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The Estimation Of Weight of Factors Influencing Bus Transit Service Quality – Evidence from KDU Commuters

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Abstract— *Among the many reasons, lack of service quality provision of the public transport systems in Sri Lanka results in continuous shift of passengers from public transport to private vehicles. This research is based on estimating the weights of service quality expectation components perceived by the passengers. Factors identified as components of the service quality were walking time from home to the bus halt, waiting time at bus halt to get the bus, in vehicle travel time, in-bus environment and the station environment. Different factor levels for each of the factors were identified through the pilot interviews with passengers. 16 cards that consisted of the different levels of all five factors were developed using factorial design. The respondents were asked to rank the choices for all the 16 cards from a sample of 300 bus passengers including 150 males and 150 females who were the users of bus routes 100, 101, 154 and 158 in Colombo district. The passengers of General Sir John Kotelawala Defence University were used for this research Conjoint analysis was used to analyze the data in order to get the utility levels and weights of each attribute. Through the conjoint analysis utility levels of walking time, waiting time, travel time, in-bus environment and the station environment were generated. The model proved to have high accuracy and validity. In this research the variation of service quality attributes with the gender also were found. Majority of the passenger's preference was the walking time given the priority as their service quality expectation. Then travel time, waiting time, in-bus environment and the station environment were the priority order respectively. Male passengers also valued the walking time as the highest and then the travel time, in-bus environment, station environment and the walking time respectively. But the preference of females differed from that because their order of priority was walking time, waiting time, travel time, in-bus environment and the station environment respectively. service quality factors that males expect and female service quality expectation.*

Keywords—Service quality, Conjoint analysis, Walkingtime, Waiting time, Travel time, In-bus environment, Station environment.

I. INTRODUCTION

Bus service quality affects the traveler attitude towards public transportation and the travel mode chosen by them. Service quality is explained according to the views of the passengers. Public bus transportation is one of the most affordable and widely spread transport mode in many countries. Public bus service should provide a good accessibility that leads to safe, convenient, reliable and effective transportation system. In reality, if the quality of service is poor and unreliable, the public bus services may worsen the transport system. Existence of public transportation affects the quality of life. Users of public transportation services are satisfied when they get a service quality than the service quality they expect. An improvement of service quality can attract additional users. This research explores the customer satisfaction towards service quality of the bus transportation. To improve service quality of bus transportation, modelling the utility of passengers on service quality is vital. This research uses conjoint analysis to estimate the utility of bus passengers on service quality expectation.

II. LITERATURE REVIEW

The service quality on public transportation gets the attention of many researchers around the world. But most of them are from European countries. The level of passenger satisfaction

was evaluated in Malaysia (Ponrahono,2016). They determined the difference of satisfaction levels regarding public bus services and analyzed the factors influencing the satisfaction level of passengers. Face to face questionnaire survey method had been used to capture the demographic and travel characteristics of the passengers. The questionnaire consisted of two categories of questions regarding the purpose of the trip and the questions aiming to capture passenger preferences.

The influence of the public transport services on quality of life in Medan city was explored (Putra and Sitanggang, 2016). Primary data had been obtained through 400 questionnaires under a random basis. Descriptive analysis and simple linear regression were the statistical analysis techniques used in this research. This analysis was done under six dimensions. Results show that the public transport had a significant influence on quality of life in Medan city. As this research used regression techniques we can observe that it involved very lengthy and complicated procedures in the process of calculation and analysis. Use of multiple linear regression for qualitative dependent variable is subject to criticsm..

A conceptual model of service quality and its implications for future research were explored (Parasuraman, 1985) . It says that only a few academic researches had been done to define and model the quality due to the difficulties and delimitations in measuring the construct. Through this research it is able to identify ten dimensions regarding expectations and perceptions of services. It also shows four key gaps on service provider's side. Proposed service quality model was based on the interpretation of qualitative data collected through in-depth executive interviews and consumer focus groups.

Structural equation model is useful to transport planners in order to understand the correlation between service quality attributes Eboli and Mazulla. It helps to identify most significant factors to improve supplied services. 16 service quality attributes were rated by 763 university students in the scale of 1-10 and the sample was subjected to statistical descriptive analysis. Presently structural equation model is not widely used in the practical applications of transport due to the various limitations of this model. The sample survey of this research was not well representative as it was addressing a specific category of users.

SERVQUAL model consisting of five dimensions as reliability, assuarance, tangibility, empathy and responsiveness under 26 attributes to investigate customer satisfaction was used [4Objective of the study was to identify the socio-demographic factors of intercity bus passengers. Capturing only to the perceptions of intercity bus passengers is the weakness of this study. Eventhough, 180 questionnaires were used to to gather data some of them had not been properly answered by the respondents.

Conceptual model suggested by MORI is used as the analytical method to analyze important service elements and attributes for passenger satisfaction among dwellers in Colombo [5] (T Ojo and Suleman, 2014) his research reveals that 17 service elements out of 33 elements are significant to determine passenger satisfaction.

Importance satisfaction (IS) method highlights that the physical characteristics of a bus transit has a less influence on the user satisfaction (. Furthermore, passengers give priority to the safety, frequency and reliability of the service than the physical characteristics. Ordered logistic regression analysis determined the relative importance of the five category attributes towards satisfaction. In the IS method there is a possibility of overestimation of the attributes. Passenger satisfaction has become the measure to evaluate the service quality. Therefore, it is important to have more academic works that estimate the weights of service quality attributes towards passenger satisfaction.

The utility and the weightage of factors that contribute towards service quality in Nanjing was explored [6]. There are many factors that influence to fulfill passenger expectation regarding service quality such as walking time, waiting time, reliabilityConjoint analysis was their statistical technique to determine the combination of attributes on respondent's choice. Respondents were given profiles to assign scores according to their preference. It is difficult to predict the behavioural patterns as they differ from one person to another. Conjoint analysis provides an answer to this issue. By using conjoint analysis it is easier to calculate attribute interactions. Hence, it can be included without increasing the complexity of the research design.

III. METHODOLOGY

As there are several attributes that influence on service quality in public bus transportation, it is a complicated task to analyze all those attributes in one model. By referring to previous researches regarding service quality in public transportation, a list of attributes that are most influential on passenger satisfaction is prepared which include the walking time from the household to the bus station, waiting time that a person has to spend in the bus transit until a bus is arrived, travel time from the origin to the destination, in-bus environment and the station environment. In-bus environment was categorized as comfortable and uncomfortable according to the availability of enough space for the passengers, number of seats, temperature within the bus, politeness of the bus operators, cleanliness and so on. Station environment was categorized as pleasant or unpleasant by considering the factors such as shelter availability, seating facilities, necessary information and pleasant surroundings.

A pilot survey was conducted including 30 passengers that are randomly selected who are using 100, 101, 154 and 158 bus routes in order to identify the existing and expected levels of each attribute as walking time, waiting time, travel time, in-

bus environment and station environment. It was observed that there is a gap between expected and existing attribute levels. Route 100 (Panadura-Pettah) and 101 (Moratuwa-Pettah) was selected because those were the main roads going through Galle road. Route 154 (Kiribathgoda- Agulana) was selected as it is going through the main road. Route 158 (Moratuwa-Piliyandala) is a feeder service in Galle road.

With the pilot survey some levels for each attribute are identified as follows.

Table 1. Different factor levels selected through the pilot survey

Walking time (min)	Waiting time (min)	Travel time (min)	In bus environment	Station environment
5 ; 10; 20	5; 10	15; 30; 60	comfortable / uncomfortable	comfortable /uncomfortable

With the factors that are mentioned above (3x2x3x2x2) 72 profiles can be made. As it is impractical to ask the respondents to rate all these profiles, fractional factorial design is used which provides a suitable fraction of all possible factor levels.16 cards are produced through SPSS software that are well representative of total attributes of the sample. These cards were later included in the questionnaire form for the respondents to rate from 0 to 100 according to their preference. (0=not likely at all, 100=definitely would). A sample of 300 passengers (150 males and 150 females) including undergraduates, academic staff and ordinary workers in Kotelawala Defence University are considered because the sample should be well representative. Face to face interviews were conducted by explaining each question in the questionnaire as there are 16 cards for the respondents to rate, if we do not give a proper explanation, respondents may get confused about those cards. Demographic information including age, gender, monthly income, trip origin, trip destination and the purpose of the trip are also asked in the questionnaire.

The 16 cards that were generated through SPSS software is shown in figure 1.

	card 1	**card 2**	**card 3**	**card 4**
Walking time	20	**5**	20	**20**
Waiting time	10	**5**	5	**5**
Travel time	60	**15**	15	**30**
In bus environment	uncomfortable	uncomfortable	comfortable	uncomfortable
Station environment	pleasant	unpleasant	unpleasant	pleasant
	.....	.....	.....	.....
	card 5	**card 6**	**card 7**	**card 8**
Walking time	**5**	**5**	20	5
Waiting time	**10**	**10**	10	5
Travel time	**30**	**30**	15	60
In bus environment	comfortable	uncomfortable	comfortable	uncomfortable
Station environment	pleasant	unpleasant	unpleasant	unpleasant
	.....	.....	.....	.....
	card 9	**card 10**	**card 11**	**card 12**
Walking time	10	5	10	5
Waiting time	10	10	5	5
Travel time	15	15	30	15
In bus environment	uncomfortable	uncomfortable	comfortable	comfortable
Station environment	pleasant	unpleasant	unpleasant	pleasant
	.....	.....	.....	.....
	card 13	**card 14**	**card 15**	**card 16**
Walking time	5	5	10	10
Waiting time	5	10	10	5
Travel time	60	15	60	15
In bus environment	comfortable	comfortable	comfortable	uncomfortable
Station environment	pleasant	pleasant	unpleasant	pleasant
	.....	.....	.....	.....

Figure 1. Sixteen cards generated through SPSS

A. Conjoint analysis

Conjoint analysis is the statistical technique used in this research. It is an advanced market research technique to identify the attributes that people really value about a service. Conjoint analysis is a survey based statistical technique to determine the combination of attributes that has the highest impact on bus passenger service quality expectation. In the application of conjoint analysis, an assumption is made that it involves m attributes with the I th attribute at S_i levels. (I=1,2,3,..,m). Full factorial design models the utility of a profile. The utility levels of the attributes are modeled using the following equation.

$$U_n = U_o + \sum_{i=1}^{m} \sum_{j=1}^{k_i} a_{ij} U(x_{ij})$$

U_n = utility of a general service

a_{ij} = dummy variable (a_{ij}=1, when the i th attribute at a j th attribute is available in a service profile , if not a_{ij} =0)

u(x_{ij})= utility of the i th profile at the j th attribute.

u_0= constant

IV. DATA ANALYSIS AND FINDINGS

A. Passengers' viewpoint on service quality attributes

According to the objective of identifying the most influential factor towards service quality, viewpoint of 300 passengers that are using 100,101,154 and 158 bus routes in Colombo are analyzed with SPSS. Utility values of each attribute can be shown in the table 1.

Table 2. Utility levels of passengers

		Utility estimate	Standard error
Walking time	5 minutes	.267	.750
	10 minutes	3.317	.880
	20 minutes	-3.583	.880
Waiting time	5 minutes	-.475	.563
	10 minutes	.475	.563
Travel time	15 minutes	.400	.750
	30 minutes	-1.450	.880
	60 minutes	1.050	.880
In-bus environment	comfortable	.450	.563
	uncomfortable	-.450	.563
Station environment	comfortable	.100	.563
	uncomfortable	-.100	.563
(Constant)		8.333	.622

The Pearson's R and the Kendall's tau are taken as the measures of calculating the goodness of fit. They indicate the fitness between the model and obtained data. The value of these two parameters can be seen as 0.862 and 0.728 respectively. These values for the parameters are closer to 1.000 and the significances of these two parameters are 0.000 and 0.000. They are very small at a five percent level of significance. Therefore, we can conclude that this model has a high accuracy.

Table 1 shows the utility values and the standard errors of the attributes. Factor levels represent the preference of the interviewees as the standard error values in table 1 are lesser than the estimated utility values.

According to the above utility table, in case of walking time highest utility is for 10 minutes and the minimum utility level is for 20 minutes. When considering about the waiting time highest utility is for 10 minutes and lowest utility is for 5 minutes. For the travel time highest utility can be seen for 60 minutes. Comfortable in-bus environment and comfortable station environment are having the highest utility levels. When the utility level of a certain attribute is higher it shows that passengers have a higher preference towards that particular factor level. Accordingly, passengers are having a higher preference for a walking time of 10 minutes, waiting time of 10 minutes, traveling time of 60 minutes with a comfortable in-bus environment and a pleasant station environment. Passengers value walking time a lot when comparing with the other factors.

The range of the utility values acts as a measure to depict how important the factor is to overall preference. Factors with greater utility ranges are much significant than the factors with low utility ranges. Accordingly, the relative importance of the factors can be calculated as;

$$V_{ij}=\frac{maxU_{ij}-minU_{ij}}{\sum_j (maxU_{ij}-minU_{ij})}$$

V_{ij} is the relative importance of the j^{th} factor for i^{th} respondent and U_{ij} is the utility value of j^{th} factor for i^{th} respondent. Then the relative importance of each factor for the entire respondents can be calculated as;

$$V_j=\frac{\sum_i V_{ij}}{\sum_i \sum_j V_{ij}}$$

Accordingly, the weights of all the factors are shown in table below.

Table 3. Averaged importance scores or the weights of attributes

Walking time	60.262
Waiting time	8.297
Travel time	21.834
In bus environment	7.860
Station environment	1.747

The most important attribute for the passenger satisfaction is the walking time. Next important attribute for passenger satisfaction is the travel time from the origin to the destination. People consider the walking time more than the travel time taken to reach their expected destination by the bus. The third attribute that is influencing the passenger satisfaction is the waiting time of them at the bus stop/station. According to the averaged importance scores we can see that people consider the condition of the in-bus environment more than the station environment. Least score is given to the station environment. Through that we can analyze that passengers consider about the factors such as available space, seating facilities, temperature, politeness of the bus operators and cleanliness inside the bus more than the shelter availability, seating facilities, necessary information and pleasant surroundings in station environment.

B. Viewpoint of male passengers on service quality attributes

Data collected from 150 male passengers was analyzed with SPSS and the utility table is as follows.

Table 4. Utility values of the male passengers

		Utility Estimate	Standard Error
Walking time	5 minutes	-.031	.476
	10 minutes	1.755	.559
	20 minutes	-1.724	.559
Waiting time	5 minutes	-.109	.357
	10minutes	.109	.357
Travel time	15 minutes	.385	.476
	30 minutes	-.708	.559
	60 minutes	.323	.559
In bus environment	comfortable	.537	.357
	uncomfortable	-.537	.357
Station environment	comfortable	.280	.357
	Uncomfortable	-.280	.357
(constant)		8.411	.395

Pearson's R and Kendall's tau are 0.821 and 0.700 respectively and we can observe that those values are closer to 1.000. The significance of these two parameters are 0.000 and 0.000. Therefore, the significances are less than 0.05. Through this we can conclude that this model is with a high accuracy.

According to the table 3, highest utility is for 10 minutes and the lowest is for 20 minutes. For the waiting time highest utility is for 10 minutes and the lowest is for 5 minutes. Travel time has got the highest utility when it is 15 minutes and next is for 60 minutes and the minimum is for 30 minutes. In the utility table comfortable in-bus environment has got higher utility value than the comfortable station environment.

The factor weights for the preference of the male passengers is given in below table 4.

Table 5. Averaged importance scores or the weights of attributes for male passengers

Walking time	54.144
Waiting time	3.400
Travel time	17.018
In-bus environment	16.708
Station environment	8.730

The weight of walking time is 54.144 and that is greater than the other factor weights. Therefore, male passengers value walking time the most. The weights of the travel time and the in-bus environment are nearly the same (17.018 and 16.708 respectively). The weights of waiting time and the station environment are quiet small.

C. Viewpoint of the female passengers on service quality attributes

The data collected from 150 female passengers are analyzed in order to get the utility levels as follows.

Table 6. Utility levels of the female passengers

		Utility estimate	Standard error
Walking time	5 minutes	-1.98	.517
	10 minutes	1.327	.607
	20 minutes	-1.129	.607
Waiting time	5 minutes	-.300	.388
	10 minutes	.300	.388
Travel time	15 minutes	.261	.517
	30 minutes	-.289	.607
	60 minutes	.028	.607
In-bus environment	comfortable	.213	.388
	uncomfortable	-.213	.388
Station environment	comfortable	.167	.388
	Uncomfortable	-.167	.388
(constant)		8.484	.429

The values for Pearson's R and the Kendall's tau are 0.672 and 0.500. They are closer to 1.000 and the level of significances are 0.002 and 0.003 which are lesser than 0.05. Therefore, we can conclude that this model has a high accuracy.

The highest utility levels of the female bus passengers are for 10 minutes walking time, 10 minutes of waiting time, 15 minutes of travel time, comfortable in-bus environment and comfortable station environment.

The weights of each factor towards the satisfaction of the female passengers are given in the below table 6.

Table 7. Averaged importance scores or the weights of attributes for female passengers

Walking time	56.245
Waiting time	13.732
Travel time	12.592
In-bus environment	9.780
Station environment	7.651

Female passengers value walking time the most because the weight of the walking time is higher than the other factors. Passengers have given nearly equal weights for the waiting time and the travel time (13.732 and 12.592 respectively). In-bus environment and the station environment have got the least weights. Female passengers have given a priority to the in-bus environment than the station environment.

D. Contrastive analysis of bus passenger service quality expectation between male and female passengers

In order to understand whether the utilities and weights of factors that are affecting the service quality expectation vary with the gender of the person, the factor weights are male and female passengers were compared.

The comparison of the factor weights is shown in the following table 7.

Table 8. Comparison of the weights

	Male passengers	Female passengers	All passengers
Walking time	54.144	56.245	60.262
Waiting time	3.400	13.732	8.297
Travel time	17.018	12.592	21.834
In-bus environment	16.708	9.780	7.860
Station environment	8.730	7.651	1.747

The factor weight of the walking time is the highest no matter for the male passengers or female passengers. Male passengers give priority to travel time of the bus more than the female passengers. Female passengers value the waiting time at the bus station more than the travel time. For males they value travel time of the journey at the second place but female value the waiting time at the second place. Males prefer a bus facility that reduces their travel time more than a bus that is having a less waiting time. When considering about the females most important factor for them is the waiting time more than travel time. According to the factor weights male passengers prefer buses with good internal environment This paper is regarding the estimation of factors of bus transit's service quality analysis in Colombo. The main objective is to estimate the weightage of utility of service quality expectation of bus passenger transport. Due to the difficulty in analyzing the behavioral processes, this paper models traveler service quality expectation through conjoint analysis method station. This paper investigates the viewpoint of male passengers and female passengers separately in order to identify whether the utility and weightage of service quality attributes differ with the gender.
Male passengers value the walking time, travel time, in-bus environment, station environment and waiting time respectively while female passengers value walking time, waiting time, travel time, in-bus environment and the station environment in sequence. Passenger as a whole gives priority for the walking time from their households to the bus Station. In-bus environment gets the least priority from both male and female passengers. Female passengers value waiting time a lot while male passengers give least importance to it. Male passengers give nearly same values to the travel time and in-bus environment.

than the facilities and conditions of the station environment. They pay less attention to the facilities such as seats, shelters that are provided in a bus station. Males value the in-bus environment even more than waiting time at the bus station. But the female passengers value in-bus environment to a lesser extent when comparing with waiting time. When taking the utilities and weights relating with the station environment they are very small values, but male passengers value the waiting time even less than the condition of the bus station environment. Males give a priority to the station environment than females.

V. CONCLUSION

Accordingly, administrative bodies should pay much attention towards reducing the walking time of the passengers. There are various bi roads connecting to the main Galle road and people use various alternative modes to reach bus stations at the main road. If the regulatory bodies increase the number of bus stations according to the household density it will improve the demand for public transportation. As future extensions of this study, sample size can be increased more than 300 and the comparison can be expanded along different categories such as income levels, trip purpose, age and traveling costs. In this study the scores are entered to SPSS at the beginning and then calculated the ratings manually in SPSS. When there are similar scores they were rated according to the preference of the interviewer. In the future a mechanism can be proposed to avoid this limitation. Online surveys can be used to gather data which are more efficient and cost effective than face to face interviews. Furthermore, this study can be done for the long distant routes to analyze whether the passenger perceptions change with the distance of a journey.

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