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MEASURING CUSTOMER SATISFACTION OF SERVICE QUALITY BY FUZZY EVALUATION APPROACH

(Mengukur Kepuasan Pelanggan Terhadap Kualiti Perkhidmatan Menggunakan Pendekatan Penilaian Kabur)

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ABSTRACT

Service quality plays an essential part in customer satisfaction. There are many approaches to measure customer satisfaction through delivery of service quality. One of the issue that leave the decision maker in an awkward position in selecting the most appropriate criteria available is by customer satisfaction. Therefore, the purpose of this study is to evaluate the customer satisfaction of service quality by using advanced methods; fuzzy evaluation approach. The service quality selected is based on five criteria, which are tangible, responsiveness, assurance, empathy, and reliability. The linguistic term of each criterion is used to get the best evaluation result. The developed questionnaire is distributed to twenty experts in the service quality at Jabatan Hal Ehwal Agama Islam Kelantan (JHEAIK) for one day duration. The findings showed that all the criterias meet the high level of service quality with the level satisfaction in between 0.6 and 0.8. The lowest ranking level of satisfaction are Responsiveness (C2) and Reliability (C5). Meanwhile, Tangible (C1) and Empathy (C4) are the the middle value of customer satisfaction. Lastly, with the highest value of level satisfaction which is Assurance (C3). The outcome of the study will help to increase customer satisfaction at JHEAIK by improving their management service quality according to each criteria. Therefore, the fuzzy evaluation is a powerful approach to evaluate the criteria level for customer satisfaction in service quality.

Keywords: customer satisfaction; fuzzy evaluation; service quality

ABSTRAK

Kualiti perkhidmatan memainkan peranan penting dalam memenuhi kepuasan pelanggan. Terdapat banyak pendekatan untuk mengukur kepuasan pelanggan terhadap kualiti perkhidmatan. Salah satu masalah janggal ialah dalam memilih kriteria yang paling sesuai yang sedia ada untuk memenuhi tahap kepuasan pelanggan. Oleh sebab itu, tujuan pembelajaran ini adalah untuk menilai tahap kepuasan pelanggan terhadap kualiti perkhidmatan dengan menggunakan kaedah yang lebih terkehadapan; kaedah penilaian kabur. Lima kriteria kualiti perkhidmatan yang di pilih adalah Kesetaraan, Tanggungjawab, Jaminan, Empati dan Kebolehpercayaan. Istilah linguistik telah digunakan untuk setiap kriteria bagi menganalisa keputusan yang terbaik. Soal selidik yang dibangunkan telah diedarkan kepada dua puluh pakar dalam kualiti perkhidmatan di Jabatan Hal Ehwal Agama Islam Kelantan (JHEAIK). Hasil keputusan mendapati semua kriteria kualiti perkhidmatan adalah di peringkat tinggi dalam memenuhi tahap kepuasaan pelanggan iaitu antara 0.6 dan 0.8. Tahap kepuasan pelanggan terhadap kualiti perkhidmatan yang paling rendah ialah Tanggungjawab (C2) dan Kebolehpercayaan (C5). Sementara itu, Kesetaraan (C1) dan Empati (C4) adalah pada tahap sederhana. Akhir sekali, tahap kepuasan yang paling tinggi ialah Jaminan (C3). Hasil keputusan dari pembelajaran boleh di gunakan untuk membantu pihak pengurusan di JHEAIK bagi meningkatkan tahap kepuasan pelanggan untuk setiap kriteria. Oleh itu, penilaian kabur adalah satu kaedah yang berkesan dalam menilai setiap kriteria dalam memenuhi tahap kepuasan pelanggan.

Kata kunci: kepuasan pelanggan; penilaian kabur; kualiti perkhidmatan

1. Introduction

As globally accredited halal certification bodies, the Islamic Development Department of Malaysia (JAKIM) and the State Islamic Religious Department (JAIN) need to formulate an appropriate solution to improve the quality of services delivered to their clients. Undeniably, service quality is more difficult to assess than commodity quality, but it plays an essential role in improving customer satisfaction. Unfortunately, based on previous studies, numerous issues have been raised regarding the Halal certification process, such as lack of competent staff in handling the process (Ahmad *et al*. 2017), unsystematic filing system, which leads to the inefficiency of the operation (Yusuf *et al*. 2015), the cost incurred relatively high, especially for small and medium industries (Hamid *et al*. 2017), strict procedures imposed by JAKIM and JAIN cause a delay in the process (Krishnan *et al*. 2017) and also the complexity of the Halal certification manual cause difficulties in understanding the process, particularly for non-Muslim applicants (Soraji *et al*. 2017).

Table 1: Summary of fuzzy application

Author(s)	Method Used
Mahmud *et al.* (2020)	Arithmetic fuzzy set equation and the center of area method were adopted. The gap or difference in outcomes was seen between normal taxi and Grab services.
Prayudha *et al.* (2020)	The subjectivity problem of respondents can be solve through Fuzzy-SERVQUAL method and the result was effected the satisfactions among them.
Wardana *et al.* (2020)	Fuzzy method was applied to calculate the service quality which is tangible, reliability, responsiveness, assurance and empathy.
Kang *et al.* (2020)	In order to calculate the weight of each item in the early stage of data mining and filters out items with a high degree of consensus, the Fuzzy Delphi Method (FDM) is used.
Stefano *et al.* (2020)	There are two methods used which is the SERVQUAL to collect data and Fuzzy Analytic Hierarchy Process (FAHP) to calculate weights and perceptions of service quality.
Farhadi *et al.* (2020)	Fuzzy DEMATEL and ANP techniques applied to evaluate the priority of factors effecting health service quality.
Zhang and Li (2020)	AHP-fuzzy comprehensive evaluation method is used to calculate the customer satisfaction.
Su and Xu (2020)	Applied Fuzzy comprehensive evaluation method to build an evaluation model and the evaluation weight of each level index is calculated.
Lijuan and Qingyu (2016)	Fuzzy comprehensive evaluation is adopted to evaluate the tourism service quality.
Kabadayi and Cirpin (2016)	A novel fuzzy Analytic Process (AHP) cmethod was developed to determine the service quality expectation in the veterinary hospital.
Mohd *et al.* (2016)	Fuzzy Multi-Criteria Decision Making (MCDM) is used to evaluate the service quality provided by library.

Based on these issues, this study used the SERVQUAL model to assess the service quality provided by JAKIM and JAIN. This tool was developed by Parasuraman *et al*. (1988), which consists of five dimensions, namely tangibles, reliability, responsiveness, assurance, and empathy. Thus, this study used a set of questionnaires to collect data for measuring these five dimensions provided by Jabatan Hal Ehwal Agama Islam Kelantan (JHEAIK), one of the State

Islamic Religious Department (JAIN) in Malaysia. Further, this study applied a Fuzzy Evaluation Approach to rank these five SERVQUAL dimensions.

It is crucial to rank the five SERVQUAL dimensions based on the clients' perception. So, JHEAIK will be aware of the service quality dimensions required by the clients and determine which dimension needs to be improved in the future. The ranking will also enable JHEAIK to focus its attention and resources on the proper dimension. Many researchers have adopted various fuzzy theories in evaluating and ranking the service quality regarding customer satisfaction within diverse organizations and industries, as summarized in Table 1.

The rest of the paper is discussing about the methodology: Fuzzy evaluation formulation, implementation which is from raw data convert to fuzzy evaluation approach, result and discussion, and lastly conclusion.

2. Methodology

The present paper by Alias *et al.* (2014) proposed seven step of fuzzy evaluation. The systematic computational procedure are explained in the following algorithm:

Step 1: Determine the importance criteria to evaluate
Step 2: Convert criteria into triangular fuzzy numbers
Step 3: Compute distance between two fuzzy numbers
Step 4: Verifying the data evaluation
Step 5: Aggregate fuzzy evaluation
Step 6: Defuzzied the fuzzy evaluation
Step 7: Calculate fuzzy decision making (FDM)

The process of fuzzy evaluation is illustrated as follows:

Step 1: *K* experts are invited to determine the importance of rating alternatives and evaluation criteria using linguistic variable (Table 2 and Table 3).

Table 2: Linguistic variables for importance weight of criteria

Value	Linguistic Variable	Fuzzy Scale
1	Extremely Unimportant (EU)	(0.0,0.0,0.3)
2	Not Very Important (NV)	(0.0,0.3,0.5)
3	Not Important (NI)	(0.3,0.5,0.7)
4	Important (I)	(0.5,0.7,1.0)
5	Extremely Important (EI)	(0.7,1.0,1.0)

Table 3: Linguistic variables for the rating alternatives

Value	Linguistic Variable	Fuzzy Scale
1	Very Low (VL)	(0.0,0.0,0.3)
2	Low (L)	(0.0,0.3,0.5)
3	Medium (M)	(0.3,0.5,0.7)
4	High (H)	(0.5,0.7,1.0)
5	Very High (VH)	(0.7,1.0,1.0)

Step 2: Convert the linguistic variable as suggested in Table 2 and Table 3 into triangular fuzzy numbers by using

$$\tilde{r}_{ij} = \frac{1}{K}\left[\tilde{r}_{ij}^{\,1} \oplus \tilde{r}_{ij}^{\,2} \oplus ... \oplus \tilde{r}_{ij}^{\,K}\right] \tag{1}$$

where,

$\tilde{r}_{ij}^{\,K}$ = rating of alternative i with respect to criteria j

$$\tilde{w}_j = \frac{1}{K}\left[\tilde{w}_j^{\,1} \oplus \tilde{w}_j^{\,2} \oplus ... \oplus \tilde{w}_j^{\,K}\right] \tag{2}$$

$\tilde{w}_j^{\,K}$ = jth criteria weight of kth expert for $i = 1,...,m,\ j = 1,...,K$

and the operation laws for two triangular fuzzy number are

$$\tilde{m} \oplus \tilde{n} = \left(m_1 + n_1, m_2 + n_2, m_3 + n_3\right) \tag{3}$$

$$\tilde{m} \otimes \tilde{n} = \left(m_1 n_1, m_2 n_2, m_3 n_3\right) \tag{4}$$

where,

$\tilde{m} = \left(\tilde{m}_1, \tilde{m}_2, \tilde{m}_3\right)$ and $\tilde{n} = \left(\tilde{n}_1, \tilde{n}_2, \tilde{n}_3\right)$.

Step 3: The distance between the averages of $\tilde{w}_j$ and $\tilde{w}_j^{\,k}$, and the averages of $\tilde{r}_{ij}$ and $\tilde{r}_{ij}^{\,k}$ as $k = 1,...,K$ are computed using vertex method for each expert. The distance between two fuzzy numbers $\tilde{m}$ and $\tilde{n}$ then, is computed using the formula:

$$d\left(\tilde{m}, \tilde{n}\right) = \sqrt{\frac{1}{3}\left[\left(m_1 - n_1\right)^2 + \left(m_2 - n_2\right)^2 + \left(m_3 - n_3\right)^2\right]} \tag{5}$$

Step 4: As stated in Cheng and Lin (2002), if distance between expert evaluation data and average is less than the threshold value of 2.0, then all experts are considered achieved a consensus. Meanwhile, If the relation between two fuzzy number achieved greater than 75% of consensus, then go to step 5 (Chu & Hwang 2008); otherwise it will require a second round of surveys.

Step 5: Fuzzy evaluation will be aggregated by:

$$\tilde{A} = \begin{bmatrix} \tilde{A}_1 \\ \tilde{A}_2 \\ ... \\ \tilde{A}_m \end{bmatrix} \quad \text{where } \tilde{A}_i = \tilde{r}_{i1} \otimes \tilde{w}_1 \oplus \tilde{r}_{i2} \otimes \tilde{w}_2 \oplus ... \oplus \tilde{r}_{in} \otimes \tilde{w}_n \tag{6}$$

Step 6: Fuzzy evaluation in step 5, $\tilde{A}_i = \left(a_{i1}, a_{i2}, a_{i3}\right)$ is defuzzified for each alternative option using

$$a_i = \frac{1}{4}\left(a_{i1} + 2a_{i2} + a_{i3}\right) \tag{7}$$

Step 7: Finally, Fuzzy Decision Making (FDM) weighted is calculated by using the formula:

$$W_{FDM} = \frac{a_i}{\sum a_i} \tag{8}$$

3. Implementation

In getting some data, a questionnaire or an experts' opinion are important part in fuzzy selection technique. In this study, the data were collected using SERVQUAL and Likert Scale questionnaire from strongly not agree (1) and strongly agree (5). The focus criteria used in this study represented in Table 4 is chosen from a part of 10 criteria by Parasuraman *et al.* (1988).

Table 4: Definition of each criteria (Source of definition: Parasuraman *et al.* (1988))

Ci	Criteria	Definition
C1	Tangible	The appearance of physical facilities, equipment, personnel and communication materials
C2	Responsiveness	The willingness to help customers and to provide prompt service
C3	Assurance	The knowledge and courtesy of employees and their ability to convey trust and confidence
C4	Empathy	The provision of caring, individualized attention to customer
C5	Reliability	The ability to perform the promised service dependably and accurately

In this study, the data were collected from JHEAIK to identify customer satisfaction of criteria in Table 4. Data from twenty experts (E1, E2, …, E20) were examined using fuzzy evaluation method to transform into fuzzy sets. The overall data firstly computed their average all sections of each criteria. So, Table 5 and Table 6 shown the computed original data to the fuzzy evaluation set.

Table 5: Original evaluation data for rating criteria and expert evaluation

Criteria/Expert	E1	E2	E3	E4	E5	...	E15	E16	E17	E18	E19	E20
C1	H	H	VH	VH	VH	...	VH	VH	VH	VH	H	H
C2	H	H	VH	H	VH	...	VH	VH	VH	VH	H	H
C3	VH	VH	VH	H	VH	...	VH	VH	VH	VH	H	H
C4	H	VH	VH	H	VH	...	VH	VH	VH	VH	H	H
C5	H	VH	H	H	H	...	VH	H	VH	VH	H	H

Table 6: Original Evaluation Data for Rating Criteria

Criteria	C1	C2	C3	C4	C5
Fuzzy Linguistic Variable	I	I	EI	I	I

After evaluating data for rating criteria and expert evaluation were determined, the decision marker used the linguistic variable in Table 2 and Table 3 to determine the important weights of criteria and average fuzzy rating of criteria according to linguistic fuzzy variable as Table 7 and Table 8.

Each distance obtained confirmed that their Threshold value of 2.0. The obtained distance value support that the data collection from the questionnaire are acceptable. Then, fuzzy evaluation of each criteria are aggregated using Eq. (6), gives Table 9.

Table 7: Fuzzy weight of criteria

Criteria	Fuzzy Rating of Criteria		
C1	0.5	0.7	1.0
C2	0.5	0.7	1.0
C3	0.9	1.0	1.0
C4	0.5	0.7	1.0
C5	0.5	0.7	1.0

Table 8: Average fuzzy rating of criteria

Criteria	Average Fuzzy Rating		
C1	0.6000	0.8500	1.0000
C2	0.5900	0.8350	1.0000
C3	0.6200	0.8800	1.0000
C4	0.6000	0.8500	1.0000
C5	0.5900	0.8350	1.0000

Table 9: Aggregate fuzzy evaluation for each criteria

Criteria	Aggregate Fuzzy Evaluation		
C1	0.3000	0.5950	1.0000
C2	0.2950	0.5845	1.0000
C3	0.5580	0.8800	1.0000
C4	0.3000	0.5950	1.0000
C5	0.2950	0.5845	1.0000

In the last step, the criterias were defuzzified by Eq. (7) before the decision ranking are made as in Table 10 and Table 11. The derivation of customer satisfaction of service quality are calculated using Eq. (8).

Table 10: Defuzzification

Criteria	Customer Satisfaction Evaluation
C1	0.6225
C2	0.6160
C3	0.8295
C4	0.6225
C5	0.6160

Table 11: Ranking of customer satisfaction

Criteria	Customer Satisfaction Evaluation	Level of Satisfaction
C1	0.6225	2
C2	0.6160	3
C3	0.8295	1
C4	0.6225	2
C5	0.6160	3

Table 12: Average of all criterias

Total Value of Customer Satisfaction for all criterion	Average
3.3065	0.6613

4. Result and Discussion

A fuzzy evaluation approach is used in this study to convert linguistic terms into fuzzy numbers to reflect the expertise opinion on service quality. An expert opinion is often used to collect uncertainty information and the fuzzy number provides a simple way to solve that uncertainty. The fuzzy number is an extension of fuzzy set theory and it efficiently solves uncertainty information derived from expert opinions. Using this approach, customer satisfaction can be measured more accurately since it takes into account all the uncertainty conditions such as vagueness, imprecision, and inconsistent information. In our case, vagueness was caused by an absence of information from the expert group and was resolved by determining a weighted average for each criterion shown in Table 7. It has been determined successfully that each of the criteria (C1, C2, C3, C4, C5) has a fuzzy weight. After that, weight distance measures are computed for each criterion to solve the imprecise condition due to different observer expert opinions, and the results are shown in Table 8 as an overall fuzzy rating for criteria. Aggregation is followed by the next step to solve the inconsistency condition, as there are two or more contradictory values for the information collected for each criterion. Results are displayed in Table 9 as an aggregated fuzzy evaluation for each criterion. In the end, the defuzzification method is used to analyse the satisfaction result for service quality in Table 10, as shown in the following example.

Based on the results of the study, a fuzzy evaluation model led to a successful ranking of customer satisfaction in services quality. The result shown in Table 11 shows that the criteria of Responsiveness (C2) and Reliability (C5) score the same at 0.6160, indicating the lowest level for customer satisfaction. So, customers are less satisfied with customer service when they are not responsive to their needs and unable to deliver the promised service reliably and accurately. Furthermore, Tangible (C1) and Empathy (C4) are also the second ranking with the same level of satisfaction as 0.6225, which indicates that the appearance of physical facilities, equipment, personnel, and communications materials, as well as the provision of caring, individualized attention to customers are middle values of customer satisfaction. Meanwhile, with the highest scoring of 0.8295, Assurance (C3) indicated that trust and confidence are dependent on the skill and courtesy of employees within the service quality of JHEAIK. Assurance (C3) reveals that customers are most satisfied with JHEAIK's service quality thanks to employees' knowledge and courtesy and their ability to convey trust and confidence. It is the highest level of satisfaction indicates. Consequently, from the precise result, JHEAIK department can find out the lowest and the highest criteria of its service quality.

5. Conclusion

This study was evaluated and ranking the customer satisfaction of five criteria (C1, C2, C3, C4, C5) based on fuzzy linguistic evaluation. From the ranking results, all the values of level customer satisfaction for each criteria is "high" in linguistic term since each criteria (Table 11) represent the value more than 0.5. Therefore, the management of JHEAIK will maintain the service quality provide to their customer. The total value of all criterion in Table 12 is 3.3065, so this give the average customer satisfaction of 0.6613. As a conclusion, we can say that, the overall result of customer satisfaction in service quality at JHEAIK is good. In future study, the

result obtained using fuzzy evaluation algorithm will compare to other existend method that evaluate the customers satisfaction of all service qualities from Parasuraman *et al*. (1988).

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