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The Fuzzy Decision Operations for Satisfying the Criteria of Customer Satisfaction

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Abstract: Customer relationship management (CRM) has emerged as a prominent aspect of business. In this respect, one of the notable developments of quality movement is an assessment of the customer satisfaction. The fuzzy rule based decision support system may be used as customer satisfaction rating system is useful where simple linear relationships do not subsist, where attribute evaluations are highly correlated and where some ability to make legal opinions in the context of the specific application is needed. In this paper, we are concentrating on the relationship between the costs of recharge coupon and talk time and validity and then analysis of consequence in the context of client satisfaction. So that at the base of this scheme we can select a profitable and customer satisfied recharge coupon of a mobile telecommunication company. This report introduces an approach to evaluate the character and reliability related customer satisfaction from recharge coupon and talk time data at each individual customer level and fuzzy logic will help us to resolve the customer satisfaction data. Finally a fuzzy logic approach is employed to construct the satisfaction model.

Keywords- *Customer relationship management, Customer Satisfaction, linguistic judgment, fuzzy sets.*

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I. INTRODUCTION

Increasing contest and the increase of business around the world, forced most of the businesses to look at ways of bettering the quality of their products and services and the carrying out of their processes [1]. Service suppliers are expected to face strong competition for survival, since clients have become increasingly tender to service quality. Clients know what they deserved to come when they are receiving services from any service oriented industry. Clients are given sort of freedom to create choices and an opportunity to pick out which companies to dispense with. Hence, service companies must embark new measures to determine ways to heighten the quality of service and eventually satisfying their clients. Customer satisfaction becomes the focal point in pulling young customers and retains the existing one. A customer's estimated experience of the extent to which a provider's service fulfills his or her expectations [2]. Through customer satisfaction, companies retain their clients and reach new market shares [3] [4].

Client data and information technology (IT) tools form the basis upon which any successful CRM strategy is built [11]. The demand for greater profitability requires an organization to proactively pursue its relationships with customers [12]. Despite the fact that CRM has come to be extensively called an important enterprise technique, there's no universally time-honored definition of CRM [13].

Even though new customers are welcomed almost in every line of business, the principal objective of companies is to maintain clients for a long-time period. The entire value of a lifetime customer is almost unquantifiable, and allows firms to achieve a competitive advantage against competitors [4] [5]. The emotion of satisfaction among customers derived from service quality offered by service providers. This natural process is affected by factors such as time, location, and position. For example, 'the service provided is better than what I expected', 'the gap between the expected and perceived service is not big', 'generally speaking, I am met with the service' are some of the many statements to reflect service quality. These entire examples show the satisfaction levels in a common plain statement. As function to evaluate these statements, many methods have been developed to assess client satisfaction. It has been a normal practice to pick up data through surveys with questionnaire prior to studying. The ordinal level scale that most often used in questionnaire is the Likert scale where rankings are presented in the form of 1 for 'strongly agree'; 2 for 'agree'; 3 for 'unsure', 4 for 'disagree', and 5 for ' disagree'. Understandably, someone who circles 5 disagrees with the statement more than someone who does to circle 4. Nevertheless, the degree of differences or gaps between 4 and 5 is unclear, since an ordinal scale indicates the relative place, not the magnitude of the deviation between the options. Thus, the available arithmetic operations ideally must include ordinal measures such as median and mode, but decidedly not appropriate to include standards of mean or arithmetic mean. Therefore, the results of a study based on the ordinal scale cannot usually be statistically analyzed by traditional statistical methods [6] [7].

Moreover, measuring satisfaction level and service quality is not merely descriptive statistical matters because of the concept of these languages are inherently intangible in nature and hard to fix. Consumers' judgment toward a service depends basically on the intensity of their feelings or expectations about various features associated with the service and the weight of attribute [8]. Consumers' beliefs or expectations typically involved perceptions over the avail and its attributes stemming from their experience with the service. So, perceptions depend greatly on the linguistic mind and decisions usually employ subjective knowledge and linguistic data. The linguistic values are difficult to measure throughout a classical mathematical function. Ace of the mathematical theories that evolved to deal with linguistics judgment is fuzzy set theory. Fuzzy set theory which was introduced by Zadeh (1965) is employed to manage the vagueness of human opinion, since it can represent vague expressions such as 'usual' 'fair' and 'satisfied' which are seen as the natural representative of customers' preference and

opinion. Fuzzy set theory offers an alternative meanings to adapt with the unclear boundaries and subjective nature. Indeed, it was really fortunate that the fuzzy set theory provides a framework that cope with uncertainty in language, that is, subjective uncertainty [9] [10].

Fuzzy logic is a powerful technique for solving a broad reach of industrial control and information processing applications [14]. The fuzzy logic controller has its ancestry with the E. H. Mamdani [15] researches, based on theories proposed by L. Zadeh [16]. It has come out as a tool to deal with decisions in which the phenomena are uncertain, imprecise, partial truth or qualitative decision-making problems achieve robustness, flexibility, and low price, but it cannot automatically take on the rules it uses to reach those decisions [17]. Reference [18] proposes a fuzzy classification model for online customers. Reference [19] implements a data mining solution to customer segmentation for desirable products. Reference [20] proposes a fuzzy logic model for appraisal of the intention to purchase based on the available information sources and the expert knowledge. Reference [21] design a fuzzy Classification Query Language which allows sellers to improve customer equity, launch loyalty programs, automate mass customization, and refine marketing efforts. Reference [22] develops fuzzy evaluation and classification model to bring the position of the company, show the benefit of high CS and propose a solution of increase CS in CRM. Reference [23] proposes a hierarchical fuzzy classification of online customers, which combines a relational database and fuzzy logic. Reference [24] proposes concepts, methods and models conceive the important criteria affecting the customers' satisfaction in banking organizations based on Delphi method. Sorting out these criteria based on Kano Model. Reference [25] designs a fuzzy model for selection of customers who should be targeted for deposit subscription schemes. Selection criteria are devised along the basis of customer's loan balance, customer's age and yearly income. This paper aims at developing a fuzzy based decision support framework for customer loyalty and satisfaction. The elements of the model include; (1) a prototype of a computer assisted system for customer loyalty analysis and relationship management organization that helps supermarket to identify the level of dedication to their customers, (2) a knowledge base model for obtaining important data that will be utilized in developing a decision support organization. (3) A fuzzy logic decision support system for customer satisfaction that helps companies in reaching important decisions to improve their services to clients and thus maximize profit. In parliamentary law to attain our objective, a subject of fuzzy set operations on the level of membership of input.

We explore fuzzy set operations to infer knowledge from the rules. This resulted in the formation of some stages of influence of input variables on the end product. In section 2, we present the research objective while in Section 3 the research methodology is given. Section 4 presents the model experiment and results of the findings are discussed. Finally, in Section 5, conclusion and some recommendations are made.

II. RESEARCH OBJECTIVE

The objective of this paper is to develop a fuzzy- based decision support framework and apply the model for customer loyalty, sales accuracy, reliability, robustness and profit generated by an industry.

III. RESEARCH METHODOLOGY

Customer Satisfaction Modeling by Fuzzy Association Rules:

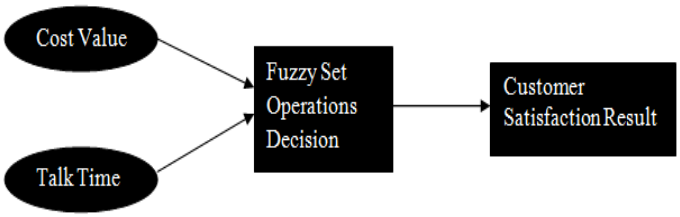

Figure.1.1: Fuzzy set decision support model for finding customer satisfaction data.

A fuzzy logic approach is used to construct the satisfaction model given above. Modeling of Fuzzy decision support system has depended on the two variables these are the cost of the recharge top up and talk time. The sets can be used to aid in finding customer satisfaction data or decision making for finding batter top up. Table 1.1 have the cost and talk time of number of top up and corresponding figure. 1.2 showing the relationship between top up and talk time.

TABLE 1.1: COST AND TALK TIME OF A TOP UP VOUCHER

S.No.	Cost	Talk Time
1	10.00	7.47
2	20.00	14.95
3	30.00	22.42
4	40.00	30.90
5	50.00	39.37
6	55.00	43.61
7	60.00	47.85
8	70.00	56.32
9	80.00	64.80
10	90.00	73.27
11	100.00	81.75
12	110.00	90.22
13	120.00	98.69
14	130.00	107.17
15	140.00	115.64
16	150.00	124.12
17	160.00	132.59
18	170.00	141.07
19	180.00	149.54
20	190.00	158.02
21	200.00	166.49
22	210.00	174.97
23	220.00	220.00
24	230.00	191.92
25	240.00	200.39
26	250.00	208.86
27	260.00	217.34
28	270.00	225.81
29	280.00	234.29

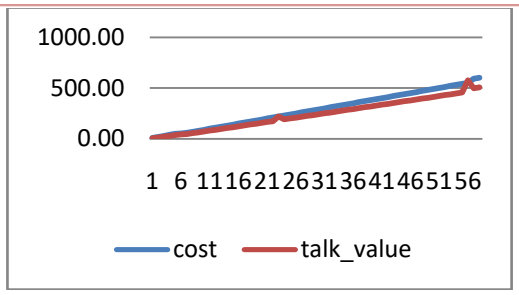

Figure 1.2:Relationship between cost and talk time

Fuzzy set operation for decision making:

There are a number of top up given in the top up table given above now the matter is this, a customer who is buying a top up give, the more satisfaction or how a customer decide to select a top up on which he will get maximum talk time.

Thus, our project is how to maximize the talk time in the low range of monetary value. Fuzzy intersection operation can be used for getting the decision.

Decision =Fuzzy intersection [degree of membership of monetary value and talk time of top up voucher]

The fuzzy intersection of A and B is

$A \cap B \equiv \{x, \mu A \cap B(x) \mid x \in U \text{ and } \mu A \cap B(x) = \min(\mu A(x), \mu B(x))\}$ …….(1)

Fuzzy rules for finding customer satisfaction for a recharge coupon are:

1) If the cost of recharge coupon is low and talk time is excellent then the customer may give the excellent response.
2) If the cost of recharge coupon is high and talk time is a good medium, then the customer may contribute the median answer.
3) If the cost of recharge coupon is average and talk time is excellent then the customer may give the best answer.
4) If the cost of recharge coupon is high and talk time is moderate then the customer may give the miserable response.

Customer satisfaction = Intersection [talk time, cost]

Degree of membership of cost and talk time of top up voucher:

Linear Representation:

In the linear representation, given in [26] that mapping input to the degree of membership can be described as a straight line.

Linear representation rose, which is the set began on domain values that have a degree of membership value zero (0) to move to the right toward the domain value having a higher degree of membership as shown in Figure 1.2 Membership functions.

Linear representation down, is the opposite of the first is a straight line that starts from the value of the domain with the highest degree of membership on the left side, then moves down to the value of a domain that has a lower degree of membership as shown in Figure 1.3 Membership functions.

A membership function for a fuzzy set A on the universe of discourse X is described as $\mu A: X \rightarrow [0,1]$, in which each thing of X is mapped to a value among zero and 1. This value, known as membership function value or degree of membership function, quantifies the grade of membership of the element in X to the fuzzy set A.

Membership functions allow us to graphically represent a fuzzy set. The x axis represents the universe of discourse, whereas the y axis represents the degrees of membership in the [0,1] interval.

Simple functions are used to build membership functions. Because we are defining fuzzy concepts, practicing more complex functions does not add more precision.

$$\mu_A(x) = \begin{cases} 0, & x < a \\ \frac{x-a}{b-a}, & a \le x \le b \\ 1, & x > b \end{cases} \quad \text{.....(2)}$$

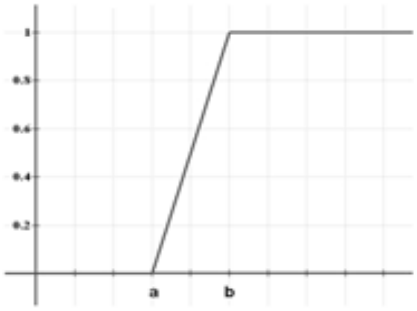

Figure 1.3: Linear representation rose membership function

$$\mu_A(x) = \begin{cases} 0, & x > d \\ \frac{d-x}{d-c}, & c \le x \le d \\ 1, & x < c \end{cases} \quad \text{.....(3)}$$

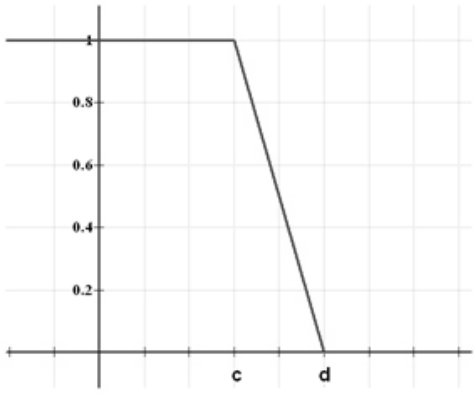

Figure 1.4: Linear representation down membership function

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$$\mu_{cost}(X) = \begin{cases} 0 & cost(X) > 280 \\ & 280\text{-}cost(X) / 280\text{-}10 \\ 1 & cost(X) < 10 \end{cases} \quad \ldots\ldots (4)$$

$$\mu_{talk\_time}(X) = \begin{cases} 0 & talk\_time(X) < 10 \\ & talk\text{-}time(X) - 10 / 280\text{-}10 \\ 1 & talk\text{-}time(X) > 280 \end{cases} \quad \ldots\ldots (5)$$

ALGORITHM 1.1: FUZZY INTERSECTION OPERATION

Input: Set of crisp values of Cost and Talk Time of all n top ups.

Output: µDecision set of degree of membership of n.

```
1.  Initialize x=:cost[n],y=:cost[1];
2.  for i=:1 to n do {
3.  if( cost[i] >x)
4.  a[i]=:0.0;
5.  else if( (cost[i] <x) && (cost[i]>=y)
6.  a[i]=: (x-cost[i]) / x-y;
7.  else a[i]=:1.0; }
8.  Initialize x=:val[1],y=:val[n];
9.  for j=:1 to n do {
10. if( val[j] < x)
11. b[k]=:0.0;
12. else if( (val[j] > x) && (val[j]<=y))
13. b[j]=: (val[j] - x) /y-x;
14. else b[j]=:1.0; }
15. for k=:1 to n do{          // calculate µDecision
16. if(a[i] >= b[j])
17. c[k]=:b[j];
18. else  c[k]=:a[i];
19. }
```

Equation (2) and (3) calculate the level of membership of monetary value and talk time of a recharge coupon. As per the table 1.2 given below the high degree of membership of cost shows the low range of price of top up and low degree of membership gives the costly top up results. On the this way the high degree of membership gives the highest talk time and low degree of membership gives the less talk time. The relationship between the cost of top up and the talk time is that low cost top ups are giving the more talk time or equal talk time. So the matter of customer satisfaction is that a customer may attract to those top up recharge vouchers which are giving the more talk time in same or less price or cost.

IV. EXPERIMENTAL RESULT:

The proposed algorithm caries out the analysis of the number of 29 top up and after implementation in turbo C++ calculate the degree of membership of cost, according to equation (4) and degree of membership of talk time using equation (5) of values given in table 1.1 and generating the values given in table1.2.

TABLE 1.2: THE DEGREE OF MEMBERSHIP OF COST AND TALK TIME

Membership Degree cost	Membership Degree talk time	Decision
1.00	0.00	0
0.96	0.01	0.01
0.92	0.04	0.04
0.88	0.07	0.07
0.85	0.16	0.16
0.83	0.12	0.12
0.81	0.22	0.22
0.77	0.17	0.17
0.74	0.29	0.29
0.70	0.23	0.23
0.66	0.41	0.41
0.62	0.29	0.29
0.59	0.32	0.32
0.55	0.35	0.35
0.51	0.39	0.39
0.48	0.42	0.42
0.44	0.45	0.44
0.40	0.48	0.4
0.37	0.51	0.37
0.33	0.54	0.33
0.29	0.57	0.29
0.25	0.61	0.25
0.22	0.77	0.22
0.18	0.67	0.18
0.14	0.70	0.14
0.11	0.73	0.11
0.07	0.76	0.07
0.03	0.79	0.03
0.00	1.00	0

Fuzzy intersection operation gives the result that how a customer can be satisfied on the basis of cost and talk time. So the final result is the minimum of both variables.

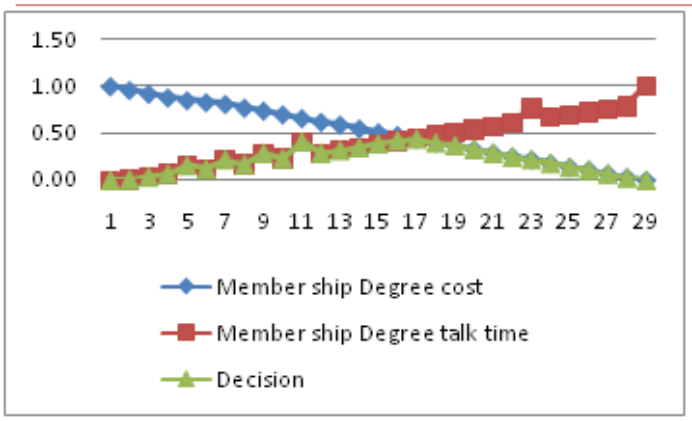

Figure1.5: Result after applying algorithm 1.1 on crisp data given in Table1.1

The intersection will compute the minimum of all three variables and compute the result which is given in the table no. 1.2. More talk time value in less cost will attract the customer to buy it.

V. CONCLUSION:

The fuzzy decision support system can be used for making better decision in the various fields, in this paper, we only focused on the types of recharge coupons. Our system basically helps in selecting a better plan so that we can get more benefit and more satisfaction. The example given in this paper is clearly justified the use of fuzzy operations and rules for giving batter business decisions and understanding of customer behavior and buying habits. The method given in this paper may improve enterprise's benefit.

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