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The Application of Triangular Fuzzy Number-Based Conjoint Analysis Method in Measuring Students' Satisfaction toward UTM Bus Services

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Abstract
The fuzzy conjoint analysis model is frequently used in different decision-making operations to measure the degree of preferences. In spite of that, it is gaining traction due to its capacity to analyse questionnaire questions in surveys that ask respondents to assess their preferences using linguistic concepts. In certain preference data, it is better presented in the form of linguistic terms or linguistic values defined on a continuous scale. In this case, fuzzy numbers can be used to express these kinds of linguisticvariables numerically. In this study, a Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM) is proposed for the purpose of measuring a group of UTM students' satisfactions toward UTM bus services and for ranking of the bus service dimension using degree of similarities. The proposed TFN-CAM is implemented in ranking and analysing the level of the students' satisfaction level with UTM bus services. The Triangular Fuzzy Number-Based on Conjoint Analysis Method (TFN-CAM) was implemented and the rating level of each service dimension's satisfaction was highlighted along with each respective degree of similarities. Results for ranking the services were determined based on their respective value of similarities degree. The result shows that, the higher the degree of similarities, the lower the students' satisfaction toward the bus's service.
Keywords: Conjoint analysis; linguistic values; triangular fuzzy numbers; services performance; satisfaction level

1. Introduction

Fuzzy Conjoint Method (FCM) is a method that based on fuzzy set preference model and is commonly used for analysing and evaluating the survey of satisfactions level in human, services or education. The Fuzzy Conjoint Method (FCM), on the other hand, employs the fuzzy set to determine the membership function of the linguistic values, which includes the weight score and overall attribute for various degrees of confidence that cannot be acquire [1]. As a result, A Fuzzy Number Conjoint Method (FNCM) based on triangular fuzzy numbers has been established in this work.

In this study, linguistic variables are used to convey the degree of preferences that are represented as discrete fuzzy sets. The membership degrees that characterise discrete fuzzy sets shows a specific individual's or a group of people level of satisfaction or preference in assessing the traits or aspects related with a given topic under investigation. This implies that the score of weight and overall attribute for different levels of confidence cannot be determined. Furthermore, the fuzzy set in discrete form does not reflect effectively when dealing with human assessment while fuzzy numbers with a continuous membership function can explain the fuzziness of human abstract perceptions. As a conclusion, in this study, the fuzzy number-based conjoint method (FNCM) that is based on triangular fuzzy number is proposed.

Items in a certain questionnaire may be tied to some traits, criteria, or circumstances, depending on the chosen subject that require respondents to deliver the answers in the form of language ratings. Hence, in this study, the Triangular Fuzzy Number-Based Conjoint Analysis Method

(TFN-CAM) has been explored. In the meantime, the method of applying the Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM) has been discovered in analysing the satisfaction level of students towards UTM bus services that was obtained through the questionnaire that contains the preferences satisfaction levels of the provided service.

2. Literature Review

2.1. UTM Bus Services

Universities in Malaysia must ensure that their campus infrastructure can accommodate an increasing population in order to support the country's goals of developing higher education and becoming a regional education centre. According to Dell'Olio *et al.* [2] ensuring students' ease of mobility on campus is a key priority for university administrators, and having an amazing infrastructure is insufficient unless it is complemented by an equally remarkable transportation system, including car service. Demanding an effective, comfortable and efficient bus services is a customers’ right since the customer pays to utilize the services [3].

Most institutions encourage students to ride bicycles or walk [4] in order to campaign to make the campuses green again [5]. This is not only an excellent way to relieve traffic congestion, but it is also a good kind of exercise. Nonetheless, this notion has not been well received by students, who cite heat, intense sweating, and humidity as reasons for preferring to use buses. Bus services should become a viable option for sustainable transportation in the future, whether on university campuses [6] or in other densely populated locations.

Students rely significantly on public transportation on practically all Malaysian university campuses. Students will miss courses, spend valuable time and effort, and will be discouraged from taking the shuttle buses if the campus transportation services are of poor quality. In addition, numerous inconveniences such as bus service delay, uncomfortable rides, safety concerns, and unhelpful bus operators contribute to bus riders' bad view of campus- provided transportation services.

According to Universiti Teknologi Malaysia (UTM) rules, first-year students are not permitted to bring their own automobiles and instead, must walk or take campus bus provided by UTM itself. Even though this appears to be a biased judgement favouring the wealthy students, the perk afforded to the fortunate ones in terms of dorms cannot match with the luxury of being near to their lecture rooms. Other students, on the other hand, are incurring financial expenditures as a result of the upkeep of their personal automobiles. As a result, this survey arrives at an appropriate time, with the goal of determining students' satisfaction with the bus services now operating on campus routes.

Unfortunately, the importance of fixing the campus transportation system has never been more underlined than today, as students have voiced their objections to university administration.

2.2 . Quality of Services

Throughout the previous decades, service quality has been a subject of interest for many studies [7]. It has also been increasingly receiving academic attention by management scholars, and has been prioritized in the management domain [8]. Parasuraman et al.[9] describes the quality of service as “the degree and direction of discrepancy between the consumer’s perceptions and expectations, or the extent to which a service meets or exceeds customer expectations.” By identifying differences between customer expectations and perceptions of service, management personnel would be able to remedy shortcomings in the products or services they offer. To relate this to public transport services, a transit user is viewed as a customer who needs to be satisfied with the quality of service; users of public transport services compare the provided transit services with their needs and expectations [9].

Satisfaction could be represented as a function of the performance of the attributes of the service, personal needs (and/or preferences) of the user, past experiences, and previous knowledge. During the last decades, efforts have been made to evaluate transport user satisfaction by assessing the quality of the service and identifying users’ priorities [10].

2.3 . Fuzzy Sets Theory

Zadeh proposed fuzzy set theory to cope with problems including uncertainty and fuzziness [11]. Several researchers have used fuzzy set theory to investigate situations involving uncertainty. Chien *et al.* [12] employed fuzzy numbers to measure perceived service quality and explain Taiwanese retail shop strengths and limitations [13]. According to Alreck *et al.* [14], most surveys in marketing research employ Likert-scales to gauge respondents' attitudes, which are linguistic in character. Instead of using discrete data, they applied statistical approaches that can handle continuous data [14]. Hung *et al.* [15] used fuzzy arithmetic procedures to clarify the appraisal of weapon systems. The qualitative dataor language phrases utilised to indicate inaccurate judgments of decision criteria or performance qualities in the aforementioned fuzzy-based studies are all stated using fuzzy numbers [10].

Definition 1 [13] Fuzzy Set

A fuzzy set *A* in *X* is a set of ordered pairs, *A* = {(*x, μ(x))* | *x* ∈ *X*} where*μ(x)* denotes the degree of membership of the element x in the universe X.

Specifically, a discrete fuzzy set defined on a discrete universal set, *X*= {*i, i=1,2,…n*}*,* can be represented as $A = \{\frac{\mu(X_i)}{X_i}, X_i \epsilon X\}$ or $A = \sum_K \frac{\mu(X_i)}{X_i}$, while fuzzy set define on continuous universal set *X* also can be written as $A = \int_X \frac{\mu(X_i)}{X_i} dx$

Definition 2 [16] Linguistic Variable

Linguistic variable is a variable that can take words as its values. These words which are known as linguistic values or linguistic terms are characterized by fuzzy setsdefined in the universe of discourse upon which the variable is defined.

2.4 .Triangular Fuzzy Number (TFN)

There are several types of fuzzy numbers according to fuzzy set theory which are Trapezoidal, Triangular, Gaussian and others. Fuzzy set theory seeks to convert linguistic variables to quantitative values by accounting for uncertainty in people’s decision-making process. Therefore, in general, the definition of TFN is given as follows:

Definition 3 [16] Fuzzy Number

A fuzzy number is a regular, real number that has been generalized. It denotes a connected set of possible values, each with its own weight between 0 and 1. As a result, a fuzzy number is a subset of a convex, normalized fuzzy set of the realline.

Definition 4 [16] Triangular Fuzzy Number

Let *a*, *b* and *c* be real numbers with *a* < *b* < *c*.Then a fuzzy number *A* = (*a, b, c*) is called triangular fuzzy number if its membership function is given by

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1}, & x \in [a_1, a_2] \\ \frac{x-a_3}{a_2-a_3}, & x \in [a_1, a_2] \\ 0, & otherwise \end{cases} \quad (1)$$

2.5 . Arithmetic Operations of Triangular Fuzzy Number (TFN)

Several arithmetic operations can be defined on fuzzy numbers dependingon the form of the number.

Let *A* = (*a*,*b*,*c*) and *B* = (*l*,*m*,*n*). For instance,

Addition operation on TFN

$$A+B=(a,b,c)+(l,m,n) \quad (2)$$

$$=(a+l,\ b+m,\ c+n)$$

Subtraction operation on TFN:

$$A-B=(a,b,c)-(l,m,n) \quad (3)$$

$$=(a-n,\ b-m,\ c-l)$$

Multiplication operation on TFN:

$$A.B=(a,b,c)\ .(l,m,n) \quad (4)$$

$$=(al,\ bm,\ cn)$$

Division operation on TFN:

A/B=A.B-1 (5)

=al,bm,cn

where *B-1=1l,1m,1n*

Therefore, the triangular fuzzy number method was used in this paper.

2.6 Degree of Similarity

The similarity degree between A and B can be calculated as,

$$SIM(A,B) = \frac{1}{1+d(A,B)} \quad (6)$$

where $d(A,B)=|P(A) - P(B)|$ with $P(A)=\frac{a_1+4a_2+a_3}{6}$ and $P(B) = \frac{b_1+4b_2+b_3}{6}$

3. Methodology

3.1. Research Design and Procedure

It is essential to determine the processes for carrying out this study in order to guarantee that the study's objectives are accomplished. Hence, a proper study procedure must be carried out. To begin, the definition and theory of fuzzy sets and triangular fuzzy numbers will be fully explored in order to have a better knowledge ofthe study topic. Then, for each degree of satisfaction, linguistic variables with associated fuzzy values will be created and expressed by the relevant notations.

Then, create a questionnaire containing the selected service dimensions as shown as in Table 3.1 and also set three linguistic variables with their respective triangular fuzzy numbers value as in Table 3.2. Obtain the responses and sort accordingly based on the satisfaction levels for each service dimension. The results obtain will be carried out to calculate the aggregated TFN values and the degree of similarities for each service dimension. Lastly, the service dimensions are ranked descending based on the similarities degree.

Table 3.1 below shows 8 services dimensions, that labeled as D_n where *n* = {*1,2,3,4,5,6,7,8*}. All these services dimension were determined from self-observation towards the UTM bus, brainstorming and surveying among undergraduate students which UTM bus service that they focused on.

Table 3.1 The dimensions of the service quality

Notation, D_n	**Service Dimension**

D_1	Accessibility
D_2	Time to arrive at your location
D_3	Have suitable pick up and drop off point
D_4	Comfortability
D_5	Easy to obtain bus information
D_6	Courtesy
D_7	Safety
D_8	Cleanliness of the bus

Table 3.2 below shows 3 linguistic variables, that labeled as L_m where *m* = {*1,2,3*}. All these values of linguistic variables were determined from self preferences.

Table 3.2 Fuzzy correspondences of linguistic variables

Notation, L_m	**Linguistic Variable**	**Triangular Fuzzy Number**
L_1	**Not satisfied**	(0, 0, 0.4)
L_2	**Average**	(0, 0.4, 0.8)
L_3	**Satisfied**	(0.4, 0.8, 1.0)

Throughout this study, five phases of procedure will be carried out. The details of each step are described in Table 3.3 below.

Table 3.3 Study design and procedure

Phase	**Research Methodology and Procedure**	**Description**
1	Literature review	Study on the related articles, journal or books about: i. Definition, concept and properties of fuzzy sets and triangular fuzzy numbers ii. Concepts of degree of similarity, S of triangular fuzzy numbers iii. Previous research related to the current Study
2	Form a questionnaire	Obtain data from a questionnaire that contains the bus service dimensions with three linguistic variables to be chosen by respondents'satisfactions level.

3	Analyse and evaluate the result	Analyse the result and evaluate the satisfactions level using TNF-CAM.
4	Analyse and rank	Analyse the data obtain from the calculation and continue to find the similarity degree to rank the services.
5	Conclusion and suggestions	This phase will include a summary of the study as well as suggestions for further research.

3.2. Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM)

In the context of examining factors, the TFN-overall CAM's process is as follows:

1. Determine the set of services domain, $D = \{D_n\}, n = 1,2,3,\dots,k$.
2. Defined the linguistic variables for ratings by TFN's, $L_m, m = \{1,2,3\}$, where $L_m = (b_1^m, b_2^m, b_3^m)$, $m = \{1,2,3\}$

   Hence,

   $L_1 = (b_1^1, b_2^1, b_3^1),\ L_2 = (b_1^2, b_2^2, b_3^2),\ L_3 = (b_1^3, b_2^3, b_3^3)$
3. Set the responses number, r_{nm}, with respect to services dimension, D_n with linguistic variables, $L_m, m = \{1,2,3\}$.
4. Obtain the TFN that representing the aggregated linguistic variables $\widetilde{D_n}$ with respect to the *n*-th services dimension, D_n where,

   $$\widetilde{D_n} = \sum_{m=1}^{t} (\alpha_{nm} L_m)$$
   $$= \sum_{m=1}^{t} (\alpha_{nm} b_1^m, \sum_{m=1}^{t} \alpha_{nm} b_2^m, \sum_{m=1}^{t} \alpha_{nm} b_3^m) \tag{7}$$
   $$= (b_1^n, b_2^n, b_3^n)$$

   such that

   $$\alpha_{nm} = \frac{r_{nm}}{\sum_{m=1}^{t} r_{nm}} \tag{8}$$

   represents the proportion of the *n*-th services dimension and *m*-th linguistic term.
5. Calculate the similarities degree between aggregated linguistic variables for *n*-th services domain $\widetilde{D_n} = \{b_1^n, b_2^n, b_3^n\}$, *n* = 1,2,…,*k* and the linguistic variables, $L_m, m = \{1,2,3\}$ using the similarity measure $S_{nm}(\widetilde{D_n}, L_m)$ where

   $$S_{nm}(\widetilde{D_n}, L_m) = \frac{1}{1 + d(P(\widetilde{D_n}) - P(L_m))},\ n = 1,2,3,\dots,k, m = \{1,2,3\} \tag{9}$$

   with $$P(\widetilde{D_n}) = \frac{(b_1^n + 4b_2^n + b_3^n)}{6} \tag{10}$$

   and $$P(L_m) = \frac{(b_1^m + 4b_2^m + b_3^m)}{6}. \tag{11}$$
6. Identify the linguistic variables that are associated with the highest membership degrees obtained in Step 5. These linguistic variables will be respectively chosen to represent the overall group preference ratings towards the factors being evaluated.
7. Rank the services domain based on the ordering of the corresponding overall group preference ratings, followed by the associated degrees of similarities, in descending order.

3.3. Computing Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM) using Table in Excel

1. Construct a table consist of three linguistic variables, L_m where *m = 1,2,3* with their corresponding triangular fuzzy numbers values, labelled as b_{m1}, b_{m2}, and b_{m3} as shown as in Table 3.4 below.

Table 3.4 Linguistic variables with corresponding triangular fuzzy numbers values

	Linguistic Variables, L_m			$\mathbf{P}(L_m) = \frac{(b_1^m + 4b_2^m + b_3^m)}{6}$
	L_1	L_2	L_3	
b_m^1	b_1^1	b_2^1	b_3^1	$\mathrm{P}(L_1) = \frac{(b_1^1+4b_2^1+b_3^1)}{6}$
b_m^2	b_1^2	b_2^2	b_3^2	$\mathrm{P}(L_2,) = \frac{(b_1^2+4b_2^2+b_3^2)}{6}$
b_m^3	b_1^3	b_2^3	b_3^3	$\mathrm{P}(L_3) = \frac{(b_1^2+4b_2^2+b_3^2)}{6}$

2. Determine the set of services domain, D = $\{D_n\}, n = 1,2,3,4,5,6,7,8$ with the three linguistic variables, L_m where *m = 1,2,3.* Then, a table can be constructed containing, the responses number, r_{nm}, obtained from the questionnaire's respondents shown in Table 3.5 below.

Table 3.5 Responses number with services domain and linguistic variables.

Responses Number, r_{nm},				
Services Domain, D_n	**Linguistic Variables, L_m**			
	L_1	L_2	L_3	$\sum_{m=1}^{t} r_{nm}$
D_1	r_{11}	r_{12}	r_{13}	$r_{11} + r_{12} + r_{13}$
D_2	r_{21}	r_{22}	r_{23}	$r_{21} + r_{22} + r_{23}$
D_3	r_{31}	r_{32}	r_{33}	$r_{31} + r_{32} + r_{33}$
D_4	r_{41}	r_{42}	r_{43}	$r_{41} + r_{42} + r_{43}$
D_5	r_{51}	r_{52}	r_{53}	$r_{51} + r_{52} + r_{53}$
D_6	r_{61}	r_{62}	r_{63}	$r_{61} + r_{62} + r_{63}$
D_7	r_{71}	r_{72}	r_{73}	$r_{71} + r_{72} + r_{73}$
D_8	r_{81}	r_{82}	r_{83}	$r_{81} + r_{82} + r_{83}$

Where,

$$L_1 = (b_1^1, b_2^1, b_3^1), L_2 = (b_1^2, b_2^2, b_3^2), L_3 = (b_1^3, b_2^3, b_3^3)$$

3. Calculate the aggregated values for each service dimension, $\widetilde{D_n}$ using the equation 7 and equation 8. Then, compute the results obtain in a table as Table 3.6 below.

Table 3.6 Aggregated values for each service dimension, $\widetilde{D_n}$

Aggregated Service Dimension, $\widetilde{D_n}$	b_1^n	b_2^n	b_3^n	$\mathbf{P}(\widetilde{D_n},) = \frac{(b_1^n+4b_2^n+b_3^n)}{6}$
$\widetilde{D_1}$	b_1^1	b_2^1	b_3^1	$\mathrm{P}(\widetilde{D_1},) = \frac{(b_1^1+4b_2^1+b_3^1)}{6}$
$\widetilde{D_2}$	b_1^2	b_2^2	b_3^2	$\mathrm{P}(\widetilde{D_2},) = \frac{(b_1^2+4b_2^2+b_3^2)}{6}$
$\widetilde{D_3}$	b_1^3	b_2^3	b_3^3	$\mathrm{P}(\widetilde{D_3},) = \frac{(b_1^3+4b_2^3+b_3^3)}{6}$

$\widetilde{D_4}$	b_1^4	b_2^4	b_3^4	$P(\widetilde{D_4},) = \frac{(b_1^4+4b_2^4+b_3^4)}{6}$
$\widetilde{D_5}$	b_1^5	b_2^5	b_3^5	$P(\widetilde{D_5},) = \frac{(b_1^5+4b_2^5+b_3^5)}{6}$
$\widetilde{D_6}$	b_1^6	b_2^6	b_3^6	$P(\widetilde{D_6},) = \frac{(b_1^6+4b_2^6+b_3^6)}{6}$
$\widetilde{D_7}$	b_1^7	b_2^7	b_3^7	$P(\widetilde{D_7},) = \frac{(b_1^7+4b_2^7+b_3^7)}{6}$
$\widetilde{D_8}$	b_1^8	b_2^8	b_3^8	$P(\widetilde{D_8},) = \frac{(b_1^8+4b_2^8+b_3^8)}{6}$

Where $\widetilde{D_n} = (b_1^n, b_2^n, b_3^n)$, for *n=1,2,3,4,5,6,7,8*

4. Calculate the similarities degree between aggregated linguistic variables for *n*-th services domain $\widetilde{D_n}$= $\{b_1^n, b_2^n, b_3^n\}$, *n* = 1,2,…,*k* and the linguistic variables, $L_m, m = \{1,2,3\}$ using the similarity measure $S_{nm}(\widetilde{D_n}, L_m)$ using the equation 9 and the results of P($\widetilde{D_n}$,) and *P(*L_m*)* from the previous table, Table 3.5 and Table 3.6. Table 3.7 below shows the results of the similarities degree, $S_{nm}(\widetilde{D_n}, L_m)$ for all services domain.

Table 3.7 Similarities degree for all services domain

Similarities Degree, $S_{nm}(\widetilde{D_n}, L_m)$	**m**		
n	**1**	**2**	**3**
1	S_{11}	S_{12}	S_{13}
2	S_{21}	S_{22}	S_{23}
3	S_{31}	S_{32}	S_{33}
4	S_{41}	S_{42}	S_{43}
5	S_{51}	S_{52}	S_{53}
6	S_{61}	S_{62}	S_{63}
7	S_{71}	S_{72}	S_{73}
8	S_{81}	S_{82}	S_{83}

5. Identify the linguistic variables that are associated with the highest membership degrees obtained in Step 5. These linguistic variables will be respectively chosen to represent the overall group preference ratings towards the factors being evaluated.
6. Rank the services domain based on the ordering of the corresponding overall group preference ratings, followed by the associated degrees of similarities, in descending order.

4. Results and discussion

Measuring satisfactions level from a group of people have proposed varieties of method based on fuzzy set theory and the Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM) is used to calculate the satisfactions level of Universiti Teknologi Malaysia (UTM) students towards UTM bus services.

The data collected from the questionnaire were used to compute in Triangular Fuzzy Number-Based Conjoint Analysis Method (TFN-CAM) and obtained the similarity degree for each services dimension. The questionnaire was created using Google Form was distributed among the students. The results for gender, age, education level, and the frequency of using UTM bus were obtained directly from the Google Form. Table 4.1 below shows the summary of demographic of survey participation obtained from the questionnaire.

Table 4.1 The demographic of survey participation

Variable		Percentage (%)
Gender	Male	21.1
	Female	78.9
Age	18-21	2.6
	22-25	94.8
	26 and above	2.6
Education level	Undergraduate	97.4
	Postgraduate	2.6
Bus usage frequently	Daily	26.3
	Weekly	13.2
	Once a month	7.9
	Less often than once a month	52.6

From the questionnaire in Google Form, the number of respondents choosing the linguistic variables or the satisfaction levels for each service dimension also obtained from the Google Form directly. Table 4.2 below shows the number of responses (r_{nm}) for each services dimension, D_n, and linguistic variables, L_m respectively.

Table 4.2 Number of Responses on Services Dimension

	Number of Responses (r_{nm})			
Services Dimension D_n	**Linguistic Variables**, L_m			**Total Responses**
	L_1	L_2	L_3	
D_1	3	25	10	38
D_2	8	25	5	38
D_3	2	15	21	38
D_4	3	13	22	38
D_5	13	20	5	38
D_6	0	25	13	38
D_7	1	18	19	38
D_8	3	15	20	38

Using the information from Table 4.2 with the Triangle Fuzzy Number (TFN) of linguistic variable, the value of aggregated Triangular Fuzzy Number (TFN) for all the services domain were calculated. Table 4.3 below shows all the aggregated Triangular Fuzzy Number (TFN).

Table 4.3 Aggregated Triangular Fuzzy Number (TFN) for Service Dimension, $\widetilde{D_n}$

$\widetilde{D_n}$	Aggregated TFN
$\widetilde{D_1}$	(0.1053, 0.4737, 0.8211)
$\widetilde{D_2}$	(0.0526, 0.3684,0.7421)
$\widetilde{D_3}$	(0.2211, 0.6000,0.8895)
$\widetilde{D_4}$	(0.2316, 0.6000, 0.8842)
$\widetilde{D_5}$	(0.0526, 0.3158, 0.6895)
$\widetilde{D_6}$	(0.1368, 0.5368, 0.8684)
$\widetilde{D_7}$	(0.2000, 0.5895, 0.8895)
$\widetilde{D_8}$	(0.2105, 0.5789, 0.8737)

Next, the aggregated values of service dimension, $\widetilde{D_n}$ from Table 4.3 were used to calculate the similarities degree to identify the group preference for each service dimension. The summary results for each similarity were shown in Table 4.4 below. The highest similarity values of the linguistic variable determined as the satisfaction level of the service. For instance, $\widetilde{D}_2$ highest similarity degree is at L_2 at 0.9785 followed by L_1 at 0.7626 and L_3 at 0.7201 which conclude that service dimension D_2, the time taken for the bus to arrive at the students' location was considered at average satisfaction among the students. .

Table 4.4 Degree of Similarities between $\widetilde{D_n}$ and L_m

Aggregated Service Dimension, $\widetilde{D_n}$	**Similarity Degree,** $S_{nm}\ (\widetilde{D_n}, L_m)$			**Group Preference**
	L_1	L_2	L_3	Rating
$\widetilde{D_1}$	0.7125	**0.9344**	0.7713	Average
$\widetilde{D_2}$	0.7626	**0.9785**	0.7201	Average
$\widetilde{D_3}$	0.6586	0.8438	**0.8463**	Satisfies
$\widetilde{D_4}$	0.6582	0.8432	**0.8469**	Satisfies
$\widetilde{D_5}$	0.7889	**0.9383**	0.6981	Average
$\widetilde{D_6}$	0.6855	**0.8885**	0.8056	Average
$\widetilde{D_7}$	0.6632	**0.8514**	0.8388	Average
$\widetilde{D_8}$	0.6667	**0.8571**	0.8333	Average

Lastly, the results from Table 4.4 were arranged in descending order based on the service dimension highest linguistic variable similarity degree and has been summarized in Table 4.5. Table 4.5 shows that, the service dimension that has <0.8500 degree of similarity, have the level of satisfied among the students. It is also shows that the higher the degree of similarity, the higher the tendency for the service to considered average by the students.

Table 4.5 Final Rating of Linguistic and Ranking of Services.

Ranking of Services	**Service Dimension (**D_n**)**	**Level of Satisfaction Rating**	**Degree of Similarity**
1	Time to arrive at your location (D_2)	Average	0.9785
2	Easy to obtain bus information (D_5)	Average	0.9383
3	Accessibility (D_1)	Average	0.9344
4	Courtesy (D_6)	Average	0.8885
5	Cleanliness of the bus (D_8)	Average	0.8571
6	Safety (D_7)	Average	0.8514
7	Comfortability (D_4)	Satisfied	0.8469
8	Have suitable pick up and drop off (D_3)	Satisfied	0.8463

Conclusion

In this research, a fuzzy conjoint analysis approach based on triangular fuzzy numbers has been provided, in which triangular fuzzy numbers are combined with certain modifications into the existing discrete fuzzy based conjoint method. This enables for continuous representation of preference ratings. The approach was used to assess the satisfaction levels of a group of UTM students with regard to the university's bus services. The services that students were most satisfied with the comfortablity of the bus and appropriate pick-up and drop-off sites, whereas time arrival at the location, available bus information, accessibility, courtesy, bus cleanliness, and safety were services that most UTM students considered as average.

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