Identifying Important Features of Paratransit Modes in Sylhet City, Bangladesh: A Case Study Based on Travelers Perception

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Abstract

Paratransit modes are familiar modes of transportation in Sylhet city and across Bangladesh. Field investigation marked the existence of motorized, non-motorized and battery driven paratransit modes across city. Though non-motorized vehicles such as rickshaws and easy bike were found in every survey location but people preferred motorized transportation. Young age range people mostly used this media as transportation. Students and service holders were most predominant type of users found from the survey. User satisfaction was used for measuring important characteristics of paratransit modes and the results indicated that about 70% people fall somewhere between satisfied to somewhat satisfied. A Multinomial and an Ordered Logit model were utilized to analyze passenger satisfaction and both of them agreed that female passengers were dissatisfied regarding present paratransit systems. Fitness and cleanliness were considered as influential features of the existing modes. Lack of flexible movement of paratransit modes especially motorized ones around city roads was the main driving force of making the mode unreliable to users. People showed positive attitude towards overall service, safety and security of paratransit vehicles operating in Sylhet city. The fare structure made this transport system popular, but operational shortcomings such as congestion make the prospect of existing modes questionable.

Keywords: Paratransit; Motorized; Satisfaction; Flexibility; Congestion.

1. Introduction

Effective transportation is essential for people living in the quickly developing urban world. The demand of travelling has increased significantly in developing countries and now far exceeds for available transport modes [1]. Therefore, local public transportation in developing countries fail to meet the demand of public mobility [2]. Poor service quality, meagre output, abysmal maintenance strategy, and overloading were observed as driving factors for public transport failing to meet the demand of public mobility [3-5]. As a result, people were embracing different paratransit modes (motorized and non-motorized) which provide more time efficient travel to reach the desired destination [6].

Paratransit is a mode of transport service which is affordable and can provide travelers a feeling of using personalized vehicles [7]. Paratransit provides significant advantages to both drivers and users on the basis of accessibility, flexibility of movement, easy and unimpeded lane movement, low operating and maintenance cost [2, 8]. In many developed nations, paratransit modes are used to serve people with disabilities [9-10]. The usage of this particular transport systems are two fold for developed and developing countries. In developed countries, paratransit is used as a demand response system, while in developing countries, (lower living standard, densely populated and availability of labor) it is used for

bridging the gap between public and private service for fulfilling the need of the people for transportation [11]. Paratransit modes are predominately used as urban transport in a country like India, Nigeria and Indonesia [12-14].

Bangladesh is a densely populated country and Sylhet is no exception [15]. The decadal population growth rate grew in Sylhet from 4.5 to 25 percent from 1951 to 2011 [16]. The road users or travelers in Bangladesh are predominantly dependent on paratransit modes for movements such as in the form of tempo, auto rickshaw etc. [11, 17]. Sylhet, which is a greater division of Bangladesh, is also considered a paratransit dominant arena with availability of many diverse types of transit [18]. The predominant use of paratransit modes throughout Bangladesh reflects the trust and alacrity of people. Paratransit, the most informal form of transport service, varies from rickshaw (human driven) to small mini bus of 25 seats [14, 19-20]. Moreover, most of school trips around the Sylhet city were provided by small occupancy paratransit modes such as auto, rickshaw and CNG (four stroke motorized transport) [21]. In addition, the battery driven auto rickshaw called 'Tomtom'/ 'Easy Bike' was still present in some roadways even after the ban in 2015 due to its risky and accident prone trademark [22]. Improper burgeon of population resulted in unexpected imbalance between traffic demand and supply, thus congestion was formed by non-motorized paratransit modes [23]. Government has taken the initiative to launch more four stroke three wheelers in Sylhet to minimize the sufferings of passenger's wallets (due to being charging higher by the drivers) despite knowing the pressing issue of traffic jam in the roadways [24]. It can be assumed that paratransit modes are providing tremendous advantages to the people in one hand and on the other creating problematic concerns such as accidents and traffic jams. These negative impacts of paratransit mode raise substantial concerns about these modes of transport.

The objective of this research is to measure satisfactory and influential characteristics of existing paratransit modes operating in Sylhet City. In addition, to explore present condition of paratransit modes available in the city as well as highlight the need of users using existing paratransit modes.

2. Problem Statement

The significant increase in urbanization and industrialization is triggering the growth of city population as more people move towards city areas. Thus, the increasing demand of vehicles results in more paratransit modes marking their way to the roadways of Sylhet. However, the increase of vehicles on the roadway not only creates traffic jams but also increases travel and delay periods. Currently the government is focusing on launching small motorized transport to meet the travel demand of people living in Sylhet. With this issue in mind, understanding the opinions of travelers with respect to the different existing paratransit modes can produce valuable information which might help authorities to launch modes of paratransit with the satisfactory characteristics for smoother transportation in the future. Moreover, existing service evaluation of paratransit modes through people's perception can answer the question of whether people need more transportation like this or not. If more transportation like paratransit modes are required to satisfy travelers, then deficient areas of this particular mode might also be evaluated to improve the mobility and satisfaction of users.

3. Literature Review

Different research has pointed out the dominant usage of paratransit modes in developing countries. Booming population, deficient traffic infrastructure and low per capita income not only made this cheap and convenient mode popular in developing countries but also contributed significantly to meet the demand of public transport as well [11]. In countries such as Philippines, Indonesia, Malaysia and Thailand, motorized paratransit modes were capable of meeting the demand (20-50%) of public transportation due to their flexibility, frequent service and low cost [25]. Paratransit is considered as one of the efficient and effective mode of transport because a small number of these particular modes such as 18% of the total transport are capable of transporting large amount (above 50%) of travelers in the roadway [26]. Paratransit modes such as the van, jitney, shuttle, microbus, and minibus in Indonesia became a vital option for citizens and continually supported the existing public transport by providing feeder connections [27]. Paratransit modes such as 'motodop' and 'remork' (motorized) in Phnom Penh, Cambodia were considered as public transport for citizens due to the absence of proper mass transit system [26].

In the early stages, research regarding any transit facility was usually restricted to focusing on the technical characteristics of that particular facility [28]. But in the later stages, transit service quality and operating performance were taken into account in relation to passenger satisfaction levels [29-30]. The quality of service concept was primarily used for public transport to evaluate different attributes such as operating speed, reliability, safety, aesthetics, cleanliness, behavior and fare [31-33]. In recent times, user satisfaction and perception has been an essential tool for performance measurement linked to service quality and its attributes [34-35]. Thus, quality, safety, security, travel time, fare, reliability, responsiveness, waiting time, comfort etc. were considered in measuring the satisfaction of users of bus service [36-37]. Moreover, Logistic regression models such as Ordinal, Binomial and Multinomial were improvised to measure the driving factors related to traveler's satisfaction of a particular service [17, 38-39].

Within the context of paratransit modes, satisfaction level is a crucial component in the selection of a particular mode of paratransit. People's perception of tricycle quality in Nigeria suggested that no particular differences were held

between affordability, regularity, comfort and safety of the paratransit mode [14]. In addition, a large number of respondents emphasized that poor road network system affected the operation of the respective mode [14]. Ordinal, Probit and Binary Logit were implemented to analyzed 54 factors associated with paratransit modes in Indonesia for measuring user satisfaction and future choice [40]. The study highlighted the association of financial factors in choosing a particular mode of paratransit [40]. Although, most travelers were dissatisfied regarding the quality provided by the paratransit systems, research indicated the potential of paratransit modes being used as a successful feeder mode [41].

Perception of privately owned paratransit mode users in Indonesia in terms of modes condition and loyalty indicated the popularity of these modes for present as well as future terms [41]. A study on paratransit mode of Dhaka City, Bangladesh revealed that availability, speed, integration with supporting modes, travel time, cleanliness and ticketing systems were important features of paratransit service quality [17]. Moreover, many researches focused on identifying the service level provided by different paratransit modes in terms of satisfaction level of users [42]. The research in terms of measuring important factors affecting fare structure of paratransit modes in Phnom Penh, Cambodia resulted in sorting out the two factors such as trip attributes and drivers working condition that significantly influenced the fare level [26].

Performance measure is an identical tool to identify people's perception towards a particular mode of transport and conservation of higher satisfaction level among travelers may drive them to tolerate some sort of negative outcome of the respective service as well [43]. Different influential factors of a transport system such as efficiency, reliability, responsiveness of service provider and socio-economic aspects of travelers greatly convince the passengers at some level of degree thus people are greatly influenced towards them [43]. The mode such as paratransit not only accepted among people for its diverse advantageous role such as physical characteristics but also for fluent operational activities as well [11].

In summary, paratransit modes are considered as a vital transportation medium for people living in developing countries because the small amount and size of this transport can carry large number of population. Satisfaction of travelers is the key issue for assessing the performance of a particular transport system in a region. For paratransit modes, statistical analysis of different service quality attributes in terms of traveler's satisfaction might be a suitable pathway to measure overall performance.

4. Methodology

The primary focus of the research is to explore the important factors regarding paratransit modes in Sylhet city. The study involves an overview of study area (spots of survey location along with an idea about paratransit modes), design of questionnaire, data collection and statistical analysis of collected data.

4.1. Study Area

Sylhet city is situated at the northeastern part of Bangladesh and Sylhet City Corporation is located at 28.850 N and 98.80 E with an area of 26.50 sq. kilometers [15]. Population growth is also high enough (2.1%) in comparison with other cities of Bangladesh [15]. Rickshaw (human driven), easy bike, van, auto rickshaw (CNG) and tempo (motorized) are the major source of transportation around the city corporation. A report of Bangladesh Bureau of Statistics (BBS) figured out registered and un registered paratransit modes operating in the roadway of Sylhet City Corporation at the year of 2011 (See Table 1) [16]. Non- motorized vehicles such as rickshaw (human driven), easy bike (battery driven) and vans were dominant paratransit types operating in Sylhet city. Along with registered vehicles, significant amount of un-registered vehicles also came into the ground of discussion as well. In fact, for motorized paratransit mode such as auto-rickshaw/ tempo, un-registered vehicles were more in amount than registered vehicles operating in the roadway of Sylhet city. The statistics presented here provides an idea of legal/illegal existence of paratransit operations in Sylhet city. Vans are particularly used in the Sylhet city for transporting goods from one place to another. In addition, motorized vehicles such as Laguna and tempo were also available around the Sylhet city. Human driven rickshaws were present everywhere around the road network of Sylhet City Corporation.

Table 1. Number of registered and un-registered paratransit modes in Sylhet city

`	Number of registered vehicles	Number of un-registered vehicles
Rickshaw	24431	752
Van	500	67
Easy Bikes	1250	219
Auto rickshaw (CNG) and Tempo	49	61

High density locations as well as important places such as existence of schools, colleges, shopping center, local markets and offices were taken into account for selecting the spots for survey. Moreover, some stations or stands (starting or ending point) for vehicles such as tempo, Laguna and auto rickshaw were also selected for the survey locations. About

22 locations were selected around the Sylhet City Corporation considering availability of all the paratransit modes. The selected places (black square spots) for the surveys are presented in the Figure 1. The physical and operational characteristics of available paratransit modes based on field investigation are presented in Table 2. Some glimpse of different paratransit modes is provided in Figure 2.
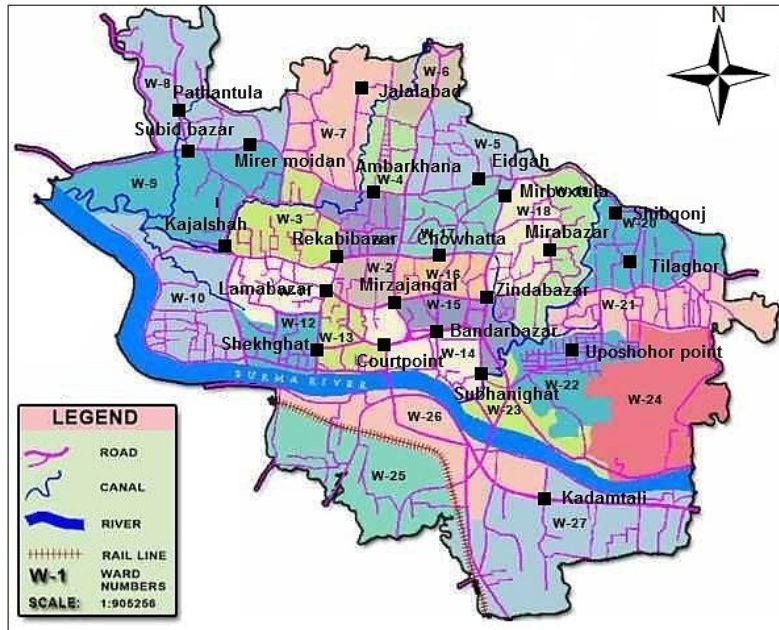

Figure 1. Spots representing survey location around Sylhet City Corporation

Figure 2. Glimpse of paratransit modes in Sylhet city

Table 2. Physical and operational characteristics of paratransit modes

Mode	Number of wheels	Number of seats	Mode of operation	Coverage
Rickshaw	3	2	Human driven	All the roadways
Easy Bike	3	6	Battery driven	All the roadways
CNG (reserved)	3	5	Motorized	All the roadways
CNG (Shared)	3	5	Motorized	Select routes
Tempo	3	12	Motorized	Select routes
Laguna	4	12	Motorized	Select routes

4.2. Questionnaire Design and Survey

The questionnaire was based on extensive literature review and field investigation. A lengthy and extended form of questionnaire was avoided in order to make it as simple as possible. The structure of the questionnaire contained 9 valuable sections. The first section addressed the demographic information of travelers and the other 8 sections were as follows: quality, reliability, safety and security, service, fare, impact on roadway condition, environmental impacts and satisfaction levels. Demographic information of each traveler consisted of sex, age, profession, trip purpose and the most frequently used mode of paratransit. Each sections (quality, reliability, safety, service and fare) contained 2 questions with first one gave the existing condition of each of the attributes (in a Likert scale format) and the second question focused on influential factors related to that particular attribute. Impact of paratransit on roadway conditions and

environment section occupied only one question whereas each presenting the opinion of travelers towards it. Finally, the overall satisfaction level was identified by answering satisfied, somewhat satisfied and not satisfied with present paratransit systems. The variables taken into consideration for building questionaries' survey are presented in Table 3. The undergraduate research students of Civil Engineering Department of Leading University conducted the survey at selected spots. At the respected locations, travelers were asked about the selected questions and their opinions were documented. In some cases, the rush of travelers, particularly during the evening periods and the arrival of paratransit modes, restricted the surveyors of taking full responses during that stage. Total of 973 responses from users of paratransit modes around Sylhet City Corporation were considered for further analysis.

Table 3. Variables considered in the Questionnaire

Sections	Variables
Demographic information	Sex (Male or Female)
	Age range (15-30, 30-40, 40-50, above 50)
	Profession (Student, service holder, housewife, businessman and others)
	Trip purpose (Academic, workplace/business, recreation and others)
	Frequent Mode (rickshaw, electric rickshaw, Shared CNG, hired CNG, Laguna/ tempo)
Quality	Very poor, Poor, satisfactory, Good and excellent
Factors affecting quality	Seat comfort level, fitness of vehicle, Cleanliness of vehicle and sitting arrangement
Reliability	Very reliable, reliable, somewhat reliable and not reliable
Factors affecting reliability	Moving flexibility around all city roads, Travel time, higher waiting time, co-ordination with supporting modes
Safety and Security	Very poor, Poor, satisfactory, Good and excellent
Factors affecting safety & security	Lighting facility, security of goods, unsafe speed and inexperienced driving standard
Service	Very poor, Poor, satisfactory, Good and excellent
Factors affecting service	Boarding style, cooperation of crews with passenger, Ticketing system and choice of routes
Fare	High, average and low
Factors affecting fare	No metering system, unexpected increase in fare in adverse environmental conditions and unexpected increase during different types of festivals
Environmental impact	Noise pollution, air pollution and no impact
Operational impact	Congestion, accident and road deterioration
Satisfaction	Satisfied, somewhat satisfied and not satisfied

4.3. Statistical Approach

Several statistical analysis techniques are available for analyzing the satisfaction level of the paratransit mode users. For this research, it is important to relate the satisfaction level with the available attributes of paratransit system of Sylhet city to identify the most important ones. Satisfaction attributes along with dissatisfactory ones can be identified through statistical analysis which may help to improve the present paratransit system. Identifying important factors associated with satisfaction and dissatisfaction level of travelers will be a key issue for implementing statistical approach. Logistic regression can be used as a tool to implement in this research because it is suitable in analyzing the satisfaction level of users not only for paratransit modes but also for other modes such as buses [14, 17, 40]. Here, the Multinomial Logistic Regression (MLR) was used to identify the important features of the paratransit modes. Regression analysis is a statistical approach to identify relation between variables and MLR is used when dependent variables are more than two in quantity [44-45]. In this research, the dependent variables were separated into three categories (satisfied, somewhat satisfied and not satisfied) and thus it is perfectly matches with the selected approach taken into consideration for analysis. The research took the not satisfied as the baseline for operating this particular model. Based on the research conception [46], the multinomial logit model for a non-reference category with respect to reference category is:

$$Log\left[\frac{\prod i \ (j = non\ reference)}{\prod i \ (j = reference)}\right] = \beta_{0j} + \beta_{1j}x_{1i} + \ldots\ldots\ldots\beta_{kj}\ x_{ki} \tag{1}$$

Now for this research, the MLR models are presented in Equation 2 and 3 respectively.

$$Log\left[\frac{\prod i \ (j = 0)}{\prod i \ (j = 2)}\right] = \beta_{00} + \beta_{10}x_{1i} + \ldots\ldots\ldots\beta_{k0}\ x_{ki} \tag{2}$$

$$Log\left[\frac{\prod i \ (j = 1)}{\prod i \ (j = 2)}\right] = \beta_{01} + \beta_{11}x_{1i} + \ldots\ldots\ldots\beta_{k1}\ x_{ki} \tag{3}$$

If Y is a response variable with having 3 categories (j= 0,1,2) and multinomial distribution than probability parameter's expressed as $\pi_{i(j=0)}$, $\pi_{i(j=1)}$ and $\pi_{i(j=2)}$ for satisfied, somewhat satisfied and dissatisfied (level of satisfaction) respectively. Here, the number of set of observation = i= 1….n = 687. β_{00} and β_{01} represented the intercepts for two model and x_1, x_2, …x_k are explanatory variables. β_{1j} …. B_{kj} represent the co-efficient of each of the explanatory variables for each category (j). The data was limited to 687 due to unavailability of information among each section of designated variables.

The second approach was taken here as implementation of Multilevel Ordered Logistic Regression (OLR) which was considered as the extension of MLR [46]. OLR is a type of regression which considered more than two ordinal dependent variables [47]. The use of OLR is justified because the satisfaction level of users (dependent variables) varied from satisfactory to not satisfactory (1= satisfied, 2= somewhat satisfied and 3= not satisfied). If the response variables are considered as Yi (i= 1, 2 and 3) with C ordered (C =3) categories then the probabilities are

$$P\ (Y = i) = \pi_i;\ (i=1,2\ \text{and}\ 3) \tag{4}$$

Now the cumulative probabilities with order C-1 is:

$$\mu_{(i)} = P\ (Y \le i) = \pi_1 + ….+ \pi_i;\ \ i = 1…C\text{-}1 \tag{5}$$

The following holds for $\mu_i = P\ (Y_j \le i)$ for each unit j (number of observation= 1…..n) and each category i (i = 1…C-1)

$$Log\ \left[\frac{\mu_i}{1 - \mu_i}\right] =\ Log\ \left[\frac{P(y_j \le i)}{P(\ y_j > i)}\right] =\ \beta_0 - \beta_{1j}x_1 + …….. \beta_j\ x_j \tag{6}$$

The model for the cumulative probabilities is

$$\mu_i = P\ (y \le i\ ) = \left[\frac{e^{\beta_0 + \beta_1 x_1 + \cdots \beta_j x_j}}{1 + e^{\beta_0 + \beta_1 x_1 + \cdots \beta_j x_j}}\right] \tag{7}$$

In this case, β_0 representing the intercept and β_1, β_2 … β_j presenting the co-efficient of j (j=1…n). β_1, β_2 … β_j are same for each value of i.

The probabilities of individual categories of satisfaction can be represented through Equation 8.

$$P\ (y = i\ ) = \left[\frac{e^{\beta_i - (\beta_1 x_1 + \cdots \beta_j x_j)}}{1 + e^{\beta_i - (\beta_1 x_1 + \cdots \beta_j x_j)}}\right] - \left[\frac{e^{\beta_{(i-1)} - (\beta_1 x_1 + \cdots \beta_j x_j)}}{1 + e^{\beta_{(i-1)} - (\beta_1 x_1 + \cdots \beta_j x_j)}}\right] \tag{8}$$

In OLR, variables are considered to have same slope across all level of dependent variables [48]. Stepwise Logistic regression for both types (MLR and OLR) was utilized to figure out the most influential factors of paratransit modes in Sylhet City. In the first model of each, all the required factors were taken into consideration. Variables which had a p-value <0.25 were selected for fitting into the next model [49]. More precisely, if any of the variables in a single category of independent variables came out with p value less than 0.25 in first step of analysis this enabled the entire category for further analysis. Consequently, if all the variables of a selected category consisted of p value greater than 0.25 in any of the analyzed steps would result in removal of the entire category for further stepwise analysis. The final models will be presented with variable categories where at least one independent variable was proved as significant (p value less 0.5) [50].

5. Results and Discussions

Field investigation of each of the spots of survey location and availability of different paratransit modes are presented in Table 4. Human driven rickshaw and easy bike were the most common vehicles found in all survey spots. Moreover, these vehicles were found traveling on almost every type of roadway from small local roads to large city roads of Sylhet City. Auto rickshaw or CNG was also common, but found absent in some of the observed locations. Among the two form of auto rickshaw (hired and shared), shared auto-rickshaw had specific locations for stopping or starting and a specific ending point (station). They also covered some routes of their choice. Hired auto-rickshaw (CNG) also had some stations across the city area but travelers can hire them from any place while they are vacant. Laguna and Tempo also focused on their own routes while having a certain station for their starting, ending, or stops. According to the field study, they (Laguna and Tempo) were not available in all the routes of the city. The field study sites were selected in a way that could cover each of paratransit modes passengers considering stations/stand of particular modes as well.

Demographic chapter of the questionnaire describes briefly about the passengers using the paratransit system of Sylhet City. Almost an equal number males and females of the studied population used paratransit modes in the Sylhet city (Figure 3a). As the age increased, people were less dependent on the paratransit mode of transport as presented in the Figure 3b. The youngest age range people used the paratransit modes significantly (32%) while the users dropped

continually as the age range increased. More than half of the passengers in total were student and service holder (both public and private) while 15 percent were businessman and 20 percent were housewives (Figure 3c). Working or business comprised 38%, recreational 27% and academic 24% of paratransit usage (Figure 4a). In terms of overall satisfaction level, 28.4% passengers were satisfied, 43.9% were somewhat or not properly satisfied and 27.7 % were dissatisfied with the paratransit systems available in Sylhet city (Figure 4b).

Table 4. Field investigation results

Serial no	Location	Paratransit Modes				
		Rickshaw	Easy Bike	Hired CNG	Share CNG	Laguna/Tempu
01	Ambarkhana	Yes	Yes	Yes	Yes	Yes
02	Jalalabad	Yes	Yes	Yes	No	No
03	Subidbazar	Yes	Yes	Yes	Yes	No
04	Mirer Moidan	Yes	Yes	Yes	Yes	No
05	Pathatula	Yes	Yes	Yes	Yes	No
06	Sekhghat	Yes	Yes	Yes	Yes	No
07	Kajalshah	Yes	Yes	Yes	Yes	No
08	Rekabi Bazar	Yes	Yes	Yes	Yes	No
09	Mirja Jangal	Yes	Yes	Yes	Yes	No
10	Lamabazar	Yes	Yes	Yes	Yes	No
11	Chawhatta	Yes	Yes	Yes	No	No
12	Naya Sarak	Yes	Yes	Yes	No	No
13	Zindabazar	Yes	Yes	Yes	No	No
14	Coart Point	Yes	Yes	Yes	Yes	Yes
15	Bandar Bazar	Yes	Yes	Yes	Yes	Yes
16	Eidghah	Yes	Yes	Yes	Yes	Yes
17	Mira Bazar	Yes	Yes	Yes	Yes	Yes
18	Shibgonj	Yes	Yes	Yes	Yes	Yes
19	Uposhohor	Yes	Yes	Yes	Yes	Yes
20	Tilagor	Yes	Yes	Yes	Yes	Yes
21	Subanighat	Yes	Yes	Yes	Yes	Yes
22	Kadamtali	Yes	Yes	Yes	Yes	Yes

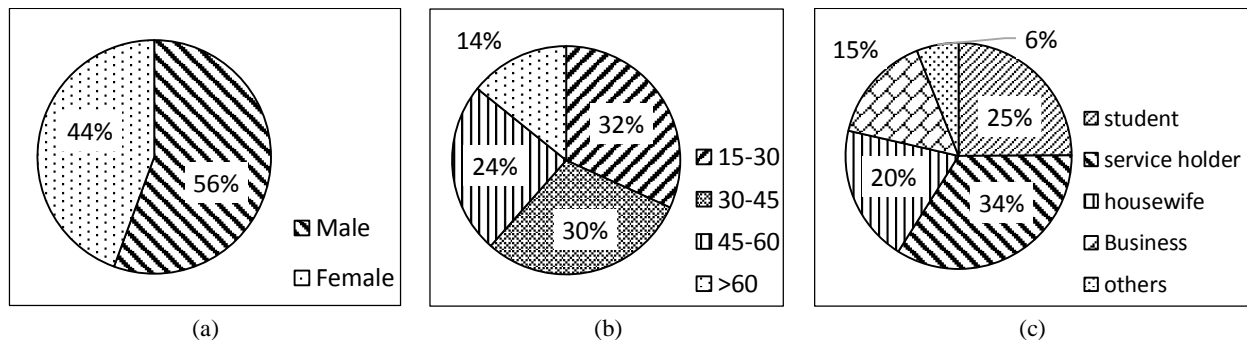(a)   (b)   (c)

Figure 3. Proportion of passengers regarding (a) sex, (b) age range and (c) profession (from left)

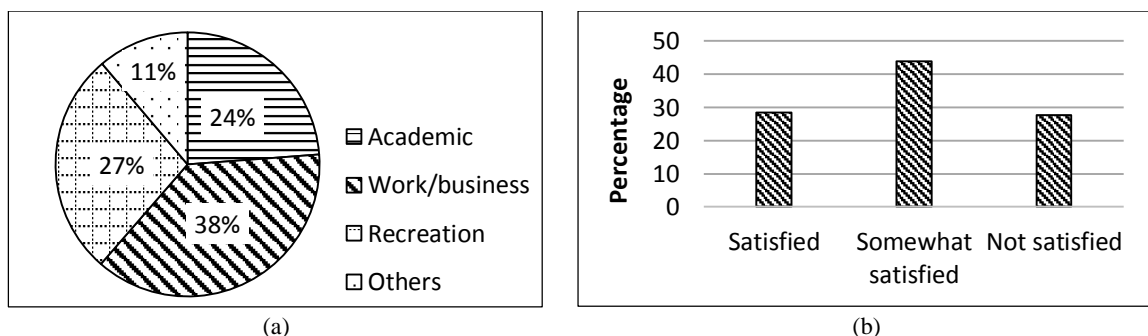(a)   (b)

Figure 4. (a) Proportion of trip purpose and (b) distribution of passenger's satisfaction level (from left)

Modal split of paratransit modes is essential to find out the most popular vehicle among all of the available paratransit modes (Figure 5). Among rickshaws, people preferred the electric rickshaws (Easy Bike) rather than human driven rickshaws. Motorized vehicle found greater preference among all paratransit modes than slow moving non-motorized vehicles. More than half of the respondents preferred Shared CNG and Laguna/ tempo for their preferred transportation mode simply because of their fast movement along the roadway and economic cost. CNG showed most popular form of transport but Laguna/ Tempo was also not far behind of it in terms of popularity. The Government's plan to launch more motorized paratransit mode is justifiable and suitable for city population. But, in the context of paratransit modes existence, non-motorized modes were identified more significant in amount than motorized one in Sylhet city (Table 1 presented the view). In that case, reduction or replacement of unregistered non-motorized paratransit modes with motorized ones may not be only fulfilling the requirements but also may improve mobility across the city roadways as well.
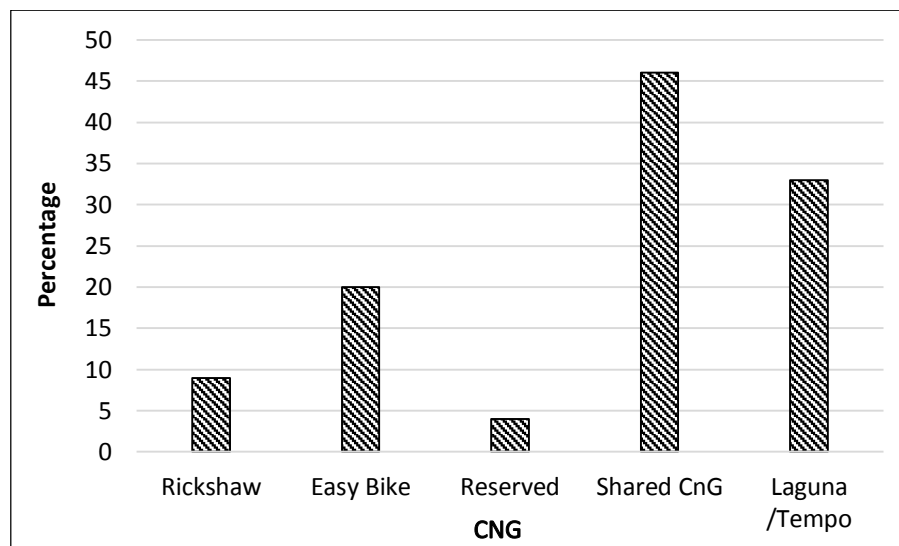

Figure 5. Modal Split of different preferred paratransit modes

Table 5 represents the percentage distribution of passenger responses towards different attributes excluding the aforementioned ones. More than 50% of the respondent question against the present quality of paratransit system (27.41% very poor and 38.83 % poor) while more than 50% stated the range of reliability from somewhat to not reliable. Safety and security were well balanced as dominate in responses (more than 50%) and fell in the category of good to excellent. Fitness (44.33%), flexibility of moving towards all possible roadways around the city road network (46.57%) and lighting (34.55%) were chosen the most important factors affecting quality, reliability, and safety of paratransit modes. In addition, cleanliness, high waiting time and unsafe speed were identified as second most important factors in the respective category. Around half of the respondents identified the service provided by the present paratransit modes as very poor to poor. Choice of routes (around 50%) of paratransit modes, especially the motorized ones (few popular motorized modes such as Laguna, tempo follows some selective routes), were found as the most critical features affecting the service significance. The low fares of paratransit modes is one of the important factors of the growing popularity of paratransit modes around the city. A percentage of around 55% in account of low fare (fare category) suggested this conclusion as well. No metering got the highest response of 42.13% among factors that affect the fare standard of the paratransit modes. In addition, people were also showed some positive responses towards inclination of fare in different occasional (bad weather or different religious and national festival time) basis. Congestion had a percentage of 39.89% and noise pollution had 56.81%, scored the highest priority in operational and environmental impacts of paratransit in Sylhet city respectively.

Two identical Logistic Statistical approaches were taken into account to identify most effective factors of paratransit modes in Sylhet city. Stepwise Logistic regression was performed for both Multinomial and Ordered Logit and statistically insignificant variables were removed. Total of 687 samples were taken into account to identify the strong relation between passenger's satisfaction (dependent variables) and other associated factors (independent variables).

Multinomial Logistic Regression (MLR) and Ordered Logistic Regression (OLR) analysis were performed for the 687 observations gathered from the questionnaire. Two models, MLR-1 and MLR-2 were drawn from the analysis. MLR-1 compared two dependent variables of Satisfied with not satisfied while MLR-2 compared another two of somewhat satisfied with not satisfied in the analysis. In same way, the ordered logit model (OLM) tested the variables in the range from satisfied to not satisfied. In both cases, the last category of each the variables (both dependent and independent) was considered as a reference category and their co-efficient (B) value was labeled as 0. Some of the independent variable groups such as modes of paratransit, overall quality, factors of reliability, Safety and Security, and factors of service and environmental impact were found insignificant in both MLR and OLR models and thus removed

from the final models. However, presence of insignificant variables at each group in both final models were marked (Table 5). For interpreting the results, those variables were retained in the model, if one of the variables in the same parameter category was significant (p value less than 0.05) in at least one of the final model (Fan et al. 2016). Both of the models fitted well with the data as -2 log likelihood function dropped significantly as moved from initial to final model. Both models significantly decreased the -2 log likelihood function, but Multinomial performed better than the Ordered Regression.

Table 5. Frequency percentage of factors taken into consideration for analyzing satisfaction of paratransit users

Elements	Frequency (%)	Elements	Frequency (%)	Elements	Frequency (%)
Quality		**Reliability**		**Safety and Security**	
Very poor	27.41	Very reliable	18.33	Very poor	10.44
Poor	38.83	Reliable	14.38	Poor	17.08
Satisfactory	12.18	Somewhat reliable	29.59	Satisfactory	18.15
Good	18.99	Not reliable	37.7	Good	29.67
Excellent	2.59	**Factors affecting reliability**		Excellent	24.66
Factors affecting quality		Flexibility of moving at all roads	46.57	**Factors affecting safety and security**	
Seat comfort	7.86	Travel time	20.19	Lighting	34.55
Fitness	44.33	Higher waiting time	26.35	Security of goods	22.79
Cleanliness	37.35	Co-ordination with supporting modes	6.89	Unsafe speed	27.44
Seating arrangement	10.46	**Factors affecting service**		Inexperience driving standard	15.22
Service		Boarding style	22.12	**Fare**	
Very poor	13.21	Co-operation of crews with passengers	11.17	High	24.77
Poor	39.97	Ticketing system	19.56	Average	20.88
Satisfactory	18.39	Choice of routes	47.15	Low	54.35
Good	19.77	**Environmental impacts**		**Factors affecting fare**	
Excellent	8.66	Noise pollution	56.81	No metering	42.13
Operational impact		Air pollution	32.21	Increase due to bad weather	30.51
Congestion	39.89	No impact	10.99	Increase due to national or religious festivals	27.36
Accident	31.57				
Road deterioration	28.54				

P value also suggested the same information as it was less than 0.05 at 95% confidence interval. Intercepts were also providing a sig. (Table 6) value less than 0.05 suggesting a well-balanced model to interpret. The two models were well suited to each other and identified the important factors of paratransit systems operating in Sylhet City. Multinomial models performed better in the analysis but the Ordered Logit Model also proved effective in accordance to 95% confidence interval. Thus, a combination of Multinomial and Ordered logit models were taken into consideration for identifying identical features of paratransit modes. Table 6 gives detailed information regarding parameters taken in both models. In terms of sex, male passengers were satisfied (p= 0.035 and 0.009) as opposed to female in both MLR-1 and OLR. But in MLR-2, male passengers were less likely to somewhat satisfied than dissatisfied with B= -1.714 and p = 0.002. In the Multinomial Logit model, positive estimates indicated that the chance of satisfactory or somewhat satisfactory increased as the value of the independent variable increased. The negative coefficient value in OLR indicated that satisfaction of passengers increases with the increase in value.

A negative B value in the OLR suggests satisfaction with paratransit systems in Sylhet city for male passengers rather than females. Male passengers were happy regarding the present paratransit modes while female passenger satisfaction ranged from somewhat satisfied to not satisfy. In Bangladesh, every vehicle system has some seats that are supposed to be reserved for the female passengers. But in some cases, transport providers or operators do not pay attention and enforce this seating due to the uncertainty of female passengers at each stoppage. In addition, at a crowded stoppage, it is very difficult for female passengers to compete with male passengers to get into the vehicle especially in shared motorized paratransit modes like CNG, tempo, Laguna. Elderly people were more satisfied than younger as the models (MLR-1 and OLR) highlight in the Table 5. Higher value of Exp (B) of 25.712 with p value of 0.000 in the age range of 45-60 marked as satisfactory paratransit systems for elderly people using this system of transport. All other younger and older generation were not even somewhat satisfied with the present paratransit system. But ordered logistic regression showed satisfactory level of paratransit system for the age of 30-60 (p = 0.035 and 0.000) as well. In MLR

models, every profession people were dissatisfied with the paratransit modes operating in Sylhet city as the p value clearly indicates. But OLM indicating satisfactory paratransit system for students (B= -2.03 and p= 0.000). This is a positive outcome as students preferred the cheapest way of travel thus paratransit should be an easy choice for them, particularly across Sylhet city where school, college or university buses are not very popular. All trips made by the passengers of paratransit modes were dissatisfied with the present paratransit system as p values close to or above 0.05. Consequently, a negative value for multinomial and a positive value for ordered model of B signified the dissatisfaction level of users. People are dissatisfied with the present paratransit system for any sorts of trip but they are bound to use them as no other options are available.

Table 6. Parameter estimates of Logistic Regression Models

Variables	MLR-1			MLR-2			OLR	
	B	Exp(B)	Sig.	B	Exp(B)	Sig.	B	Sig.
Sex								
Male	1.473	4.362	0.035	-1.714	0.180	0.002	-0.726	0.009
Female	0			0			0	
Age								
(15-30)	-1.847	0.158	0.111	-1.21	0.299	0.166	1.845	0.000
(30-45)	1.717	5.570	0.076	1.202	3.327	0.120	-0.826	0.035
(45-60)	3.247	25.712	0.000	0.524	1.69	0.551	-3.242	0.000
(>60)	0			0			0	
Profession								
Student	2.044	7.720	0.145	-1.019	0.361	0.328	-2.026	0.000
Service holder	-0.571	0.565	0.564	-0.851	0.427	0.286	1.139	0.020
Housewife	-0.397	0.673	0.766	-0.434	0.648	0.642	-0.569	0.291
Business	-0.417	0.659	0.693	-2.003	0.135	0.035	-0.154	0.768
Others	0			0			0	
Trip Purpose								
Academic	-5.675	0.003	0.000	-2.820	0.060	0.031	2.910	0.000
Work	-4.725	0.009	0.000	-4.259	0.014	0.000	2.231	0.000
Recreation	-4.555	0.011	0.000	-4.951	0.007	0.000	2.101	0.000
Others	0			0			0	
Factors (quality)								
Seat comfort	-0.657	0.519	0.453	-0.302	0.739	0.702	2.528	0.000
Fitness	-4.159	0.016	0.000	-2.578	0.076	0.000	3.973	0.000
Cleanliness	-3.339	0.035	0.000	-0.447	0.640	0.578	3.900	0.000
Seating arrangement	0			0			0	
Overall Reliability								
Very reliable	-2.865	0.057	0.011	-0.587	0.556	0.551	1.237	0.011
Reliable	-0.445	0.641	0.675	0.219	1.245	0.820	-0.195	0.678
Somewhat reliable	0.784	2.190	0.451	1.981	7.247	0.029	-1.120	0.012
Not reliable	0			0			0	
Factors (reliability)								
Moving flexibility	-4.575	0.010	0.000	-2.223	0.108	0.013	2.405	0.000
Travel time	-2.062	0.127	0.056	-2.812	0.060	0.001	0.239	0.501
Higher waiting time	-0.353	0.702	0.726	-0.895	0.408	0.340	-0.160	0.701
Coordination of support modes	0			0			0	
Factors (safety & security)								
Lighting facility	5.867	353.06	0.000	6.409	607.33	0.000	-5.609	0.000
Security of goods	4.097	60.184	0.000	2.566	13.012	0.000	-2.969	0.000
Speed	5.984	397.03	0.000	3.624	37.494	0.000	-4.792	0.000
Inexperience driving standard	0			0			0	

Overall Service								
Very poor	-5.561	0.004	0.011	-6.294	0.002	0.000	3.220	0.000
Poor	-1.782	0.168	0.230	-2.761	0.063	0.016	1.672	0.003
Satisfactory	-0.049	0.953	0.974	-2.376	0.093	0.038	0.629	0.211
Good	1.807	6.094	0.260	-3.419	0.033	0.004	-0.975	0.047
Excellent	0			0			0	
Fare condition								
High	-0.873	0.418	0.287	-0.136	0.873	0.837	-0.053	0.884
Average	1.165	3.21	0.130	0.899	2.432	0.183	-1.575	0.000
Low	0			0			0	
Factors (high fare)								
No metering	1.214	3.367	0.160	1.739	5.689	0.028	-1.651	0.000
Adverse weather	-1.203	0.300	0.118	1.594	4.924	0.010	0.058	0.864
Social & religious occasion	0			0			0	
Operational impact								
Congestion	-2.545	12.737	0.002	3.635	37.89	0.000	1.202	0.001
Accident	1.004	0.366	0.214	1.993	7.341	0.010	1.200	0.001
Road deterioration	0			0			0	
Intercept 1	3.043		0.000	4.484		0.006	-2.341	0.004
Intercept 2							1.719	0.031
Model fitting information								
-2 log likelihood (null)			1704.444				1704.444	
-2 log likelihood (Final)			523.862				898.873	
Sig. (P value)			0.000				0.017	

Fitness and cleanliness of paratransit modes were less likely to satisfy passengers than seating arrangements in MLR-1 with negative B values along with p value less than 0.05. People were more dissatisfied with the fitness rather than cleanliness as confirmed by MLR-2 (B= -2.578 and p= 0.000). OLR highlighted about importance of all the 3 variables (fitness, cleanliness and seat comfort) rather than sitting arrangement (positive B value with p value less than 0.05). MLR models are more preferable than OLR, and so fitness and cleanliness were considered as the most important driving feature for quality of a paratransit mode. People were less likely to mention paratransit modes that were very reliable than were not reliable in MLR-1. In addition, MLR-2 supported the same finding as people were somewhat satisfied with the somewhat reliability of paratransit modes in Sylhet City. The OLR was concluded by examining the non-reliability of paratransit modes by having B= 1.237 and p = 0.011. In context of reliability, paratransit modes fall towards more dissatisfactory than satisfactory. As mentioned earlier, motorized modes are more popular than non-motorized but lack of coordination, lack of a number of good services and improper route selection make the scenario more complex for the passengers in terms of reliability. Flexibility of moving along the city roads and travel time among the factors of reliability were less likely to satisfy the passenger than coordination of support modes in MLR-1. In addition, MLR-2 highlighted only the travel time which people felt dissatisfied rather than somewhat satisfied. On the other hand, OLR focused on the flexibility of moving as prime factor of dissatisfaction in reliability section as did MLR-1. Paratransit modes like the human driven rickshaw had the flexibility of moving across all the streets of Sylhet city but motorized vehicles, like Shared CNG and Laguna, did not have the same flexibility as they are only used on operational routes. Because people favored motorized modes over non-motorized thus flexibility of transit will be a problem that motorized vehicles will need to overcome. All the three models suggest the satisfactory performance of paratransit modes in the safety and security section in terms of inexperienced driving. All the factors satisfy the p value and possessing positive and negative value of B in both MLR and OLR models. This highlights the satisfactory characteristics of safety and security. With regards to overall service, passengers were less likely to say very poor or poor than excellent for the paratransit system. All three models supported this finding. People were well satisfied with the overall service provided by the paratransit modes operating in Sylhet City. OLR presented the fare characteristic of paratransit was average to low as per the opinion of users. The fare was reasonable making this mode of transport very popular in the regions like Sylhet. Diverse results were found from three models in regards to high fares. In MLR-2, both the cause identified as somewhat satisfied regarding passenger's opinion than dissatisfied in terms of fare burgeon due to social and religious occasion. OLR clearly indicates that people were dissatisfied with the metering service. It is evident that the paratransit modes in Sylhet city should not require a metering service. This will provide a chance for individuals to bargain with the drivers and choose the most economical option. However, a rainy day or adverse weather condition or during the

time of any occasion (religious and national), drivers double or triple their prices. People gave a widespread opinions based on their experience in that issue thus the model also provides a diverse result. In the operational section, congestion was the prime concern for the people pursuing paratransit mode for their transportation mode. All the models gave high priority to the factor of congestion and the reason is often the high amount of non-motorized paratransit modes. Non-motorized are slower modes and usually are responsible for traffic jams and road congestion.

6. Conclusion

Paratransit is an essential element of transportation for the people of Sylhet city. The people living there are dependent on paratransit. A questionnaire survey was designed to identify the most crucial factors in terms of satisfaction of the paratransit passengers. A field study was also conducted to overview the presence of paratransit modes at designated location that were carefully chosen. The Human driven rickshaw, Easy bike and hired CNG were found at every studied location. But Shared CNG, Laguna and Tempo were not found in every location as they maintained certain routes for their transportation. In addition, Shared CNG, Laguna and Tempo were found as the most popular vehicles. This may be due to their economically variability and fluent mobility. This conclusion supports the Government's opinion of increasing the 4 stroke auto-rickshaw (CNG) in city. The Laguna, which is also a motorized transport, has the same operational characteristics such as CNG but more seats in comparison. This might be a beneficial option for transportation as well. Preferring motorized transport across the city roadways may result in decreasing the non-motorized vehicles particular the un-registered ones. More than half of the respondent were male and fell in the age range of 15-45. The survey data highlighted that students and service holders preferred the use of the paratransit system. MLR and OLR were drawn to select the most important factors of paratransit modes. Both of the models worked well in that as they were able to provide conclusive evidence regarding the crucial features of paratransit modes. Male passengers were satisfied with the service than female passengers, and younger generation people were not satisfied with the present paratransit modes. More or less all profession of people with any purpose of riding paratransit modes were signified as dissatisfied with the current paratransit modes. Fitness of the vehicles was considered as the prime concern in terms of the quality of paratransit. In addition, cleanliness played a large role in influencing the quality of paratransit as well. The results of statistical analysis show the unreliability of paratransit modes in terms of satisfaction of users. It was found that motorized modes were most popular form of transport, but their unavailability hampered the satisfaction level of passengers. Safety and security of paratransit system were considered satisfactory based on the statistical approaches taken into consideration. In addition, service provided by the paratransit system over the Sylhet City Corporation area was deemed excellent and fare structure was considered as average to low. These factors drive the familiarity of other vehicles out of sight in comparison with paratransit modes. Passengers were satisfied with no metering service of paratransit modes in Sylhet city. They were somewhat satisfied regarding the causes of burgeoning fare due to adverse weather condition. Congestion was the prime concern of paratransit mode as all of the models identified it as the number one priority. The indulgence of non-motorized vehicle in the city road and a lesser amount of motorized paratransit mode is usually triggers the congestion in the city roads.

Though features were driven in corporation with the present paratransit modes but indirectly these can be considered as a feedback of people for considering any new mode of transportation system in Sylhet city as well as in Bangladesh. People were more interested in using motorized vehicle than non-motorized therefore more motorized vehicles can meet the travel demand. In addition, motorized vehicle can replace the non-motorized paratransit modes and may reduce travel time and congestion. However, rather than CNG, more Laguna (4 stroke as well) would be an appropriate choice for making smoother transportation by decreasing the bulk amount of traffic as well as transporting more people. A more detailed analysis of modal split between Laguna and CNG vehicle should be done to find which vehicle would be beneficial for implementing on the roadway of Sylhet city. But for increasing the satisfaction of users, motorized vehicle must be able to cover every important route and provide flexible routes with uninterrupted mobility to the users. All the modes of paratransit traveling in Sylhet city should address the traveling discomfort of female passengers. Although no metering system is available, a fare structure for per miles travelled by each of the modes could be used to ease the people movement and provide a fair payment structure.

7. Acknowledgement

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9. Appendix: Questionnaire for Measuring User perception of Paratransit Modes in Sylhet City
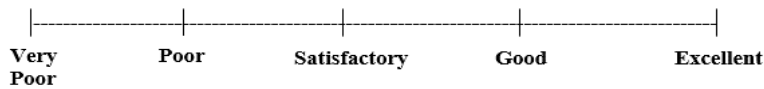
This questionnaire is part of the study being carried out by Students of Department of Civil Engineering, Leading University, Sylhet, Bangladesh to examine perception of paratransit users toward different attributes of service. Put a tick mark based on your preference among all option at each question presented here. All responses will be treated confidentially and we thank you in advance for your co-operation.

1. **Demographic Information**

   - **Sex: a) Male** ☐   **b) Female** ☐

   - **Age Range: a) 15-30** ☐ **b) 30-45** ☐ **c) 45-60** ☐ **d) > 60** ☐

   - **Profession: a) Student** ☐ **b) Service holder** ☐ **c) Housewife** ☐ **d) Business** ☐

     e) Others ☐

   - **Trip Purpose: a) Academic** ☐ **b) Work/ business** ☐ **c) Recreation** ☐ **d) Others** ☐

   - **Preferred paratransit modes: a) Rickshaw** ☐ **b) Easy Bike** ☐ **c) Reserved CNG** ☐

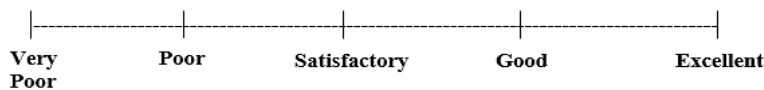   **d) Shared CNG** ☐ **e) Laguna/ Tempo** ☐

2. **Quality**

   - **What is the preferred quality of present paratransit modes available in Sylhet city?**

     ```
     |----------------|----------------|----------------|----------------|
     Very           Poor         Satisfactory      Good          Excellent
     Poor
     ```

   - **Which factor is tremendously affecting the quality of paratransit modes?**
     a) **Seat Comfort Level** ☐ **b) Fitness of Vehicle** ☐ **c) Cleanliness** ☐
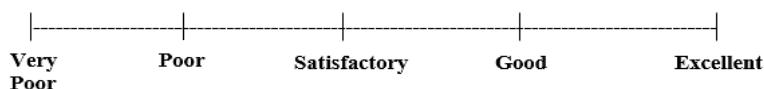
     d) Sitting Arrangements ☐

3. **Reliability**

   - **What is the preferred reliability of present paratransit modes available in Sylhet city?**

     ```
     |----------------|----------------|----------------|----------------|
     Very           Poor         Satisfactory      Good          Excellent
     Poor
     ```

   - **Which factor is tremendously affecting the reliability of paratransit modes?**
     a) **Moving flexibility around all city roads** ☐ **b) Travel Time** ☐

     c) **Higher Waiting Time** ☐ **d) Co-ordination with supporting modes** ☐

4. **Safety and Security**

   - **What is the preferred safety aspect of present paratransit modes available in Sylhet city?**

     ```
     |----------------|----------------|----------------|----------------|
     Very           Poor         Satisfactory      Good          Excellent
     Poor
     ```

   - **Which factor is tremendously affecting the safety and security of paratransit modes?**
     a) **Lighting** ☐ **b) Security of Goods** ☐ **c) Unsafe Speed** ☐

     d) **Inexperience Driving Standard** ☐

5. **Service**

- **What is the preferred service quality of present paratransit modes available in Sylhet city?**

|----------------|----------------|----------------|----------------|----------------|
Very Poor   Poor   Satisfactory   Good   Excellent
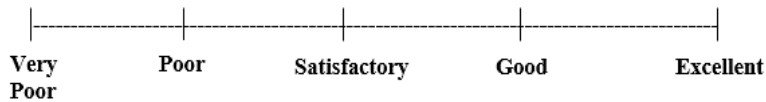
- **Which factor is tremendously affecting the service quality of paratransit modes?**
  a) **Boarding Style** ☐   b) **Co-operation of Crews with Passengers** ☐

  c) **Ticketing System** ☐   d) **Choice of Route** ☐

6. **Fare**

- **What is the present Fare condition of paratransit modes in Sylhet City?**
  a) **High** ☐   b) **Average** ☐   c) **Low** ☐

- **Which factor is tremendously affecting the Fare structure of paratransit modes?**
  a) **No Metering System** ☐

  b) **Unexpected Increase in Fare due to Adverse Environmental Condition** ☐

  c) **Unexpected Increase in Fare due to Different Types of Festivals** ☐

7. **Environmental Impact**

- **What is the probable environmental impact of paratransit modes of Sylhet City?**

  a) **Noise Pollution** ☐   b) **Air Pollution** ☐   c) **No Impact** ☐

8. **Operational Impact**

- **What is the probable operational impact of paratransit modes of Sylhet City?**
  a) **Congestion** ☐   b) **Accident** ☐   c) **Road Deterioration** ☐

9. **Satisfaction**

- **What will be your perception regrading level of satisfaction for paratransit modes in Sylhet City?**
  a) **Satisfied** ☐   b) **Somewhat Satisfied** ☐   c) **Not Satisfied/ Dissatisfied** ☐