



Application of the Fuzzy Logic Tool to Evaluate Customer Satisfaction in Hotels

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ABSTRACT

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Tourism organizations have the challenge of facing a highly competitive environment which leads to actions that guarantee the quality of their services. Hence the need for this research that aims to design and apply a methodology to assess the satisfaction of tourists in a hotel organization according to the imprecise nature of this object of measurement, by using the postulates of fuzzy logic. The use of this tool in the measurement processes for these purposes is considered the main contribution of this research. The proposed methodology was successfully implemented in a tourist destination, leading to a greater validity of the measurements related to the satisfaction of its customer.

1. Introduction

Nowadays, achieving full customer satisfaction is an essential requirement to earn a place in the "mind" of the customers and therefore in the target market, for this reason the objective of keeping each customer satisfied has crossed the borders of the area of marketing to become one of the main objectives of all the functional areas of our tourism companies; guaranteeing this practice: customer loyalty (which translates into future sales), free distribution (which translates into new customers) and positioning in the market.

Multiple mathematical treatments have been proposed, to establish the variables, dimensions and links that exist between them to analyze customer satisfaction, such as SERVQUAL, the use of fuzzy logic, quantitative methods, genetic algorithms, Bayesian statistics, neural networks, and structural equations, among others (Stefano, Casarotto Filho, Barichello, & Sohn, 2015; Saeedpoor, Vafadarnikjoo, Mobin, & Rastegari, 2015; Bandaru et al., 2015; Hao, Yu, Law, & Fong, 2015; Coussement, Benoit, & Antioco, 2015; Leong, Hew, Lee, & Ooi, 2015; Aktepe, Ersöz, & Toklu, 2015a, 2015b; Satsanguan, Fongsuwan, & Trimetsoontorn, 2015). Specifically, fuzzy logic provides a means to face real-world situations, complex and dynamic situations, is used to solve a variety of problems, mainly those related to control of complex industrial processes and decision systems in general, the resolution and data compression. The research presented has its general objective: To evaluate the satisfaction of clients in a tourist destination through the use of the postulates of fuzzy logic.

2. Methodology

The research presented is considered quasi-experimental, based on its application and the way to control the research variables. The methodological proposal was applied in a hotel entity of the tourist destination of Holguín, Cuba third tourist destination of the country which presents the greatest diversity of tourist modalities to offer. It receives more than 400,000 tourists per year. The results presented were the result of the application of the instruments to 143 tourists from different countries such as Canada, United Kingdom, Germany, Holland, and others.

The methodology begins with the definition of each one of the attributes considered as influential in the general satisfaction of the clients. Each of the attributes is considered independent variables and the importance thereof; while the objective variable establishes the integrated evaluation of the attributes.

Then we proceed to define the linguistic labels for the independent variables. For the evaluation of the attributes and the objective variable are established as the linguistic label: deficient, acceptable and satisfactory. While for the importance it is established the categories of high, medium and low. Next, the ranges of variation of the variables are established, associated to diffuse subsets and plotted. Figure 1 represents the diffuse subsets established in the specific case of the application that is being developed. For the construction of the graphs, the following equations are used.

$$\text{Deficient} = 1 - \frac{x}{N} = \text{Low}$$

$$\text{Excellent} = \frac{x}{N} = \text{High}$$

$$\text{Acceptable} = \begin{cases} 0 & x \leq 0 \\ \frac{x-2}{4-2} & 0 \leq x \leq 2 \\ 1 & 4 \leq x \leq 6 \\ \frac{8-x}{8-6} & 6 \leq x \leq 8 \\ 0 & x \geq 8 \end{cases} = \text{Medium}$$

Defined and graphed the fuzzy subsets should proceed to the construction of the rules that link the independent variables and the dependent or objective variable. For the case under study, the elaborated rules would be those that are represented in table 1.

Table 1: Rules established for the integral evaluation of attributes

Evaluation of attributes	Categories	Importance of attributes		
		Low	Medium	High
Satisfactory		Acceptable	Acceptable	Satisfactory
Acceptable		Acceptable	Acceptable	Acceptable
Deficient		Deficient	Deficient	Deficient

Once the attributes of a process have been evaluated, the design of the fusion method for the evaluation of the processes begins, going through a logic similar to the previous one, as reflected below.

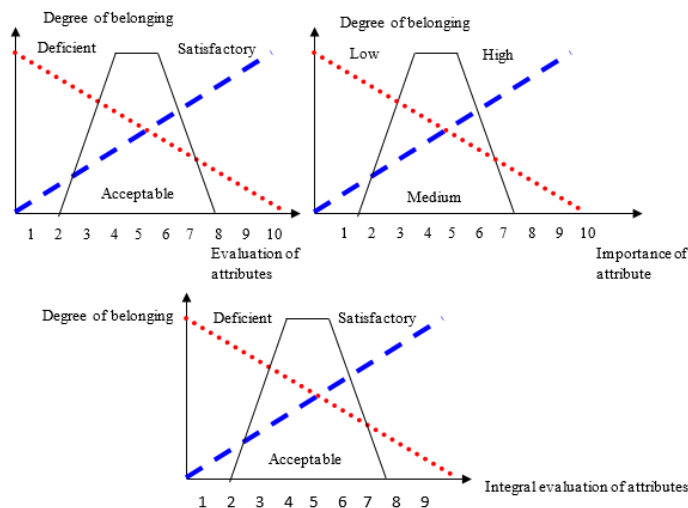


Figure 1: Variation ranges of the variables and their association to the fuzzy subsets

On this occasion, independent variables are considered as belonging to the deficient and satisfactory categories of the attributes that make up the process, determined by the median of the integral evaluations of the attributes of the processes and the importance of the process established

by the design group. The dependent variable is the evaluation of the process. Linguistic labels similar to those defined above are maintained, as well as the ranges of variation of the variables and the association to the fuzzy subsets are used, as illustrated in figure 1, only the evaluation of the attributes is exchanged for the evaluation of the process.

For the evaluation of the processes, the rules to establish would be those that are represented in figure 2.

Once the attributes and processes have been evaluated, it is possible to obtain the satisfaction evaluation in general. On this occasion, the independent variables are the degrees of belonging to the category of deficient and satisfactory of the processes that are determined by the median of the evaluations of the processes, while the dependent variable is the evaluation of satisfaction. The following labels are used for all the variables: deficient, acceptable and satisfactory. In the same way, diffuse subsets similar to those shown in Figure 1 are established and the same equations for the construction of the graphs are conserved. For this stage, the elaborated rules would be those shown in table 2.

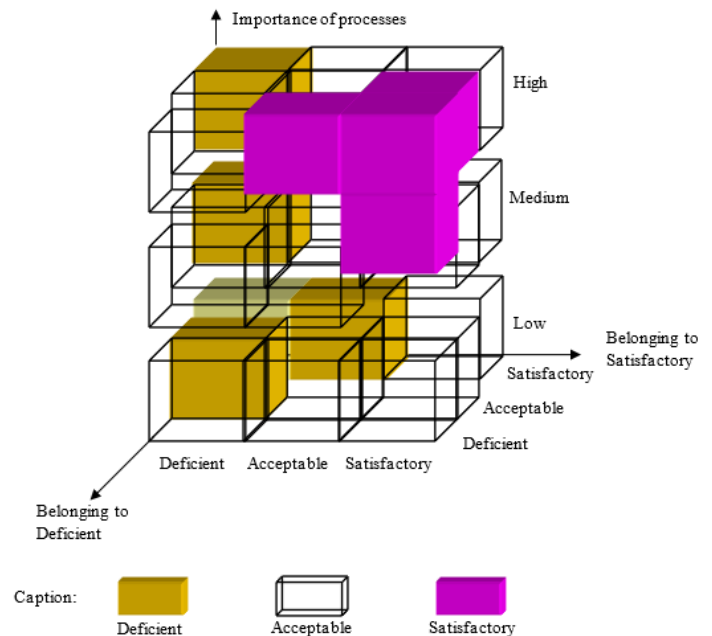


Figure 2: Rules established for the evaluation of the process

Table 2: Rules established for the evaluation of satisfaction

Processes belonging to deficient	Categories	Processes belonging to superior		
		Deficient	Acceptable	Satisfactory
Deficient		Acceptable	Satisfactory	Satisfactory
Acceptable		Deficient	Acceptable	Satisfactory
Satisfactory		Deficient	Deficient	Acceptable

After the fuzzification stage, the aggregation process begins. This process begins by establishing the aggregation criterion. There is in the literature (Saeedpoor, Vafadarnikjoo, Mobin, & Rastegari, 2015) of the subject a set of recommendations to choose the mathematical function to be used according to the way of elaboration of the rules. Table 3 summarizes some of the mathematical functions to be used according to the logical operators.

Table 3: Suggestions for selecting the mathematical operator

Logical operator used	Recommended mathematical operator	Mathematical operator to be used in technology
Y	Minimum, product or algebraic sum	Minimum
O	Maximum	Maximum

There are different methods in the literature for defuzzification, among these are: the initial value, where the aggregate function reaches the maximum value (SOM); the central value, where the function reaches the maximum value (MOM); the final value, where the function reaches its maximum value (LOM); and the most popular method of defuzzification: the calculation of the center of gravity or centroid, which returns the center of the area under the curve. For the calculation of the center of gravity, the general formula (1) is used.

$$Cg = \frac{\sum_{i=1}^n V_i * GpV_i}{\sum_{i=1}^n GpV_i} \tag{1}$$

Where:

V_i = Value that the variable takes in i

GpV_i : Degree of belonging to the diffuse subset when the variable takes the value i

Once the previous steps have been developed, the design of the instruments for the collection of information begins. The input variables that need to be evaluated are: The importance of the attributes, the importance of the processes and the status of the attributes, the first two are established by the design team giving a value between 1 and 10 considering the latter as an expression of the maximum importance to reach and one like the minor, for this the consensus method is used that is considered more appropriate.

In order to determine the status of the attributes, it is recommended to apply a sample size representative of the total number of customers that visit the destination, to which it is requested to evaluate the degree to which the attributes were able to satisfy it. The evaluation scales are adapted to the established linguistic labels (deficient, acceptable and satisfactory). The attributes to be evaluated would be those listed in table 4.

Table 4: List of attributes

Processes	Attributes
Desk	Courtesy at the desk
	Information at the desk
	Speed at the desk
	Courtesy of the telephone service
	Speed of telephone service
	Courtesy of bellboy
	Speed of bellboy
	Information of bellboy service
Food and beverages	Food quality

Processes	Attributes
	Variety of food
	Courtesy of the service staff
	Speed of the gastronomic service
	Variety of coffee shop offer
	Quality of the cafeteria offer
	Courtesy of the cafeteria staff
	Speed of the cafeteria service
Recreation	Quality of the pool
	Variety of gastronomic offer in the pool
	Courtesy of pool area staff
	Speed of pool area staff
	Daytime recreation activities
	Night recreation activities
	Quality of music
	Variety of music
Music combination	
General services	Cleaning of common areas
	Sensation of security
	Maintenance services
Lodging	Cleaning of the rooms
	Comfort of the rooms
	Courtesy of the lodging staff

The designed instrument is applied with an annual frequency. To determine the size of the sample, formula (2) is applied.

$$n = \frac{Z^2 N p_s (1 - p_s)}{(N - 1) d^2 + Z^2 p_s (1 - p_s)} \tag{2}$$

Where:

$Z = 1,645$ (Value tabulated according to the degree of freedom)

N = Total of tourists visiting the destination in period.

$P = 0.5$ (probability of obtaining valid information from the respondents)

$D = 0.1$ (admissible error)

Defined the previous aspects proceeds to the application of the designed instrument, ensuring that the response rate is high and the correct way of filling. Based on the information collected in each of the attributes, the median will be used as a value that integrates the different criteria. With the values obtained by the application of the instrument and the importance of the attributes established by the design team, the established rules are evaluated. In this way, the degrees of belonging of the independent variables to each of the established fuzzy subsets are obtained and the value of the objective variable is chosen according to the established mathematical operator (minimum or maximum).

Subsequently, all the rules in the objective function are evaluated. For this, the degree of belonging of the dependent variable (integral evaluation of the attribute) must be determined for each rule, considering the degree of belonging to the diffuse subset that represents the rule (deficient, acceptable and satisfactory) and the value that it takes to be evaluated in the previous step, known as alpha cutting¹ (α).

¹ Saeedpoor, Vafadarnikjoo, Mobin, & Rastegari, 2015

Depending on the previous steps, the aggregation process starts. In this case, as the function (min) is proposed, the function (max) for the aggregation is used, which means that for each value of the variables the higher value of the ones offered by the rules for the value of the variable must be selected. The input for the defuzzification process is a fuzzy set (the output of the aggregation stage) and the outputs are simple concrete numbers. Real-world systems require numerical results.

According to the defuzzification method established in the design stage, we proceed to obtain the integral value of the satisfaction with the attribute, which must be substituted in the function of the curve created during the aggregation step, to intercept each one of the functions of the diffuse labels or subsets established for the target variable. Determining in this way the degree of belonging to each of these established subsets: deficient, acceptable and satisfactory. Knowing then the evaluation of the attribute.

Once the above actions have been concluded and based on their results, the evaluation of the processes is started. For this, the importance of the processes established by the design team and the median of the degrees of belonging to the diffuse subsets are used as starting data of deficient and satisfactory attributes that make up the process in the analysis. Each one of the 27 rules (for each of the attributes) established in the evaluation processes. The process of aggregation and defuzzification are carried out in the same way as it was done for the attributes.

Finally, to evaluate the general satisfaction of the tourists, the median of the degrees of belonging to the fuzzy subsets of deficient and satisfactory obtained during the evaluation of each of the processes under analysis is used as starting data. Each one of the 9 rules established in table 4 must be evaluated. The process of aggregation and defuzzification is carried out in the same way as it was done for the attributes and processes.

Achieved a general assessment of satisfaction it is necessary to delve into the causes of the result of the satisfaction assessment and serve as a starting point for the design of service improvement. For this reason, the inhibiting factors that make the excellence of the process of providing the service impossible and which definitely have to be activated to improve the organization's results will be determined. For this, it is proposed to analyze the essential processes of the five fundamental factors in organizational performance (Noda Hernández, 2004) see Table 5.

Table 5: Possible factors that inhibit satisfaction

Factor	Internal customer	Capital	Supplies	Management
Aptitude Can do	Know-how F2: training Essential processes • Knowledge • Experience • Skill To have F3: quantity	To have F3: technology Essential processes • Stocks • Operation • Location • Coherence	To have F4: supplies Essential processes • Quantity • Quality • Opportunity	Know-how F2: training Essential processes • Knowledge • Skills • Ability to act. F5: leadership Essential processes • Planning, execution, and control
Act accordingly				

Once the factors that limit tourists' satisfaction have been identified, actions are designed to mitigate the effect of the factors and contribute to improving the quality of the service.

3. Results and Discussion

Table 6: Importance of the attributes

Importance	Attributes
9	Courtesy at the desk
9	Information at the desk
10	Speed at the desk
8	Courtesy of the telephone service
8	Speed of telephone service
7	Courtesy of bellboy
7	Speed of bellboy
6	Information of bellboy service
10	Food quality
9	Variety of food
10	Courtesy of the service staff
9	Speed of the gastronomic service
10	Variety of coffee shop offer
10	Quality of the cafeteria offer
10	Courtesy of the cafeteria staff
9	Speed of the cafeteria service
7	Quality of the pool
7	Variety of gastronomic offer in the pool
8	Courtesy of pool area staff
7	Speed of pool area staff
7	Daytime recreation activities
7	Night recreation activities
7	Quality of music
7	Variety of music
7	Music combination
8	Cleaning of common areas
10	Sensation of security
8	Maintenance services
10	Cleaning of the rooms
10	Comfort of the rooms
8	Courtesy of the lodging staff

Table 7: Importance of the processes

Processes	Importance
Desk	7
Lodging	10
Food and Beverages	10
Recreation	9
General Services	8

The instrument designed to determine the status of the attributes was applied to 143 customers. The results are shown in table 8.

Table 8: Summary of the satisfaction analysis with the attributes

Processes	Attributes	Attributes		MOM	Belonging to		
		Evaluation	Importance		Superior	Satisfactory	Insufficient
Desk	Courtesy at the desk	9	9	9,5	0.95	0.25	0.05
	Information at the desk	8	9	9	0.9	0.5	0.1
	Speed at the desk	6	10	5	0.5	1	0.5
	Courtesy of the telephone service	6	8	5	0.5	1	0.5
	Speed of telephone service	6	8	5	0.7	0.75	0.3
	Courtesy of bellboy	6	7	5	0.5	1	0.5
	Speed of bellboy	6	7	5	0.5	1	0.5
	Information of bellboy service	6	6	5	0.5	1	0.5
Food and beverages	Food quality	8	10	9	0.9	0.5	0.1
	Variety of food	3	10	1.45	0.5	1	0.5
Recreation	Courtesy of the service staff	8	8	9	0.9	0.5	0.1
	Speed of the gastronomic service	4	10	5	0.5	1	0.5
	Variety of coffee shop offer	4	9	5	0.5	1	0.5
	Quality of the cafeteria offer	6	10	5	0.5	1	0.5
	Courtesy of the cafeteria staff	7	9	8.5	0.5	1	0.5
	Speed of the cafeteria service	6	10	5	0.5	1	0.5
	Quality of the pool	5	10	5	0.5	1	0.5
	Variety of gastronomic offer in the pool	8	10	9	0.9	0.5	0.1
	Courtesy of pool area staff	6	9	5	0.5	1	0.5
	Speed of pool area staff	4	7	5	0.50	1.00	0.50
General services	Daytime recreation activities	2	7	1.5	0.15	0.75	0.85
	Night recreation activities	4	8	5	0.50	1.00	0.50
	Quality of music	6	7	5	0.50	1.00	0.50
	Variety of music	4	7	5	0.50	1.00	0.50
	Music combination	1	7	1.5	0.15	0.75	0.85
	Cleaning of common areas	6	7	5	0.50	1.00	0.50
	Sensation of security	2	7	1.5	0.15	0.75	0.85
	Maintenance services	2	7	1.5	0.15	0.75	0.85
	Cleaning of the rooms	6	8	5	0.15	0.75	0.85
	Comfort of the rooms	9	10	9.5	0.95	0.25	0.05
Lodging	Courtesy of the lodging staff	5	8	4.95	0.50	1.00	0.51

According to this, most attributes have a satisfactory behavior tending to the superior. The attributes: courtesy in desk, information in desk, cleaning of rooms, courtesy of the lodging staff, courtesy of the staff of the cafeteria and sense of security present a superior behavior tending to satisfactory. While the attributes: cleanliness of common areas, the combination of music, variety of music and nocturnal recreation activities were evaluated as insufficient with a tendency to satisfactory. Subsequently, the processes were evaluated, obtaining the results shown in table 9.

Table 9: Analysis of customer satisfaction with hotel processes

Processes	Median of the degree of belonging of the attributes to		Importance of processes	MOM	Belonging to		
	Superior	Insufficient			Superior	Satisfactory	Insufficient
Desk	0.50	0.50	7	5	0.51	1	0.5
Lodging	0.90	0.10	10	9.4	0.94	0.30	0.06
Food and beverages	0.50	0.50	10	5	0.52	1	0.5
Recreation	0.47	0.53	9	5	0.49	1	0.5
General services	0.49	0.51	8	5	0.51	1	0.5

As it is observed, in a general way the processes tend to show a similar behavior that is predominantly satisfactory, standing out in a positive way the lodging process, where two of its three attributes were very well evaluated: cleaning of rooms and courtesy of the lodging staff. Finally, in the third level of integration, the results shown in Table 10 were obtained.

Table 10: Result of the general evaluation of satisfaction

Median of insufficient	Median of superior	Belonging to insufficient	Belonging to satisfactory	Belonging to superior
0.5	0.51	0.5	1	0.5

In general, it can be said that the entity has satisfied customers with a minimum tendency towards higher. The fundamental strengths are concentrated in the lodging process and the greatest difficulties in the recreation process and general services with the attributes of cleanliness of common areas, the combination of music, variety of music and night recreation activities.

As a result of the application of the previous stages, it could be established that the main causes that affect the quality of the service are related to the lack of specialized personnel that professionally coordinate the recreation activity and design the recreational spaces according to the customers of markets that visit the facility, mainly in what concerns the selection of music.

4. Conclusions

Based on the above results, the following conclusions are made: It is possible using the postulates of fuzzy logic to achieve an assessment of customer satisfaction more in line with the fuzzy or imprecise nature of satisfaction. The application of the methodology in the entity under study made it possible to obtain a general evaluation of the satisfaction of tourists in the organization and identify the factors that affect it. On this basis, actions were designed for improvement.

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