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IMPLEMENTING FUZZY APPROACH TO ASSESS THE BEST HOTEL SERVICES

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ABSTRACT

The focus of this study is to select the best hotel services using the hierarchical Multi-Criteria Decision Making (MCDM) model based on fuzzy set theory. This decision support system named Best Hotel Service System (BHoS) relates to the selection of hotel that satisfies all the required criteria from customers. Linguistic variables are used in this study to estimate ranks and weight of the criteria such as beauty, convenience, safety, services, price, entertainment, comfort, food and facilities. These criteria are described in term of triangular or trapezoid fuzzy number. MCDM model is used in order to select the criteria of the hotels. Finally, this study will focus on Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS), a nearness coefficient to specify the ranking of all hotels through calculating distance from both Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) which are simultaneously defined. Evaluation to the application has been done through usability test and user acceptance test. The results have proved the positive impact towards the process of BHoS through the acceptance of all mentioned criteria. The high mean values for user reactions to the system, the interface design, navigation, and content show that BHoS is easy to use and able to recommend the best hotel services based on the user's preferences.

Keywords: fuzzy logic, hotel services, MCDM, linguistic variables, TOPSIS.

INTRODUCTION

Decision making problem is the process of finding the best selection from all of the feasible options. Decision can be made by providing weights to different criteria and all the weights are obtain from expert groups. It is important to determine the structure of the problem and explicitly evaluate multi criteria. For example, in selecting the best hotel services, certain decisions have been taken based on different criteria. There are not only very complex issues involving multi criteria, some criteria may have effect toward some problem, but over all to have an optimum solution, all the alternatives must have common criteria which clearly lead to more informed and better decisions (Aruldoss, Lakshmi & Venkatesan, 2013).

According to Novák, Perfilieva and Močkoř (1999), fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Although the fuzzy approach is very complicated to use but many qualitative and quantitative factors that are taken into consideration such as price, quality, and criteria should be considered in choosing the best hotel in term of appropriate services. Linguistic variables which are used to estimate ranks and weight of the factors will be described in term of triangular and trapezoidal fuzzy number. MCDM model based on fuzzy set theory is used to select the best hotel services that satisfy all the required criteria (Chou, Hsu & Chen, 2008).
A selection of best hotel services is important to the customers who are considering a comfortable accommodation. The selections are usually judged by human perception measurement itself and budget uncertainty. Therefore it is hard to make a decision to measure the level of hotel services.

If there are inappropriate decisions making in selecting the hotel services, it always lead to customer dissatisfaction. In addition, customers are also wasting time in finding and choosing the best hotel in terms of services if there is no guidance that can assist and give unbiased recommendations to them.

Sometimes the hotel service selection is very difficult for customer to express the preferences using numerical value but fuzzy logic approach is more appropriate to use. This is because some of the key criteria described in linguistic information are qualitative and subjective in nature.

Thus, the main focus of this study is the method of selecting the best hotel services based on fuzzy logic approach. The method will be implemented in a web application known as Best Hotel Service System (BHoS). BHoS is designed to assist customer by put on their desired weightage on each of the predetermined criteria such beauty, convenience, safety, services, price, entertainment, comfort, food and facilities. Next, the decision system will rank each of the criteria based on the input from the user to recommend them the best hotel. This application will become a new medium to deliver, recommend, and providing information to people who need to choose the best hotel services based on selected criteria.

FUZZY APPROACH BACKGROUND

Fuzzy logic

According to Kaehler (1993), Fuzzy logic is a method of problem solving control system that lends itself

to implementation of systems that consists of easy, small, large, embedded micro-controllers to large, multi-channel PC or workstation based data acquisition and control systems. Fuzzy logic can be implemented in hardware, software or combining both. Fuzzy logic provides a simple way based on vague, ambiguous, imprecise, noisy, or missing input information to arrive at a definite conclusion.

Fuzzy logic needs some numerical parameters to operate. The exact values of this numbers are usually not critical unless very responsive performance needed for what is considered significant error and significant rate-of-change-of-error.

MCDM model based on fuzzy set theory is pertaining to structure and solve decision and planning problems involving multiple criteria. This relates to the selection of hotels that satisfies all the required criteria.

Multi-criteria decision making

Multi-Criteria Decision Making (MCDM) model is a problem solving approach in decision making involving many criteria, objectives and factors (Sauian, 2010). A basic characteristic of the goals is that they are often contradicting each other. For example, we need a bigger house, but we can only afford the cheaper price.

Horder (2009) indicated that MCDM is a common methodology that develops a list of criteria, and then the weight for each criterion. Every option gets every criterion according to how they will meet. Finally the score is multiplied by the weight and the results for each option added to give a rating for choice. Figure-1 shows the weight for each criterion and rating for each option based on their score.

Criteria	Time	Effort	Know-ledge	Unit Cost	Speed	Fit?	Refer-rals	
Weights	8	10	6	3	10	10	4	Rating
Option1	8	7	8	8	9	7	10	406
	8×8 = 64 + 7×10 = 70 + 8 x 6 = 48 + 8×3 = 24 + 9×10= 90 + 7×10= 70 + 10×4=40							*=406*
Option2	7	5	9	3	9	7	8	361
Option3	9	6	6	6	6	8	7	354

Figure-1. Options rating based on MCDM methodology.

Based on Figure-1, every MCDM methods have their own advantages and disadvantages. The advantage of MCDM is that it provide a balanced view of how appropriate any options, and help to taking emotion from the equation. One of the disadvantages is critical criteria may be abscured in the overall score. Overall, though MCDM may be a bit of a blunt instrument for truly complex decisions, it is much better than making serious decisions on gut feel alone.

Linguistic variables

A linguistic variable is defined as a variable whose values are sentences in a natural or artificial language. Thus, if tall, not tall, very tall, very very tall, etc. are values of height, then height is a linguistic variable (Zadeh, 1973). A linguistic variable is a variable that figure described as linguistically, is very useful and beneficial in dealing with the situation, because the concept of a linguistic variable is very difficult to be explained as a preset amount of terms (Zimmermann, 1991).

TOPSIS

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is one of the methods used to solve the decision making problem. According to Opricovic and Tzeng (2004), the most fundamental principle in TOPSIS is that the chosen alternatives should have the shortest distance from the ideal solution to the negative ideal solution. Ahi, Aryanezhad, Ashtiani and Makui (2009) stated that TOPSIS method comprises the following steps:

- The normalized decision matrix is calculated
- The weighted normalized decision matrix is calculated
- Define the ideal solution and negative ideal solution
- Compute the separation measures using the π dimensional Euclidean distance for ideal solution and negative ideal solution
- The relative closeness to the ideal solution is calculated.
- Rank order of priority

Hybrid fuzzy MCDM for vendor selection

The study by Vahdani, Alem-Tabriz, and Zandieh (2009) focuses on developing an empirically based framework for formulating and selecting a vendor in supply chain.

The researchers relate the fuzzy set theory to evaluate the vendor selection decision by applying AHP in obtaining criteria weight and applied TOPSIS for obtaining final ranking of vendors. Experimental study through vendor selection that has been carried out has clarified the usefulness of the model.

A new method for ranking hotels based on group decision making in Honeybee Swarms

Arai, Furuta, and Ito (2013) attempted to improve the accuracy of a hotel ranking system by applying an algorithm based on the behavior of honeybees. Criterions used for evaluation are dinner menu, room comfort, accommodation fee, room service, and spa conditions.

They have conducted a simulation to demonstrate the effectiveness of this algorithm. In the simulation, the score for each factor is set randomly from 1 to 5. To express the inclination of reviewers, each reviewer is given a weight for their evaluation of each factor. Each

weight is set randomly as a real number from 0 to 1. Results from the simulation have confirmed the effectiveness of the honeybee algorithm for the top-ranked hotels.

BHoS CONSTRUCTION

Methodology

There are four key activities involved in the system development of BHoS. Figure-2 shows the summarized phases involved including; Planning, Design, Implementation, as well as Testing and Analysis. Design and Implementation Phase outcomes will accomplish the whole objective of this study.

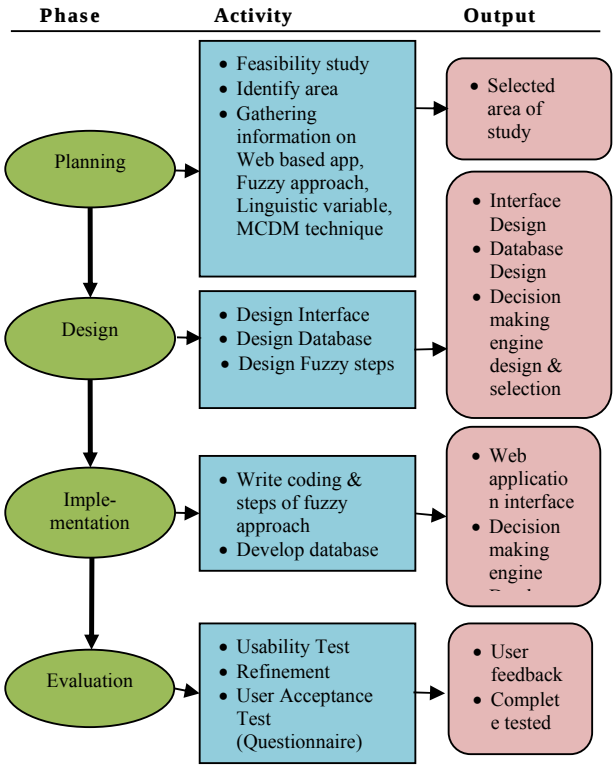


Figure-2. Methodology of the study.

ERD

An Entity Relationship Diagram (ERD) is a graphical representation of entities and their relationships to each other, which are typically used in computing in regards to the organization of data in the database. Elements found in the ERD are Entities, Relationships and Attributes (Janssen, 2013). Based on Figure-3, this system contains seven entities which are Admin, Berita, Criteria, Hotel, Keputusan, Save_Cri and Weight_Cri.

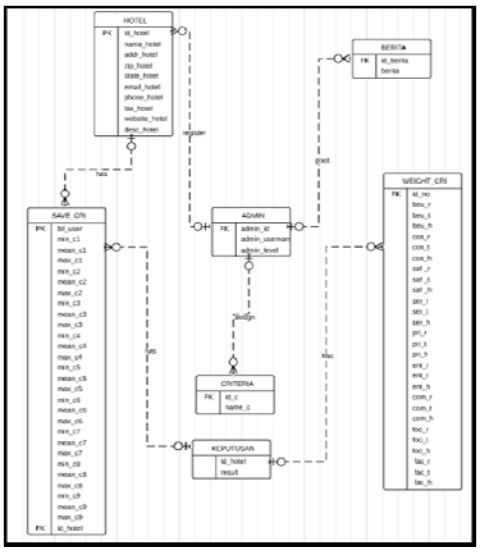


Figure-3. ERD for BHoS.

DFD

Data Flow Diagram (DFD) shows the input, process and output of each entity. This gives the clearest view of how BHoS operates and presenting how input data was transformed to output result through a series of functional transformation. The Context Diagram and Diagram 0 for BHoS are illustrated in Figure-4 and Figure-5 that show the graphic diagram presentation of data flow.

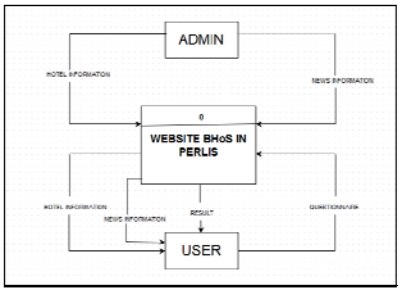


Figure-4. Context diagram for BHoS.

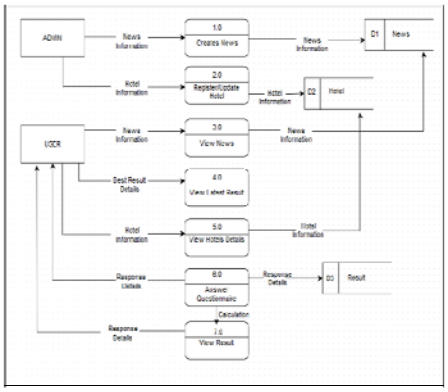


Figure-5. Diagram 0 DFD for BHoS.

Development

Adobe Dreamweaver CS3 and MySQL database in phpMyAdmin are the main tools that have been used in developing BHoS. Besides, the interfaces were constructed using HTML, PHP and Cascading Style Sheet (CSS) in order to make the designs look more organized. Both interfaces and database are integrated by using PHP language. In addition, this application also used JavaScript language to generate form validation function.

Formula implementation

This research was begun with taking data from the distributed questionnaires to customers who live in several hotels in Perlis. Questionnaires were dispersed at the Hotel Seri Malaysia (A1), Hotel Metro Inn (A2), Putra Palace Hotel (A3), Hotel Sri Garden (A4) and the Seaview Hotel (A5). The method used is TOPSIS, a nearness coefficient to specify the ranking of all hotels through calculating distance from both fuzzy positive ideal solutions. This method will helps to identify the best hotel services and able to recommend it to the users.

A survey have been conducted to evaluate the criteria required by the user before staying in a hotel, and has successfully implemented the results into the system. Based on the survey, the selected criteria are beauty, convenience, safety, services, price, entertainment, comfort, food and facilities of a hotel.

There are a number of steps should be used to calculate the fuzzy approach in order to select the best hotel and give recommendation to the customer:

i) **Step-1 :** Build table for assessment of decision makers regarding weight of criteria

The first step is to estimate the importance of each criterion, for example decision makers use linguistic weight variables that will be shown in Figure-6. The linguistic variable "Not Very Important" can be shown as (0.0, 0.1,0.2), "Not Important" can be shown as (0.1, 0.2, 0.3), "Medium" can be shown as (0.4, 0.5,0.6), "Important" can be shown as (0.7, 0.8, 0.9) and "Very Important" can be shown as (0.8, 0.9, 1.0).

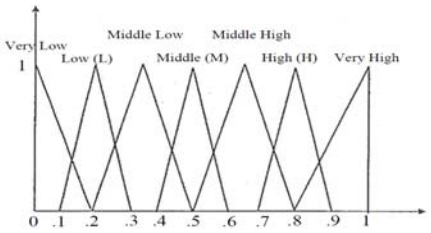
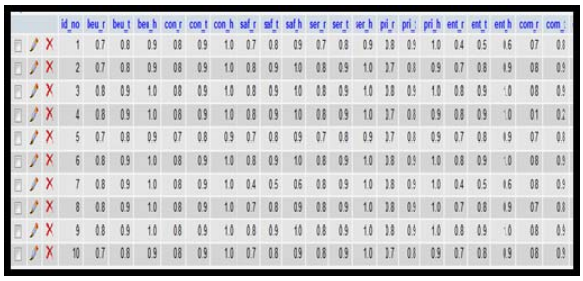


Figure-6. Option's linguistic variables for key weight of each criterion.

The importance of weights (defined criteria) by the decision makers is shown in Figure-7 from phpMyAdmin. Each value is collected from respondents who had stayed at the chosen hotel. Each respondent will choose the criteria they want or they think it is important in choosing the best hotel.



	id_no	beu_r	beu_t	beu_h	con_r	con_t	con_h	saf_r	saf_t	saf_h	ser_r	ser_t	ser_h	pri_r	pri_t	pri_h	ent_r	ent_t	ent_h	com_r	com_t
X	1	0.7	0.8	0.9	0.8	0.9	1.0	0.7	0.8	0.9	0.7	0.8	0.9	0.8	0.5	1.0	0.4	0.5	0.6	0.7	0.8
X	2	0.7	0.8	0.9	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.7	0.8	0.9	0.7	0.8	0.9	0.8	0.9
X	3	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.5	1.0	0.8	0.9	1.0	0.8	0.9
X	4	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.7	0.8	0.9	0.8	0.9	1.0	0.1	0.2
X	5	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8
X	6	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.5	1.0	0.8	0.9	1.0	0.8	0.9
X	7	0.8	0.9	1.0	0.8	0.9	1.0	0.4	0.5	0.6	0.8	0.9	1.0	0.8	0.5	1.0	0.4	0.5	0.6	0.8	0.9
X	8	0.8	0.9	1.0	0.8	0.9	1.0	0.7	0.8	0.9	0.8	0.9	1.0	0.8	0.5	1.0	0.7	0.8	0.9	0.7	0.8
X	9	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.5	1.0	0.8	0.9	1.0	0.8	0.9
X	10	0.7	0.8	0.9	0.8	0.9	1.0	0.7	0.8	0.9	0.8	0.9	1.0	0.7	0.8	0.9	0.7	0.8	0.9	0.8	0.9

Figure-7. Assessment of decision makers regarding weights of criteria in phpMyAdmin.

ii) **Step-2 :** Build table for assessment of decision makers regarding hotels with different criteria

Decision makers use linguistic ranking variables which are shown in Figure-8 to rank candidates considering each criterion. Ranking of the five options which is Hotel Seri Malaysia, Hotel Metro Inn, Putra Palace Hotel, Hotel Sri Garden and Seaview Hotel by different criteria as portrayed in Figure-9.

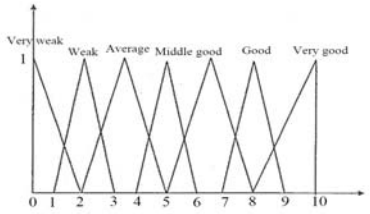
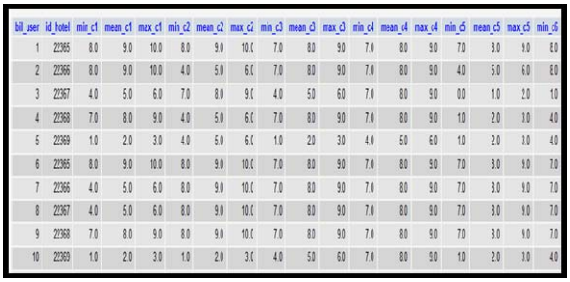


Figure-8. Linguistic variables for ranks.



bil_user	id_hotel	min_c1	mean_c1	max_c1	min_c2	mean_c2	max_c2	min_c3	mean_c3	max_c3	min_c4	mean_c4	max_c4	min_c5	mean_c5	max_c5	min_c6
1	22365	8.0	9.0	10.0	8.0	9.0	10.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	9.0	9.0	8.0
2	22366	8.0	9.0	10.0	4.0	5.0	6.0	7.0	8.0	9.0	7.0	8.0	9.0	4.0	5.0	6.0	8.0
3	22367	4.0	5.0	6.0	7.0	8.0	9.0	4.0	5.0	6.0	7.0	8.0	9.0	0.0	1.0	2.0	1.0
4	22368	7.0	8.0	9.0	4.0	5.0	6.0	7.0	8.0	9.0	7.0	8.0	9.0	1.0	2.0	3.0	4.0
5	22369	1.0	2.0	3.0	4.0	5.0	6.0	1.0	2.0	3.0	4.0	5.0	6.0	1.0	2.0	3.0	4.0
6	22365	8.0	9.0	10.0	8.0	9.0	10.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	3.0	9.0	7.0
7	22366	4.0	5.0	6.0	8.0	9.0	10.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	3.0	9.0	7.0
8	22367	4.0	5.0	6.0	8.0	9.0	10.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	3.0	9.0	7.0
9	22368	7.0	8.0	9.0	8.0	9.0	10.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	3.0	9.0	7.0
10	22369	1.0	2.0	3.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	1.0	2.0	3.0	4.0

Figure-9. Assessment of decision makers regarding hotels with different criteria in phpMyAdmin.

iii) **Step-3 :** Convert each of Step 1 and Step 2 into a graph

In this step, the values will be converted the Figure-9 to the triangular fuzzy numbers that shown in Step-1.

iv) **Step-4 :** Calculate fuzzy decision matrix of hotels to be assessed

According to Eshlaghy and Ehsanifar (2011), this technique describes the formula equation of Fuzzy

decision matrix calculation for hotels. The formula for calculating the fuzzy decision matrix:

$\tilde{u} = (a,b,c)$ $k = 1, 2, 3..., k$

$a = \min \{ak\}$

$b = \frac{1}{k}\sum_{k=1}^{k} b$

$c = \max\{ak\}$

Table-1. Label of linguistic term.

Label	Linguistic term
Ai	**Hotels**
A1	Hotel Seri Malaysia
A2	Hotel Metro Inn
A3	Putra Palace Hotel
A4	Hotel Sri Garden
A5	Hotel Seaview
Ci	**Criteria**
C1	Beauty
C2	Convenience
C3	Safety
C4	Services
C5	Price
C6	Entertainment
C7	Comfortable
C8	Food
C9	Facilities
Di	**Respondents**

Next, the value below will be taken as an example for the calculation. Based on Table-1, the first step to calculate the fuzzy decision matrix is to find the minimum number of beauty criteria (C1) and the Hotel Seri Malaysia (A1). This formula a = min {ak} is used to select the minimum value from the database that shown in Figure-10.

Figure-10. Screenshot of Assessment of decision makers regarding hotels with different criteria in Microsoft Excel.

The data from customers who were checked out from the hotel were selected. The minimum number for C1, 8.0, 8.0, 8.0, 8.0, 8.0, 8.0, 8.0, 8.0, 8.0 and 7.0 are chosen. The answer is 7.0 which is the minimum value from the C1 and A1 in the database that will be illustrates in Figure 15.

Then, the formula $b = \frac{1}{k}\sum_{k=1}^{k} b$ was used to calculate the mean for the criteria of beauty (C1) and Hotel Seri Malaysia (A1). For example, (9+9+9+9+9+9+9+9+9+8) / 10 = 8.9. The answer is 8.9. 8.9 is a mean value number from the C1 and A1 in the database.

The last calculation in this step, calculates the maximum number. Use the formula c = max {ak} to calculate the maximum number of the criteria of beauty (C1) and Hotel Seri Malaysia (A1).

Figure-11 portrayed the minimum, mean, and maximum value for beauty (C1) and Hotel Seri Malaysia (A1).

The minimum value
The mean value
The maximum value

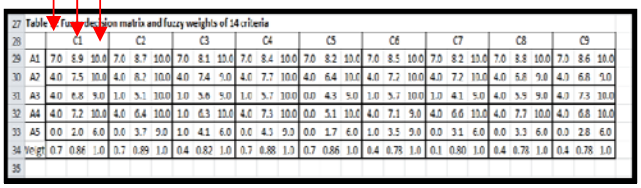


Figure-11. Fuzzy decision matrix and fuzzy weight for five hotels.

v) **Step-5 :** Calculate the fuzzy weight of hotels to be assessed

In this step, the technique has been implemented in the coding where it describes the same formula as STEP 4 (Eshlaghy and Ehsanifar, 2011).

vi) **Step-6 :** Calculate weighted normalized fuzzy decision matrix

The formula, *a1= (weight in ai) (aij) / n* was used to calculate weighted normalized fuzzy decision matrix.

For the calculation, the value in Figure-12 is shown as the example.

(7.0 x 0.7) / 10 = 0.49
(8.9 x 0.86) / 10 = 0.77
(10.0 x 1.0) / 10 = 1.0

		C1		
29	A1	7.0	8.9	10.0
30	A2	4.0	7.5	10.0
31	A3	4.0	6.8	9.0
32	A4	4.0	7.2	10.0
33	A5	0.0	2.0	6.0
34	Veigt	0.7	0.86	1.0

Figure-12. Fuzzy decision matrix and fuzzy weight for five hotels.

This is an example to calculate the weighted normalized fuzzy decision matrix. This calculation is for example to the Hotel Seri Malaysia (A1) and for which the criteria of beauty (C1).

vii) **Step-7 :** Calculate the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS)

There are 2 formulas will be used to calculate the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS).

Formula FPIS:

$$A^{+} = max\sqrt{\frac{1}{3}[(m1-n1)^2+(m2-n2)^2+(m3-n3)^2]}$$

Formula FNIS:

$$A^{-} = min\sqrt{\frac{1}{3}[(m1-n1)^2+(m2-n2)^2+(m3-n3)^2]}$$

For the calculation of the FPIS, STEP 6's result is as an example and the calculation is:

$$A^{+} = max\sqrt{\frac{1}{3}[(0.49-1)^2+(0.77-1)^2+(1.00-1)^2]}$$

$$A^{+} = 0.32$$

For the calculation of the FNIS, STEP 6's result is as an example and the calculation is:

$$A^{-} = min\sqrt{\frac{1}{3}[(0.49-0)^2+(0.77-0)^2+(1.00-0)^2]}$$

$$A^{-} = 0.78$$

viii) **Step-8 :** Calculations for di^{-}, di^{+} and *CCi*

The formula used for calculating di^{-}, di^{+} and CCi which is:

$$cci = \frac{di^{-}}{di^{+} + di^{-}}$$

The first calculation in this step is calculates the total of di^{+}. While the second is to calculate the total of di^{-}. The values from STEP 7's outcome were used. This calculation is an example for all the hotels that have been selected. The last calculation in this step is to calculate the CCi the given formula.

Calculation for the hotel Seri Malaysia (A1):

$$cci = \frac{6.82}{3.73 + 6.82}$$

$$cci = 0.64$$

Based on the calculation, all total CCi were compared to all the hotels to get the highest value as proposed in TOPSIS technique. TOPSIS technique will choose the best result by choosing the highest value. The results show that Hotel Seri Malaysia has a maximum value of 6.54. Therefore, based on analysis that has been done, the best services of the Hotel that will be recommended to customer is Hotel Seri Malaysia (label A1) which has the highest total value as shown Figure-13.

	Di+	Di-	Cci
A1	3.73	6.52	0.64
A2	4.9	5.76	0.54
A3	5.59	5.44	0.49
A4	5.23	5.75	0.52
A5	6.77	3.78	0.36

Figure-13. Screenshot of di^{-}, di^{+} and CCi.

BHos interface design

There are a few main pages in the BHoS including Homepage, Hotel Descriptions, Questionnaire and Result has been provided to the users in order to obtain the best services hotel.

A. Homepage

This is the welcome page Figure-14 to this website and the users are required to click the "Click Here" button to answer the questions and start ranking the hotel for the respondents who have stayed in the selected hotel. The users are not required to log in. In addition, the 'latest results' is available for the users who need know the best hotel in terms of the services.

Figure-14. Home page of BHoS.

B. Hotel descriptions page

The users have to choose the hotel Figure-15 and the page will provides all the descriptions about the hotel, including location, phone number, and picture. "Click Here" will take the user directly to the hotel website.

Figure-15. Screenshot of hotel descriptions page.

C. Questionnaire page : Step 1

Figure-16 displays the Select Criteria page or site survey where users need to select or rank criteria based on user's preferences. The criteria consist of beauty, convenience, safety, services, price, entertainment, comfort, food and facilities.

Figure-16. Screenshot of questionnaire page.

After that, the users have to rank the criteria according to the scale given as 'Not Very Important, 'Not Important', 'Medium', 'Important and 'Very Important. If the users need to know about the criteria example, move the mouse on the text or the criteria, and the details will be pop-up. If any of the radio buttons is left empty, the alert will appear to notify the user so that they fill it up.

D. Questionnaire page : Step 2

Figure-17 shows the Select Criteria page or further study after completion of the first step completed. On this page, the users must first select the hotel that used to be occupied or have experience staying at selected hotel. After that, users have to rank the criteria according to the scale given as 'Very Poor' , 'Poor' , 'Medium' , 'Good' and 'Very Good'. If any of the radio buttons is left empty, the alert will appear to notify the user so that they able fill it up.

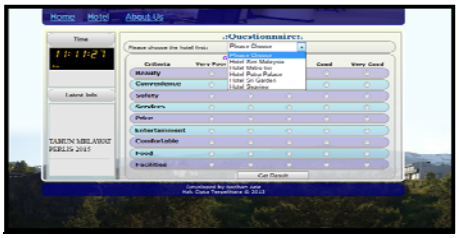


Figure-17. Screenshot of Questionnaire page.

E. Result page

After the users have completed all Question 1 and Question 2, the value that users have ranked will be saving in database. The system will calculates the best hotel services based on given ranking. The user able to view the results for best hotel services Figure-18. In addition, users may also perceive the values that are collected for the best hotel that able to get the highest results.

Figure-18. Screenshot of result page.

EVALUATION

BHoS is a web based system that developed to deliver, recommend and give information to user who wants to choose the best hotel services based on the selected criteria. Recommendations are from the respondents which are also the customers who check out from the hotel by answering the questionnaire. The questionnaire involves the criteria of the hotel such as beauty, convenience, safety, services, price, entertainment, comfort, food and facilities.

Usability test

Usability testing is one of the techniques used to ensure the users that using the system able to run and operate certain tasks in the right manner (Gaffney, 1999). In this usability testing, an expert in the fuzzy logic, and five experts in computer science field have been involved.

In this part, the respondents have been given twelve tasks. They have interacted with the system based on the instructions given in order to get the results and improvements to the constructed recommender website. The website has been tested in terms of design, navigation, content, terminology, understanding and interactivity. During the test, the respondents indicated their comments and suggestions for the web's improvement. The expert in fuzzy logic was given the same task to examine the construction site was in a proper manner.

Result of usability testing

These tasks took about 8 to 10 minutes for the user to complete the entire tasks assigned to them. From the usability test observations, mostly all the tasks assigned have been completed.

Table-2. Usability testing task for BHoS.

Task	Instruction
Task 1	The user wants to go to main menu
Task 2	The user wants to view the Latest Result for the best hotel services in Perlis
Task 3	The user wants to view the News
Task 4	The user wants to answer the questionnaire to get the result for the best hotel services
Task 5	Users want to give an answer for each criterion based on the criteria in this interesting and important at the hotels
Task 6	Users want to see explanation or examples for each criterion (tooltip)
Task 7	Users want to choose a hotel that was once occupied
Task 8	Users want to rank the criteria according to user preferences
Task 9	The user gets the result
Task 10	The user wants to view a list of hotels
Task 11	The user wants to view hotel details
Task 12	The user wants to visit link the website of the hotel to get more information

Table-2 shows a list of tasks to be performed by the users of the decision recommender application. As mentioned, there are twelve tasks given to 10 respondents with various backgrounds, as the users of this decision system. They need to perform as the user by filling in the questions and select the user's hotel, view a list of hotels and hotel information, and also see the end result of the best hotels. In addition, the users were also provided with link to the hotel website to get more information.

As an overall, the performance of their tasks has been accomplished and capable to solve the given tasks successfully. Briefly, it can be concluded that BHoS's users are able to complete the tasks given to them by giving a clear instruction. Moreover, this website is easy to navigate, fast loading and easy to understand to the respondents.

User acceptance test

User acceptance test was conducted to find out the users acceptance toward the decision recommender application. During the test, the users were given the questionnaire and they have to answer questions based on their observations while performing the given tasks.

The questionnaire consists of 16 questions that were created to achieve the objectives of the application. The users should evaluate the system based on the interface design, navigation, content and user reactions to the system. Respondents from different backgrounds are involved in the test and finally results from the test will be evaluated and analyzed.

Finding and analysis

The statistical analysis conducted in this research is a descriptive analysis. Descriptive analysis is used to describe the basic features of the data where it provides the overall summary of the results. Results of descriptive analysis for user acceptance test shows that the mean for each question is in the range between 3.70 to 4.50.

The users have evaluated the system based on four criteria which are reactions to the system, interface design, navigation and contents. The overall mean of the mean obtained from the descriptive statistic can be classified into three scales category which are i) Negative (0-1.66), ii) Neutral (1.67-3.33) and iii)Positive (3.34-5.00). The range of these classes is between 0 until 5.

Table-3. Range of mean for descriptive statistics.

Criteria	Min	Max	Mean	Category
Reaction to the system	4.20	4.40	4.30	Positive
Interface design	3.70	4.50	4.20	Positive
Navigation	4.20	4.50	4.30	Positive
content	3.70	4.50	4.18	Positive

From the calculation, the result shows that the overall mean are in the positive range and this system can be concluded that were accepted by the user. The overall result of user evaluation for each criterion has been summarized in the Table-3. The mean for *reaction to the system criteria* is 4.30. For *interface design criteria*, the overall mean is 4.20. While for *navigation*, the mean value is 4.3 and *content criteria* gain 4.18 of mean.

Overall, it can be concluded that, each criterion of the system obtained a positive feedback from the users. This means that, users are satisfied with the BHoS as illustrates in Figure-19 with the results for each criterion.

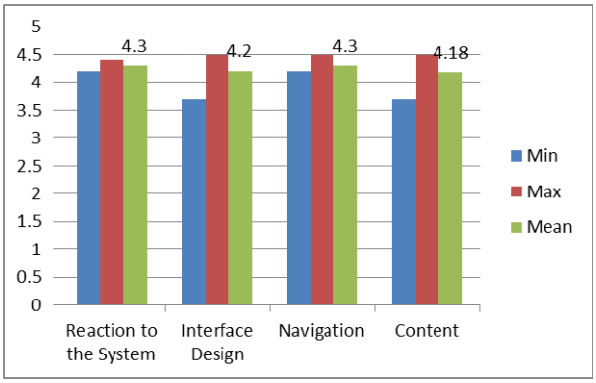


Figure-19. Overall result of evaluation for each criterion.

CONCLUSIONS

The application to assess and select the BHoS using a Fuzzy Logic has been successfully developed and obtained a positive response from the users. BHoS was built using hierarchy MCDM, Linguistic variables, TOPSIS, FPIS and FNIS model based on fuzzy set theory provides opportunities and ways to help users in finding the best hotel services. This web application then will recommends the best hotel services to the customer. There are a lot of benefits to tourism agencies can be gained in order to suggest which is the best hotel to tourist by providing 'Latest Result' based on data taken from customers who checked out from the selected hotel. Besides that, the method used seems to be accepted by the users since there are positive feedbacks from the evaluation (usability and user acceptance test). All the criteria involved able to have quite high mean value, proving that this web application is worthwhile to the users. There a few recommendations suggested for the future works of BHoS in order to improve its quality and features such as more attractive and user-friendly interfaces, and able to show the hotel ranking, and other useful information to consumers. Generally, all the objectives for this research have been achieved and also have a good feedback from the users.

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