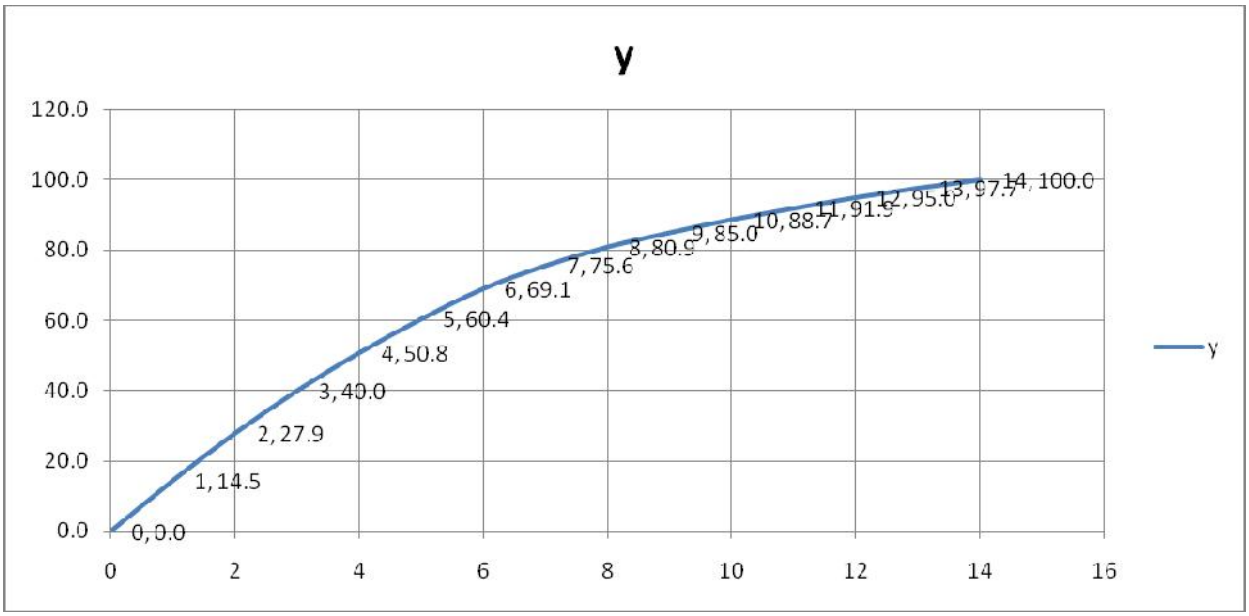
6. Arranging in tabulate form the cumulative percentage of all attributes for Pareto diagram analysis as shown in the Table 1. Pareto diagram is plotted by taking ranking of all attributes on *x* axis and cumulative % of normalized attributes value on y axis as shown in the Figure 1.
7. According to the Pareto diagram the attributes are grouped in to Highly Desirable, Desirable and Optional. Highly Desirable which contributed 50-60% of the customer's satisfaction level. Desirable which contributed 30-40% of the customer's satisfaction level. Optional which contributed 10-20% of the customer's satisfaction level.
8. Now, these data can be used in manufacturing the product according to the customer choice considering the highest desirable attributes at lowest possible cost, further this analysis can be used at the product design and development stage for various models of the products.

The first priority of the enterprise in the product design and development is to incorporate the features of all the attributes grouped in Highly Desirable. It helps in faster technological upgrading of products, cost reduction and more product variant.

Table 1: Cumulative Percentage of Attributes

Normalized	0.145	0.134	0.121	0.108	0.096	0.086	0.065	0.053	0.041	0.037	0.032	0.031	0.027	0.023
Normalized (%)	14.5	13.4	12.1	10.8	9.6	8.6	6.5	5.3	4.1	3.7	3.2	3.1	2.7	2.3
Cum. Att. Value	14.5	27.9	40.0	50.8	60.4	69.1	75.6	80.9	85.0	88.7	91.9	95.0	97.7	100.0

Figure 1: Pareto Diagram



Methodology help in the idea generation stage in New Product Development Decision Process. Data analysis by the suggested methodology used in mass marketing segment. Product Adaptation is possible to meet regional customer preferences.

Paper is also followed by a case study to understand the methodology.

CASE STUDY

In the case study number of customers surveyed is 100. Preference choice of each customer's is given in the appendix 1. A survey is conducted to collect the data regarding the preference choice of the customers in purchasing a car in the range of Rs. 2-5 lakhs. Customers have to fill the choice about their requirement of all the given attributes in the data sheet in the value between 0 and 1. In the paper excel sheet is so prepared that by feeding the preferences choice of the attributes directly Pareto diagram is plotted.

$$S_1 = \sum_{j=1}^{100} A_{1j} = A_{11} + A_{12} + A_{13} + \ldots\ldots\ldots\ldots + A_{1100} = 75.2$$

$$S_2 = \sum_{j=1}^{100} A_{2j} = A_{21} + A_{22} + A_{23} + \ldots\ldots\ldots\ldots + A_{2100} = 69.9$$

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$$S_{14} = \sum_{j=1}^{100} A_{14j} = A_{141} + A_{142} + A_{143} + \ldots\ldots\ldots\ldots + A_{14100} = 11.9$$

$$T = \sum_{i=1}^{m} S_i = S_1 + S_2 + \ldots\ldots\ldots\ldots + S_{14} = 519.8$$

$$S_{1N} = \frac{S_1}{T} = 0.145$$

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$$S_{14N} = \frac{S_{14}}{T} = 0.023$$

ANALYSIS

It can be concluded from the Pareto diagram Figure 1 that 50-60% of the customer's satisfaction is contributed by only four or five attributes which can be grouped in to Highly Desirable attributes. So, the design and development of the product should mainly focus on Highly Desirable. The inferences drawn from the analysis of the primary data collected from the survey is that most of the customer's preferred mileage and price in the product. 20-30% of the customer's satisfaction is contributed by next three or four attributes of the product which is grouped in to Desirable. In the last Optional grouped by all remaining attributes which contribute only 10-15% of the customer's satisfaction.

The case study which is covered in the paper result that attributes which grouped in to Highly Desirable are mileage, price, AC, maintenance and engine cc which contributed 60.4% of the customer satisfaction level. Attributes which grouped in to Desirable contribute 28.2% of the customer satisfaction level are alloy wheel, audio FM, dual airbags, seating capacity and interior design. Attributes which are grouped in to Optional are colour, central locking, heater and power window which contribute only 11.3% of the customer satisfaction level. The research paper also acknowledges that the weightage of Optional is very nominal in the preferences of the customer's.

CONCLUSION

These papers acknowledge a methodology to understand and fulfilling the customer's requirement based on their choices and preferences. The product attribute significantly influence customer to make purchase decision. The above mentioned work provide to the organization basic information about mass customer preferences which is to utilized by manufacturing organization in product design and development in order to satisfy a vast market demand thus capturing requistic market.

In the paper a new techniques is suggested to group attributes in to Highly Desirable which mostly influences customers. The analysis of grouping attributes is based on the fuzzy choice of the product attributes associated with fuzzy membership function.

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