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Fuzzy TOPSIS Implementation for the Determination of Priority Scale in Improving Service Quality

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***Abstract*— Service quality plays a crucial role in economic development, particularly in the service industry, such as hotel services. Despite this, many hotels lack a systematic approach to help management identify areas that require improvement based on customer feedback. This research aims to develop a system that supports efforts to enhance service quality, utilizing the Fuzzy TOPSIS method. The study incorporates 150 data points obtained from questionnaires distributed to hotel service customers. The research involves two trials: service improvement priority and service eligibility. The results indicate an 84.45% accuracy level for service improvement priority testing, based on 120 out of 150 data points. Additionally, the accuracy level for service eligibility testing is 85.34%, derived from 131 data points out of the total 150. The research findings highlight the cafeteria as a significant area requiring improvement in service quality, aligning with the insights of hospitality experts. These results can serve as a foundation for management to enhance service quality based on selected criteria and alternatives.**

***Index Terms*— service; industry; quality; fuzzy; TOPSIS**.

I. Introduction

In the era of globalization, the main factor that makes a significant contribution to a country's economic progress is the hospitality and tourism sector, especially the lodging sector (hotels, hostels, apartments, etc.) [1] So, the competition between service providing companies to increase. This requires every company to have strategies and innovations to attract customer interest, one of which is by improving service quality. Service quality has an important role in economic development, including the service industry [2]. Strategies to improve service quality can attract customer interest in determining the hotel services they want to use. However, differences in customer interests make the facilities and quality of services offered not necessarily suitable for customers. Hotel businesses are required to always be sensitive to changing needs and attitudes from customers. In the service industry, especially lodging, customers must pay attention to customer needs and hotel efficiency in order to increase sales [3][4]. Several studies have been conducted on improving service quality and its impact on customer satisfaction, focusing on various subjects. For example, research have been conducted to explores the effect of hotel service quality on customer loyalty [5][6][7].

Based on several previous studies, one of the strategies in service quality control is to incorporate digitization in line with current advancements. So far, many hotel services have only provided the option for customers to submit complaints to the front office, which are then manually forwarded to the management. Meanwhile, the management of the hotel that we used as the object of research does not yet have its own system that can facilitate the identification of facilities and services requiring improvement based on customer complaints. In fact, reviews on Google regarding the hotel we researched show that several customers provided feedback. Examples include the front office service not being available 24 hours, the hotel not providing breakfast, and issues with the cafeteria only offering snacks rather than other food options. So far, there have been 280 Google reviews [8] revealing repeated customer complaints, yet the absence of any response from the hotel could lead to a further drop in its rating. Despite Google reviews being one of the benchmarks for customers seeking temporary accommodations, 1-star and 2-star ratings persist. Therefore, we propose to create a system that can accommodate customer complaints with the aim that management can improve hotel services. This ineffectiveness hampers the management of consumer complaints. Thus, the strategy for improving service quality is impeded. Consequently, there is a need for a digitalization-based system with a methodology that can assist management in identifying services and facilities requiring improvement based on customer complaints. Several previous studies have explored various decision-making methods developing thus far. For example, a utilizes the Fuzzy method combined with AHP to determine ranking criteria for analyzing strategic service quality [2]. The study is conducted from the perspective of digital transformation in the hospitality industry. Another research study [9] examines the comparison between the TOPSIS and Fuzzy TOPSIS methods in evaluating financial performance analysis of banks. Additionally, a study [10] performs a stability analysis of the method by altering the service quality ranking for different metro lines. Other research on transportation service case studies has also been carried out in this study [11]. Controlling service quality was also discussed regarding passenger satisfaction in assessing service quality in the airline industry [12]. Another study [13] focused on construction of a service quality scale. Lastly, the research study [1] also discussed the issue of service quality and human resources in providing services.

Based on some of these studies, the Fuzzy TOPSIS method theoretically exists and can be used to assess service quality. This is supported by the theory proposed by Yoon & Hwang as cited in [14], which states that Fuzzy TOPSIS is the appropriate method for decision-making in determining priorities, TOPSIS is a popular method in a mathematical approach that selects the optimal solution by measuring the distance of each alternative to the positive ideal solution and negative ideal solution simultaneously. In decision making systems, positive ideal solutions are popular solutions used to maximize benefit criteria and minimize cost criteria. In contrast to the positive ideal solution, the negative ideal solution is a less popular solution in maximizing the criteria [15][16] such a research [17] and [18]. The method solves problems based on the fundamental idea that the chosen alternative has the closest distance to the positive ideal solution and the farthest distance from the negative ideal solution. Additionally, research conducted by [1] suggests that the Fuzzy TOPSIS method can be served as a measure of the performance of alternative decisions using simple computational forms, the same as the use of the Fuzzy TOPSIS method in research [19], then [20] and the last one is [21].

This research focuses on developing a system that can support efforts to improve service quality. The system was built by utilizing the Fuzzy TOPSIS method, which has been proven to effectively address problems by emphasizing the shortest distance to a positive ideal solution and the farthest distance from a negative ideal solution. The study focuses on a hotel, which is one of the businesses of the hotel businesses of state universities in Malang Indonesia. Data was collected by distributing questionnaires to customers over approximately one month. The study aims to assist the inn management team in identifying areas where services may be suboptimal according to customers. Consequently, the findings can facilitate immediate improvements in service quality.

Several previous studies have been conducted to measure the level of service quality. For instance, research conducted in [5] focused on examining customer satisfaction levels and customer involvement behavior (CEB). The study investigates the mediating relationship between website quality, customer satisfaction, and CEB. The results indicate that customer satisfaction has a significant impact on CEB and customer loyalty. Furthermore, additional research on the impact of service quality on customer satisfaction was conducted in [6]. The study assessed hotel service quality during the COVID-19 pandemic using data from 400 hotels in Thailand. The research findings demonstrate that service quality has a significant influence on customer loyalty. Additionally, research conducted in [7] aimed to investigate the relationship between service quality (SQ) and customer loyalty (CL), with a focus on the mediating role of customer satisfaction (CS) and customer delight (CD). The study involved 313 hotel customers. The results indicated that service quality had a significant positive effect on both customer satisfaction and delight. Furthermore, the findings revealed that customer satisfaction and delight effectively mediated the relationship between service quality and customer loyalty.

Based on the literature briefly mentioned in the background, this study employs the Fuzzy TOPSIS method as a decision-making approach to identify service criteria that require improvement. Previous studies have demonstrated the effectiveness of this method in addressing various issues, as exemplified by research conducted [1]. The study conducted a comparison between the TOPSIS and Fuzzy TOPSIS methods for financial performance analysis. The object of the research is banks. Another research study [10] applied Fuzzy theory analysis in conjunction with TOPSIS to evaluate service quality in rail services. A survey was conducted to assess service quality based on several criteria, including access (egress), security checks, ticket purchases or recharges, card swiping, transfers, waiting for boarding, in-vehicle experience, and other extended services. The research presents the findings of several criteria that require improvement. Research on evaluating business performance of homestay in China is also conducted [22]. The research proposes an alternative selection method using Fuzzy TOPSIS. It has been found that after the COVID-19 pandemic, homestays operating in rural areas have optimal performance. These results can be used as a benchmark by experts in assessing the quality of homestays. Lastly, the research study [20] served as the basis for choosing the method employed in this study. The research implementing Fuzzy TOPSIS by utilizing quality dimensions as input for the quality of public transportation services.

TABLE 1
ALTERNATIVE BASED ON REGARDING HOTEL BUSINESS STANDARDS

No	Alternative
1.	Rooms
2.	Bathrooms
3.	Cafetaria
4.	Front office
5.	Worship place
6.	Parking lots

TABLE 2
CRITERIA BASED ON REGARDING HOTEL BUSINESS STANDARDS

No	Criteria
1.	Products
2.	Service
3.	Cleanliness
4.	Security
5.	Management
6.	Health

Several previous studies that have been conducted focused on improving service quality through programs built using the same method. However, expert opinion must be an important consideration because experts have knowledge of the case studies used. This research combines surveys conducted on customers who are service recipients with the opinions of experts in the hotel sector who are deemed to have more knowledge in improving service quality in the hotel business. The experts used in this research were three hotel industry experts from three different hotels in Indonesia. The data collected from customers and experts is processed by the system and produces output which is expected to help determine the service quality improvement decision support system.

The Fuzzy TOPSIS method operates by selecting the alternative with the highest value, which represents the chosen alternative that requires service quality improvement. The implementation of the Fuzzy TOPSIS method is integrated into a web-based system that can effectively handle customer complaints. The data that is processed is 150 data resulting from the answers of customers who are hotel customers for one month.

II. METHOD

This research commences with a survey aimed at studying and analyzing the condition of the research object, enabling the definition and formulation of the problems faced by the research object. In this step, brief interviews were conducted with experts in the research object field to identify the criteria and alternatives considered for establishing a reference in determining the priority scale for improving the service quality. The interview results revealed the utilization of six criteria, including service, cleanliness, management, and health. The selection of the six criteria was based on interviews with experts, taking into account the Minister of State Apparatus Empowerment and Bureaucratic Reform Regulation Number 29 of 2022 concerning Monitoring and Evaluation of the Performance of Public Service Delivery [23] regarding General Guidelines for the Implementation of Public Services and the Regulation of the Minister of Tourism and Creative Economy of the Republic of Indonesia Number PM.53/HM. 001/MPEK/2013 [24] regarding Hotel Business Standards.

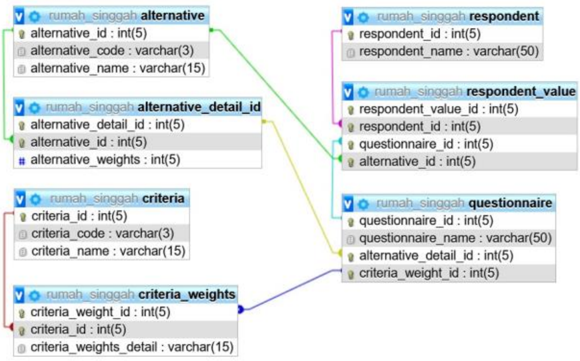

Fig. 1. Design of database system

Experts and respondents were asked several questions regarding hotel services and facilities used as research objects. Experts answered questions based on previously mentioned government regulations. Some of the questions answered by experts and respondents included ranking service quality criteria from most important to least important. Additionally, there were questions about each alternative, assessed based on the provided criteria. The assessment consists of 5 points: very low, low, sufficient, good, and very good.

As for the determined alternatives, there are six of them, as shown in Table 1. While the alternative will be assessed based on the criteria used in the study. The criteria are shown in Table 2.

These criteria and alternatives were identified by experts based on the available facilities and common customer complaints. The study utilizes data collected from customers over one month, resulting in a successful acquisition of 150 data points, which serve as input for the system. The system was built on a web basis using the Code Igniter framework and programming language using PHP. The database uses phpMyAdmin and contains a total of seven tables. These tables include alternatives, alternative details, criteria, criteria weights, respondents, respondent values, and questionnaires. The seven tables are related to each other as shown in Figure 1. Then, the design of the web page for inputting customer assessments of hotel services is shown in Figure 2.

The method in this study aims to identify the alternative with the highest value to improve service quality. The research methodology employed in this

Fig. 2. Questionnaire form of the quality assessment system

determines the priority for service improvement. Each point outlined above will be discussed in greater detail in the subsequent sub-chapters.

A. *Criteria*

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The application of Fuzzy TOPSIS to determine priority scales involves several steps, including criteria evaluation, alternative eligibility assessment, decision-making, and ranking decision rules. The criteria utilized are measurements, rules, and standards that aid in decision-making. The eligibility of alternatives is determined by various constraints, such as physical availability, resource availability, and information constraints, among others. Subsequently, the evaluation of each available alternative's criteria must be conducted to assess their attractiveness to the criteria weight values or weight values. The weight value of each alternative $Ai(i = 1, 2, . . . , m)$ for each criterion $Cj(j = 1, 2, . . . , n)$ the weight values of each alternative

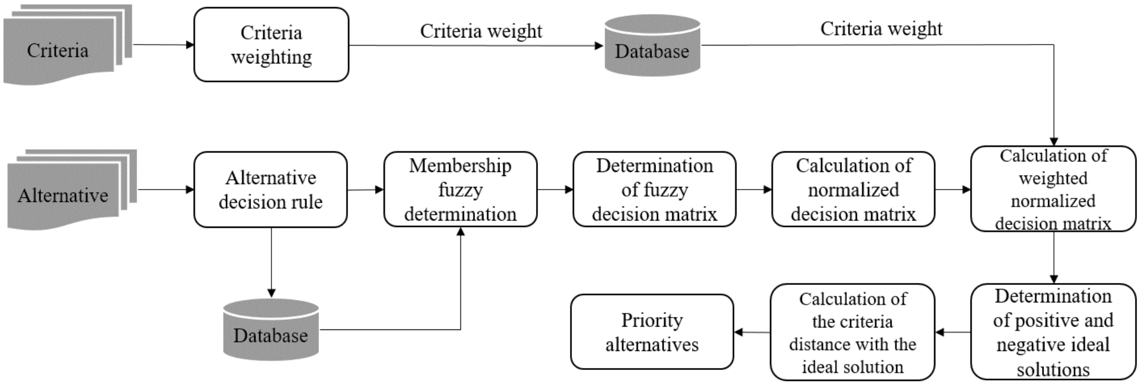

Fig. 3. Block diagram of the method

study is illustrated in Figure 3. The figure illustrates the flow of the research system, which incorporates the implementation of the Fuzzy TOPSIS method. The system database stores the weights assigned to each predefined criterion. The subsequent step involves determining alternative decision rules for each predefined alternative. These rules are utilized to calculate the value of alternative decisions based on assessments provided by respondents. Fuzzy membership is then determined to facilitate the creation of a fuzzy decision matrix in the subsequent stage. The decision matrix is further transformed into a normalized form. Next, the predetermined criteria weights are multiplied by the normalized decision matrix, resulting in a weighted normalized decision matrix. With the weighted normalized decision matrix in hand, it becomes possible to identify the positive ideal solutions and negative ideal solutions. The final step involves calculating the distances between the criteria and the positive ideal solutions, as well as the negative ideal solutions. This calculation yields the outcome, which can be represented as a decision matrix, which can be written as: $D = [xij]m\times n, i = 1, 2, . . . ,m; j = 1, 2, . . . , n$.

In this system, the weighting of the criteria is determined by experts and then calculated by the system using the Fuzzy TOPSIS method to establish the ranking of each alternative. The objective is to identify the prioritized alternatives for service improvement. The criteria weighting is divided into five categories: very low, low, sufficient, good, and very good. Each expert provides an assessment for the six criteria, indicating their importance on a scale ranging from very unimportant to very important.

Table 3 displays the criteria weight rule, indicating the value of the alternative decision rule for each weight. The alternative decision rules range from 0.0 to 1.0, representing fuzzy rules. Based on the criteria weighting rules, the importance assessment for criteria weighting conducted by the hospitality experts can be converted into a matrix, as illustrated in Table 4. The

TABLE 3
CRITERION WEIGHT RULES

No.	Criterion Weight	Value 1	Value 2	Value 3
1	Very Low	0.0	0.0	0.2
2	Low	0.0	0.2	0.4
3	Enough	0.2	0.4	0.6
4	Good	0.4	0.6	0.8
5	Very Good	0.6	0.8	1.0

TABLE 5
CRITERION WEIGHT

No.	Criteria's Name	Value 1	Value 2	Value 3
1	Product	0.00	0.15	0.35
2	Service	0.50	0.70	0.90
3	Cleanliness	0.40	0.60	0.80
4	Security	0.20	0.40	0.60
5	Management	0.30	0.50	0.70
6	Health	0.00	0.05	0.25

TABLE 4
TRIANGULAR FUZZY NUMBER VALUE

Criterion	Expert Hotels Object 1			Expert Hotels Object 2			Expert Hotels Object 3			Expert Hotels Object 4		
Product	0	0.2	0.4	0	0.2	0.4	0	0.2	0.4	0.	0	0.2
Service	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8	0.4	0.6	0.8
Cleanliness	0.4	0.6	0.8	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1
Security	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6
Management	0.2	0.4	0.6	0.2	0.4	0.6	0.6	0.8	1	0.2	0.4	0.6
Health	0	0	0.2	0	0	0.2	0	0	0.2	0	0.2	0.4

table depicts the conversion of the values provided by the hospitality experts, who serve as the objects, into a matrix by replacing each expert's judgment with a predetermined value based on the criteria weight rule, which follows the Fuzzy rule. By evaluating the level of importance for each criterion through the perspectives of the four hospitality experts, the weighted importance for each criterion is obtained by summing up the values assigned by each expert and dividing it by the number of hospitality experts, as illustrated as in (1).

$$\frac{\sum value\ of\ all\ the\ hotel's\ object\ expert}{\sum hotel's\ object\ expert} \quad (1)$$

Table 5presents the calculation results of the importance weight assessment for each criterion. The calculation results consist of three weights, as they correspond to the triangular curve representation that utilizes three parameters.

B. Alternative

Based on the survey results and discussions held by the researchers with experts, taking into account the facilities available at the research object, six alternatives were identified: rooms, bathrooms, cafeterias, front offices, worship place, and parking lots. The system conducts calculations using the Fuzzy TOPSIS method, resulting in a ranking for each alternative to be selected. The alternative with the lowest preference value is given the highest priority for service improvement. The alternative decision rules are presented in Table 6.

TABLE 6
ALTERNATIVE DECISION RULES

No.	Criterion Weight	Value 1	Value 2	Value 3
1	Very Low	0.0	0.0	2.0
2	Low	0.0	2.0	4.0
3	Enough	2.0	4.0	6.0
4	Good	4.0	6.0	8.0
5	Very Good	6.0	8.0	10.0

The described alternative represents the object of the study. The system testing utilizes 150 data obtained from customer questionnaires. These data will be compared with the opinions of three experts from hotel services who will serve as a basis for comparison. The ranking of alternatives will then be used as a reference for further calculations in the research, employing the Fuzzy TOPSIS method. The flowchart depicting the ranking of priority alternatives for service improvement using Fuzzy TOPSIS is presented in Figure 4. The figure illustrates the first step that needs to be taken,

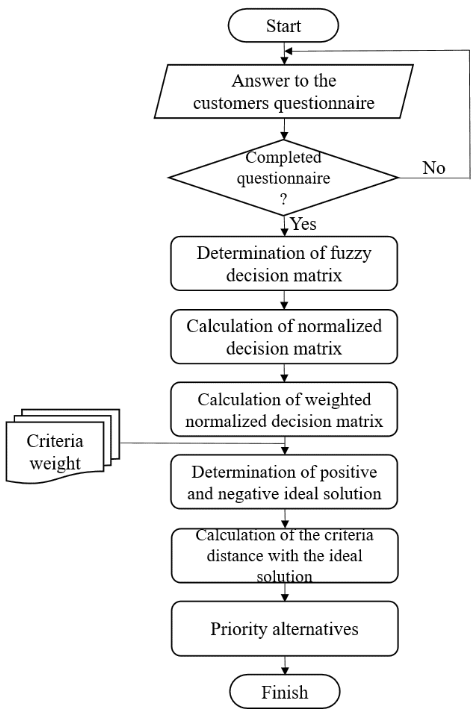

Fig. 4. Flowchart proposed method of Fuzzy TOPSIS

which is to assign a triangular fuzzy number value for each visitor's response. The data from the visitor questionnaires will then be compared with the opinions of three experts in the hotel service industry. The subsequent step involves creating a fuzzy decision matrix, which is later transformed into a normalized decision matrix. These results are further multiplied by the criteria weights, resulting in a weighted normalized decision matrix. The values for positive and negative ideal solutions are then calculated. From these calculations, the distance between each alternative and the ideal point can be determined. The distance between the alternatives and the ideal point represents the final result in the form of a preference value.

C. *Method Design*

The data, which has been transformed into alternative rules, will be evaluated and converted into a matrix using the predetermined criteria weights as references. Subsequently, the data is processed to generate a matrix by dividing the count of each criterion by the total number of respondents. The formula for this calculation is presented as in (2).

$$\frac{\sum value\ of\ all\ the\ respondent}{\sum respondent} \quad (2)$$

After completing all the calculations, a fuzzy decision matrix and a matrix divisor are obtained. The matrix divisor is determined by taking the square root of each criterion raised to the power of two, resulting in a fuzzy decision matrix. Each alternative is assigned a value for each criterion. The fuzzy decision matrix is subsequently transformed into a normalized decision fuzzy matrix by dividing it by the matrix divisor. Once the fuzzy decision matrix is obtained, the next step involves converting the matrix into a normalized decision matrix. This is achieved by dividing each weight assigned to each alternative for each criterion by the corresponding matrix divisor. The subsequent step involves converting the matrix into a normalized decision matrix by dividing each weight assigned to each alternative for each criterion by the matrix divisor. Then, the normalized decision matrix is further transformed into a weighted decision matrix by multiplying each weight with the corresponding criterion weight that was determined during the criteria weighting stage.

The subsequent step after obtaining the weighted normalized decision matrix is to calculate the positive ideal solution and the negative ideal solution. The positive ideal solution is determined by identifying the alternative with the highest value across all criteria, while the negative ideal solution is determined by identifying the alternative with the lowest value across all criteria.

Once the alternative's distance to the ideal points is calculated, the final result, which is the preference value, can be determined. The alternative's distance to the positive ideal solution is in (3), (4), and (5):

$$D_i^+ = \sqrt{\sum_{j=1}^{n}\left(y_{ij} + y_i\right)^2} \quad i = 1, 2, \ldots, m \quad (3)$$

The alternative's distance to the negative ideal solution is formulated as follows:

$$D_i^- = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_i\right)^2} \quad i = 1, 2, \ldots, m \quad (4)$$

To calculate the preference value for each alternative, the following formulation is used:

$$CC_i = \frac{D_i^-}{D_i^- + D_i^+} \quad i = 1, 2, \ldots, m \quad (5)$$

III. Result and Discussion

This study utilizes questionnaire data collected from customers, resulting in a total of 150 data points. Additionally, the responses provided by three hospitality experts were used for comparison with the customers' answers. The customer data, collected successfully from the respondents, is processed using

TABLE 7
FUZZY DECISION MATRIX

Alt	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5			Criterion 6		
1	5.36	7.36	9.36	5.20	7.20	9.20	4.56	6.56	8.56	4.48	6.48	8.48	5.52	7.52	9.52	3.52	3.52	7.52
2	4.72	6.72	8.72	4.08	6.08	8.08	4.16	6.16	8.16	3.60	5.60	7.60	4.48	6.48	8.48	3.52	3.52	7.52
3	2.08	4.08	6.08	3.28	5.28	7.28	3.36	5.36	7.36	3.28	5.28	7.28	2.64	4.40	6.40	5.12	5.12	7.12
4	5.28	7.28	9.28	5.68	7.68	9.68	4.80	6.80	8.80	4.08	6.08	8.08	5.44	7.44	9.44	5.76	5.76	7.76
5	4.40	6.40	8.40	4.16	6.16	8.16	3.20	5.20	7.20	3.36	5.36	7.36	4.24	6.24	8.24	5.70	5.70	7.60
6	2.80	4.80	6.80	2.88	4.88	6.88	3.28	7.28	5.28	2.80	4.80	6.80	3.52	5.52	7.52	4.72	4.72	6.72

TABLE 8
NORMALIZED DECISION MATRIX

Alt	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5			Criterion 6		
1	0.51	0.48	0.47	0.49	0.47	0.45	0.47	0.45	0.44	0.50	0.47	0.45	0.51	0.48	0.47	0.42	0.42	0.42
2	0.45	0.44	0.43	0.38	0.39	0.40	0.43	0.42	0.42	0.40	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.42
3	0.20	0.27	0.30	0.31	0.34	0.35	0.34	0.36	0.35	0.37	0.38	0.39	0.24	0.28	0.31	0.38	0.39	0.39
4	0.50	0.48	0.46	0.54	0.50	0.50	0.50	0.47	0.45	0.46	0.44	0.43	0.50	0.48	0.46	0.45	0.44	0.43
5	0.42	0.42	0.42	0.39	0.40	0.33	0.33	0.36	0.37	0.38	0.39	0.39	0.39	0.40	0.40	0.43	0.42	0.42
6	0.27	0.27	0.34	0.27	0.32	0.34	0.34	0.36	0.38	0.31	0.35	0.36	0.32	0.35	0.37	0.33	0.36	0.37

TABLE 9
WEIGHTED NORMALIZED DECISION MATRIX

Alt	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5			Criterion 6		
1	0	0.07	0.16	0.25	0.33	0.41	0.19	0.27	0.35	0.10	0.19	0.27	0.15	0.24	0.33	0	0.02	0.10
2	0	0.07	0.15	0.19	0.28	0.36	0.17	0.25	0.34	0.08	0.16	0.24	0.12	0.21	0.29	0	0.02	0.10
3	0	0.04	0.11	0.15	0.24	0.32	0.14	0.22	0.30	0.07	0.15	0.23	0.07	0.14	0.22	0	0.02	0.10
4	0	0.07	0.16	0.27	0.35	0.43	0.20	0.28	0.36	0.09	0.18	0.26	0.15	0.24	0.32	0	0.02	0.10
5	0	0.06	0.15	0.20	0.28	0.36	0.13	0.21	0.30	0.08	0.16	0.24	0.12	0.20	0.28	0	0.02	0.11
6	0	0.05	0.12	0.14	0.22	0.31	0.14	0.22	0.30	0.06	0.14	0.22	0.10	0.18	0.26	0	0.02	0.09

TABLE 10
POSITIVE IDEAL POINT AND NEGATIVE IDEAL POINT

	Criterion 1			Criterion 2			Criterion 3			Criterion 4			Criterion 5			Criterion 6		
FPIS	0	0.07	0.16	0.25	0.33	0.41	0.19	0.27	0.35	0.10	0.19	0.27	0.15	0.24	0.33	0	0.02	0.10
FNIS	0	0.07	0.15	0.19	0.28	0.36	0.17	0.25	0.34	0.08	0.16	0.24	0.12	0.21	0.29	0	0.02	0.10

a fuzzy decision matrix as depicted in Table 7, enabling further analysis in subsequent steps. Moreover, the assessment of the hotel service expert regarding the existing facilities at the subject in is presented in**.**

Table 7 displays the fuzzy decision matrix, which was derived by transforming the respondents' answer matrix into a fuzzy decision matrix. Subsequently, the fuzzy decision matrix is converted into a normalized decision fuzzy matrix by dividing it by the matrix divisor.

After transforming the questionnaire responses into a fuzzy decision matrix, the next step is to calculate the normalized decision matrix. This involves dividing the values in the fuzzy decision matrix by the matrix divisor. The resulting normalized decision matrix is presented in Table 8. The table presents the normalized decision matrix, which is obtained by dividing each weight of each alternative in each criterion by the matrix divisor. Following that, the normalized decision matrix is multiplied by the predetermined criteria weights to produce the weighted normalized decision matrix, as depicted in Table 9.

Next, the positive ideal point and negative ideal point are determined, as illustrated in Table 10. In the table, FPIS represents the positive ideal point, while FNIS represents the negative ideal point. The positive ideal point is the highest value among all values in each criterion column, while the negative ideal point is the lowest value among all values in each criterion column.

After obtaining the positive ideal point and negative ideal point from the alternative matrix multiplication table against the next criteria, the next step is to determine the separation measures or the distance of each alternative to the positive ideal point and negative ideal point, as shown in Table 11. The table shows the D+ value, which represents the alternative distance to the positive ideal point, and the D- value, which represents the alternative distance to the negative ideal point. Based on these values, the weight or priority of each alternative can be determined. This weight determines the most prioritized alternative for service improvement. The preference values can be seen in Table 12. The table presents the final result of the calculation, which is the preference value. By sorting the preference values from highest to lowest, we can determine the alternative with the highest priority for service improvement. The test results indicate that the cafeteria has the highest priority for service improvement, as it obtained the lowest preference value.

TABLE 11
ALTERNATIVE DISTANCE TO THE IDEAL POINT

Alternative Code	Alternative	D+	D-
A1	Bedroom	0.01	0.10
A2	Bathroom	0.05	0.06
A3	Cafetaria	0.10	0.01
A4	Front-Office	0.01	0.10
A5	Worship Place	0.06	0.05
A6	Parking Area	0.10	0.02

TABLE 12
PREFERENCE VALUE

Alternative Code	Alternative	Preference Value
A1	Bedroom	0.87
A2	Bathroom	0.53
A3	Cafetaria	0.13
A4	Front-Office	0.94
A5	Worship Place	0.44
A6	Parking Area	0.17

After obtaining the results of the system trial with the input, which are the questionnaire responses from the respondents, the accuracy of the system can be calculated to determine its effectiveness. The accuracy calculation involves three steps. First, calculating the priority of service engagement by visitors. Second, evaluating the eligibility of the service. Third, calculating the overall accuracy of the system.

1) Service Improvement Priority: The assessment results of service improvement from the system were compared with the responses obtained from 150 data of customer’s questioner answer, as well as the opinions of three hospitality experts. The purpose of this comparison was to determine the level of agreement or discrepancy between the two sets of data. The results of the analysis show that of the 150 data obtained, 120 data show a value "match" with the results shown by the system, the “cafeteria” is an alternative that requires service improvement. Meanwhile, 30 other data show "not match" with the results shown by the system. Thus, the accuracy of service improvement priorities by customers shows accuracy:

$$\frac{120}{150} \text{ x } 100\ \% = 90\ \%$$

TABLE 13
SERVICE IMPROVEMENT QUALITY TRIALS BY EXPERT

Expert	Alternative	Priority		
		System	Hospitality Expert	Output
Expert-1	Bedroom	5	5	Match
	Bathroom	4	4	Match
	Cafetaria	1	2	Not Match
	Front-Office	6	6	Match
	Worship Place	3	3	Match
	Parking Area	2	1	Not Match
Expert-2	Bedroom	5	5	Match
	Bathroom	4	4	Match
	Cafetaria	1	1	Match
	Front-Office	6	6	Match
	Worship Place	3	3	Match
	Parking Area	2	2	Match
Expert-3	Bedroom	5	5	Match
	Bathroom	4	4	Match
	Cafetaria	1	1	Match
	Front-Office	6	6	Match
	Worship Place	3	3	Match
	Parking Area	2	2	Match

Meanwhile, the data generated by the expert's assessment showed that 16 data were "match" with the results shown by the system (as shown in the Table 13) while only two data showed "not match" with the results shown by the system. Therefore, the accuracy of service improvement priorities by experts shows an accuracy of:

$$\frac{16}{18}\ x\ 100\ \% = 88.89\ \%$$

Measuring the accuracy level of service improvement priority trials shows the final accuracy to be:

$$\text{Service Improvement Priority Accuracy} = \frac{Accuracy\ 1 + Accuracy\ 2}{2} = \frac{80\ \% + 84.45\%}{2}$$

$$= 84.45\ \%$$

1) Service Eligibility: The results of the service eligibility trial of the system were compared with the results of the service eligibility trial from 150 data generated by customers who were respondents and three hospitality experts. The purpose of comparing the two data is to determine the suitability or incompatibility of the data. The eligibility test resulted in two choices: to be repaired or maintained. The output shows that the choice is to be repaired if the preference value is less than 0.50, whereas if the preference value is more than 0.50, then the output shows that the alternative is to be maintained. The results of the analysis show that out of the 150 data obtained, 131 data show a value "match" with the results shown by the system, indicating that the cafeteria is an alternative that requires service improvement. Meanwhile, 19 other data show "not match" with the results shown by the system. Thus, the accuracy of service improvement priorities by customers is:

$$\frac{131}{150} \text{ x } 100\ \% = 8.34\ \%$$

TABLE 14
SERVICE ELIGIBILITY TRIALS BY EXPERT

Expert	Alternative	Eligibility		
		System	Hospitality Expert	Output
Expert-1	Bedroom	Maintained	Maintained	Match
	Bathroom	Maintained	Maintained	Match
	Cafetaria	Repaired	Repaired	Match
	Front-Office	Maintained	Maintained	Match
	Worship Place	Repaired	Maintained	Not Match
	Parking Area	Repaired	Repaired	Match
Expert-2	Bedroom	Maintained	maintained	Match
	Bathroom	Maintained	maintained	Match
	Cafetaria	Repaired	Maintained	Not Match
	Front-Office	Maintained	Maintained	Match
	Worship Place	Repaired	Maintained	Not Match
	Parking Area	Repaired	Repaired	Match
Expert-3	Bedroom	Maintained	Maintained	Match
	Bathroom	Maintained	Maintained	Match
	Cafetaria	Repaired	Repaired	Match
	Front-Office	Maintained	Maintained	Match
	Worship Place	Repaired	Repaired	Match
	Parking Area	Repaired	Repaired	Match

Meanwhile, the data generated by the expert's assessment showed 15 data "match" with the results shown by the system, indicating agreement. While only three data show "not match" with the results shown by the system (as shown in the Table 14). Thus, the accuracy of service improvement priorities by experts is:

$$\frac{15}{18}\ x\ 100\ \% = 83.34\ \%$$

Measurement of the level of service eligibility accuracy shows the final accuracy to be:

$$\text{Serviceability Accuracy} = \frac{Accuracy\ 1 + Accuracy\ 2}{2}$$

$$= \frac{87.34\ \% + 83.34\ \%}{2}$$

$$= 85.34\ \%$$

Based on the conducted tests and the accuracy measurements of each test, the accuracy level of the Fuzzy TOPSIS method when implemented in an application to determine priority scales for improving the quality of hotel business services can be observed. In this study, the criteria weights were determined by four experts from the management of the research object. These criteria weights serve as a reference for obtaining a weighted normalized decision matrix. Upon obtaining the weighted normalized decision matrix, positive ideal solutions and negative ideal solutions are derived. Subsequently, the distances between the criterion values and the positive and negative ideal solutions are determined.

Based on these distances, the final result is the preference value. The results from the system serve as a basis for measuring the accuracy level by comparing them with the results derived from the data obtained from 150 respondents and three of hospitality experts.

In this trial, a comparison was made between the data obtained from the system's trial and the 150 data collected from customer respondents. The accuracy level was measured by evaluating the agreement between the available data. Based on the test results using the 150 existing data, the accuracy level is determined to be 80% according to the precision formula.

Then, the results of the service improvement priority trial by comparing the data obtained from the system's trial with the data provided by three hospitality experts. The accuracy level was measured by evaluating the agreement between the data from the hospitality experts. Based on the trial results using data from three hospitality experts with 18 available data, an accuracy level of 88.89% was obtained according to the precision formula.

After conducting the service improvement priority test, the second test carried out is the service eligibility trial. The service eligibility trials were performed twice, comparing the system's data with data from both hospitality experts and customers. The first service eligibility test involved comparing the system's trial results with the analysis results obtained from the questionnaire data. The accuracy level was measured by evaluating the agreement between the system's data and the data from the questionnaire. Based on the trial results and the analysis of the questionnaire data, an accuracy level of 87.34% was achieved using the precision formula.

The second service eligibility test is conducted by comparing the system's trial results with the trial results using data from three hospitality experts. The comparison of data from the experts will determine the accuracy level. Based on the test results using data from the three hospitality experts, with a total of 18 available data points, an accuracy level of 83.34% was achieved.

This research succeeded in showing that the results provided by the system built showed the same results as the expert's opinion. This proves that expert opinion is very influential and can be used as a basis for the system being built to have a high level of accuracy. This research has advantages that have not been demonstrated in previous studies like the research we mentioned in the background section. This research's advantage is by comparing the opinions of experts with the results managed by the system. Previous research used expert scores only on triangular fuzzy number values without comparing the final system results with expert opinions regarding the object under study. Several studies show that Fuzzy TOPSIS can work well if used as a method in decision support systems.

IV. Conclusions

Based on the trials conducted by implementing the Fuzzy TOPSIS method in the application for determining the priority scale to improve the quality of hotel business services, it can be concluded that the implementation of the Fuzzy TOPSIS method is effective in supporting decision-making for service improvement priorities. The high accuracy levels achieved, as measured by precision formulas, further validate the usefulness of the Fuzzy TOPSIS method in this context. This research also indicates that the system successfully yielded results consistent with the opinions of selected experts. This implies that the system built can assist hotel management in identifying areas for service quality improvement.

For future research, we aim to compare the results of our work with other methods and with method developments that have been carried out. This will enable us to construct an even more refined system

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