SERVICE QUALITY ASSESSMENT OF PARATRANSIT MODE BY STRUCTURE EQUATION MODEL (SEM) IN DHAKA CITY

A THESIS SUBMITTED

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BY

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This Thesis titled "Service quality assessment of paratransit mode by structure equation model (SEM) in Dhaka city" submitted by S M Mostafizur Rahman, Roll No 1014110014, Session 2014-2015 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of **Masters of Science in Civil Engineering (Transportation)** on 10 December 2016.

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I hereby declare that this thesis is my original work and it has been written by me entirety. I have duly acknowledged all the sources of information which have been used in the thesis.

This thesis has also not been submitted for any degree in any university previously.

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Abstract

This thesis was aimed to explore service quality assessment of effective paratransit mode by structure equation model (SEM) in Dhaka city. The study examined survey questions for fifteen different routes of paratransit service in Dhaka city to collect the data and to get an idea of users' perception about the service. Paratransit is recognized in Dhaka as special transportation services with more flexibility and availability in selected routes operated by private companies and individuals. Generally these vehicles are known as "Leguna" or "Tempo". A two-step methodology has been adopted for this research. The first part was addressed data collection approach incorporating a purpose-built questionnaire survey. The performance variables included in the survey are selected from various focus group discussion and expert counsel of academicians, practitioners, bus operators and policy makers. The second part was the structural equation models developed in this study. For each empirical model, the process of model development followed the approach of trial and error in terms of accommodating variables as well as by observing the overall goodness of fit values of the respective models. Structural Equation Modeling (SEM), an advanced technique which permits to introduce exogenous, endogenous as well as latent variables is used for this study. The results found with two latent variables, physical appearance and Service Features. From the analysis it is found that "Physical Appearance" has a little less influence than "Service Features" on the overall paratransit service quality (SQ). It indicates that users of developing countries are more concern about the service provided by the paratransit. "Punctuality and Reliability", "Fitness of Vehicle", and "Travel Cost" are found to be the most significant observed variables that influence the SQ. Moreover, results from the best SE model show that "Speed of Para Transit" is not influenced by "Quality of Driver". This counterintuitive result is explained by the prevailing congestions in Dhaka city, which force vehicles to crawl in the network. So, speed choice does not solely depend on the drivers. It was suggested in recommendation that the appropriate authority of paratransit should take necessary steps immediately to improve the limitations to make this service more reliable and user friendly, which will decrease the pressure on public transportation service and private vehicles in the city. The study findings can be utilized by the city transportation officials of developing countries to improve the overall paratransit performance to attract new users as well as retain the current ones.

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Chapter 1

Introduction

1.1 Background And Problem Statement of the Study

Paratransit is the name given to the informal public transport modes in developing countries which encompass a variety of transport modes and service facilities falling in between the conventional transport services and private automobiles (Wikipedia, 2016). The most logical and precise definition of paratransit is the functional one, which states " Paratransit is urban passenger transportation service usually in highway vehicles operated on public streets and highways in mixed traffic (Zaman,2007); it is provided by private or public operators and it is available to certain groups of users or to the general public" (Kiwan 2007). The concept of paratransit, however, differs in the context of developed and developing countries. In developed countries, paratransit is often used for demand responsive systems such as shared-ride taxis, dial-a-ride and subscription buses, (Wilber, 2011). In the context of developing countries, the lower standard of living, high population density, availability of cheap labour force etc., have together provided a bewildering array of transport modes bridging the gap between public bus and private automobiles (Kiwan 2007).

Dhaka city has a population around 17 million people which has a growing rate 05% every year (Google,2016). This is one of the densest city on earth, wikipedia,(50000 per square kilometer).The city also does not have sufficient infrastructure of public transportation system.

Fig 1.1: Existing Condition of Dhaka City

In absence of effective public transportation system, the paratransit modes have spreaded all over the city to meet the present demand. They provide flexible and frequent services to small settlements through narrow streets, where no other service is available at a relatively low fare.

A number of studies were done on paratransit in different cities, but most of them were limited to only certain specific area. This paper will consolidate users perception of paratransit and analyze the data by 'Structure Equation Modeling' (SEM) by developing three models by the software STATA 13.

1.2 Importance of Transportation for Economic Development

Transport is an important component of economic activity in all countries, specially for the developing countries. Since ancient times, cities and trade centers have developed in locations that took advantages of the availability of transportation connections such as rivers, roads, protected harbors and railways. The potential for enhancing economic and social development through improvements in the transport sector are very large indeed. It helps the generation of economies of scale, increased competition, reduced cost, systematic urbanization, export-led faster growth hand a larger share of international trade.

A vision sets the direction for development and guide formulation of policy measures and strategies to attain identified objectives. Unfortunately, no such vision for transport development exists in Bangladesh. The current disturbing trends in transport development indicate the need for policy directions to make such development environmentally and otherwise sustainable and to create a transport system that can meet the growing demand for transport services which is resulting from increasing economic liberation and external orientation of the economy. It is generally agreed that a well-articulated transport policy is needed for the development of transport sector, even when the private sector plays an increasing role in such development. The level of transport needs in a growing economy depend on the pattern of development.

Transport policy can influence the way the transport needs associated with a particular pattern met. A policy is required to answer such vital question, among others, as who will provide transport infrastructure, who will provide transport services, how transport infrastructure and services should be priced, what the appropriate roles of various transport modes in a transport system are, and how to resolve potential conflicts between transport

developments and the environment. There is growing interest in the concepts of sustainability, sustainable development, and sustainable transport. Sustainability reflects one of the most fundamental human desires supported by virtually all philosophies and religions: to create a better future world. It provides guidance for long-term, strategic decision-making. Sustainability emphasizes the integrated nature of human activities and therefore the importance of comprehensive planning that coordinates between sectors, jurisdictions and groups.

1.3 Definitions of Paratransit

The term "paratransit" means "alongside transit" (Lave and Mathias, 2006). This term was first used in the mid-1960s to describe transportation services that would approximate the convenience and ubiquity of vehicle, which ensure the efficiency and economy of public transport (Koushki, 2003). "Paratransit is urban passenger transportation service usually in highway vehicles operated on public streets and highways in mixed traffic; It is provided by private or public operators and it is available to certain groups of users or to the general public, but adaptable in its routing and scheduling to individual user's desires in varying degrees" (Shimazaki and Rahman, 1995). Although the term has been popularly used worldwide, its concept differs among the developed and developing countries. In North America, paratransit is one of the flexible door-to-door transport services (complementary mode) specifically provided to elderly or physically handicap people (in compliance with the Americans with Disabilities Act) and is all other forms of demand-responsive services (Lave and Mathias, 2006). In Europe, paratransit refers to particular public transport services including dial-a-ride, ride-sharing, jitneys, and shuttles (Orski, 1975; Mulley and Nelson,

2009). In these countries, paratransit modes include those between private vehicle and formal transit, ranging from taxis to bus lines.

1.4 Global overview of paratransit

There are plenty small, low-performance vehicles driven by private operators that serve low-income areas in different parts of the world. In some places, environmental-friendly, pedal-powered modes, like the Pedi cabs of Manila, Rickshaw at Dhaka, provide fits between markets and squatters whose narrow alleys and walkways are impenetrable by motor vehicles.

Fig 1.2: Different Types Paratransit Around the world

In other places, like Kingston, Jamaica, station wagons and vans fiercely compete head-to-head with public buses, providing curb-to-curb delivery for a premium fare. And in increasing numbers of cities and towns around the world, dozens of young men on mopeds

and motorcycles congregate at major intersections, offering feeder connections between mainline bus routes and nearby neighborhoods for a reasonable fare. These privately operated, small-scale services are varyingly referred to as "paratransit", " low-cost transport", "intermediate technologies", and "third world transport". The term adopted in this study is "informal transport", for this term best reflects the context in which this sector operates – informally and illicitly, somewhat in the background, and outside the officially sanctioned public transport sector. While private, small-vehicle, for-hire services, such as taxis, can be found in all cities of the world, what separates informal transport operators from others is that they lack, to some degree, official and proper credentials. That is, they are unsanctioned. In some instances, operators lack the necessary permits or registration for market entry in what is a restricted, regulated marketplace.

In other instances, operators fail to meet certification requirements for commercial, common- carrier vehicles – such as minimum vehicle size, maximum age, or fitness standards. Other violations include lack of liability insurance, absence of a commercial driving permit, and operation of a un classified or substandard vehicle. In spite of such transgressions, in many cases the informal transport sector is tolerated by public authorities, allowed to exist as long as it remains more or less "invisible" to most motorists, confined to low-income neighborhoods. Often, however, patrol officers and local "bosses" must be paid off for the right to operate in their "turf".

Informal transport is just one of many sectors of the underground economy that thrives in many third-world countries. Informal transport is about as close to laissez-faire transportation as can be found. Through the invisible hand of the marketplace, those who are *willing−to−pay* for transport services make deals for lifts with those who are

willing−to−provide. Thus, informal transport involves commercial transactions which distinguishes them, a s transportation services, from the provision of free lifts, whether by friends, acquaintances, or truck drivers backhauling with empty loads from the marketplace, all common forms of mobility in many poor, rural areas. It is this more limited definition of informal transport, namely ones involving *pay−for−services,* that is adopted in this research.

Informal transport services are also notable for their role as "gap fillers". They exist in large part to fill service voids left unfilled by formal public transport operators. Rapid motorization, poor road facilities, and the in ability to strategically plan for the future have given rise to horrendous levels of traffic congestion and air pollution in many mega cities of the developing world. Formal public transport services are rarely up to the task of satisfying escalating demands for travel. Most public transport operators exist as protected monopolies, and accordingly lack the incentive to contain costs, operate efficiently, innovate, or respond to shifting market demands. Buses are often old, break down periodically, and get stuck in slow moving traffic. Fares are frequently kept low to help the poor, however this reduces revenue intake which in turn precludes service improvements. All too often throughout the developing world, public transit finds itself in a web of deteriorating service and shrinking incomes. It is only because regulations and rules are laxly enforced that unlicensed operators are "informally" able to step in and pick up where public transport operators have left off.

Notwithstanding these benefits, the informal transport sector is blamed for a long list of problems that afflict cities of the developing world. Aggressive and unruly driving among drivers whose very livelihoods depend on filling empty seats all too often causes serious accidents. Excessive competition has produced too many idling and slow moving vehicles

that jam critical intersections. Traffic tieups, along with poorly maintained vehicles and low-stroke engine designs, have worsened air pollution. Often times, the sector is chaotic and disorganized. The fact that nearly identical forms of illegal vans and motorcycle taxis have surfaced in recent years indifferent corners of the globe.

Many of the same issues and concerns are being wrestled with by policymakers across Asia, the Indian subcontinent, Latin America, and sub-Saharan Africa. Such commonalities call for a far-reaching global perspective on this often maligned and vaguely understood sector. Transport decision-makers at all levels need strategies and approaches that will better rationalize, and when called for, coordinate and integrate informal transport services. An important challenge is to incorporate the informal sector into the mix of legitimate transport offerings so that it continues to provide much-needed and complementary services, but in ways that do not threaten public safety and welfare. It is vital that informal services be delivered, priced, and organized so as to complement and strengthen not only regional transport services but also regional economic and social development as a whole. Below fig 1.3 shows a paratransit mode in Dhaka city called "Leguna".

Fig 1.3 : Leguna- The paratransit in Dhaka city

1.5 Objective

The objective of the research is to evaluate the users perception of paratransit by Structure Equation Modeling (SEM) to enhance its service quality.

1.6 Thesis Outline The thesis paper is outlined as follows:

- **Chapter 1** outlines the background, overview and objective of this particular research work. It also gives an idea about the significance of this study in the perspective of Bangladesh and more specifically Dhaka city. Chapter 1 also discusses background and problem statement of the study, importance of transportation for economic development, definitions and global overview of paratransit. It also summarizes the methodology of thesis. Finally the outline of entire thesis.
- **Chapter 2** presents a review of the previous studies on paratransit in different cities around the world and other peripheral issues. It also describes the present conditions of paratransit users in Dhaka city.
- **Chapter 3** Primarily discusses about the research methodology and and also system of the use of Structure Equation Modeling for data analysis.
- **Chapter 4** Data analysis was conducted initially by Microsoft excel to find out the perception of paratransit users. Afterwards STATA 13 software is used to to create the models.
- **Chapter 5** Discusses the Results and conclusions of the thesis work.

1.7 Significance of Structure Equation Models (SEM)

There are several mathematical models used for transportation. For example ANOVA, MANOVA , Neural Network, discrete choice, ANSYS etc. But among them SEM is used in this research because it focuses on latent constructs rather than on the manifest variables used to measure these constructs. Measurement is recognized as difficult and error-prone. By explicitly modeling measurement error, SEM users seek to derive unbiased estimates for the relations between latent constructs. To this end, SEM allows multiple measures to be associated with a single latent construct.

Structural equation modeling, or SEM, is a very general, chiefly linear, chiefly cross-sectional statistical modeling technique. Factor analysis, path analysis and regression all represent special cases of SEM. It is a largely confirmatory, rather than exploratory, technique. That is, a researcher are more likely to use SEM to determine whether a certain model is valid., rather than using SEM to "find" a suitable model--although SEM analyses often involve a certain exploratory element.

Chapter 2

Literature Review

2.1 . Introduction

The informal public transport modes or "paratransit" in developing countries encompasses a variety of transport modes and service facilities falling in between the conventional transport services and private automobiles. There are good numbers of definitions of paratransit based on several different criteria. The most logical and precise definition of paratransit is the functional one, which states " Paratransit is urban passenger transportation service, usually in highway vehicles operated on public streets and highways in mixed traffic; it is provided by private or public operators and it is available to certain groups of users or to the general public, but adoptable in its routing and scheduling to individual user's desires in varying degrees."(Friman, 2001).

Although various forms of paratransit modes exist in the cities of developing countries that range from simple non-motorized human or animal powered vehicles to motorized mini buses, the motorized paratransit modes are dominant in most of the cities except Dhaka in Bangladesh and Kanpur, Jaipur in India. The passengers carrying capacity by motorized paratransit modes vary from 20 percent to more than 50 percent of total public transport demand. For example, 70 percent of the total public transport demand in Metro Manila (Philippines), 50 percent in Jakarta (Indonesia), 40 percent in Kuala Lumpur (Malaysia), and 21 percent in Bangkok (Thailand) are carried by motorized paratransit modes [ESCAP/UNCHS, 1987]. They provide flexible and frequent services to small settlements

through narrow streets, where no other service is available at a relatively low fare.

In addition, the urban paratransit sector generates a considerable number of employment opportunities, as much as 10-20 percent of the total employment in some cities.

2.2 Past Studies on Paratransit

Public transportation is a service provided by public or private entities and is available to all persons who pay the prescribed fare (Vuchicn.d, 2012). Urban public transport has been defined as a system that provides for the movement of people and goods within an urban area and also links the city to its environs (Ali 2010). Paratransit operators in the global perspective is aimed to fulfill unsatisfied demand for public transport as result of urban growth. In most cases, the share of demand served by such paratransit operators is often 50 percent and sometimes accounts for all public transport services in the urban areas (Chen 2011). Paratransit vehicles vary from human-powered pedicabs to mid-sized motorized buses (Cervero 2000; Illes 2005).

Most paratransit operations in developing countries are supplied by the private sector rather than the public sector (Sclar et al. 2007). Many observers attribute the shift to private-sector transport to inefficiencies in the major public transport companies (Khayesi 2002; Cervero and Golub 2007; Sclar et al. 2007; Schalekamp et al., 2008). Some point out that in much of An earlier study by (Golub2005) also confirmed that, in many cities, regular public transportation systems do not meet all of the demands of the marketplace, and small-scale operators, legally or illegally, enter the market to fill these gaps. Such small operators typically have little transportation business expertise (Chitere 2006; Finn et al. 2011). M□ñoz and Gschwender (2008) argue that atomized ownership leads to increased traffic rule violations and a deterioration of services. Where large numbers of private-sector operators

provide public transport, regulating and controlling such individually-owned small vehicles is a serious challenge(Sohail et al. 2004). This is especially so because the vehicles represent a multiplicity of small businesses, each of which is trying to make a profit.

This has led authorities in some African cities to focus on the question of whether an effort should be made to "formalize" or regulate paratransit operations and to try to identify the obstacles to such formalization (Kumar and Barrett 2008 (Wilkinson 2008; Wilkinson et al.2011). A range of options for managing competition have been advanced, including public monopolies, management contracting, public-private partnerships, concessioning and quality licensing (Sohail et al. 2004; Wilkinson 2008; Kumar and Barrett2008; Chitere 2009). Choosing among these options requires a good understanding of the variety and, especially, the private-sector nature of paratransit operators. Project in various countries has shown that urban bus services respond to changing contexts in many different ways. In other words, there is no unique solution to the problems facing paratransit in developing countries (Finn and Mulley 2011).

2.3 Service Quality of Paratransit

Some studies conducted about paratransit service quality such as, this is a measurement of service, how well the service level that is delivered matches customer expectations, while a firm delivering quality service means conforming to customer expectations on a consistent basis (Joewono and Kubota, 2007; Transportation Project Board, 1999, 2004)" (Lai and Chen, 2010).Service quality is an abstract concept that is hard to be defined, and in practice, often used interchangeably with satisfaction (Lien and Yu, 2001; Lagrosen et al. 2004; Lai and Chen, 2010; Sumaedi et al. 2011). However, the differences between both variables have

been clarified in the literature. Oliver (1997)explains that service quality is more specific and related to cognitive judgments while satisfaction is more holistic and associated with affective judgments. Furthermore, other facilitators (Parasuraman et al. 1994; Zeithaml and Bitner, 1996; Lien and Yu, 2001) stated that satisfaction judgments include many factors, i.e. product quality, price, situation and personal attributes, not to mention service quality.

Many studies about paratransit service quality includes in recent projects, ie, Eboli and Mazzulla (2007), Tyrinopoulos and Antoniou (2008), Iseki and Taylor (2008),and Joewono and Kubota (2007). In these studies, different attributes determining transit service quality are discussed. The main service aspects characterizing a transit service include service scheduling and reliability, service coverage, information, comfort, cleanliness, and safety and security. Service scheduling can be defined by service frequency (number of runs per hour or per day) and service time (time during which the service is available). Service reliability concerns the regularity of runs that are on schedule and on time; an unreliable service does not permit user travel times to be optimized.

Service coverage concerns service availability in the space and is expressed through line path characteristics, number of stops, distance between stops, and accessibility of stops. Information consists of indications about departure and arrival scheduled times of the runs, boarding/alighting stop location, ticket costs, and so on. Comfort refers to passenger personal comfort while transit is used, including climate control, seat comfort, ride comfort including the severity of acceleration and braking, odors, and vehicle noise. Cleanliness refers tithe internal and external cleanliness of vehicles and cleanliness of terminals and stops. Safety concerns the possibility that users can be involved in an accident, and security concerns personal security against crimes. Other service aspects characterizing transit services concern

fares, personnel appearance and helpfulness, environmental protection, and customer services such ease of purchasing tickets and administration of complaints.

2 . 4 Classification of Paratransit

Generally, paratransit system can be broadly classified into two types; non-motorized and motorized. Both types are again been sub-classified into 3 groups based on their seating capacity. They are individual type (seating capacity less than 4), shared type (seating capacity 5-10) and collective type (seating capacity 11-20). The non-motorized paratransit includes animal powered and human powered types. The examples of animal powered paratransit are tonga in India and Pakistan, calesa in Philippines, dokar or delman in Indonesia. All non-motorized paratransits are of individual type with seating capacity 2 except hand rickshaw (seating capacity 1) in India, tonga (seating capacity 2-4) in Pakistan. The seating capacity of motorized paratransit ranges widely from 2 to 18.

Fig 2.1: Two primary paratransit in Dhaka City, Leguna and Tempu

Physically, the paratransit modes have very wide range of characteristics. They have differences in terms of body size, motive power, capacity, and other technical features. The non-motorized vehicles such as becak in Indonesia, cycle rickshaw in Bangladesh and India

are essentially bicycles converted into tricycles for passengers service. The silor in Bangkok and jeepney in Manila are private motor vehicles transformed into public use vehicles. The silor is typically the Daihatsu or Suzuki pickup which is simply covered on top with a canvas roofing for the convenience of passengers. The length and width of Indonesian paratransit vary from 1.6-4.25 meters and 0.80-1.8 meters respectively. The engine capacity also differs ranging from 125 cc (motorcycle type) to 1500 cc (minibus type). Most of motorized individual type of paratransit like bajaj, ojeg in Indonesia, auto rickshaw in Bangladesh, Pakistan, Sri Lanka, xelam in Vietnam have a engine capacity of 125-200 cc, except samlor (360 cc) in Thailand. The human powered becak and cycle rickshaws have smallest driving radius. Thus paratransit vehicles of each countries were formed with a variety of technical and cultural adaptations. The various types are shown in figure 2.2

Fig 2.2. Paratransit across Bangladesh

Fig 2.3. Various paratransit modes in Asia.

2.5 . The paratransit users around the world

In most of the cities complete urban transport statistics are not available and it is very difficult to obtain the number of vehicles used for paratransit modes, in particular, effort was given to collect the required data from a number of sources. Some collected data are outdated or simply rough estimates. In Kuala Lumpur, public transport mainly consists of conventional bus (58 percent). In Philippines, jeepney is dominant. In Karachi, Kathmandu and Chiang Mai, the percentage of the number of minibus are large ranging from 50-70 percent. The number of auto rickshaws are dominant in Karachi (58 percent) and Delhi (60 percent). In Dhaka and some Indian cities such as Kanpur, Jaipur, Patna, the cycle rickshaw plays a dominant role whose percent varies from a range of 20-30 percent. In Dhaka the number of paratransit users are approximately 25-40 percent. The following table 2.1 shows the number of registered motor vehicles in Dhaka city BRTA 2016).

Table 2.1: Number of Registered Motor Vehicles in Dhaka City (Ref BRTA Website).

Bangladesh Road Transport Authority

NUMBER OF REGISTERED MOTOR VEHICLES IN DHAKA (YEARWISE)

Sl. No	Type of Vehicles	Upto-2010	2011	2012	2013	2014	2015	31-Oct-16	Grand Total
1	Ambulance	1374	137	114	190	254	358	250	**2677**
2	Auto Rickshaw	7664	112	111	60	56	428	561	**8992**
3	Auto Tempo	1662	1	1	0	0	0	0	**1664**
4	Bus	16783	1501	1218	971	1364	2221	2941	**26999**
5	Cargo Van	3231	477	278	676	603	398	762	**6425**
6	Covered Van	4277	1910	1170	1850	2352	1855	2158	**15572**
7	Delivery Van	11990	839	577	709	901	1464	1606	**18086**
8	Human Hauler	2718	569	145	115	109	502	655	**4813**
9	Jeep(Hard/Soft)	19520	1698	1241	1107	1582	3109	3639	**31896**
10	Microbus	46202	3540	2643	2227	3842	4569	4492	**67515**
11	Minibus	9490	136	103	83	135	103	125	**10175**
12	Motor Cycle	210081	34708	32810	26331	32894	46764	43977	**427565**
13	Pick Up (Double/Single Cabin)	20481	7258	5149	4908	7295	7916	6959	**59966**
14	Private Passenger Car	163004	11423	8187	9231	12972	18422	15304	**238543**
15	Special Purpose Vehicle	759	60	28	78	50	66	178	**1219**
16	Tanker	817	152	90	136	163	146	158	**1662**
17	Taxicab	36011	52	43	4	302	54	2	**36468**
18	Tractor	9923	4169	2841	1634	1443	1637	2061	**23708**
19	Truck	26922	4205	2824	3522	5767	4424	3812	**51476**
20	Others	168	0	0	660	967	1307	1945	**5047**
TOTAL		**593077**	**72947**	**59573**	**54492**	**73051**	**95743**	**91585**	**1040468**

2.6 The Relation between paratransit and Socio-economic Structure of Society

Conceptually, the increasing or decreasing trend of paratransits have a relation with the economic level of cities. With the increase in economic level, the non-motorized paratransit have a declining role. At the same time the motorized paratransit have a increasing trend to fill the gaps left by the non-motorized paratransit, if no regulations are applied. After reaching the economic condition at a certain level the demand for paratransit shows a decreasing trend and their major role changes to a feeder service due to increased number of private cars and improvement of bus services or introduction of urban rail system. Among the motorized paratransit, the demand for individual type paratransit like auto rickshaw is increasing in the cities of Delhi, Dhaka, Karachi and Colombo. Although Bangkok has

attained high economic level compared to the above mentioned cities, the number of silor is increasing as a feeder service. The only exception is the silor in Thailand and xelam in Vietnam where it provides door to door service. Sometimes the shared type deviate their routes in response to passenger demand. The collective type also follows the same service pattern as shared type of paratransit. On the other hand, public owned conventional bus transport have fixed routes and fixed stops. The percent of public owned fleet size is very small as compared to the percent of paratransit units owned by private sectors except Malaysia.

2.7 Solving Transportation problem using Structural Equation Modeling (SEM)

Structural Equation Modeling has been extensively used to solve the transportation and travel related problems. In Switzerland, they integrate latent attitudes of the individuals into a transport mode choice model through latent variable and latent class models. Psychometric indicators are used to measure these attitudes (Atasoy 2012). The research in Philippine metro passengers focuses on the deteriorating level of service at the Metro Manila MRT-3, and the perception of regular morning peak period passengers on their commuting experience and its effects on them (Charis 2012). Using structural equation modeling (SEM) they developed a measurement model consisting of nine latent factors related to their commute – exogenous factors (commuting experience): perceived crowding, predictability, perceived air quality and perceived benefits; and endogenous factors (mediators and outcome): perceived risk, perceived service quality, awareness during the commute, mental adaptation and commuting stress. (Andra Charis 2012). Structural equation modeling (SEM) is an extremely flexible linear-in-parameters multivariate statistical modeling technique. It

has been used in modeling travel behavior and values since about 1980, and its use is rapidly accelerating, partially due to the availability of improved software (Thomas 2001).

SEM, is a very general statistical modeling technique, which is widely used in the behavioral sciences. It can be viewed as a combination of factor analysis and regression or path analysis. The interest in SEM is often on theoretical constructs, which are represented by the latent factors. The relationships between the theoretical constructs are represented by regression or path coefficients between the factors. The structural equation model implies a structure for the co variances between the observed variables, which provides the alternative name covariance structure modeling. LISREL is an abbreviation of Linear Structural relations, and the name used by Jöreskog for one of the first and most popular SEM programs. Now a days structural equation models need not be linear, and the possibilities of SEM extend well beyond the original Lisrel program. Browne (1993), for instance, discusses the possibility to fit non linear curves.

Structural equation models are often visualized by a graphical path diagram. The statistical model is usually represented in a set of matrix equations. In the early seventies, when this technique was first introduced in social and behavioral research, the software usually required setups that specify the model in terms of these matrices. Thus, researchers had to distill the matrix representation from the path diagram, and provide the software with a series of matrices for the different sets of parameters, such as factor loadings and regression coefficients. A recent developments software that allows the researchers to specify the model directly as a path diagram. This works well with simple problems, but may get tedious with more complicated models.For that reason, current SEM software still supports the command- or matrix-style model specifications too.

2.9 Examples of SEM-Models

Structural equation modeling has its roots in path analysis, which was invented by the geneticist Sewall Wright (Wright, 1921). It is still customary to start a SEM analysis by drawing a path diagram. A path diagram consists of boxes and circles, which are connected by arrows. In Wright's notation, observed (or measured) variables are represented by a rectangle or square box, and latent (or unmeasured) factors by a circler ellipse. Single headed arrows or 'paths' are used to define causal relationships in the model, with the variable at the tail of the arrow causing the variable at the point. Double headed arrows indicate covariance or correlations, without a causal interpretation. Statistically, the single headed arrows or paths represent regression coefficients, and double-headed arrows covariance. Extensions of this notation have been developed to represent variances and means (cf. McArdle, 1996).

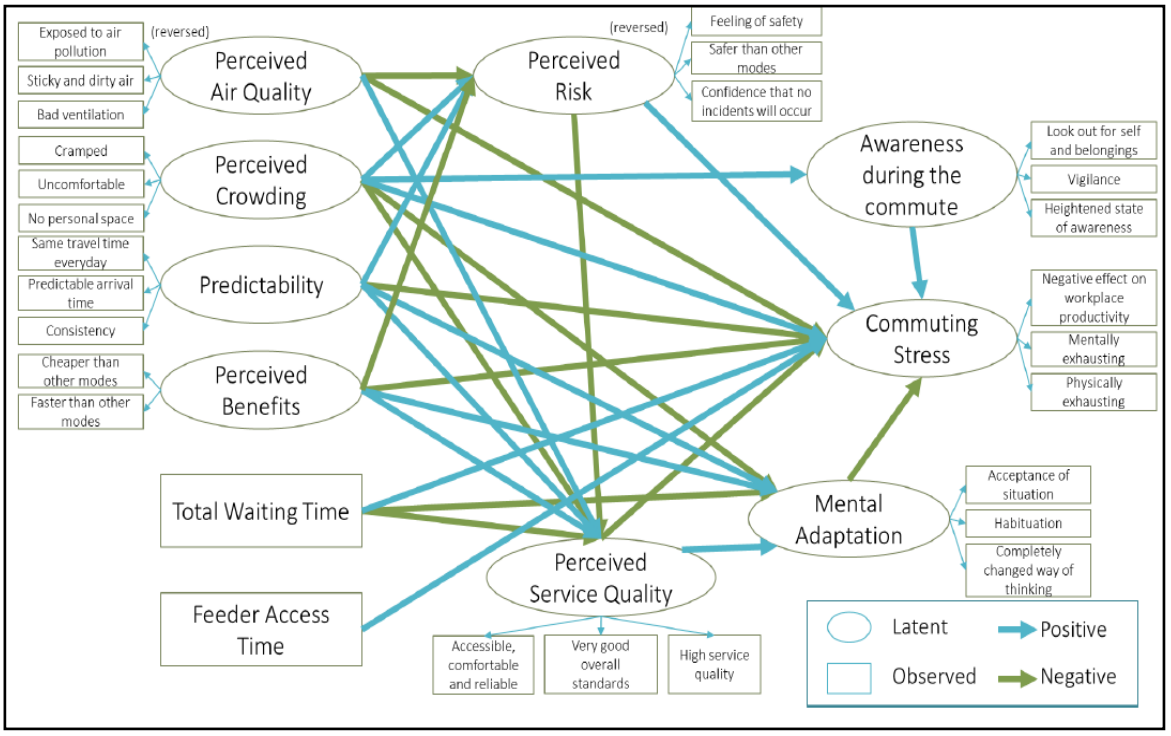


Fig 2.4: Example of a Travel behaviour research by Structure Equation Modelling

2.10 Future of Paratransit

In the future, urban rail system may relief the transport and traffic congestion problems in the cities of developing countries. But this needs a huge amount of capital investment which is almost impossible to manage for most of developing countries now. In the recent years, only Bangkok, Manila and Jakarta are planning to introduce urban rail system. In such circumstances, both non-motorized and motorized paratransit modes will continue its dominant role in the urban transport system (Pojani 2015).

As mentioned earlier that demand for non-motorized paratransit will be diminishing as the economic level is increased. But in the near future due to large employment generation and political reasons it will not be possible to withdraw the non-motorized paratransit completely (Tangphaisankun and, Akkarapol, 2009).

For such cities, it is necessary to segregate non-motorized traffic from high speed motorized transport flows for safety, except in areas where traffic speed or volume will remain low. This segregation can be achieved by making physical barrier on the road surface or providing separate lane for non-motorized transport such as cycle rickshaw lane in India and Bangladesh. Of course, the best policy would be to restrict the non-motorized transport to feeder service only. On the other hand, the operation of individual type of motorized paratransit can be confined to a feeder service - ie a "door to conventional public transport" service. The shared and collective type of paratransit may provide alternate services where public transport are not available.

2.11 Conclusion

The significant features of paratransit system in the cities of developing countries are their flexibility and door to door service. Their popularity as a public transport cannot be neglected as it is found that they carry two thirds of public transport passengers in Metro Manila for example. Certain obvious physical and technical differences have been found in terms of their passenger capacity, modal share and physical characteristics. As a private business, the paratransit vehicles are managed and operated by typical small scale independent enterprises, where most vehicles are rented on a daily basis. In some cities it generates a considerable percent of employment opportunity and also does not require much public resources which is a major attraction in many cities of developing countries with shortage of funds.

Even in the future, the role of paratransit as a transport mode cannot be underestimated in the cities of developing countries, but unfortunately, sufficient data is not available in this field in many countries. So in future, joint survey and research will be important and each government may need to change their policy and to find a cooperative measure to use a wide range of public transport modes including paratransit system in order to provide an appropriate transportation.

Chapter 3

Research Methodology

3.1 Introduction

A comprehensive field and questionnaire survey was carried out at fifteen different locations from the paratransit routes. The names of the questionnaire survey locations are:

- Farmgate (near Ananda Cinema, Tejgaon College and Tejturi Bazar).
- Newmarket (near Nilkhet and Home Economics College).
- Zigatola, Shamoly, Tejgaon, Mohammadpur, Shya Mosque.
- Gulistan (near Stadium, Nagarbhaba and Mazar), Rampura, and
- Mohkhali (near Amtoli and Railgate).

Table 3.1 Data collection included questions of following aspects

1	Prevailing Paratransit quality	13	Service features
2	Speed of Para Transit	14	Movement Flexibility
3	Punctuality and Reliability	15	Quality of Driver
4	Riding Safety	16	Travel Time (Office)
5	Travel Cost	17	Travel Time(Holidays)
6	Seat Comfort	18	Integration of sp Modes
7	Noise Level	19	Security of Goods
8	Lighting Facilities	20	Security of Passengers
9	Sitting Arrangement	21	Long Route mov performance
10	Cleanliness	22	Mov Flexibility in any Road
11	Ticketing System	23	System Performance
12	Ease of Entry-Exit	24	Physical Appearance

The statistical software STATA was used to develop the Structural equation model. The model provided suitable attribute affecting the service quality of paratransit.. There are total 21 factors highlighting the different aspects of paratransit like passenger safety, seat comfort etc. Estimation of SEM parameters in an iterative process finally produces the best fit solution to the input data.

3.2 Procedure of research Methodology

A two-step methodology is adopted for this research. The first part addresses data collection approach incorporating a purpose-built questionnaire survey. The performance variables included in the survey are selected from various focus group discussion and expert counsel of academicians, practitioners, bus operators and policy makers. A pilot survey is conducted to underline the difficulties in conveying the required information to users. The questionnaire is then finalized considering requisite amendment identified from the pilot survey.

The second part addresses the structural equation models developed in this study. Collected data is filtered for anomalies and a series of models are developed to understand thoroughly the relationships between the overall SQ of paratransit and SQ variables selected earlier. For each empirical model, the process of model development follows the approach of trial and error in terms of accommodating variables as well as by observing the overall goodness of fit values of the respective models. For testing parameter estimation, a two-tailed t-test with a critical value of 1.64 for 90% confidence level is considered as the threshold. The survey questions are given in Appendix of this paper. Table 3.2 shows the paratransit routes in Dhaka.

Table 3.2: Available para-transit Routes in Dhaka City

Sl. No	From	To
01	Gulistan	New Market
02	Gulistan	Azimpur
03	Gulistan	Madartek/Bashabo
04	Gulistan	Goran
05	Gulistan	Sipahibag
06	Gulistan	Mugdapara
07	Gulistan	Pilkhana (BGB 1 No. Gate)
08	New Market	Zigatola
09	New Market	Chak Bazar
10	Zigatola	Mohammadpur
11	Zigatola	Shyamoly
12	Farmgate	Mohammadpur
13	Farmgate	New Market
14	Farmgate	Mohakhali (Railgate)
15	Farmgate	Nabisco (Mohakhali)
16	Farmgate	Zigatola
17	Farmgate	Shyamoli
18	Farmgate	Mirpur-10
19	Mohakhali	Mirpur-10
20	Mohakhali	Gabtoli
21	Mohakhali	Mohammadpur
22	Shyamoli	Shia Moszid(Mohammadpur)
23	Mohammadpur	Badda (Link Road)
24	Mohammadpur	Gabtoli
25	Mohammadpur	Mirpur-10
26	ShiyaMoszid(Mohammadpur)	Mirpur-1
27	Malibag	Mugdapara

Survey locations have been selected from the highlighted routes to cover the maximum vicinity of para-transit service. The table 3.3 shows the locations those are selected for survey.

Table 3.3: Locations for Questionnaire Survey

Ser	Para-Transit Route	Survey Location	Distance (km)
01.	Farmgate – New Market	Beside Ananda Cinema Hall	2.76
02.	Zigatola – Shyamoly	Zigatola (Beside JBFH)	3.90
03.	Shyamoly – ShiyaMoszid	Beside Shyamoly Cinema Hall	1.50
04.	Farmgate – Mohammadpur	Beside Tejgaon College	3.27
05.	Farmgate – Nabisco (Mohakhali)	Beside Tezturi Bazar	2.74
06.	Mohammadpur – Mirpur -10	Beside Mohammadpur Stand	6.40
07.	ShiyaMoszid – Mirpur-1	Beside ShiyaMoszid	4.98
08.	Gulistan – New Market	Beside GulistanMazar	3.11
09.	Gulistan – Azimpur	Beside DSCC office	4.54
10.	Gulistan – Khilgaon / Bashabo	Beside Gulistan Stadium	3.99
11.	New Market – Chak Bazar	Beside Home Economics	3.02
12.	New Market – Zigatola	West Side of NilkhetMor	2.24
13.	Mohakhali – Mirpur-10	Mohakhali (Railgate)	7.10
14.	Mohakhali – Gabtoli	Mohakhali (AmtoliMor)	8.20
15.	Rampura – Malibag	Rampura Beside Canal	3.50

After selection of survey locations, a survey schedule has been prepared to complete the survey properly. Table 3.4 shows the schedule of questionnaire survey.

Table 3.4: Questionnaire Survey Schedule

	Paratransit Route	Date	Time	Location of Survey
01	Farmgate – New Market	14/06/2016	8.00 am	Ananda Cinema Hall
02	Zigatola – Shyamoli	14/06/2016	12.00 p	Zigatola (Beside JBFH)
03	Shyamoli – ShiyaMoszid	15/06/2016	8.00 am	Shyamoly Cinema Hall
04	Farmgate – Mohammadpur	16/06/2016	8.00 am	Beside Tejgaon College
05	Farmgate – Nabisco	16/06/2016	3.00 pm	Beside Tezturi Bazar
06	Mohammadpur – Mirpur -10	29/06/2016	4.00 pm	Mdpur Bus Stand
07	ShiyaMoszid – Mirpur-1	29/06/2016	8.00 am	Beside ShiyaMoszid
08	Gulistan – New Market	30/06/2016	12.00 p	Beside GulistanMazar
09	Gulistan – Azimpur	30/06/2016	4.00 pm	Beside DSCC Office
10	Gulistan – Khilgaon / Bashabo	01/07/2016	8.00 am	Beside Gulistan Stadium
11	New Market – Zigatola	01/07/2016	12.00 p	West side of NilkhetMor
12	New Market – Chak Bazar	02/07/2016	4.00 pm	H. Economics College
13	Mohakhali – Mirpur-10	02/06/2016	8.00 am	Mohakhali (Railgate)
14	Mohakhali – Gabtoli	05/07/2016	12.00 p	Mohakhali (AmtoliMor)
15	Rampura – Madartek	05/07/2016	4.00 pm	Rampura Beside Canal

3.3 Details of selected routes and study locations

3.3.1 Farmgate ↔ New Market: It is one of the busiest routes of Para-Transit in Dhaka City. Figure3.1 shows the location map of this route.

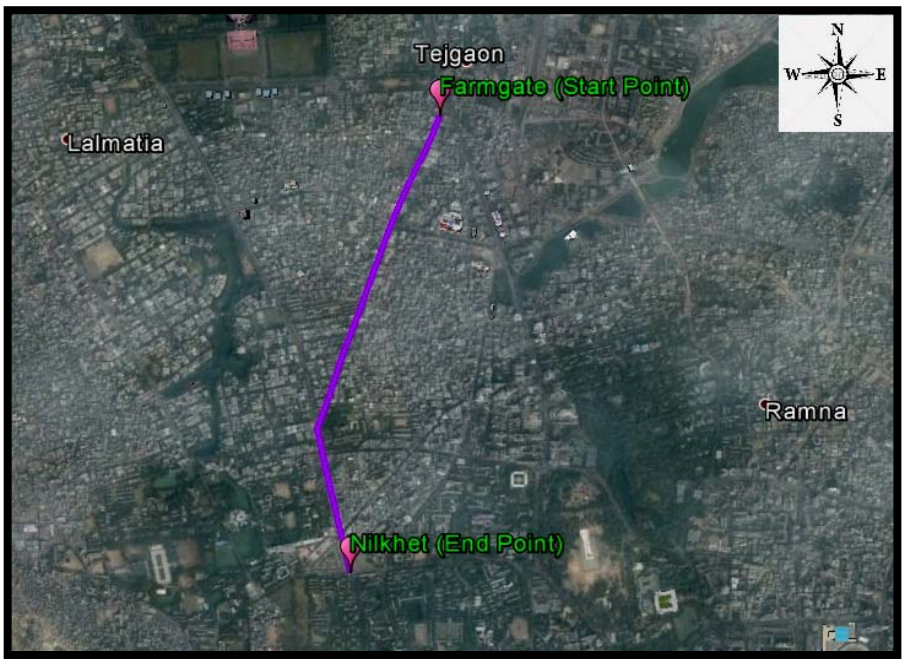


Figure 3.1: Location Map of Farmgate to New Market route.

We select Farm Gate (Beside Ananda Cinema Hall) as a location of our survey. Figure 3.2 shows the survey location at Farm gate.

Figure 3.2: Existing Condition of para-transit system at Farm Gate (Beside Ananda Cinema Hall)

3.3.2 Zigatola ↔ Shyamoli: This is another popular route of para-transit. People from Dhanmondi & Zigatola Residential area are the main user of this route. They use this route for their services or businesses or education purpose. The location map of this route shown in Figure 3.3.

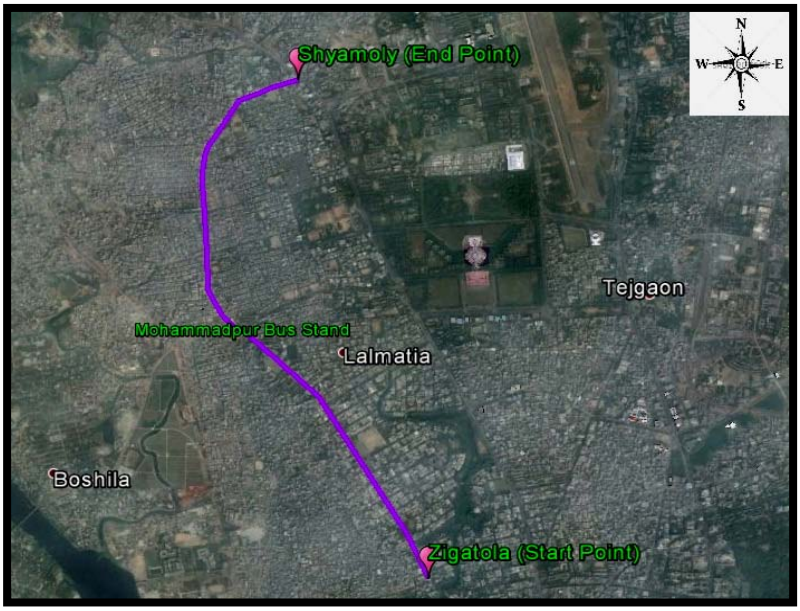


Figure 3.3: Location Map of Zigatola to Shyamoli route.

We conduct our survey at Zigatola (Beside Japan Bangladesh Friendship Hospital). Figure 3.4 shows the existing condition of para-transit at that point.

Figure 3.4: Existing Condition of para-transit system at Zigatola (Beside JBFH)

3.3.3 Shyamoli↔ShiaMoszid (Mohammadpur): Shyamoli is one of the busy traffic point of Dhaka city. It is connected to whole Dhaka city for the availability of various business or service here. Shyamoli to Shia Moszid is another busy route for para-transit. Figure 3.5 shows the Location Map of this route.

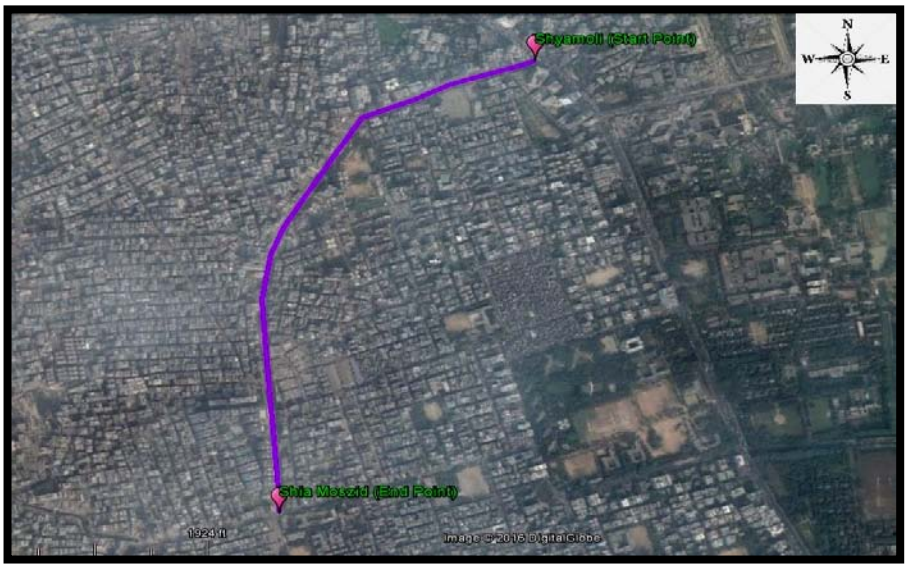


Figure 3.5: Location Map of Shyamoli to shia moszid route.

Shyamoli bus stand has been selected as a questionnarie survey location because it is a starting point of shyamoli- shiya moszid route. Figure 3.6 represents the existing condition ofpara-transit system at shyamoli (beside cinema hall).

Figure 3.6: Existing Condition of para-transit system at Shyamoli

3.3.4 Farm Gate ↔ Mohammadpur Bus Stand: Farmgate to Mohammadpur is another busy route of para-transit. This route has also other bus services but some people specially the women and students use para-transit service to avoid travelling

hazards. The Location Map of this route shown in Figure 3.7.

Figure 3.7: Location Map of Farmgate to Mohammadpur Bus Stand route.

Survey for Farmgate to Mohammadpur route has been done at Farm Gate (Beside Tejgaon College) as it is the starting point of this route. Figure 3.8 shows existing condition of para-transit vehicles at this point.

Figure 3.8: Existing Condition of para-transit vehicles at Farm gate (Tejgao College)

3.3.5 Farmgate ↔ Nabisco (Mohakhali): The roads are narrow in this route so para-transit is more suitable than buses. People are using this route to save time also. The Location Map of this route is given below:

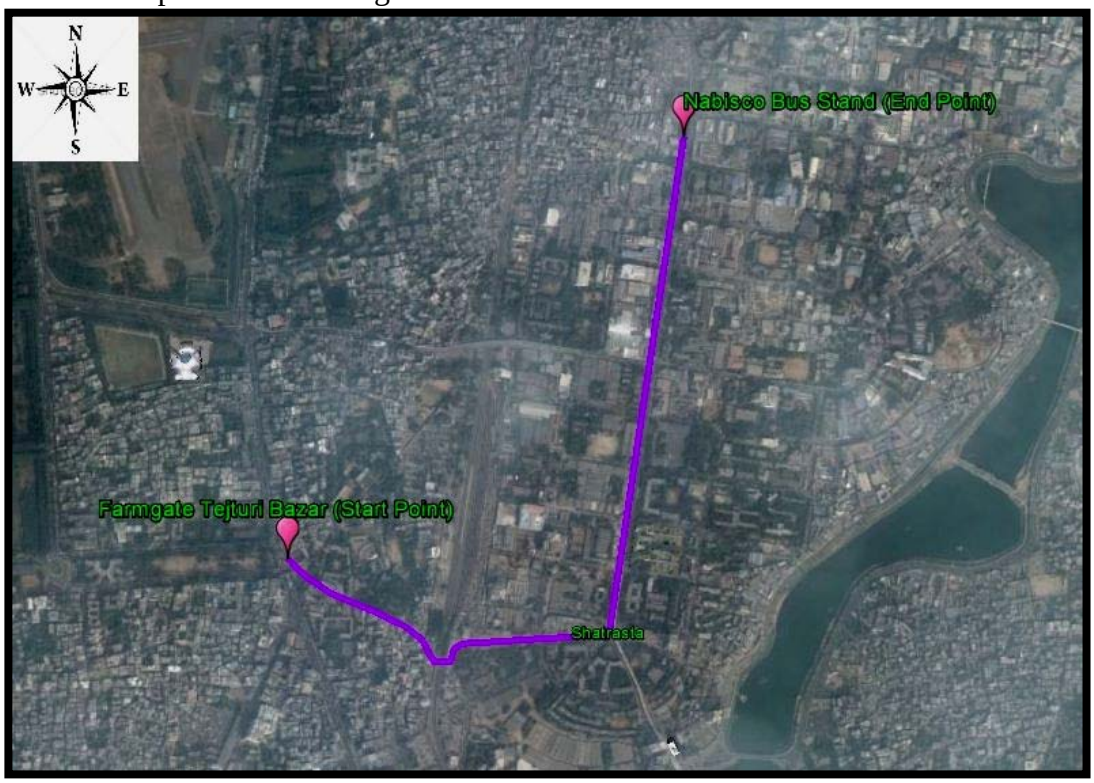


Figure 3.9: Location Map of Farmgate to Nabisco Bus Stand route.

Questionnaire survey was done at Tejturi Bazar, Farmgate. Figure 3.10 shows the existing condition of para-transit system at this point.

Figure 3.10: Existing Condition of para-transit system at Farm gate (Tejturi Bazar)

3.3.6 Mohammadpur ↔ Mirpur-10: This is also a busy route of para-transit. Everyday a lot of people are travelling from Mohammadpur to Mirpur-10 or Mirpur-10 to Mohammadpur for their daily needs. The Location Map of this route is presented in Figure 3.11.

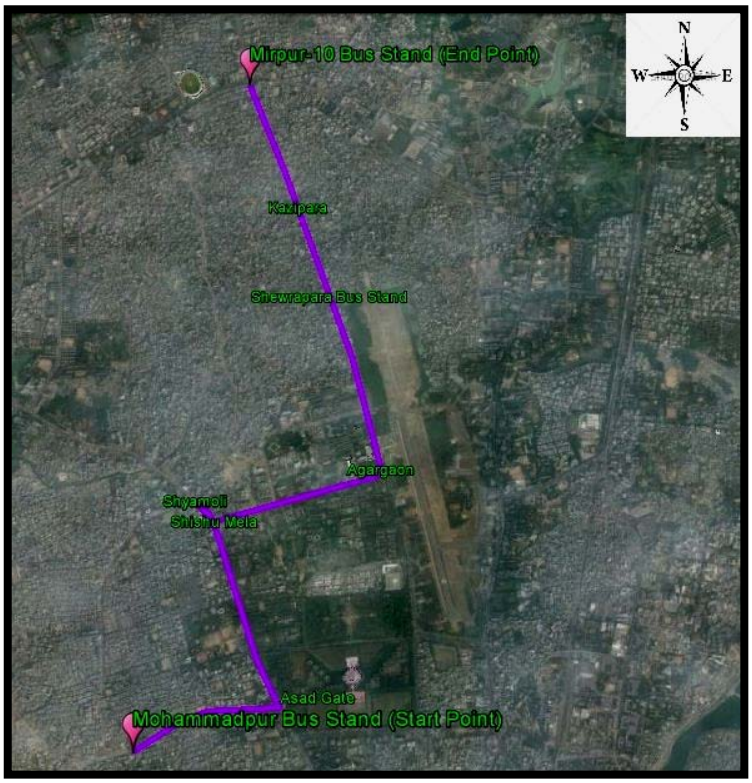


Figure 3.11: Location Map of Mohammadpur to Mirpur-10 Bus Stand route.

Questionnaire survey was conducted at the point of Mohammadpur bus stand. Figure 3.12 shows the existing condition of this point.

Figure 3.12: Existing Condition of para-transit system at Mohammadpur Bus Stand

3.3.7 Shia Moszid (Mohammadpur) → Mirpur -1: Shia Moszid is an important place situated in Mohammadpur which is mainly a residential area; on the other hand Mirpur-1isone of the busiest commercial area of Dhaka. Questionnaire survey was done at Shia moszid area because generally people are starts their journey from here. Existing condition of shia moszid point and the location map of this route are presented in 3.13 and 3.14 respectively.

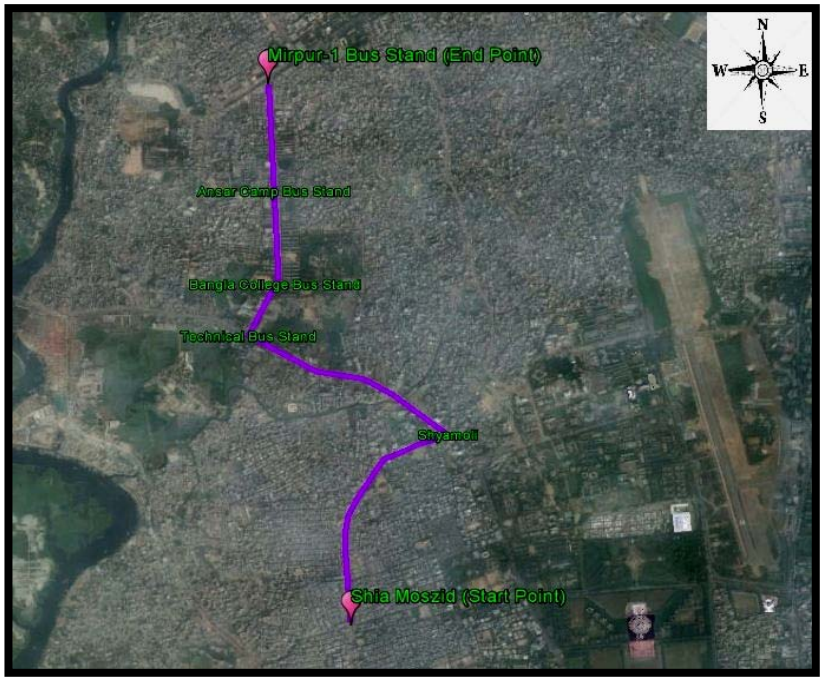


Figure 3.13: Location Map of Mohammadpur to Mirpur-10 Bus Stand route.

Figure 3.13: Existing Condition of para-transit system at Shiya Moszid

3.3.8 Gulistan ↔ New Market: Gulistan and New Market both are busy commercial area of the city, a lot of people travel from here to there daily by para-transit. There are also bus services in this route but users' choose para-transit for its flexibility. This route starts from Gulistan and goes to New Market through Banga Bazar, Chankharpul and palashi.

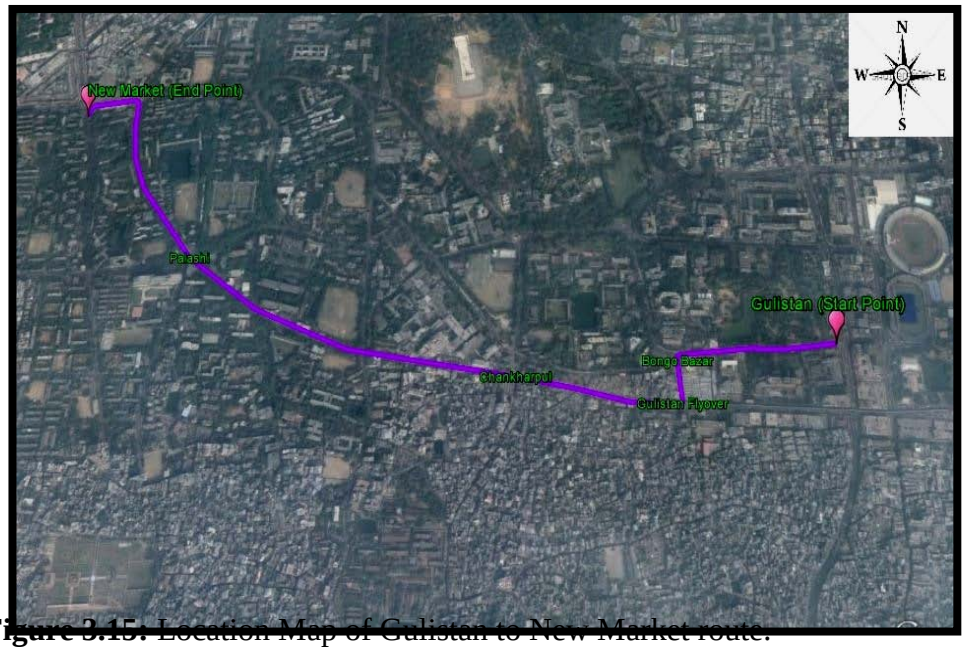


Figure 3.15: Location Map of Gulistan to New Market route.

Questionnaire survey conducted at Gulistan point (Beside Golap Shah Mazar). The existing condition of this point is presented in figure 3.16.

Figure 3.16: para-transit system at Gulistan (Beside Golap Shah Mazar)

3.3.9 Gulistan ↔ Azimpur: Gulistan to Azimpur is another route of para-transit service in this area. Sometimes Leguna of Gulistan to New Market route is going from this route. Figure 3.17 shows the location map of this route.

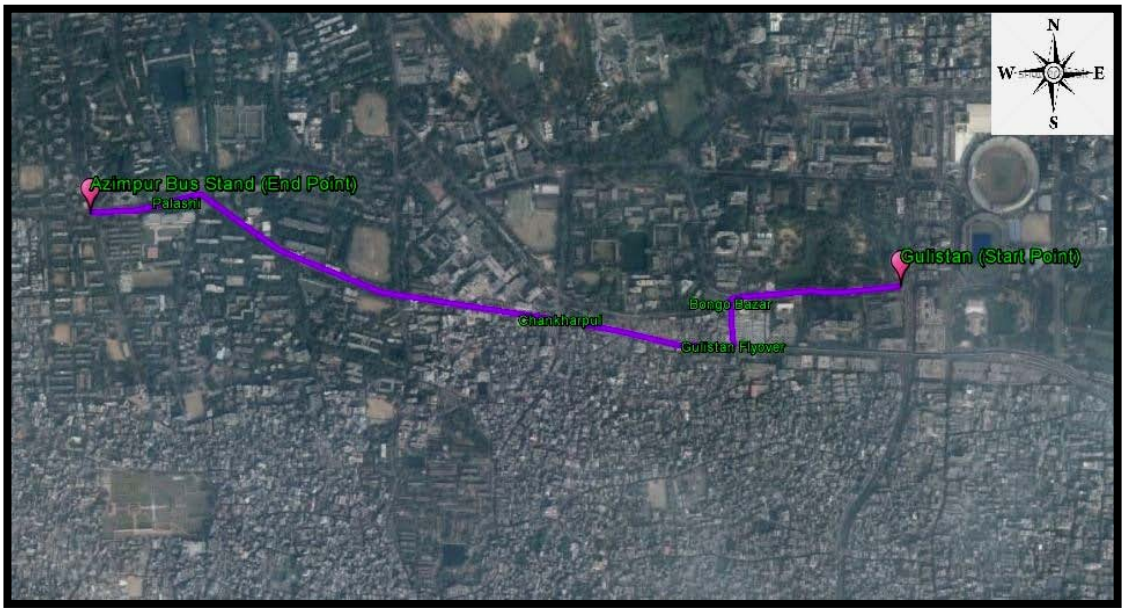


Figure 3.17: Location Map of Gulistan to Azimpur route.

Azimpur is a residential area from where people come to Gulistan daily for their work and other purposes. Most of the vehicles of this route are stands at Gulistan so questionnaire survey was conducted at Gulistan (besides DSCC building) to know the actual condition of the service.

Figure 3.18: Existing Condition of para-transit system at Gulistan (Beside DSCC Building)

3.3.10 Gulistan ↔ Khilgaon / Bashabo: Gulistan is the busiest commercial area of the city, so people come here daily from all around the city, as they came from Bashabo and Khilgaon area. Existing Condition of para-transit system at Gulistan (Beside Stadium) and the location map of this route areshown in figure 3.19 and 3.20 respectively.

Figure 3.19: Existing Condition of para-transit system at Gulistan to Basabo (Beside Stadium)

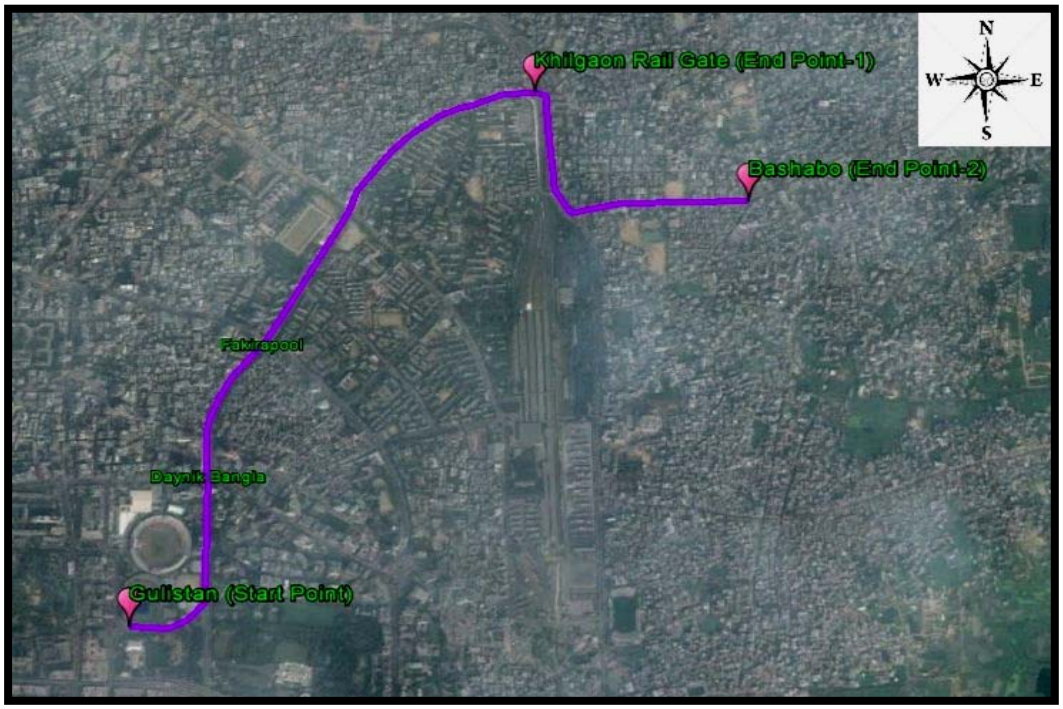


Figure 3.20: Location Map of Gulistan to Khilgaon / Bashabo route

3.3.11 New Market↔ Zigatola: There are several buses running in this route but para-transit service is also running here because of its availability and flexibility. Questionnaire survey was done at New Market (West Side of Nilkhet Mor). Existing Condition of para-transit system at this point and the location map of New Market-Zigatola route are presented in figure 3.21 and 3.22 respectively.

Figure 3.21: Existing Condition of para-transit system at New Market (West side of Nilkhet Mor)

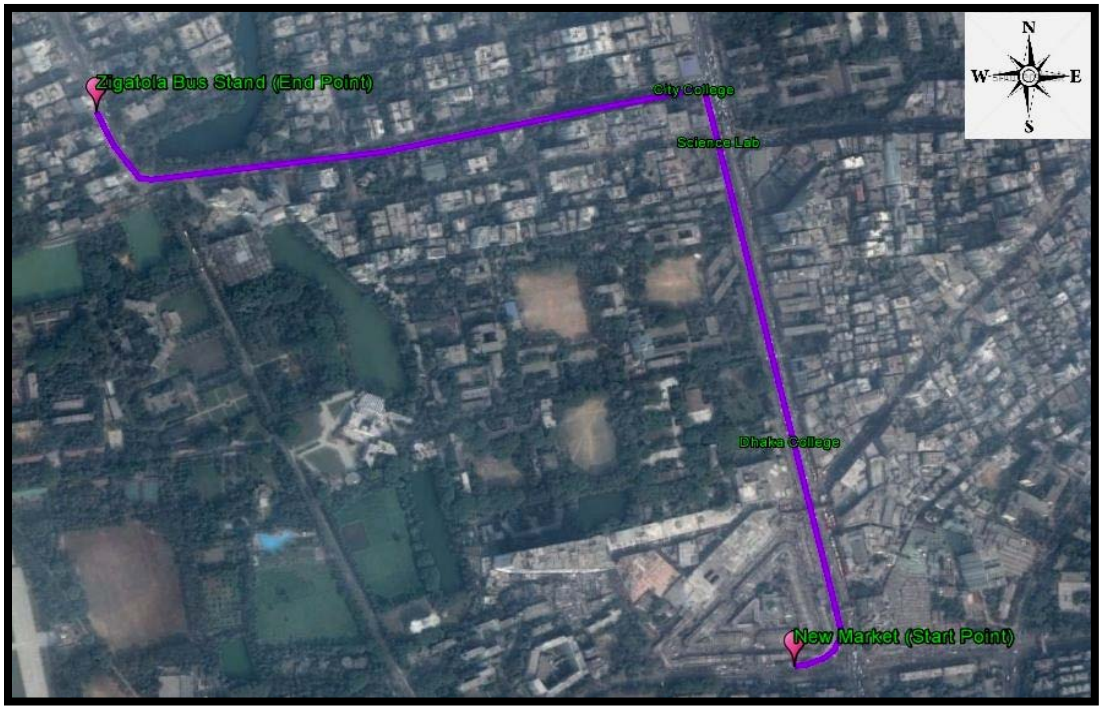


Figure 3.22: Location Map of New Market to Zigatola route

3.3.12 New Market ↔ Chakbazar: This is another route of para-transit in New Market area. Survey was conducted at New Market Side (Beside Home Economics College). Figure 3.23 and 3.24 shows the Existing condition and location map of this route respectively.

Figure 3.23: Existing Condition atNew Market (Beside Home Economics College)

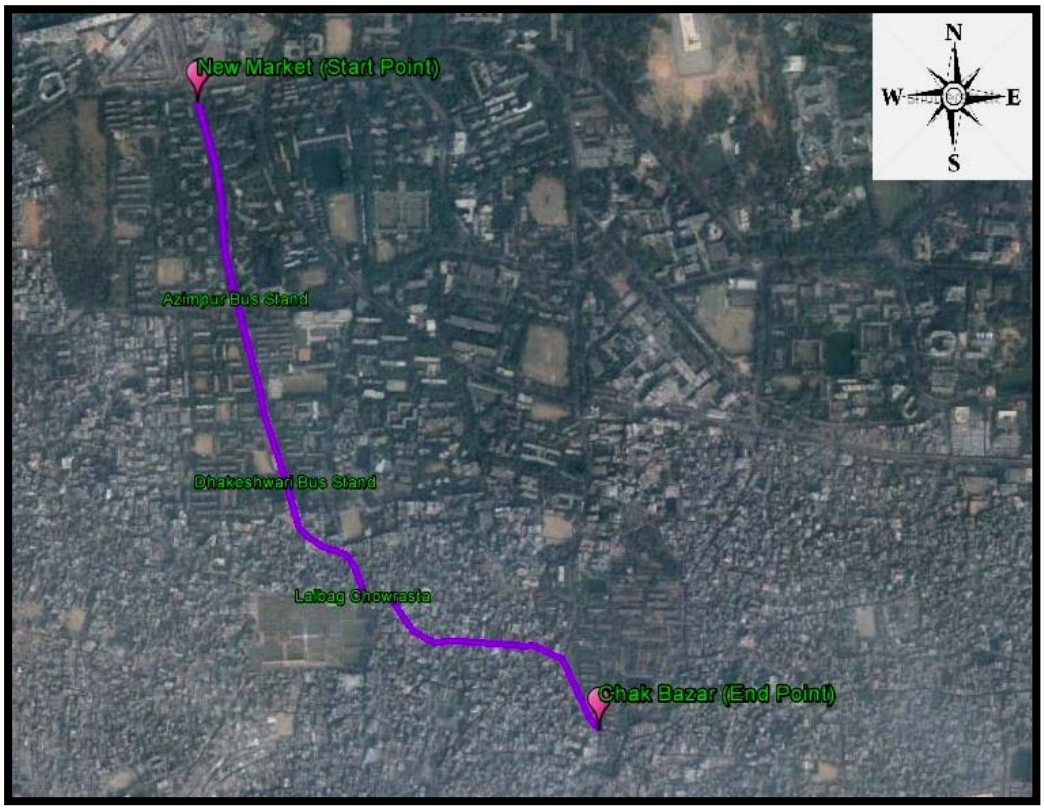


Figure 3.24: Location Map of New Market to Chak Bazar route

3.3.13 Mohakhali ↔ Mirpur -10: Mohakhali and Mirpur-10 both are commercial area and a lot of people travel in between these locations daily. Questionnaire survey was done at Mohakhali Rail gate. Existing condition and the location map is presented in figure 3.25 and 3.26 respectively.

Figure 3.25: Existing Condition of para-transit system at Mohakhali Rail gate

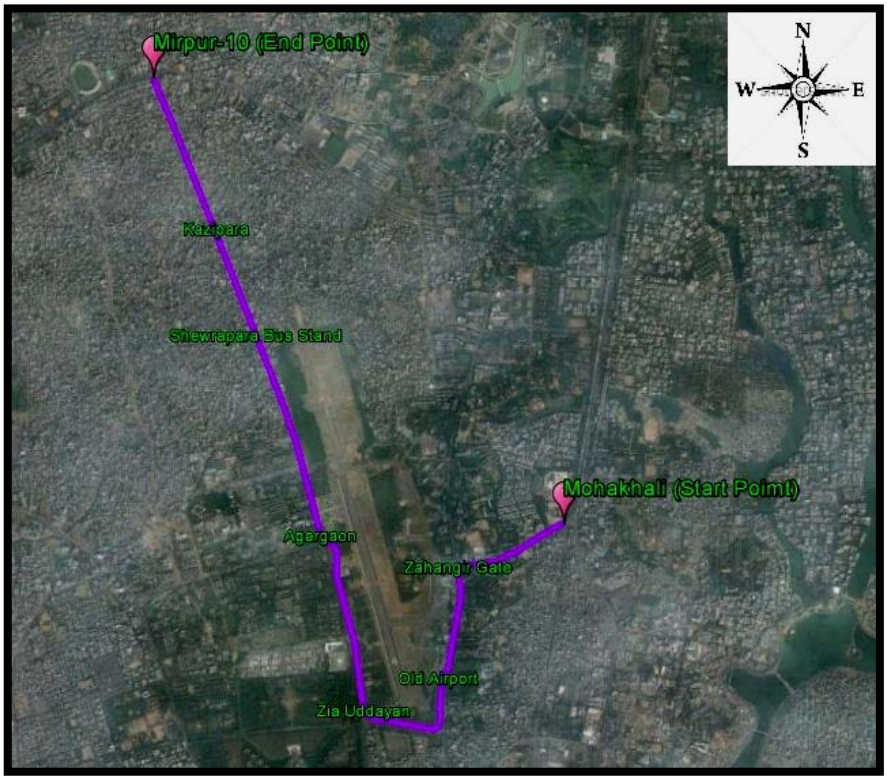


Figure 3.26: Location Map of Mohakhali to Mirpur-10 route

3.3.14 Mohakhali ↔ Gab toli: Mohakhali to Gabtoli is another busy route of traffic and para-transit also. People usually come to mohakhali and gabtoli for their works. Students also travel in this route for their educational purposes. Survey was done at Mohakhali (Amtoli Mor) which is one of the starting point of this route. Figure 3.27 and 3.28represents the existing condition at Mohakhali (Amtoli Mor) & the location map of this route respectively.

Figure 3.27: Existing Condition of para-transit system at Mohakhali (Amtoli Mor)

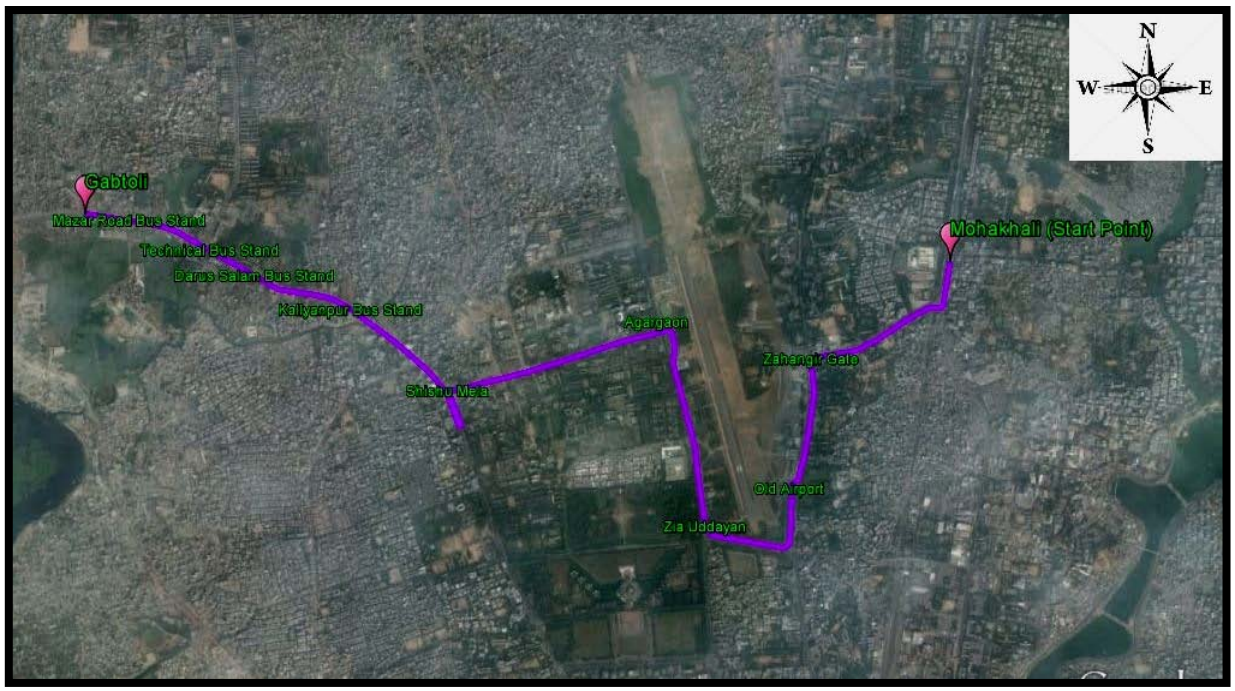


Figure 3.28: Location Map of Mohakhali to Gabtoli route

3.3.15 Rampura ↔ Madartek: This is another important route of para-transit in the city. Thousands of people travel in this route daily. Questionnaire survey was done at Rampura (Beside canal).

Figure 3.29: Existing Condition of para-transit system at Rampura (Beside TV Center)

Figure 3.30: Location Map of Rampura Bridge to Madartek route

3.4 The various classifications of Respondents

Around 30 skilled enumerators carried out face-to-face interviews at main paratransit stops around Dhaka city throughout the month of June and July, 2016. Data collection was set forth with an initial target of 2500 samples. However, reluctance to participate from the users, rush hour movements, and other unexpected situations restricted the random data samples to 2200. After filtering the anomalies, the remaining sample size was 2008. The fig 3.31 shows the respondents according to male and female, where 83% are male and rest 17% are female.

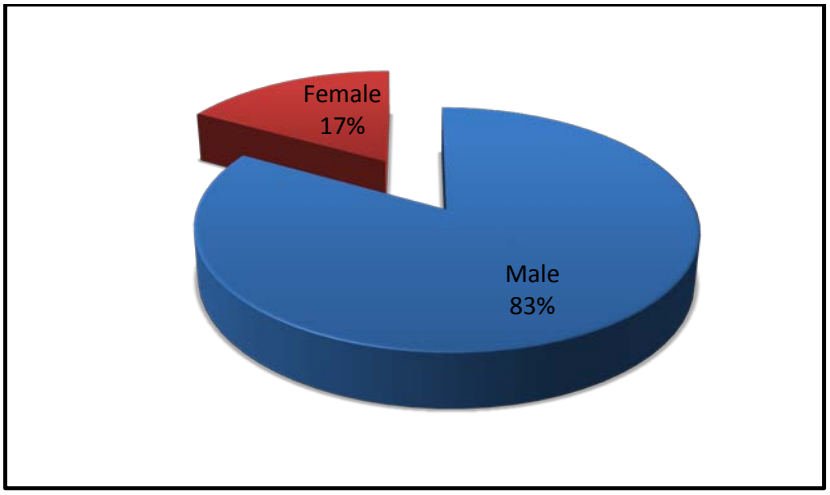


Fig 3.31: The Classification of Respondents according to Gender.

The fig 3.32 shows the respondents according to age group, where 39% are between 20-29 years old being the largest group. The second largest group is 32% between the age 30-39 years of age.

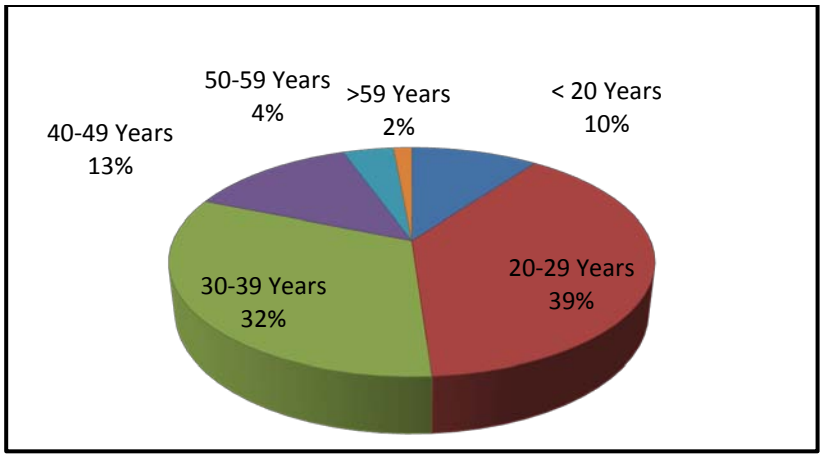


Fig 3.32: The Classification of Respondents according to age group.

Fig 3.33 classify the respondents according to age group. Here 34% has income between 15000-20000 tk per month. The lowest is the people having income less than 5000 per month.

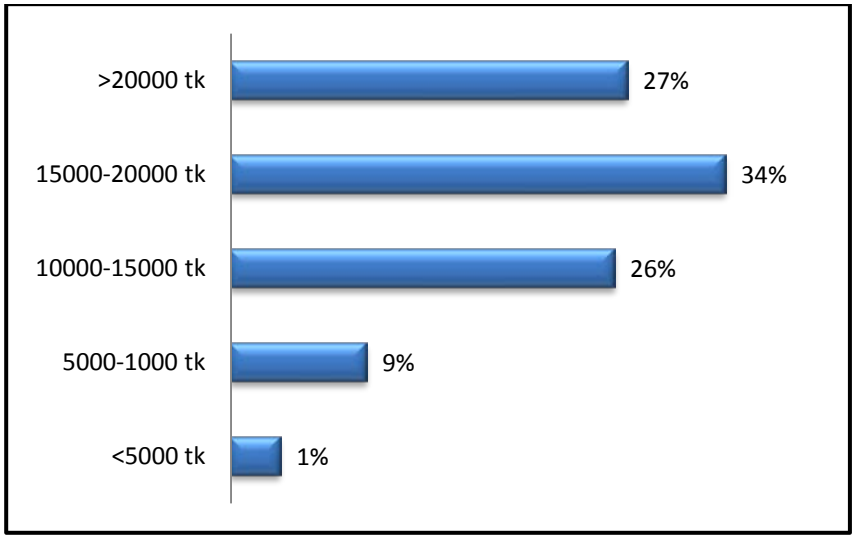


Fig 3.33: The Classification of Respondents according to monthly income.

Figure 3.34 is about the classification according to education where primary level education is highest 38% and uneducated level is about 26%

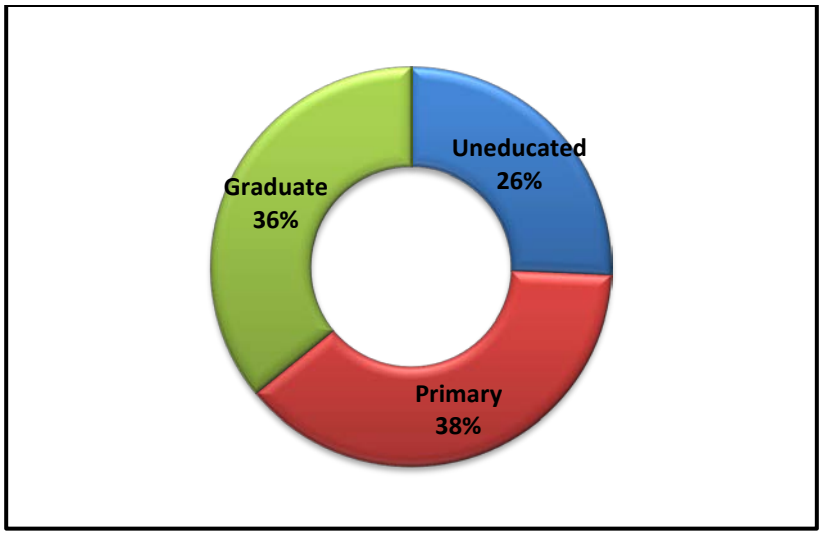


Fig 3.34: The Classification of Respondents according to education.

The final classification is about professions of respondents in figure 3.35. Here the highest paratransit users are students (29)% and second highest is the service holders (21)% of lower income people. The lowest are the housewives (9)%.

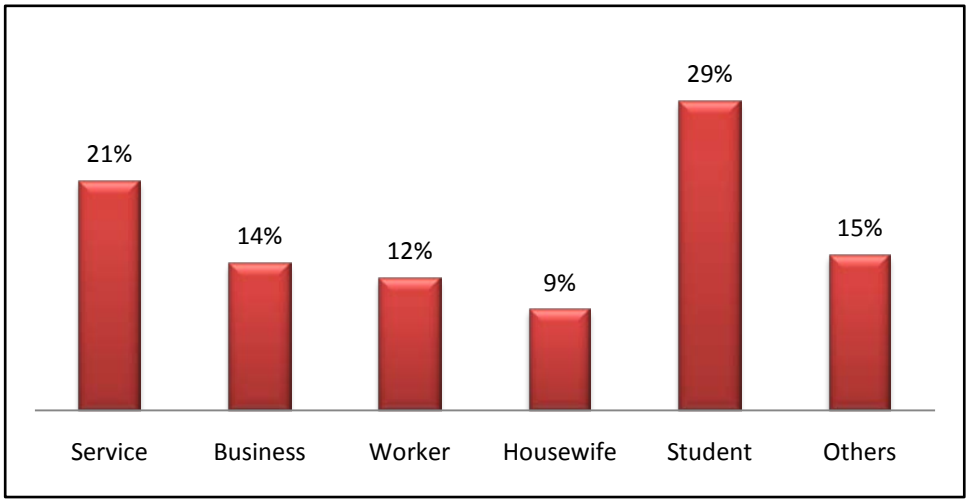


Fig 3.35: The Classification of Respondents according occupation.

3.5 Conclusion

This chapter gives a detailed overview of the study methodology as well as the data collection in the study sites. The data collection process was complex and time consuming. The questionnaire is structured into two sections. The first section aims to acquire information regarding socioeconomic characteristics of users (gender, age, occupation) and purpose for travelling. The second section focuses on twenty one SQ variables provided in a close ended format with relevant alternatives. The section aims at collecting benchmark points on a quantitative scale of 1 to 5 to rate the performance variables for a particular paratransit route, where 1 and 5 corresponds to excellent and very poor, respectively. A sample question is attached as an appendix at the end of this paper.

Chapter 4

Data Analysis and Model Generation

4.1 General

The main objective of this chapter is to assess the users' perception about the service of quality of paratransit in Dhaka city. This Chapter contains the general response of the paratransit users, data analysis of the question of survey and the details of model development by SEM.

4.2 Process of Data Analysis

Respondents all around Dhaka city were selected randomly from 15 different locations for survey. All the data from 2008 respondents were collected and stored in Microsoft excel. These data were analyzed to find out the general perception of paratransit users in Dhaka City. Thereafter Estimation of SEM parameters is done to produce the best fit solution to the input data.

4.3 Users' satisfaction ratings about paratransit service in Dhaka city

Question A: What is your idea about the prevailing para transit quality?

In this question we asked respondents about the existing condition of paratransit service quality. Around half (42%) of the respondents said that overall quality of paratransit service is Satisfactory while 30% users' think that existing condition is good. Figure 4.1 shows the user perception about prevailing paratransit quality.

Figure 4.1: User Perception about prevailing paratransit service quality

Question B: How about seat comfort level?

In paratransit service of Dhaka city, seat comfort level is not good enough. 51% respondents said that seat comfort level is poor and 20% opined that it is in very poor condition. Fig 4.2 shows that more than half of the population opined that the seat is not comfortable.

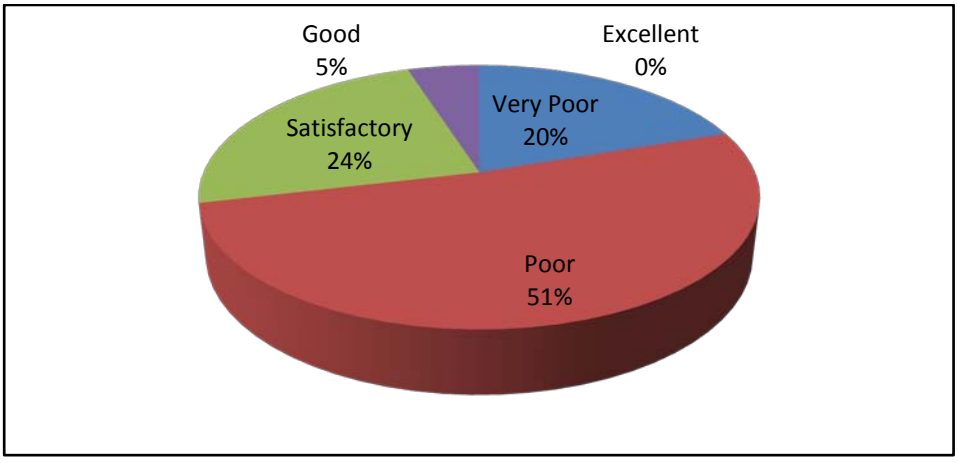


Figure 4.2: User Perception about seat comfort level of paratransit service

Question C: What is your idea about Fitness of paratransit vehicle?

In this question, respondents were asked about the fitness condition of paratransit vehicles. 48% of the users' said that the conditions of paratransit vehicles are poor (48%).

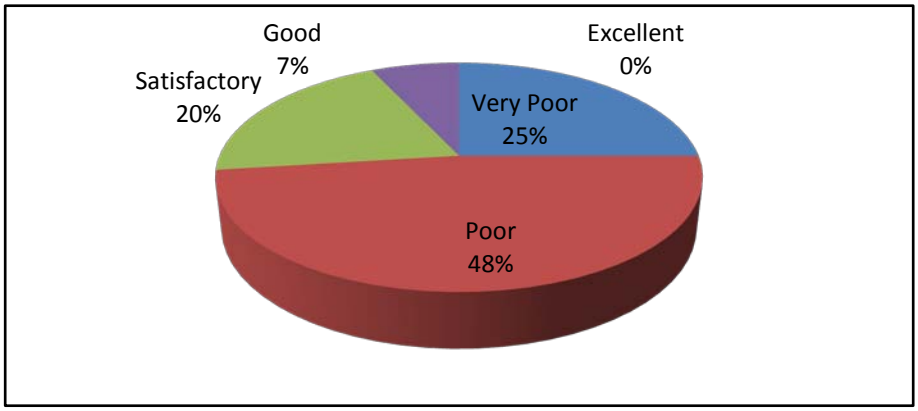


Figure 4.3: User Perception about Fitness of paratransit vehicle

Question D: How about Noise Condition of paratransit vehicle?

It is found that the noise condition of paratransit is not good enough. 45% of the respondent said that noise level is poor (noisy) while 33% mentioned it as satisfactory.

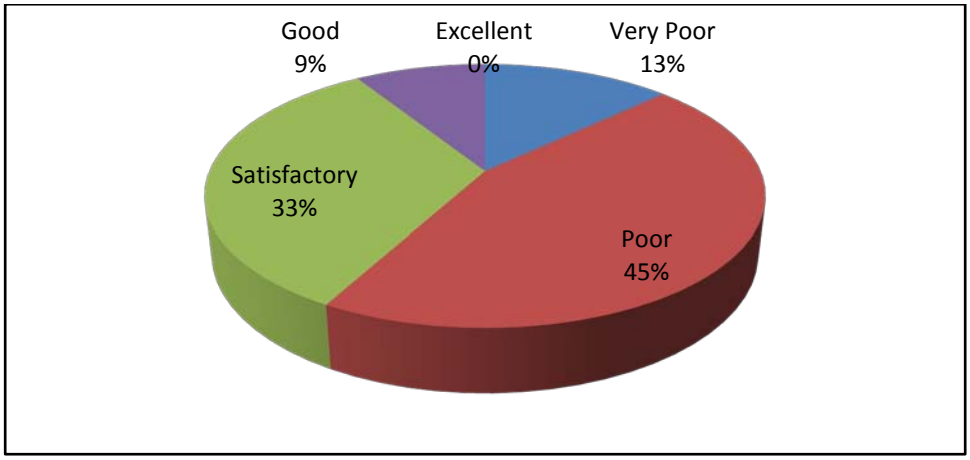


Figure 4.4: User Perception about Noise Condition of paratransit

Question E: What is idea about lighting facilities of paratransit vehicle?

Most of the time there is a small lighting facility available in a vehicle which is not sufficient for passenger. Sometimes passengers have to travel a vehicle which has no lighting system. Major portion (39%) of the respondents said that lighting facilities of paratransit is poor, while 33% said that it is satisfactory.

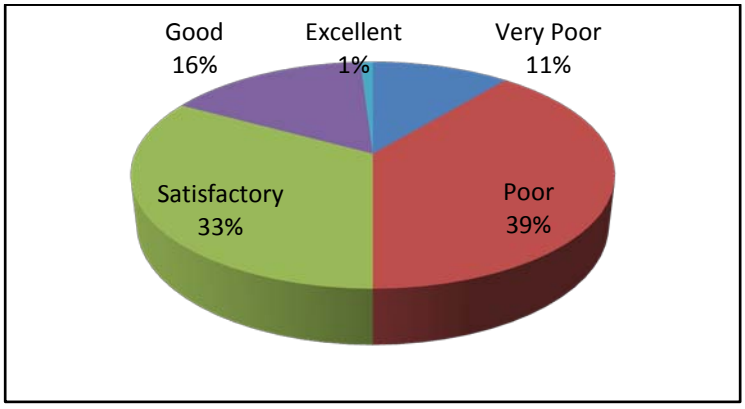


Figure 4.5: User Perception about lighting facility of paratransit

Question F: What do you think about cleanliness of paratransit vehicle?

Cleanliness of the vehicle was found satisfactory according to the users' rating. 42% respondents mentioned it is satisfactory while 35% said that it is poor.

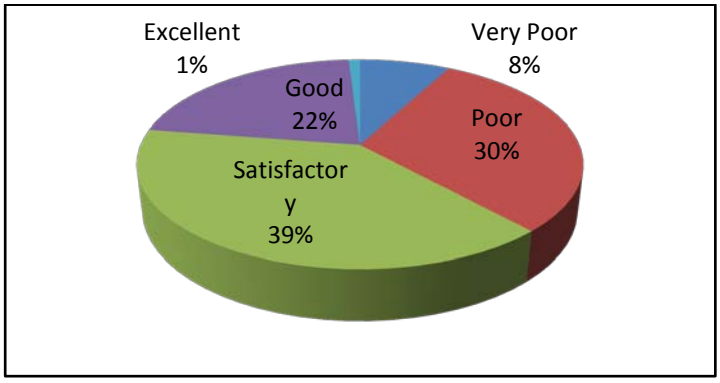


Figure 4.6: User Perception about cleanliness of paratransit

Question G: What do you think about ticketing system?

Basically there is no standard ticketing system in paratransit service. People pay fare on board based on distance. Major portion of the respondents think that this system is satisfactory (40%), users' also mentioned that this system is good (22%) while 31% opined that the existing system is poor.

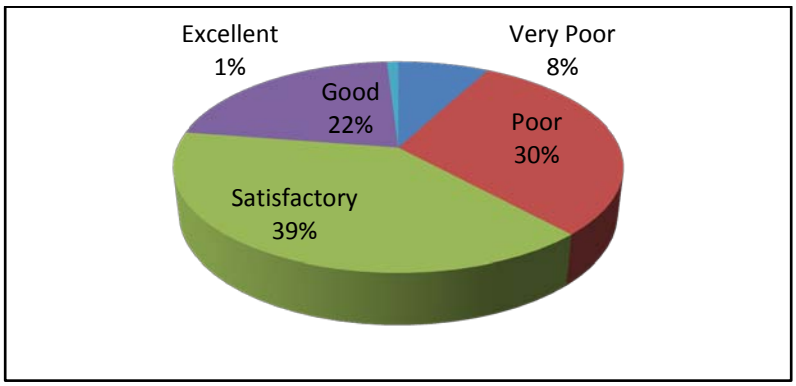


Figure 4.7: User perception about ticketing system of paratransit

Question H: What is your opinion about ease of entry-exit in paratransit system?

The ease of entry-exit of paratransit is not good enough, so most of the users' respond that it is poor (55%) and some respondents think that it is very poor (25%). Users also think that it is one of the major limitation/disadvantage of travelling by paratransit.

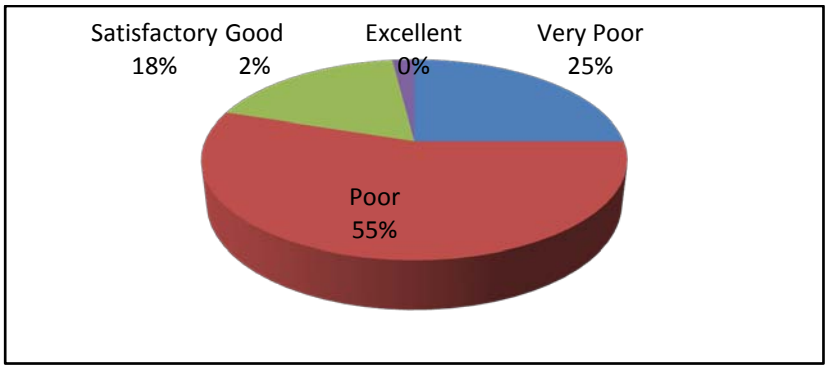


Figure 4.8: User perception about ease of entry-exit system of paratransit

Question I: What is your comment about sitting arrangements in paratransit system?

One of the main problems of travelling by paratransit in our country is its sitting arrangements. It's always so congested that passengers can not able to move even for paying their fare. Most of the respondents said that its poor (48%), some users' thinks that it's very poor (36%) and only 14% mentioned it as satisfactory.

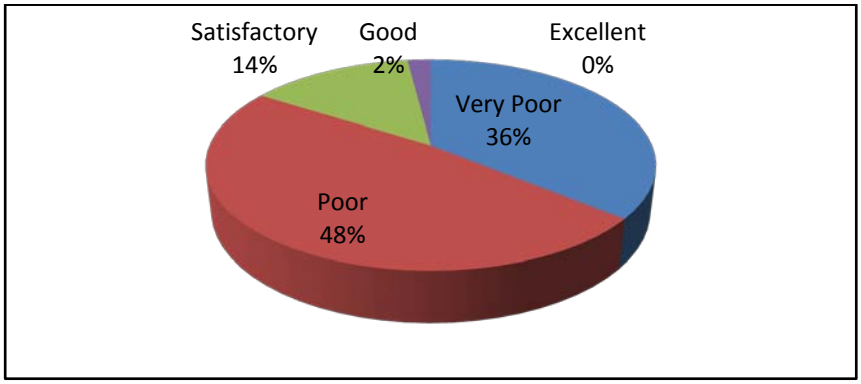


Figure 4.9: User perception about sitting arrangements in paratransit system

Question J: What is your opinion about movement flexibility in paratransit system?

As the sitting arrangement is not good enough to the passenger so movement flexibility is also not satisfactory. 42% respondents said that movement flexibility is poor in condition, 35% opined that it is very poor and 17% said that it is satisfactory.

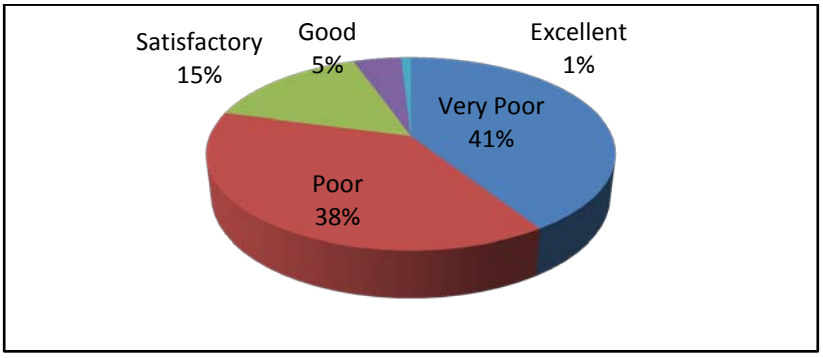


Figure 4.10: User Perception about movement flexibility in paratransit system

Question K: What do you think about quality of driver of paratransit vehicle?

Respondentsprovide different opinion about quality of driver. Some of them said they are satisfactory (31%), some users' said the quality of driver is poor (27%) as they have not proper training, education etc. 21% respondents mentioned the quality of driver is very poor as they drive very rough sometimes. Accident is a common scenario in this service.

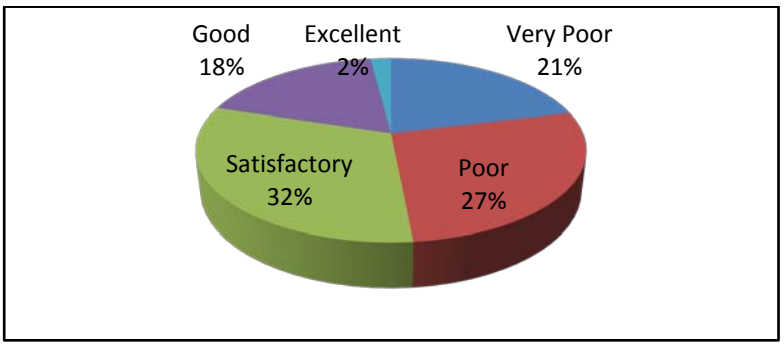


Figure 4.11: User Perception about driver's quality of paratransit service

Question L: What is your idea about speed of paratransit?

Speed is one of the most important factors that influence uses to choose paratransit service in Dhaka city. Because of their size paratransit vehicle (Tempo, Leguna) can move faster than buses.Major portionof the respondents said that speed of the vehicle is good (41%) .

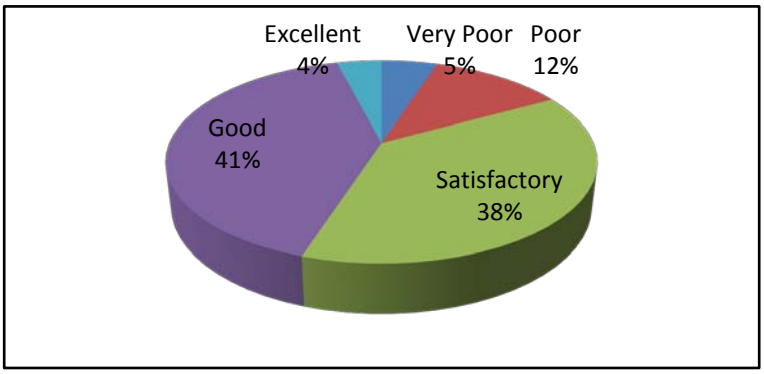


Figure 4.12: User Perception about speed of paratransit vehicle

Question M: What is your comment about availability of paratransit vehicle?

Availability of paratransit vehicle varies with the demand. It is more available in off-peak time than office time because the demand is decreased. Most of the respondents (47%) mentioned the service quality is satisfactory in terms of availability and only 12% users opined it as poo r.

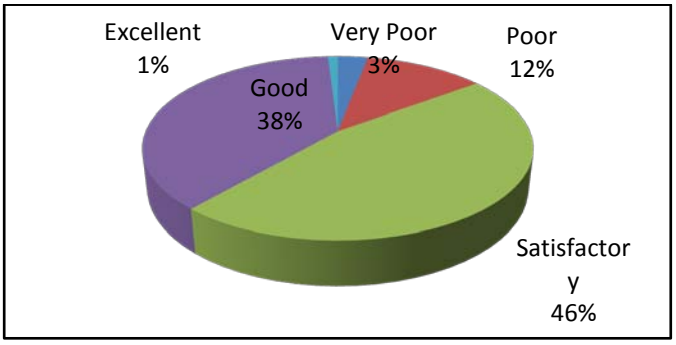


Figure 4.13: User Perception about availability of paratransit vehicle

Question N: What do you think about travel time (office days) by paratransit service?

Travel time (office days) depends on traffic volume on the road. In Sunday and Thursday, traffic volume is high so it takes time to go somewhere. Major portion of the respondents (33%) said that travel time is poor (more time consuming) in office days. on the other hand, 32% of the respondents mentioned that the travel time is satisfactory.

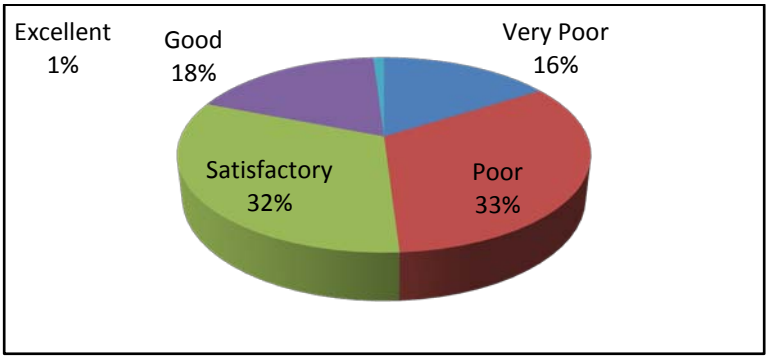


Figure 4.14: User Perception about travel time (office days) by paratransit service.

Question O: What is your opinion about travel time (holidays) by paratransit service?

Users' of paratransit are satisfied about travel time in holidays because the traffic volume remains very low. 43% respondents said that travel time is good in holidays, 36% said that it is satisfactory while 13% said that it is Excellent.

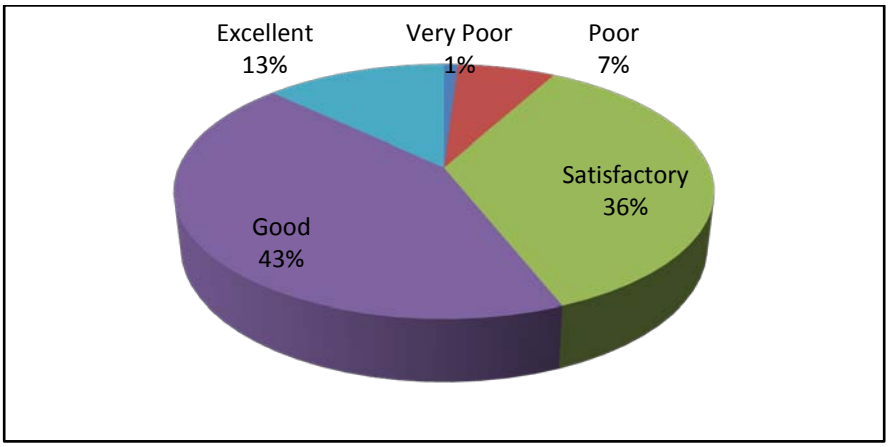


Figure 4.15: User perception about travel time (holidays) by paratransit service

Question P: What is your idea about integration with supporting modes?

Most of the paratransit user is satisfied with the integration of supporting modes. 55% user said that it is satisfactory while 37% said that it is good.

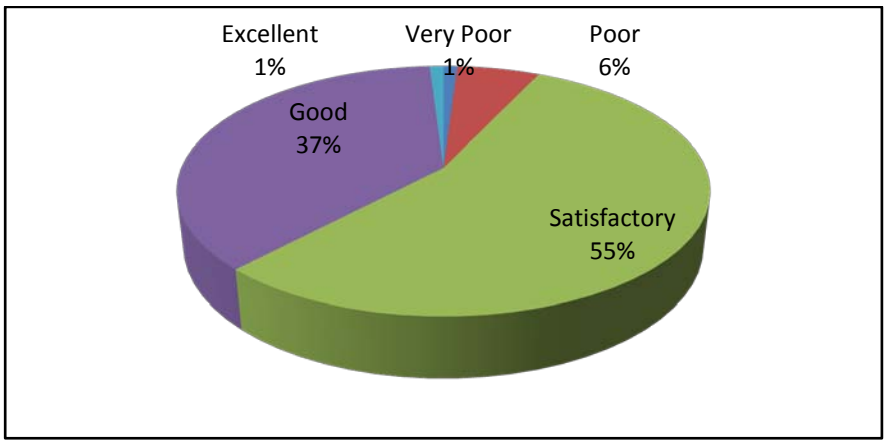


Figure 4.16: User perception about integration with supporting modes

Question Q: What do you think about security of goods inside paratransit?

It is found that the security of goods inside paratransit is satisfactory. 44% respondents mentioned that security of goods inside paratransit is satisfactory. On the other hand, 35% said that it is poor.

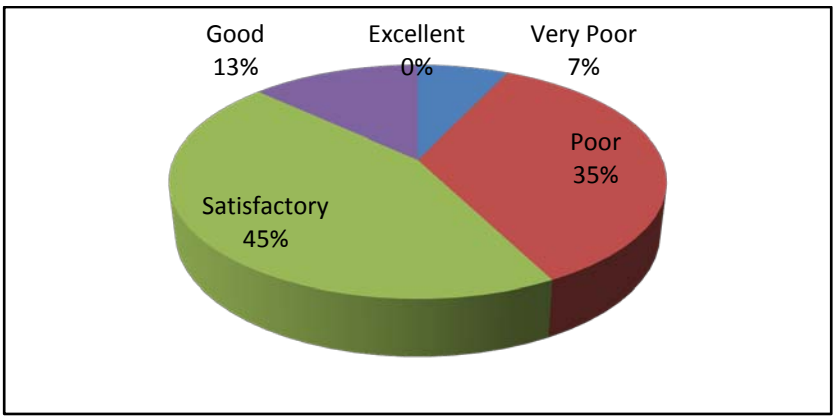


Figure 4.17: User perception about security of goods inside paratransit

Question R: What is your comment about security of passengers in paratransit service?

Security of passenger is not quite good in paratransit service as it is not safe at late night. 41% users 'mentioned that security of passenger is poor, but 39% said that it is satisfactory. Overall percentage of respondents' opinion is shown in Figure 4.18.

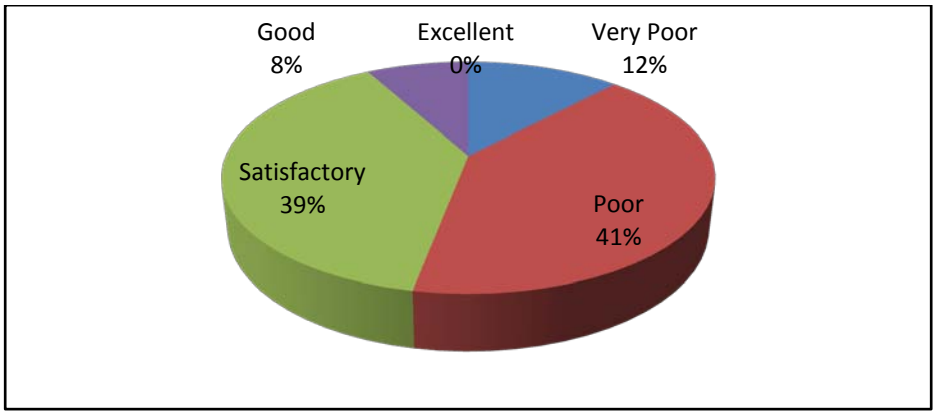


Figure 4.18: User perception about security of passengers inside paratransit

Question S: What is your opinion about riding safety of paratransit service?

There is no specific riding safety features available in paratransit service in our country. 43% respondents said that riding safety is poor but 31% said it is satisfactory. On the other hand 20% users mentioned that raiding safety is poor in this service.

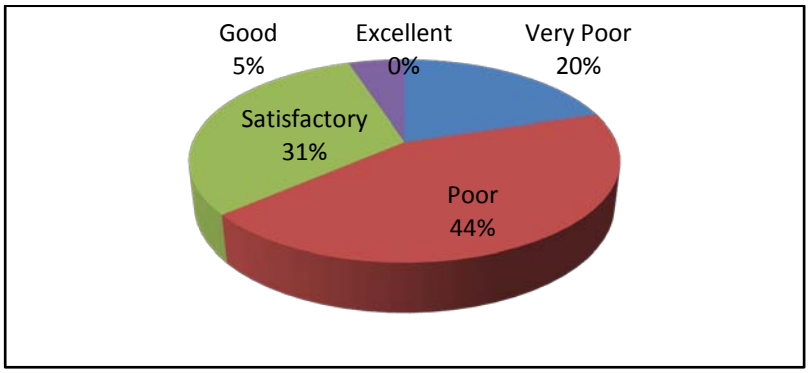


Figure 4.19: User Perception about riding safety of paratransit service

Question T: What do you think about the travel cost comparing with other transport?

Travel cost is much less than rickshaw or CNG auto rickshaw but little bit more than bus. Most of the time, respondents use the service instead of bus to save travel time. 53% of them said that travel cost is satisfactory, 27% said that it is good.

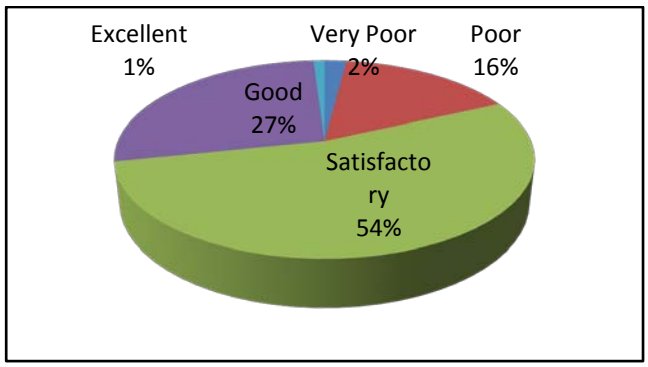


Figure 4.20: User Perception about the travel cost comparing with other transport

Question U: What is your idea about the operating cost comparing with other transport?

This question was asked to the driver/owner/operator of paratransit vehicle. For this question, 82 respondents were foundto know their opinion. Half of them (50%) said that it is satisfactory, but they also said that, it depends on fuel cost, drivers and helper's salary, maintenance / servicing cost etc.

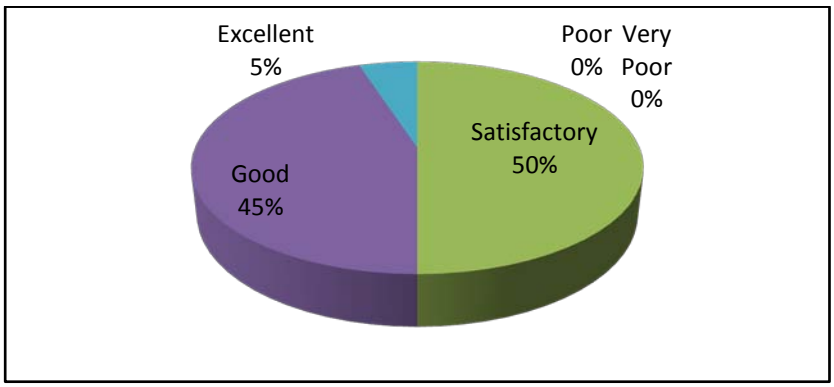


Figure 4.21: User Perception about the operating cost comparing with other transport

Question V: What is your idea about performance for long route (Inter-District) movement?

Performance for long route movement of paratransit service found poor according to the users' perception. More than half of the respondents (52%) said that it is poor for long route movement, while 25%mentioned it is satisfactory.

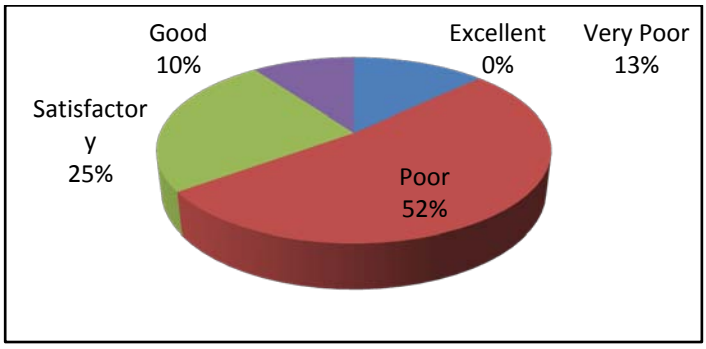


Figure 4.22: User Perception about performance for long route (Inter-District) movement

Question W: How is the movement flexibility in any road?

Paratransit users think that the movement flexibility in any road is not good for paratransit service. It is better for the roads with medium width (20-40 ft). It will not good in highways because of bus and not good at narrow roads because of rickshaw. 43% of respondents think that it is poor for all roads but 27% thinks that it is satisfactory.

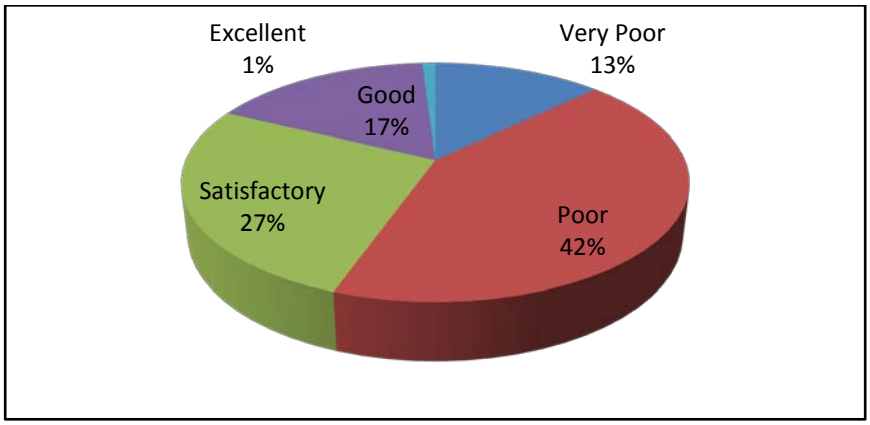
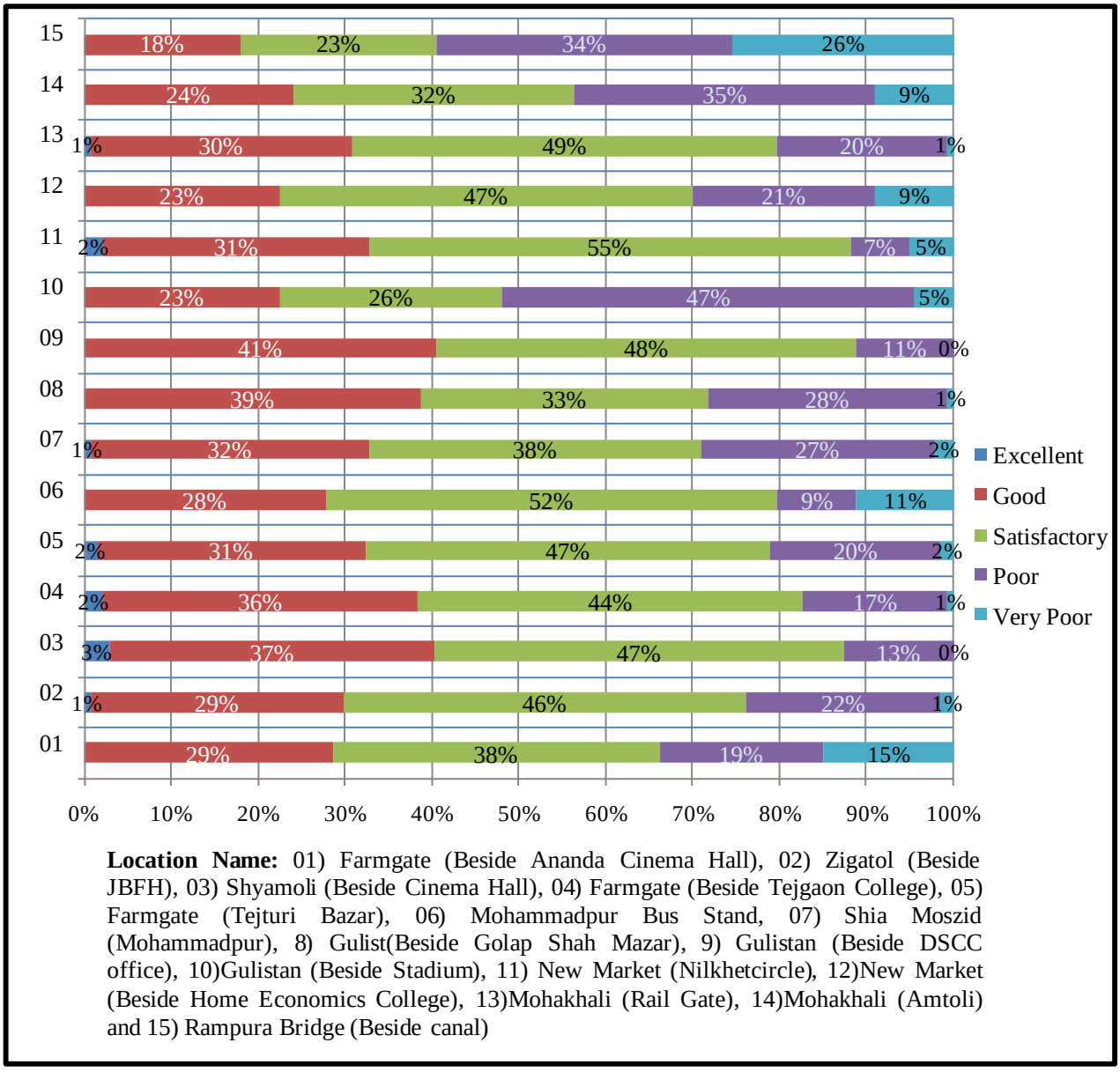


Figure 4.23: User perception about the movement flexibility in any road

4.4 Evaluation of the Rating.

These are the ratings given by respondents during questionnaire survey. According to these survey results it is found that people are using paratransit services mainly because of- availability of paratransit vehicle, speed of the vehicle, integration with supporting modes, travel time, ticketing system of the service, travel cost comparing with other modes, speed of the vehicle and cleanliness of the vehicle comparing with public transport service. There are some problems in this service also such as, seat comfort level of paratransit vehicle, fitness of the vehicle, noise level of the service, lighting facilities, ease of entry-exit system, sitting

arrangements, movement flexibility in the vehicle, travel time during office day, security of the passenger during off-peak period, riding safety, performance of long route movement and movement flexibility of vehicle in any road.



Location Name: 01) Farmgate (Beside Ananda Cinema Hall), 02) Zigatol (Beside JBFH), 03) Shyamoli (Beside Cinema Hall), 04) Farmgate (Beside Tejgaon College), 05) Farmgate (Tejturi Bazar), 06) Mohammadpur Bus Stand, 07) Shia Moszid (Mohammadpur), 8) Gulist(Beside Golap Shah Mazar), 9) Gulistan (Beside DSCC office), 10)Gulistan (Beside Stadium), 11) New Market (Nilkhetcircle), 12)New Market (Beside Home Economics College), 13)Mohakhali (Rail Gate), 14)Mohakhali (Amtoli) and 15) Rampura Bridge (Beside canal)

Figure 4.24: Users' perception rating about prevailing quality of paratransit service in Dhaka

4.5 Model Generation by Structural Equation Models (SEM)

A series of models are developed to thoroughly identify the relationships between the overall paratransit service quality (SQ) and different endogenous, exogenous and latent variables. The target is to reveal which variables represent the main SQ aspects. Starting from an initial candidate model in which a set of variables of the service quality are proposed, these models are reexamined in new candidate models, modifying the structure and pattern of variables. For each empirical model, the process of model development follows the approach of trial and error in terms of shuffling various exogenous, endogenous and latent variables as well as observing overall goodness of fit values of the model. Parameters' values are presented in Table. At the end, all the proposed candidate models are compared and the optimal one is found out. The optimal model is the most representative one of the actual scenario.

Table 4.1: Different Variables used for modeling

x	indicates exogenous variables
Y	and y indicates endogenous observed variables
Z	indicates paratransit SQ
η	indicates latent variables
ρ	indicates measurement errors in
ε	indicates measurement errors in Y
ζ	indicates errors in η
δ	indicates errors in Z
λ	indicates parameters of the Y variables
α	indicates parameters of the η variables when influence Y variables
β	indicates parameters of the η variables when they influence each other
γ	indicates parameters of η variables when influence y variables
μ	indicates parameters of η variables when influence $Z\,\Gamma$
λ_0	indicates constant value

Table 4.2. SQ variables and their role in the proposed SE models.

Item No.	Description	Model (M1)		Model (M2)		Model (M3)	
		Type	Notation	Type	Notation	Type	Notation
1	Fitness of Vehicle	En.	Y_1	En.	Y_1	En.	$\boldsymbol{Y_1}$
2	Speed of Para Transit	En.	Y_2	En.	Y_2	En.	$\boldsymbol{Y_2}$
3	Punctuality and Reliability	En.	Y_3	En.	Y_3	En.	$\boldsymbol{Y_3}$
4	Riding Safety	En.	Y_4	En.	Y_4	En.	$\boldsymbol{Y_4}$
5	Travel Cost	En.	Y_5	En.	Y_5	En.	$\boldsymbol{Y_5}$
6	Seat Comfort	Ex.	x_6	En.	y_6	Ex.	$\boldsymbol{x_6}$
7	Noise Level	Ex.	x_7	En.	y_7	Ex.	$\boldsymbol{x_7}$
8	Lighting Facilities	Ex.	x_8	En.	y_8	Ex.	$\boldsymbol{x_8}$
9	Sitting Arrangement	Ex.	x_9	En.	y_9	Ex.	$\boldsymbol{x_9}$
10	Cleanliness	Ex.	x_{10}	En.	y_{10}	Ex.	$\boldsymbol{x_{10}}$
11	Ticketing System	Ex.	x_{11}	En.	y_{11}	Ex.	$\boldsymbol{x_{11}}$
12	Ease of Entry-Exit	Ex.	x_{12}	En.	y_{12}	Ex.	$\boldsymbol{x_{12}}$
13	Movement Flexibility	Ex.	x_{13}	En.	y_{13}	Ex.	$\boldsymbol{x_{13}}$
14	Quality of Driver	Ex.	x_{14}	En.	y_{14}	Ex.	$\boldsymbol{x_{14}}$
15	Travel Time (Office Days)	Ex.	x_{15}	En.	y_{15}	Ex.	$\boldsymbol{x_{15}}$
16	Travel Time (Holidays)	Ex.	x_{16}	En.	y_{16}	Ex.	$\boldsymbol{x_{16}}$
17	Integration of Sp Modes	Ex.	x_{17}	En.	y_{17}	Ex.	$\boldsymbol{x_{17}}$
18	Security of Goods	Ex.	x_{18}	En.	y_{18}	Ex.	$\boldsymbol{x_{18}}$
19	Security of Passengers	Ex.	x_{19}	En.	y_{19}	Ex.	$\boldsymbol{x_{19}}$
20	Long Route mov perf	Ex.	x_{20}	En.	y_{20}	Ex.	$\boldsymbol{x_{20}}$
21	Mov Flex in any Road	Ex.	x_{21}	En.	y_{21}	Ex.	$\boldsymbol{x_{21}}$
22	System Performance	N/A	N/A	Lt.	η_0	N/A	**N/A**
23	Physical Appearance	N/A	N/A	N/A	N/A	Lt.	$\boldsymbol{\eta_1}$
24	Service Features	N/A	N/A	N/A	N/A	Lt.	η_2

4.6 Development of Models

Model 1(M1): M1 is constructed with five endogenous variables (item 1–item 5; Table 1 and sixteen exogenous variables (item 6 – item 21; Table 1) to estimate paratransit SQ. There is no latent variable in this model. The structure of M1 is shown in Figure 2. From the structure of M1, the following equation can be written.

$$Z = \lambda_0 + \lambda Y + \delta \text{ .... } (1)$$

Now, the Y used in equation (1) is:

$$Y = \Gamma x + \varepsilon \text{ .... } (2)$$

The structure of M1 is shown in Figure 4.25.

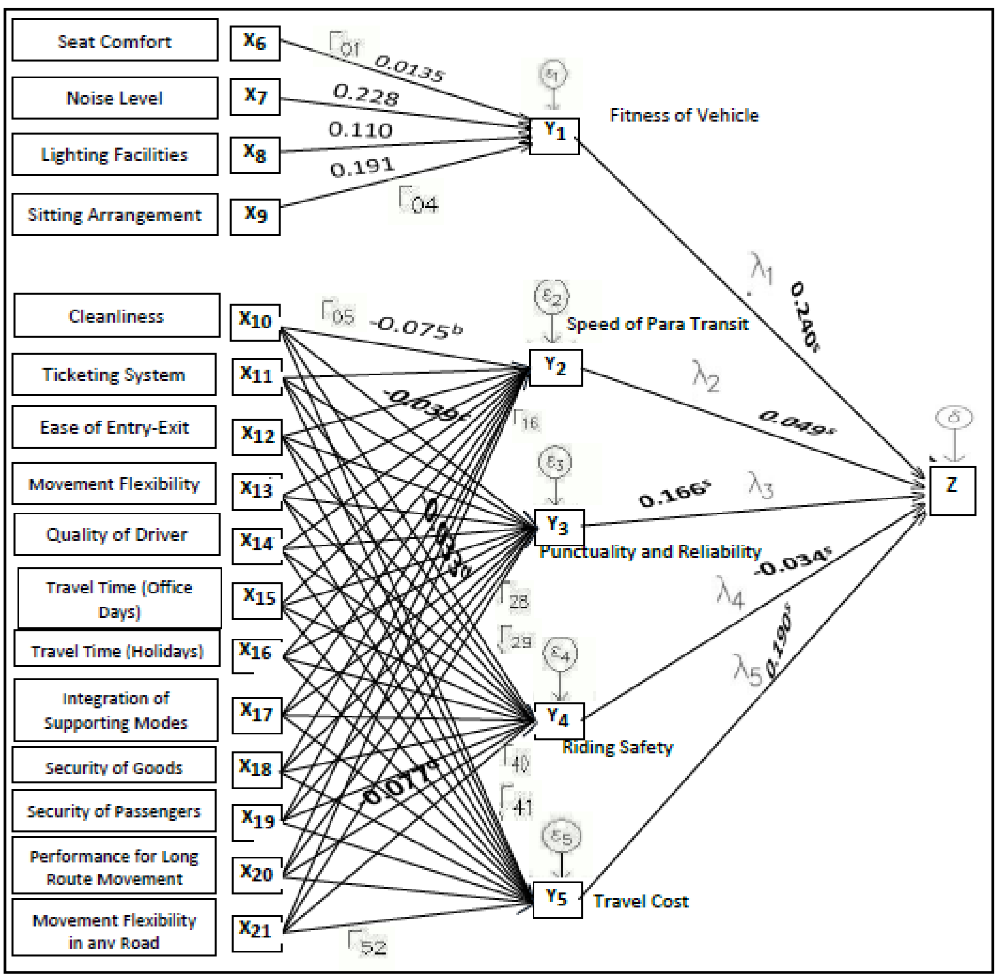


Fig 4.25: Structure Equation Model M1

4.7 **The Explanation of Model M1**

M1 is developed without any latent variable. Among the five endogenous variables used to construct M1, "Fitness of Vehicle" is composed of four exogenous variables (item 6 – item 9; Table 1) and the remaining four "Speed of Para Transit", "Punctuality and reliability", "Riding Safety" and "Travel Cost" are composed of twelve exogenous variables (item 10 – item 21; Table 1).

Here, the twelve exogenous variables influence the four endogenous variables individually. Actually the "Fitness of Vehicle" signifies the physical appearance of paratransit which is described by four physical appearance defining exogenous variables. The remaining four endogenous variables "Speed of Para Transit", "Punctuality and Reliability", "Riding Safety" and "Travel Cost" signify the service features provided by paratransit which are described by twelve service features defining exogenous variables.

The relations between exogenous and endogenous variables are established by trial and error method. To justify the model structure, variables are shuffled and the best structure with this format is obtained. "Riding Safety" is one of the major variables that should influence SQ positively because safe vehicle is always preferable by the passengers. However, the results of M1 show that "Riding Safety" is an insignificant variable. Also, it influences paratransit SQ negatively which does not match the real scenario.

Furthermore, M1 results show some other dissimilarities such as "Performance for Long Route Movement" influences "Riding Safety" negatively (-0.077, Table and "Cleanliness" influences "Speed of Para Transit" , "Punctuality and reliability" and "Riding Safety" negatively. For

these irrational results though M1 has moderate fit indices (CFI=0.702, RMSEA=0.077, SRMR=0.037; Table 3), M2 is developed.

4.8 Model 2 (M2): M2 is constructed with twenty one endogenous variables (item 1– item 21; Table 1) and one latent variable (item 22; Table 1) to estimate paratransit SQ. Here, the first five endogenous variables (item 1 – item 5; Table 1) depend on the latent variable. The latent variable is calibrated by the remaining endogenous variables (item 6 – item 21; Table 1). There is no exogenous variable in this model. From the structure of M2, the following equation can be written.

$$Z = \lambda_0 + \lambda Y + \delta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, *Y* in equation (3) symbolizes the first five endogenous variables (item1– item 5, T 1)

$$Y = \alpha\eta + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

And, η symbolizes the latent variable which is calibrated by the remaining sixteen endogenous variables (item 6 – item 21; Table 1)

$$\eta = \frac{y - \rho}{\gamma} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The structure of M2 is shown in Figure 4.26.

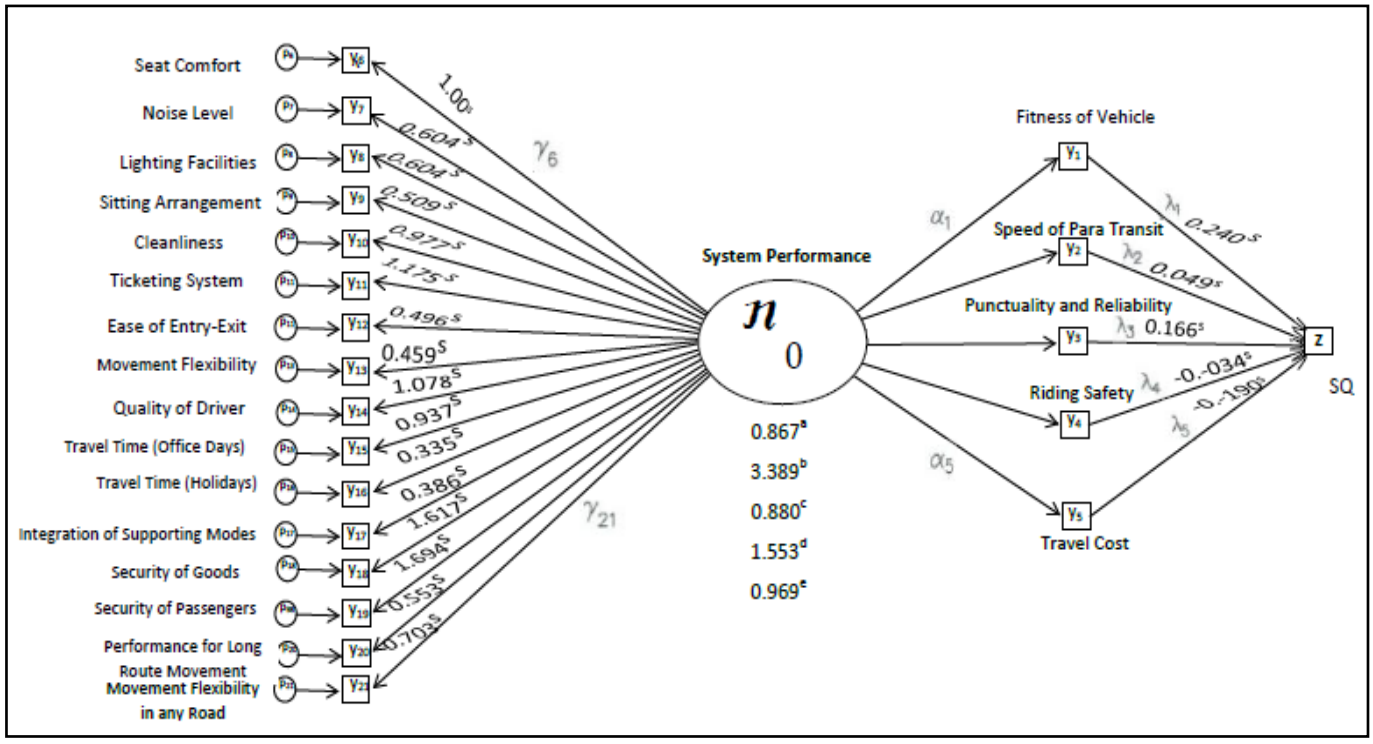


Fig 4.26: Path Diagram of Model 2

4.9. The Explanation of Model M2. The Model introduces a latent variable "System performance" (*System performance refers to entire set of performance elements of the vehicle*). Among the five endogenous variables used to construct M2, "Fitness of Vehicle", "Speed of Para Transit", "Punctuality and Reliability", "Riding Safety" and "Travel Cost" depend on "System performance" which is calibrated by sixteen endogenous variables (item 6 – item 21; Table 1).

As in M1, to justify the model structure, variables are shuffled and the best structure with this format is obtained. However, M2 results do not match the real scenario prevailing in Dhaka city. Similar to M1, M2 shows that "Riding Safety" is an insignificant variable and it influences paratransit SQ negatively, which is irrational. Also, RMSEA value is far beyond the specified limit. CFI value is also very low indicating poor fit.

4.10 . Model 3 (M3)

Model 3 (M3): M3 is constructed with five endogenous variables (item 1 – item 5; Table 1), sixteen exogenous variables (item 6 – item 21; Table 1) and two latent variables (item 23 and 24; Table 1) to estimate paratransit SQ. The structure of M3 is shown in Figure 6. From the structure of M5, the following equation can be written

$$Z = \lambda_0 + \mu\eta + \delta \text{ .....(6)}$$

Where, η in equation (6) is:

$$\eta = \frac{Y - \varepsilon}{\beta} \text{.....(7)}$$

Y in equation (12) depends on sixteen exogenous variables (item 6 – item 21; Table 1). It symbolizes the first five endogenous variables (item 1 – item 5; Table 1) and calibrates the latent variables ◻ as used in equation (11).

$$Y = \Gamma x + \varepsilon \text{.....(8)}$$

The structure of M3 is shown in Figure 4.27.

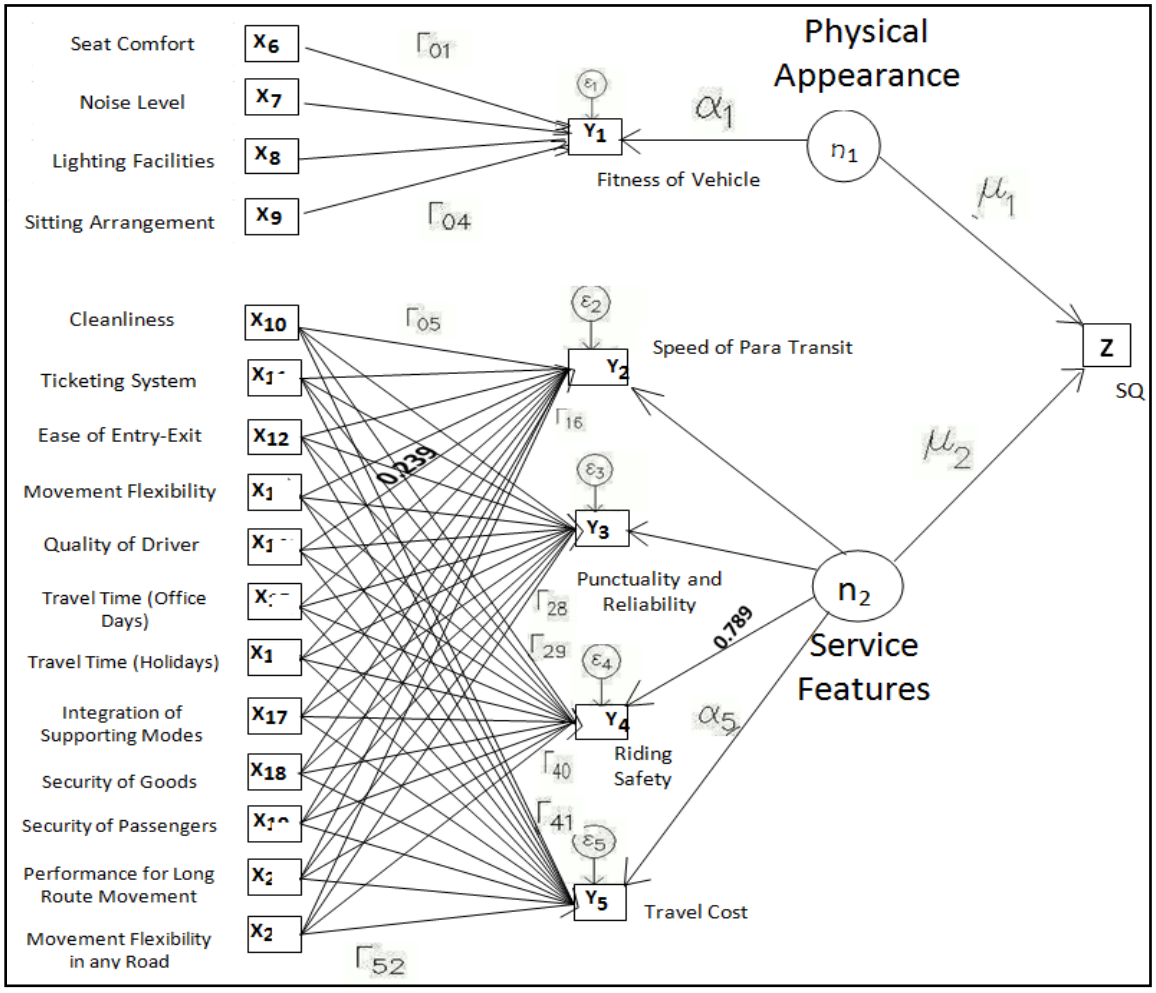


Fig 4.27: Path Diagram of Model M3

4.11. The Explanation of Model M3.

To minimize the limitation of model M1 and M2, Model M3 has developed where "Physical Appearance" is calibrated by an endogenous variable " Fitness of Vehicle" that depeds on four exogenous variables (Item 6- item 9; Table 1). "Service features" is calibrated by four endogenous variables as fol: : Speed of Paratransit", "Punctuality and Reliability","Riding Safety" and "Travel Cost". These four endogenous variables depend on twelve exogenous

variables (Item 10- item 21; Table 1). The model results show that "Riding Safety" has positive influence on the paratransit SQ, which represents the real scenario. However, M1, M2 and M3 results show negative influence.

Interestingly, M5 results show that "speed of paratransit" is not influenced by "Quality of driver. Though the result may seem irrational but this result can be explained by the prevailing congestion of Dhaka city, where speed choice does not solely depend on the drivers. Most of the times vehicles need to crawl in the network.

From the analysis, it is also seen that decreasing "TravelTime" (both during office days and holidays) increases "travel cost".This signifies vehicles that need lower trip time charge higher fares.This results match with the real scenario quite accurately.

Also this models has satisfactory fit indices (CFI=0.762, RMSEA=0.086, SRMR=0.053; Table 3). AIC value for M3 is 100538.16 (Table 4.3), which is the lowest among the three models. Thus, the structure of M3 represents the best choice to perceive the paratransit SQ.

From the results of M5, it is seen that among the observed variables, "Punctuality and Reliability", "Fitness of Vehicle" and "Travel Cost" influence SQ the most. Among the latent variables, "Service Features" gets the greatest weightage. M3 results reveal that passengers are less concerned about the "Physical Appearance" of paratransit rather they are more concerned about the "Service Features" provided by paratransit. Previous study by Hokey (2009) shows that "Door-to-door Services", "Driver Courtesy", and "Passengers Safety" are the three most significant paratransit SQ variables. Whereas, Joewono and Kubota (2007) finds "Comfort", "User Service", and "Safety and Security" are the most important variables, followed by "Provision of Information". The differences in findings may be due to the differences in

socioeconomic structures, road network conditions, public transportation availability, etc. of the study locations.

4.12 : Estimated parameters' values of different paratransit SQ models. The following table combines the parameter values of all variables (exogenous, endogenous and latent) that are used to build the models.Table 4.3 : Estimated parameters' values of different paratransit SQ models.

Observed Variables	**M1**	**M2**	**M3**
Fitness of Vehicle	0.240[s]	0.240[s]	0.899[s]
Speed of Para Transit	0.049[s]	0.049[s]	0.805[s]
Punctuality and reliability	0.166[s]	0.166[s]	1.298[s]
Riding Safety	*-0.034[s]*	*-0.034[s]*	0.789[s]
Travel Cost	0.190[s]	0.190[s]	0.854[s]
Seat Comfort	0.135	1.000[s]	0.156
Noise Level	0.228	0.604[s]	0.205
Lighting Facilities	0.110	1.048[s]	0.151
Sitting Arrangement	0.191	0.509[s]	0.160
Cleanliness	-0.075[b] -0.039[c] -0.033[d]	0.977[s]	0.069[b] *0.033[c]* 0.041[d] 0.056[e]
Ticketing System	*0.037[b]* 0.068[c] 0.036[d]	1.175[s]	*0.030[b]* 0.054[c] 0.035[d] 0.139[e]
Ease of Entry-Exit	*0.039[b]* *-0.019[c]* *-0.002[d]*	0.496[s]	*0.030[b]* *-0.019[c]* *0.002[d]* *0.017[e]*
Movement Flexibility	0.045[b] 0.067[c] 0.196[d]	1.459[s]	0.044[b] 0.076[c] 0.209[d] *0.011[e]*

Quality of Driver	*0.023*[b] *0.014*[c] *-0.014*[d]	1.078[s]	*0.021*[b] *-0.009*[c] *-0.023*[d] *0.010*[e]
Travel Time (Office Days)	*0.016*[b] 0.081[c] 0.079[d]	0.937[s]	*0.023*[b] 0.125[c] 0.106[d] -0.043[e]
Travel Time (Holidays)	0.050[b] 0.233[c] 0.031[d]	0.335[s]	0.047[b] 0.255[c] 0.032[d] -0.099[e]
Integration of Supporting Modes	*-0.024*[b] 0.128[c] *-0.004*[d]	0.386[s]	*-0.018*[b] 0.103[c] *-0.004*[d] 0.102[e]
Security of Goods	*0.033*[b] 0.059[c] 0.118[d]	1.617[s]	0.029[b] 0.058[c] 0.115[d] 0.139[e]
Security of Passengers	0.064[b] 0.096[c] 0.375[d]	1.694[s]	0.057[b] 0.100[c] 0.366[d] 0.099[e]
Performance for Long Route Movement	*0.003*[b] *0.036*[c] -0.077[d]	0.553[s]	*-0.001*[b] *0.027*[c] 0.081[d] 0.089[e]
Movement Flexibility in any Road	0.067[b] 0.102[c] 0.120[d]	0.703[s]	0.068[b] 0.120[c] 0.137[d] 0.128[e]
Latent Variables			
		0.867[a]	
		0.389[b]	
System Performance	-	0.880[c] 1.533[d]	-
		0.969[e]	
Physical Appearance	-	-	0.805
Service Features	-	-	0.952

a=influences Fitness of Vehicle,

b=influences speed of ParaTransit

c=influences Punctuality and Reliability

d=influences Riding safety

e=influences Travel Cost

x=influenced by physical appearance y=influenced by service feature

4.13 The Result- Fit Indices of Model 1, 2 and 3. The result found as follows in table 4.4 below

Table 4.4: Fit Indices of the model.

Fit Indices	Model 1	Model 2	Model 3	Ideal Range
Absolute Fit Indices				
Root Mean Squared Error of Approximation (RMSEA)	0.077	0.103	0.086	0.05-0.10
Standardized Root Mean Square Residual (SRMR)	0.037	0.087	0.053	< 0.10
Incremental Fit Indices				
Comparative Fit Indices (CFI)	0.702	0.515	0.762	1.00
Parsimony Fit Indices				
Akaike's Information Criterion (AIC)	101010.12	100887.12	100538.16	

4.14. Z Values of Different SQ Model (1.00 < Z_value < 1.64). From the parameter values, the significant variables are determined based on a two-tailed t-test with a critical value of 1.64 for 90% confidence limit. Also, these parameter values are used to compare the proposed candidate models and to find out the optimal one. The optimal model is the most representative one of the actual scenario. The value of **Z** of different important variables of SQ models are mentioned in table 4.5.

Table 4.5: Z Values of Different Variables

Observed Variables	M1	M2	M3
Riding Safety	-0.034^{s}	-0.034^{s}	0.789^{s}
Cleanliness	-0.075^{b} -0.039^{c} -0.033^{d} 0.048^{e}	0.977^{s}	0.069^{b} 0.033^{c} 0.041^{d} 0.056^{e}
Ticketing System	0.037^{b}	1.175^{s}	0.030^{b}
Ease of Entry-Exit	0.039^{b} -0.019^{c} -0.002^{d} 0.019^{e}	0.496^{s}	0.030^{b} -0.019^{c} 0.002^{d} 0.017^{e}
Movement Flexibility	0.009^{e}	1.459^{s}	0.044^{b} 0.076^{c} 0.209^{d} 0.011^{e}

Quality of Driver	0.023^{b} 0.014^{c} -0.014^{d} 0.014^{e}	1.078^{s}	0.021^{b} -0.009^{c} -0.023^{d} 0.010^{e}
Travel Time (Office Days)	0.016^{b} 0.081^{c} 0.079^{d} -0.031^{e}	0.937^{s}	0.023^{b} 0.125^{c} 0.106^{d} -0.043^{e}
Travel Time (Holidays)	0.050^{b} 0.233^{c} 0.031^{d} -0.085^{e}	0.335^{s}	0.047^{b} 0.255^{c} 0.032^{d} -0.099^{e}

4.15 Conclusion

According to Steiger (1990), a model is considered as "very good" or "good" having RMSEA value of less than 0.05 or 0.10, respectively. Browne and Cudeck (1993) suggested RMSEA 0.08 can be considered as reasonable. A value of SRMR less than 0.10 indicates a good fit (Vandenberg and Lance 2000). A CFI value closer to 1.0 indicates a good fit (Hooper et al. 2008). Furthermore, a model having the smallest AIC value is considered as the best.

Chapter 5

Conclusion & Recommendations

5.1 General

This study was conducted to understand the users' perception of paratransit in Dhaka city. Literature review revealed that very few study were conducted. The major findings of this study are summarized in the following section. Some recommendations for future study are also presented in this Chapter.

5.2 Key Findings from SEM

This study presents the result of an investigation into the relationship between the overall paratransit service quality (SQ) and variables affecting paratransit SQ. Structural Equation Modeling (SEM), an advanced technique which permits to introduce exogenous, endogenous as well as latent variables is used for this study. To identify the structure that suits paratransit data of developing countries, three different SE models are developed. From the three different SE models, the best structure is found with two latent variables:

- Physical Appearance; and
- Service Features.

From the analysis, following things found noticeable:

- It is seen that "Physical Appearance" has a little less influence than "Service Features" on the overall paratransit SQ. It indicates that users of developing countries are more concern about the service provided by the paratransit.
- "Punctuality and Reliability", "Fitness of Vehicle", and "Travel Cost" are found to be the most significant observed variables that influence the SQ.

- Moreover, results from the best SE model show that "Speed of Para Transit" is not influenced by "Quality of Driver". This counterintuitive result is explained by the prevailing congestions in Dhaka city, which force vehicles to crawl in the network. So, speed choice does not solely depend on the drivers.

- Results also revealed that decreasing "Travel Time" (both during office days and holidays) increases "Travel Cost". This signifies vehicles that need lower trip time charge higher fares.

All these results match with the real scenario quite remarkably. It is important to emphasize that all these significant variables have a decisive role in the global perception of paratransit SQ. Thus, planners and managers of paratransit should be more careful about these variables when they formulate measures for promoting this mode of public transportation. To this end, a clear perception about understanding and developing the overall paratransit SQ is provided in this paper. Most importantly, it relates passengers demand to the overall paratransit SQ. Results of this paper are based on individual users' specific observations which reflect their needs and expectations. The determination of the most and the least important least important SQ variables certainly helps to concentrate the limited resources of developing countries to improve individual SQ variables. This will support a staged development of the overall paratransit SQ. The authors plan to apply SEM to find the variables that influence paratransit SQ using a combined dataset of both users and non-users. The identified important variables will be compared with the current study. This comparison will help to attract new users.

5.3 Key Findings from Respondents

Twenty three (23) important factors regarding paratransit service quality were asked to the paratransit user in this study to know the actual condition of its service in Dhaka City.

A total 15 routes of paratransit service were surveyed to make this assessment. The subjective

assessment was made using a rating scale of excellent, good, satisfactory, poor, very poor. The respondents gave their rating on all of the 15 location of survey. It was found that majority of the paratransit user opined that, following factors are the advantages of using paratransit service:

- Availability of paratransit vehicle
- Speed of the vehicle
- Integration with supporting modes
- Travel time (Holidays)
- Ticketing system of the service
- Travel cost comparing with other modes
- Speed of the vehicle and
- Cleanliness of the vehicle comparing with public transport service
- Quality of driver
- Security of goods inside paratransit
- Operating cost of paratransit

5.4 Limitations of Paratransit

Now a day, a lot of people travel by paratransit service, but service is not advanced according to the expectations of the user. There are so many limitations are present in existing system and authority should improve these limitations to keep the ridership and attract new user. It is found that majority of the paratransit user complained that the following factors are the main limitations of paratransit service.

- Seat comfort level of paratransit vehicle is very tight
- Fitness of the vehicle is not up to standard

- Noise level of the service is very poor
- Lighting facilities are insufficient
- Ease of entry-exit system is very risky
- Sitting arrangements is congested for passengers
- Movement flexibility in the vehicle is very poor
- Travel time during office day is very high
- Security of the passenger during off-peak period is not enough
- Riding safety is insignificant
- Performance of long route movement is not remarkable
- Movement flexibility of vehicles in any road is not so good.

5.5 Recommendations to improve the quality of service

Paratransit service in Dhaka city required some improvement to become the service more user friendly. Following recommendations has been prepared based on the study.

Fitness of the vehicle should be improved

- Noise level of the vehicle should maintain properly
- Sufficient Lighting facility required

- Manufacturer should think about more flexible entry-exit system
- Sitting arrangement should be more flexible
- Paratransit authority must ensure the safety of passenger
- Standard riding safety features required
- Drivers' quality should be improved
- Government should prepare specific rules and regulations only for paratransit service
- A department or a wing may be created under Ministry of Road Transport to monitor the quality of paratransit service in Bangladesh.

5.6 Limitation of the Thesis

The study was limited to the identification of users' perception about paratransit service. Though the thesis performed thoroughly but still there were some limitations remains, which are as follows.

- The number of factors/variables are taken only 23. It could be more in practical.
- The number of respondents could be more. In this study we took only 2008. For a good result more number of respondents are require.
- There were not sufficient reliable data on the percentage of population of Dhaka city availing paratransit.
- The respondents were not very sincere in replying the survey question.

5.7 Recommendations for future study

It is expected that the outcome of this research work will facilitate identification of the best process to implement effective paratransit mode in Dhaka city. The research results will assist in recommending measures to improve the existing system with necessary modification. Following recommendation can be made for future studies:

- In future the opinions of female can be taken and the model can be developed separately for male and female. Sufficient data are required to build the model, which is more than 200. The purpose is to observe the difference between male and female opinion regarding paratransit SQ.

- Another survey can be taken by considering the non paratransit users and developing the model separately. The purpose is to observe the difference in opinion between the paratransit users and non users. It will also find out the ways and means to attract the new users.

The study findings can be utilized by the city transportation officials of Bangladesh to improve the overall paratransit performance to attract the new users as well as retain the current ones. It is also expected that the structure equation model would be able to reveal the variables influencing transit customer satisfaction to enhance the overall performance of the paratransit.

REFERENCES

Ali, A.N. (2010). An Assessment of the Quality of Intra-urban Bus Services in the City of Enugu, Enugu State, Nigeria. *Theoretical and Empirical Researches in Urban Management,* 6(15), 74-91.

Andaleeb, S.S., Haq, M. and Ahmed, R. I. (2007). Reforming inner-city bus transportation in a developing country: a passenger-driven Model. *Journal of Public Transportation*, 10(1), 1-25.

Bentler, P. M., and Chou, C. P. (1987). Practical issues in structural modeling. *Sociological Methods & Research,* 16 (1), 78-117

Browne, M. W., and Cudeck, R. (1993). Alternative ways of assessing model fit. Sage Focus Editions 154, 136-136.

Chen, C.-F. and Lai, W.-T. (2011). Behavioral Intentions of Public Transit Passengers – The Roles of Service Quality, Perceived value, Satisfaction and Involvement. *Transport Policy,* 18(2), 318-325.

Cullinane, S. (2002). The Relationship between Car Ownership and Public Transport Provision: A Case Study of Hong Kong. *Transport Policy,* 9(1), 29-39.

dell'Olio, L., Ibeas, A. and Cecín, P. (2010). Modelling User Perception of Bus Transit Quality. *Transport Policy,* 17(6), 388-397.

dell'Olio, L., Ibeas, A. and Cecin, P. (2011). The Quality of Service desired by Public Transport Users. *Transport Policy,* 18(1), 217-227.

Deng, T. and Nelson, J.D. (2010). The Impact of Bus Rapid Transit on Land Development: A Case Study of Beijing, China. World Academy of Science, *Engineering and Technology,* 66, 1196- 1206.

DLLAJ (Traffic and Road Transport Agency). (2001). The Guide of Passenger Public Transportation Price Calculation With Fixed Routes In Urban Areas. West Java, Bandung.

Eboli, L. and Muzzula, G. (2007). Service Quality Attributes Affecting Customer Satisfaction. A new customer satisfaction index for evaluating transit service quality. *Journal of Public Transportation*, 12(3), 21 – 37

Field, A. (2005). Discovering statistics using SPSS (3rd ed.). London, Sage Publications, Figini, M. (2003) *Dare valore alle esigenze dei clienti e dei dipendenti dell'azienda*,

Friman, M. and Gärling, T. (2001). Satisfaction with public transport related to service performance. *Travel Behavior Research, The Leading Edge*, ed. D. Hensher. International Association for Travel Behavior Research. Oxford: Pergamon, Elsevier Science, Ltd., 845–854.

Fu, L. and Xin, Y. (2007). A new performance index for evaluating transit quality of service.

Journal of Public Transportation, 10(3), 47 – 70.

Gitu, J. N., Okamura, T. and Nakamura, F. (2010). The Structure Of Users' Satisfaction on Urban Public Transport Service in Developing Country: the Case of Nairobi. *Journal of the Eastern Asia Society for Transportation Studies*,8, 1260~1272.

Golob,T.F. (2003). Structural equation modeling for travel behavior research. *Transportation Research Part B*, 37(1),1-25.

Grigoroudis, E. and Siskos, Y. (2002) Preference disaggregation for measuring and analyzing customer satisfaction: The MUSA method. *European Journal of Operational Research, 143(1)*, 148 – 170.

Hensher, D.A. and Brewer, A.M. (2001). Transport: An Economics and Management Perspective, Oxford University Press, New York.

Honkey. M. (2009). Evaluating The Service Quality of Paratransit Systems: An Explanatory Study of The Toledo Area Regional Transit Authority.

Hooper, D., Coughlan, J. and Mullen, M.R. (2008).Structuralequationmodelling: guide-lines for determining model fit. Electronic Journal of Business Research Methods 6(1), 53–60.

Jacobs, G. and Aeron-Thomas, A. (2000). *Africa road safety review*. Final Report, Project Report PR/INT/659/00. Washington, DC: U.S. Department of Transportation/Federal Highway Administration, Transport Research Laboratory.

Joewono, T.B. and Kubota, H. (2005). The Characteristics of Paratransit and Non-Motorized transport in Bandung, Indonesia, Journal of the Eastern Asia Society for Transportation Studies, 6, 262 – 277.

Joewonso, T.B., Ningtyas, D.U. and Tjeendra, M. (2010). Causal Relationship Regarding Quality of Service of Public Transport in Indonesian Cities, *Journal of the Eastern Asia Society for Transportation Studies*,8,1383-1397.

Joreskog, K.G. (1973). Analysis of covariance structures. In Multivariate Analysis-III, P. R. Krishnaiah, ed. New York: Academic Press, 263–285.

Kaltheier, R. M. (2002). *Urban transport and poverty in developing countries. Analysisand options for transport policy and planning*. Division 44 Environmental

Management, Water, Energy, Transport. Deutsche Gesellschaft fü r Technische Zusammenarbeit (GTZ) GmbH. Eschborn.

Kiwan, N., Lee, C., Kim, J. and Kwon, Y. (2007). Critical measures of transit service quality in various city types. Proceedings of Eastern Asia Society for Transportation Studies, 5, 414–427.

Koushki, P. A., Al-Saleh, O. I., and Al-Lumâ, M. (2003). On management's awareness of transit passenger needs. *Transport Policy*, 10(1), 17–26.

Kline, R. B. (2005). Principles and practice of structural equation modeling. 2nd ed. New York: Guilford Press.

Lee, W. G. and Jung, H. Y. (2008). Establishment about Service Level and Evaluation Model of Bus Stop. *KSCE Journal of Civil Engineering*, 28(2D), 217~225

Lei, Pui-Wa., and Qiong, Wu (2007). Introduction to structural equation modeling: Issues and practical considerations. *Educational Measurement: Issues and Practice*, 26 (3), 33-43.

Lave, H. and Mathias, A. L. (2006). Evaluating New Start Transit Program Performance: Comparing Rail and Bus, Victoria Transport Policy Institute, Canada.

Lu, X. and Pas, E. I. (1999).Socio-demographics, activity participation and travel behavior.

Transportation Research Part A, 33 (1), 1-18.

Mijares, A.C., Suzuki, M. and Yai, T. (2015). An Analysis of Metro Manila MRT-3 Passengers' Perception of Their Commuting Experience and Its Effects Using Structural Equation Modeling (SEM). EASTS 2015.

Mulley.G., Nelson (2009). Measuring the quality of service for passengers on the Hellenic railways. *Transportation Research Part A,* 42(1), 48 – 66.

Randheer, K., Al-Motawâ, A.A. and Vijay, J.P. (2011). Measuring Commuters' Perception on Service Quality Using SERVQUAL in Public Transportation. *International Journal of Marketing Studies,* 3(1), 21-34.

Shimazaki,T.A. and Rahman, M.M. (2002). Physical characteristics of paratransit in developing country of Asia, Department of Civil Engineering, College of Science and Technology, Nihon University,1-8, Kanda Surugadai, Chiyodaku, Tokyo, Japan.

Shiftan, Y. and Sharaby, N. (2012). The Impact of Fare Integration on Travel Behavior and Transit Ridership. *Transport Policy* 21, 63-70.

Straddling, S., Carreno, M. Rye, T. and Noble, A. (2007). Passenger perception and ideal urban bus journey experience. *Transport Policy*, 14(4), 283-292.

Steiger, J. H. (1990). Structural model evaluation and modification: an interval estimation approach. *Multivariate Behavioral Research*, 25 (2),173-180.

Stuart, K., Mednick, M. and Bockman, J. (2000) Structural equation model of customer satisfaction for the New York City subway system. *Transportation Research Record 1735*, Transportation Research Board, 133 – 137.

Tanaka, J. S. 1987. "How big is big enough? Sample size and goodness of fit in structural equation models with latent variables." Child Development 58 (1), 134-146.

Vandenberg, R. J. and Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: suggestions, practices, and recommendations for organizational research. *Organizational Research Methods*, 3(1), 4-70.

Vuchicn.d, T.B. and Kubota, H. (2012). User satisfaction with paratransit in competition with motorization in Indonesia: anticipation of future implications. *Transportation* 34, 337–354.

Wiley, D. E. (1973). The identification problem for structural equation models with unmeasured variables. In *Structural Equation Models in the Social Science*, A. S. Goldberger .

D. Ducan, eds. New York: Seminar Press, 69–83.

Wilber, A. (2011). *Public perception of urban transport performance and policy*. Survey Report for the EU-15, National Policy Frameworks (NPF) Urban Transport, Lyon.

Zaman, S., Zhou, W. and Shao, C. (2007) Evaluation of urban passenger transport structure.

Proceedings of Eastern Asia Society for Transportation Studies, 5, 441–449.

QUESTIONARY SURVEY ON USER'S SATISFACTION OF PARA TRANSIT SERVICE AT DHAKA CITY

User's Information

Age:
Occupation:
Income Range: 5000 tk-10000 tk-10000 tk-15000 tk-15000 tk-20000 tk/ More than 20000 tk
Survey Location:
User's Most Used Route:

QUALITY OF TRANSPORT

A. What is your idea about the prevailing para transit quality? (put a tick mark)
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

B. How about Seat Comfort Level:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

C. Fitness of para transit vehicles.

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

D. Noise level of the para transit:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

E. Lighting facilities of para transit:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

F. Cleanliness of para transit:
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

Do you have any other comments related to para transit quality of transport? (If "Yes" then put your comments.

SERVICE QUALITY

G. What do you think about the ticketing system?
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

H. Ease of entry-exit:
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

I. What is your comment about the sitting arrangement?
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

J. How is the movement flexibility?
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

K. Quality of driver:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

L. What is your idea about the speed of para transit?

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

Do you have any other comments related to para transit service quality? (If "Yes" then put your comments.

RELIABILITY

M. Availability of para transit:
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

N. Travel Time (office days):
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

O. Travel Time (holidays):
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

P. Integration with supporting modes:
(1) Excellent.
(2) Good.

(3) Satisfactory.
(4) Poor.
(5) Very poor.

Do you have any other comments related to para transit service reliability? (If "Yes" then put your comments.

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SAFETY & SECURITY

Q. Security of goods inside para transit:
(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

R. Security of passengers during off peak period:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

S. Riding Safety of para transit:

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

Do you have any other comments related to para transit service safety & security? (If "Yes" then put your comments.

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ECONOMY

T. What do you think about the travel cost comparing with other transport?

(1) Excellent.

(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

U. How is the operating cost comparing with other transport?

(1) High.
(2) Medium.
(3) Moderate.
(4) Low.

Do you have any other comments related to para transit service economy? (If "Yes" then put your comments.

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<u>TRAFFIC MANAGEMENT</u>

V. How is the performance for long route movement?

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

W. How is the movement flexibility in any road?

(1) Excellent.
(2) Good.
(3) Satisfactory.
(4) Poor.
(5) Very poor.

Do you have any other comments related to para transit traffic management ? (If "Yes" then put your comments.

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