# Performance Evaluation and Service Quality Model in the Hostel Mess

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**ABSTRACT**

The purpose of this study is to develop a service quality model in relation to a hostel mess, which describes how the quality of service is perceived by customers (students). The present work seeks to find out the service dimensions of service quality, which lead to higher levels of customer satisfaction. This paper constructs the service quality evaluation system of a hostel mess of Guru Ghasidas Vishwavidyalaya, Bilaspur, India based on customers point of view, and put forward the questionnaire of service quality in mess service in hostel and setup the evaluating overall service quality and performance extent with the help of a fuzzy logic. The result of this study would help management to identify the strength and ill performing areas of service quality and implement an effective strategy to meet the customer's expectations.

**Keywords:** Customer service satisfaction, Mess services in Hostel, Overall service quality and Performance Extent.

**INTRODUCTION**

Customer service satisfaction has become a vital issue of modern service industry competition. Accurate evaluation of customer service satisfaction is a base to improve the service quality. This paper aims to construct the service quality evaluation system of hostel mess based on the customer's (students) point of view, and put forward the questionnaire of service quality in hostel mess, and set up the evaluating customer satisfaction by Fuzzy Logic method. There are several determining factors for a hostel mess to be considered a good or a bad, like tangibility, reliability, responsiveness, assurance and empathy. Dining experience is comprised of both tangible and intangible elements.

The purpose of this study is to determine mess service quality. The aims are to:

(a) To find out customer's perception and expectations.

(b) Establish the significance of difference between perceived and expected service quality

(c) Identify the number of dimensions for expectations and perceptions scales of fuzzy model

(d) Test the reliability of the applied fuzzy model.

**1.1 Fuzzy Preliminaries**

To deal with vagueness in human thought, Zadeh (1965) first introduced the fuzzy set theory, which has the capability to represent/manipulate data and information possessing based on no statistical uncertainties. Moreover fuzzy set theory has been designed to mathematically represent uncertainty and vagueness and to provide formalized tools for dealing with the imprecision inherent to decision making problems. Some basic definitions of fuzzy sets, fuzzy numbers and linguistic variables are reviewed from Zadeh (1975), Buckley (1985), Negi (1989), Kaufmann and Gupta (1991).The basic definitions and notations below are used through out this paper until otherwise stated.

**1.2 Definitions of fuzzy sets:**

**Definition 1:**

A fuzzy set $\tilde{A}$ in a universe of discourseX is characterized by a membership function $\mu_{\tilde{A}}(x)$ which associates with each element x in X a real number in the interval [0, 1].

The function value $\mu_{\tilde{A}}(x)$ is termed the grade of

membership of x in $\tilde{A}$(Kaufmann and Gupta, 1991).

**Definition 2:**

A fuzzy set A in a universe of discourse X is convex if and only if

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min\left(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\right)$$

For all x1, x2 in X and all □□□0, 1□, where min denotes the minimum operator (Klir and Yuan,1995).

**Definition 3:**

The height of a fuzzy set is the largest membership grade attained by any element

in that set. A fuzzy set $\tilde{A}$ in the universe of discourse X is called normalized when the height

Of $\tilde{A}$ is equal to 1 (Klir and Yuan, 1995).

**1.3 Definitions of fuzzy numbers:**
Definition 1:

A fuzzy number is a fuzzy subset in the universe of discourse X that is both convex

And normal. Fig. 1 shows a fuzzy number n in the universe of discourse X that conforms to this

Definition (Kaufmann and Gupta, 1991).
**Definition 2:**

The □--cut of fuzzy number $\tilde{n}$ is defined as

$$\tilde{n}^{\alpha} = \{x_i : \mu_{\tilde{n}}(x_i) \geq \alpha, x_i \in X\},$$

$$\text{Here, } \alpha \in [0,1]$$

The symbol $\tilde{n}^{\alpha}$ represents non empty bounded interval contained in X,which can be denoted by $\tilde{n}^{\alpha} = \left[n_l^{\alpha}, n_u^{\alpha}\right]$, $n_l^{\alpha}$ and $n_u^{\alpha}$ are the lower and upper bounds of the closed interval, respectively (Kauffman and gupta,1991;Zimmermann,1991). For a fuzzy number $\tilde{n}$ ,if $n_l^{\alpha} > 0$ and $n_u^{\alpha} \leq 1$ for all $\alpha \in [0,1]$ ,then $\tilde{n}$ is called a standardized (Normalized) positive fuzzy number (Negi, 1989).

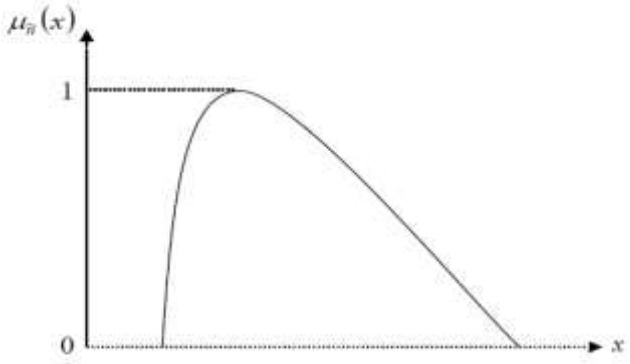



**Fig. 1.** A fuzzy number $\tilde{n}$

**Definition 3:**

Suppose, a positive triangular fuzzy number (PTFN) is $\tilde{A}$ and that can be defined as (a,b,c) shown in fig.2. The membership function $\mu_{\tilde{n}}(x)$ is defined as

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-a)/(b-a), & \text{if } a \leq x \leq b, \\ (c-x)/(c-b), & \text{if } b \leq x \leq c, \\ 0, & \text{otherwise,} \end{cases} \quad (3)$$

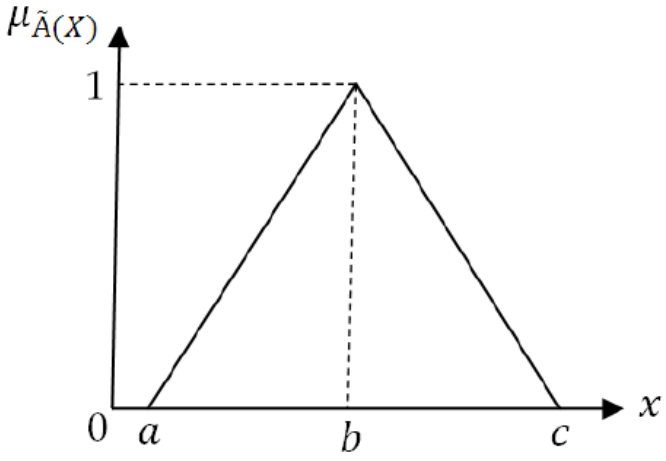



**Fig. 2.** A triangular fuzzy number $\tilde{A}$

Based on extension principle, the fuzzy sum □ and fuzzy subtraction □ of any two triangular fuzzy numbers are also triangular fuzzy numbers; but the multiplication □ of any two triangular fuzzy numbers is only approximate triangular fuzzy number (Zadeh, 1975). Let's have a two
Positive triangular fuzzy numbers, such as

$\tilde{A}_1 = (a_1, b_1, c_1)$ and $\tilde{A}_2 = (a_2, b_2, c_2)$, and a

Positive real number, r=(r,r,r).

Also the crisp value of triangular fuzzy number set $\tilde{A}_1$ can be determined by defuzzification

which locates the Best Non-fuzzy Performance (BNP) value. Thus, the BNP values of fuzzy number are calculated by using the center of area (COA) method as follows: (Moeinzadeh andHajfathaliha, 2010)

$$\mathrm{BNP_i} = \frac{\left[(c-a)+(b-a)\right]}{3} + a$$

**Definition 4:**
A matrix **D** is called a fuzzy matrix if at least one element is a fuzzy number(Buckley, 1985).

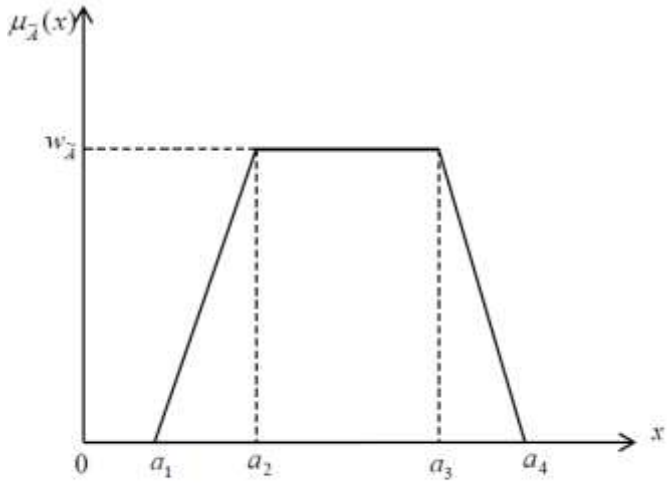



**Fig. 3** Trapezoidal fuzzy number $\tilde{A}$

**1.4 Linguistic variable:**
A linguistic variable is the variable whose values are not expressed in numbers butwords or sentences in a natural or artificial language (Zadeh, 1975). The concept of a linguistic variable is very useful in dealing with situations, which are too complex or not well-defined to be reasonably described in conventional quantitative expressions (Zimmermann, 1991). For example, 'weight' is a linguistic variable whose values are 'very low', 'low', 'medium', 'high','very high', etc. Fuzzy numbers can also represent these linguistic values.

## 2. LITERATURE REVIEW

Yoo (2012) attempted to investigate the customers' perceptions of restaurant cleanliness. Understanding what customers consider when they evaluate a restaurant's cleanliness could be beneficial for hospitality managers who could use the information to increase their restaurant's quality and to satisfy their customers. In addition, this study was conducted with two different cultural groups of customers: Westerners and Asians. Understanding how different cultures perceive restaurant cleanliness could help hospitality managers who plan to expand their business in the global market.

The results of this study indicated that the items of restroom personal hygiene, restroom appearance and server' behavior all had a positive relationship with customers' restaurant quality evaluations. The level of importance of restaurant cleanliness dimensions was found to be similar between the Western and Asian samples. The server's behavior, restroom appearance and
signage were found to be the most important dimensions for both groups. However, restroom personal hygiene was found to be the only dimension ranked differently by the two groups in the study. Westerners weighed the restroom personal hygiene as more important than did Asian respondents. Asian groups were found to have higher expectations for overall restaurant cleanliness dimensions than Western groups.

Nicolaides (2012) made an empirical assessment of customers'perceptions and expectations ofservice to measure service quality in three restaurants in a casino complex in Gauteng Province
in South Africa. The research helped to assess the levels of customer satisfaction with service provision in three restaurants and identified factors that contributed to customer satisfaction and dissatisfaction; It also determined the current status of service and compared and ranked three restaurants service provision. Another importance was the aiding in the establishment of customer service standards for the restaurants concerned. The tipping of waitrons was also used as an indicator of customer satisfaction with service provision in general. A three-column SERVQUAL instrument was used together with part of the Fishbein model. The study was able to firstly determine and analyze service gaps that exist in the service delivery procedure to measure service quality as well as general customer satisfaction and secondly, to evaluate customers' attitudes towards the service measure attributes of similar restaurants in the same location. The findings offer implications to improve service quality in restaurant business in general.
Min and Min (2011) measured the service performances of fast-food restaurant franchises in theUSA and identified salient factors influencing the service performances of fast-food restaurants over time. This paper developed a set of benchmarks that helped fast-food restaurants to monitor their service-delivery process, to identify relative weaknesses, and to take corrective actions for continuous service improvements using analytic hierarchy process and competitive gap analysis. This study revealed that a service attribute considered most important to the fast-food restaurant customers' impressions of service quality is taste of food. Also, the authors found a pattern of the correlation between the overall level of customer satisfaction with the fast-food

restaurant and its word-of-mouth reputation. Furthermore, they discovered that the customers tended to be more favorable to easily accessible and national fast-food restaurant franchises than less accessible, relatively new, and regional counterparts.

Khattab et al. (2011) studied was to measure hotels' service quality performance from the customer perspective. To do so, a performance-only measurement scale (SERVPERF) was administered to customers stayed in three, four and five star hotels in Aqaba and Petra. Although the importance of service quality and service quality measurement was recognized, there was limited research that addressed the structure and antecedents of the concept for the hotel industry. The clarification of the dimensions was important for managers in the hotel industry as it identifies the bundles of service attributes consumers find important. The results of the study demonstrated that SERVPERF seemed as a reliable and valid tool to measure service quality in the hotel industry. The instrument consists of five dimensions, namely "tangibles", "responsiveness", "empathy", "assurance" and "reliability". Hotel customers are expecting more improved services from the hotels in all service quality dimensions. However, hotel customers have the lowest perception scores on empathy and tangibles. In the light of the results, possible managerial implications were discussed and future research subjects are recommended.

Ko and Har (2008) highlighted an exploratory study of customer satisfaction of fine dining restaurants in Singapore. Since there was a causal relationship between customer satisfaction and service quality and services literature and studies were shown that service quality was an antecedent of customer satisfaction, this paper seek to find out the service dimensions of service quality, which lead to higher levels of customer satisfaction. This study suggested that the service dimensions of assurance, empathy and tangibles were the most important to customers' evaluation of service quality, and thus, might have a positive influence customer satisfaction. The service aspects of each of these dimensions were discussed and recommendations were made for restaurateurs to improve their service to ensure higher levels of customer satisfaction.

Chow et al. (2007) reported an empirical assessment of service quality in restaurant operations.The authors proposed and tested a conceptual model of service quality using structural equation modeling. Using data from a sample of 284 customers from two large full-service restaurants in southern China, the authors investigated the relationships of service quality, customer satisfaction, and frequency of patronage. The results supported the significant links between service quality and customer satisfaction, service quality and repeat patronage, but not customer satisfaction and repeat patronage. The study provided important insights into service quality and customer satisfaction in the field of restaurant operations.

Andaleeb and Conway (2006) determined the factors that explain customer satisfaction in the full service restaurant industry. Secondary research and qualitative interviews were used to build the model of customer satisfaction. A structured questionnaire was employed to gather data and test the model. Sampling involved a random selection of addresses from the telephone book and was supplemented by respondents selected on the basis of judgment sampling. Factor analysis and multiple regressions were used to test the model. The regression model suggested that customer satisfaction was influenced most by responsiveness of the frontline employees, followed by price and food quality (in that order). Physical design and appearance of the restaurant did not have a significant effect.

## 3. RESEARCH METHODOLOGY

### 3.1. Proposed Appraisement Module

A fuzzy based service quality and performance appraisement module proposed in this paper has been presented below. General hierarchy criteria (GHC) for evaluating overall service quality in relation to the hostel mess, adapted in this paper has been shown in Table 1. It consists of two-level index system; which aims at achieving the target to evaluate overall appraisement index. 1st level lists out a number of evaluation indices: tangibility, reliability, responsiveness, assurance and empathy; 2nd level comprises of various sub-indices. Procedural steps for quality and performance evaluation have been presented as follows:

1. Selection of linguistic variables towards assigning priority weights (of individual evaluation indices both at 1st as well as 2nd level) and appropriateness rating (performance extent) corresponding to each 2nd level sub-indices.

2. Collection of student's opinion in order to express the priority weight as well as appropriate rating against each of the evaluation indices.

3. Representing student linguistic judgments using appropriate fuzzy numbers set.

4. Use of fuzzy operational rules towards estimating aggregated weight as well as aggregated rating (pulled opinion of the students) for each of the evaluation index.

5. Calculation of computed performance rating of individual 1st level evaluation indices and finally overall performance index called Fuzzy Performance Index (FPI).

Appropriateness rating for each of the 1st level evaluation index $U_i$ (rating of ith 1st level index) has been computed as follow;

$$U_i = \frac{\sum U_{ij} \otimes w_{ij}}{\sum w_{ij}} \quad (01)$$

In this expression $U_{ij}$ is denoted as the aggregated fuzzy

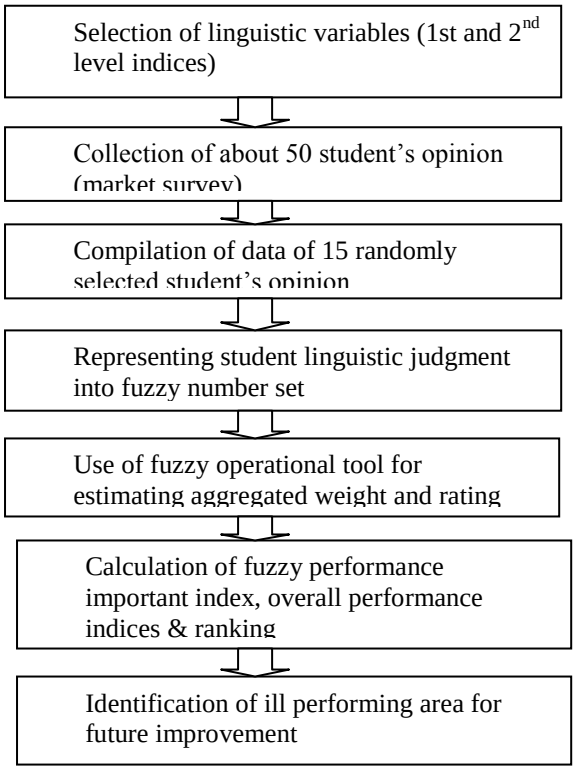
appropriateness rating against jth sub index which is under ith main index in the 1st level. Wij is the aggregated fuzzy weight against jth sub index(at 2nd level)which is under ith main index in 1st level.

The Fuzzy Performance Index (FPI) has been computed as:

$$U(FPI) = \frac{\sum U_i \otimes w_i}{\sum w_i} \quad (02)$$

In this expression Ui is denoted as the computed fuzzy appropriateness rating against ith at 1st level main index. Wi is the aggregated fuzzy priority weight against ith 1st level main index.

**Present Methodology:-**




### 3.2. Numerical Illustrations

The proposed appraisement module has been implemented in a hostel mess at Guru Ghasidas University, Bilaspur, and India.The module encompasses of various evaluation indices at different levels. After survey priority weights (importance extent) have been assigned against different evaluation indices considered in the proposed appraisement model. A questionnaire has been designed and administrated among fifty students to provide the required detail. Out of which fifteen randomly collected data has been explored to investigate application feasibility of the proposed appraisement platform. After critical investigation and scrutiny each student has been instructed to explore the linguistic scale (Table 2) towards assignment of priority weight and appropriateness rating against each evaluation indices. Appropriateness rating for 2nd level sub-indices has been furnished in Table 3. Tables 4-5 provide subjective judgment of students expressed through linguistic terms in relation to weight assignment against various evaluation indices (both at 1st and 2nd level), respectively. These linguistic expressions (human judgment) have been converted into appropriate generalized trapezoidal fuzzy numbers as presented in Table 2. The method of simple average has been used to obtain aggregated priority weights and aggregated ratings of 2nd level sub-indices (Tables 6). Computed fuzzy performance ratings and aggregated fuzzy priority weight for 1st level main indices and tabulated in Table 7. Finally, the Eq. 03 has been used to obtain overall FPI thus becomes (0.323, 0.455, 0.756)

The concept of 'Ranking of fuzzy numbers' has been adapted here to indentify ill-performing areas in relation to hostel mess service. 2nd level sub-indices have been ranked based on their individual Fuzzy Performance Importance Index (FPII). It has been computed as follows:

$$FPII_j = \left[1 - w_{ij}\right] \otimes U_{ij} \quad (03)$$

Here FPIIj is denoted as the fuzzy performance importance index of jth sub-index, whose aggregate performance rating is Uij and aggregated priority weight wij. The equivalent crisp measure corresponding to R ( FPIIIndividual ) has been computed , thus ,2nd level sub-indices have been ranked accordingly ( Table 8 ). In this survey we have considered five 1st level main indices and nineteen second level sub indices. After applying fuzzy theory on collected data as discussed above 2nd level indices are ranked. Ranking order of sub indices (Table-8) indicates good and bad parameters respectively. Those parameters or indices having high ranking, need not to give more attention to improve and vise versa.

### 4. CONCLUSIONS

The present work proposes to develop a service quality model in relation to a hostel mess, which describes how the quality of services is perceived by customers. The work examines that quality dimensions are interrelated and the importance of image should be recognized.

The contribution of this research has been furnished below.

1. Development of fuzzy-based integrated service quality and performance appraisement module in relation to a hostel mess. Industries/ enterprises/ service sectors can utilize this appraisement module as a test kit to assess and improve overall performance extent.

2. Estimation of overall performance index; identification of ill-performing areas.

3. Based on estimated overall performance index; different service sectors (of similar type: hostel mess in the present case) can be ranked accordingly (benchmarking).

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**TABLES**

Table 1: A Fuzzy Based Performance Appraisement Module for Mess Service Quality Evaluation in Hostels

| GOAL | 1ST LEVEL MAIN INDICES | 2ND LEVEVL SUB-INDICES |
|---|---|---|
| MESS SERVICE QUALITY AND PERFORMANCE | Tangibility, A | Comfortable environment, A1 |
| | | Dish tastes good (Food Quality: fresh, hot served, well cooked, well presented), A2 |
| | | Reasonable charge, A3 |
| | | Dishes quantity enough (Food Quantity), A4 |
| | | Staff appearance clean and tidy/ Employee cleanliness and tidiness, A5 |
| | Reliability, B | Timely perform commitment, B1 |
| | | Staff is enthusiasm, B2 |
| | | Service is appropriate, B3 |
| | Responsiveness, C | Service time, C1 |
| | | Speedy service, C2 |
| | | Prompt in meeting all promises, C3 |
| | | Prompt in meeting all promises, C4 |
| | Assurance, D | Staff is polite (Employee politeness/ behavioral characteristic friendly and courteous), D1 |
| | | Mess sanitation, D2 |
| | | Mess safety, D3 |
| | | Ability to recover mistakes, D4 |
| | Empathy, E | Category of dishes enough (Product/ food variety), E1 |
| | | Understand customer (Customer understanding), E2 |
| | | Solve customer's problem timely (Problem solving capability), E3 |

 

Table 2: Five-member Linguistic Terms and Their Corresponding Fuzzy Numbers.

| Linguistic term for weight assignment | Linguistic term for ratings | Fuzzy numbers |
|---|---|---|
| Very low, VL | Very Poor, VP | (0.0, 0.0, 0.25) |
| Low, L | Poor, P | (0.0, 0.25, 0.5) |
| Medium, M | Medium, M | (0.25, 0.5, 0.75) |
| High, H | Satisfied, S | (0.5, 0.75, 1.0) |
| Very High, VH | Extremely Satisfied, ES | (0.75, 1.0, 1.0) |

Table 3: Appropriateness Rating (in linguistic scale) of 2nd Level Indices Assigned by Customers.

| 2nd level indices | Appropriateness rating(in linguistic scale) of 2nd level indices assigned by customers. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
| A1 | M | M | P | S | M | S | S | M | M | ES | M | P | S | S | M |
| A2 | P | S | M | S | S | M | M | M | S | S | S | M | M | S | S |
| A3 | M | M | S | M | M | M | M | M | S | ES | M | VP | M | S | M |
| A4 | S | ES | ES | S | ES | ES | M | M | M | ES | S | ES | ES | M | S |
| A5 | P | P | P | M | P | S | P | S | M | S | P | M | S | M | P |
| B1 | VP | P | S | S | P | M | M | M | M | ES | P | M | M | M | M |
| B2 | P | P | M | M | P | M | S | S | M | S | M | P | M | M | M |
| B3 | M | M | S | S | M | S | M | S | P | M | M | VP | S | M | M |
| C1 | M | S | ES | S | S | ES | S | M | S | ES | ES | P | ES | S | S |
| C2 | M | P | S | S | M | M | S | S | M | ES | S | M | S | M | M |
| C3 | S | P | S | M | P | M | M | P | M | S | M | S | M | S | M |
| C4 | S | M | P | M | M | M | M | M | P | ES | M | ES | S | P | P |
| D1 | S | M | P | ES | M | S | S | ES | M | ES | S | VP | P | M | M |
| D2 | VP | S | M | P | VP | S | M | S | VP | S | P | P | M | VP | VP |
| D3 | VP | M | P | P | VP | M | P | S | P | ES | M | VP | P | P | P |
| D4 | VP | P | M | M | P | P | P | M | P | ES | P | VP | M | P | P |
| E1 | VP | P | S | M | M | S | S | M | M | S | S | P | S | M | M |
| E2 | M | S | S | S | P | P | M | M | S | M | VP | M | P | M | M |
| E3 | P | P | ES | S | VP | P | P | M | VP | ES | VP | ES | VP | P | VP |

 

Table 4: Priority weight (in linguistic scale) of 2nd level indices assigned by customers.

| 2nd level indices | Priority Weight (in linguistic scale) of 2nd level indices assigned by customers. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
| A1 | M | L | M | M | M | M | M | M | M | M | M | M | M | M | M |
| A2 | H | VH | H | H | VH | H | H | H | H | H | H | H | H | H | H |
| A3 | L | VL | M | L | VL | L | L | L | M | L | L | L | L | L | L |
| A4 | VH | M | H | M | VH | VH | M | VH | H | VH | VH | H | VH | VH | H |
| A5 | H | M | H | H | H | H | L | H | M | M | H | VH | H | H | VH |
| B1 | M | L | M | M | VL | M | M | M | L | H | M | M | M | M | M |
| B2 | L | M | M | L | M | M | L | L | VL | L | L | L | M | L | L |
| B3 | M | M | L | M | L | L | M | M | L | L | M | M | M | VL | M |
| C1 | M | L | L | M | M | M | L | M | H | L | M | M | L | M | M |
| C2 | M | H | L | L | L | H | M | M | M | M | M | M | M | M | H |
| C3 | L | M | M | L | L | L | VL | L | L | L | L | L | M | L | L |
| C4 | M | M | M | M | M | L | L | L | M | M | M | M | M | M | M |
| D1 | H | H | H | H | L | H | L | M | H | H | H | H | H | H | H |
| D2 | VH | H | VH | VH | VH | VH | VH | H | VH | VH | VH | VH | VH | VH | H |
| D3 | H | VH | H | H | H | H | H | M | H | H | H | VH | H | H | VH |
| D4 | H | M | H | M | M | M | M | VH | M | H | H | H | M | H | H |
| E1 | M | L | M | L | L | L | VL | M | L | M | M | M | L | M | L |
| E2 | L | M | L | VL | M | VL | L | L | VL | L | L | L | VL | VL | M |
| E3 | VL | L | VL | VL | VL | VL | M | VL | L | VL | VL | VL | L | M | H |

 

Table 5: Priority Weight (in linguistic scale) of 1st level indices assigned by customers.

| 1st level indices | Priority Weight (in linguistic scale) of 1st level indices assigned by customers. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
| A | M | S | M | S | M | S | M | M | M | ES | M | M | S | S | M |
| B | P | P | S | S | P | M | M | S | M | S | M | P | M | M | M |
| C | S | M | S | S | M | S | S | M | M | ES | S | S | S | M | M |
| D | VP | M | P | M | VP | M | P | S | P | ES | VP | M | P | P | P |
| E | P | P | S | S | P | P | M | M | P | S | P | M | P | M | M |

 

Table 6: Aggregated Fuzzy Priority weight and Aggregated Fuzzy Rating of 2nd level indices.

| 2nd level indices | Aggregated Fuzzy Priority Weight, Wij | Aggregated Fuzzy Rating, Uij |
|---|---|---|
| A1 | (0.233, 0.483, 0.733) | (0.330, 0.583, 0.817) |
| A2 | (0.533, 0.783, 1.000) | (0.367, 0.617, 0.850) |
| A3 | (0.333, 0.250, 0.500) | (0.317, 0.550, 0.783) |
| A4 | (0.583, 0.833, 0.950) | (0.550, 0.800, 0.933) |
| A5 | (0.450, 0.700, 0.917) | (0.200, 0.450, 0.700) |
| B1 | (0.217, 0.450, 0.700) | (0.250, 0.483, 0.717) |
| B2 | (0.083, 0.317, 0.567) | (0.283, 0.483, 0.733) |
| B3 | (0.150, 0.383, 0.633) | (0.300, 0.533, 0.783) |
| C1 | (0.183, 0.433, 0.683) | (0.517, 0.767, 0.933) |
| C2 | (0.250, 0.500, 0.750) | (0.367, 0.617, 0.850) |
| C3 | (0.050, 0.283, 0.533) | (0.283, 0.533, 0.783) |
| C4 | (0.200, 0.450, 0.700) | (0.283, 0.533, 0.750) |
| D1 | (0.433, 0.683, 0.933) | (0.367, 0.600, 0.800) |
| D2 | (0.700, 0.950, 1.000) | (0.183, 0.350, 0.600) |
| D3 | (0.533, 0.783, 0.983) | (0.133, 0.330, 0.567) |
| D4 | (0.400, 0.650, 0.883) | (0.117, 0.333, 0.433) |
| E1 | (0.117, 0.350, 0.600) | (0.300, 0.533, 0.750) |
| E2 | (0.050, 0.217, 0.467) | (0.250, 0.483, 0.733) |
| E3 | (0.067, 0.167, 0.417) | (0.200, 0.367, 0.567) |

Table 7: Aggregated Fuzzy Priority Weight and computed Fuzzy Rating of 1st level indices.

| 2nd level indices | Aggregated Fuzzy Priority Weight, Wi | Aggregated Fuzzy Rating, Ui |
|---|---|---|
| A | (0.367, 0.620, 0.850) | (0.370, 0.618, 0.822) |
| B | (0.250, 0.500, 0.750) | (0.273, 0.500, 0.743) |
| C | (0.417, 0.667, 0.900) | (0.376, 0.619, 0.832) |
| D | (0.117, 0.300, 0.517) | (0.196, 0.396, 0.602) |
| E | (0.183, 0.433, 0.567) | (0.261, 0.480, 0.693) |

 

Table 8: Ranking order of 2nd level indices.

| 2nd level indices | FPII | Crisp Value | Ranking Order |
|---|---|---|---|
| A1 | (0.253,0.301,0.218) | 0.257 | 10 |
| A2 | (0.171,0.134,0.000) | 0.102 | 15 |
| A3 | (0.211,0.412,0.319) | 0.338 | 3 |
| A4 | (0.229,0.134,0.047) | 0.136 | 14 |
| A5 | (0.110,0.135,0.058) | 0.101 | 16 |
| B1 | (0.196,0.266,0.215) | 0.212 | 12 |
| B2 | (0.259,0.330,0.317) | 0.302 | 6 |
| B3 | (0.255,0.329,0.287) | 0.280 | 7 |
| C1 | (0.422,0.435,0.296) | 0.384 | 1 |
| C2 | (0.275,0.303,0.212) | 0.265 | 9 |
| C3 | (0.269,0.382,0.366) | 0.339 | 2 |
| C4 | (0.226,0.293,0.225) | 0.248 | 11 |
| D1 | (0.208,0.190,0.053) | 0.150 | 13 |
| D2 | (0.055,0.017,0.000) | 0.024 | 19 |
| D3 | (0.062,0.072,0.000) | 0.048 | 18 |
| D4 | (0.070,0.116,0.051) | 0.079 | 17 |
| E1 | (0.265,0.346,0.300) | 0.303 | 5 |
| E2 | (0.238,0.378,0.391) | 0.336 | 4 |
| E3 | (0.187,0.306,0.331) | 0.275 | 8 |

 