EVALUATION OF SATISFACTION LEVEL OF WATERBUS SERVICES IN DHAKA CITY FROM COMMUTERS' PERSPECTIVE

By

Fawziya Fariha Anan (160051019)

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A THESIS SUBMITTED

FOR THE DEGREE OF BACHELOR OF SCEINCE IN

CIVIL AND ENVIRONMENTAL ENGINEERING

Department of Civil and Environmental Engineering

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Project Report Approval

The thesis titled "EVALUTION OF SATISFACTION LEVEL OF WATERBUS SERVICES IN DHAKA CITY FROM COMMUTERS' PERSPECTIVE" submitted by Fawziya Fariha Anan, Nawsin Ahmed, and Kazi Tahsina Habib, St. No. 160051019, 160051043 and 160051059 has been found as satisfactory and accepted as partial fulfillment of the requirement for the Degree Bachelor of Science in Civil Engineering.

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It is hereby declared that this thesis/project report or any part of it has not been submitted elsewhere for the award of any Degree or Diploma.

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List of Abbreviations

BIWTC	Bangladesh Inland Water Transport Corporation
UNECE	United Nations Economic Commission for Europe
PT	Public Transport
LMIC	Low and Middle Income Country

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Abstract

Traffic congestion is considered as an acute problem for Dhaka city, the capital of Bangladesh. The whole city got stuck at the peak hours due to heavy traffic volume and the city incurs huge economic loss due to loss of working hours. As Dhaka is surrounded by five main rivers i.e., Buriganga, Balu, Tongi, Turag and Sitolakha as well as several lakes (i.e., Hatirjheel, Dhanmondi, Gulshan etc.) are observed inside the city, implementation of water bus services was considered as a solution to avoid traffic congestion in certain places for the commuters here. That's why initially BIWTC (Bangladesh Inland Water Transport Corporation) had launched a water bus service from Sadarghat to Gabtoli touching several locations through Buriganga and Turag rivers. However, the service is about to fail and very infrequent now due to lack of insufficient passengers. Perhaps poor service quality was one of the major reasons for the insufficiency of passengers which were not explored by the concerned authority.

Thus this study aims to evaluate the satisfaction level on the service quality and safety of the water bus service in Dhaka city. A water bus service on Hatirjheel lake connecting areas among Gudaraghat, Gulshan 1, Film Development Corporation, Merul-Badda is considered as a case study for this research. Although it is a running service, however, the perceptions of stakeholders regarding the service and safety issues of water bus have not been assessed yet, which is very important for promoting and flourishing water bus services in Dhaka city to save time of the commuters in future. The satisfaction level on the service quality and safety will be measured by 150 passengers using this route through a questionnaire survey. The questions will focus two broader perspectives i.e. service quality and safety of the water bus. The service quality of water bus involves many features such as cleanliness, comfort, punctuality, reliability, seating capacity, convenience whereas safety perspective accounts issues like drivers' operating characteristics, safety equipment, emergency equipment, health facility, harassment etc. Linear regression model will be developed to evaluate the effects of respondents' socio economic, demographic and travel characteristics on service quality and safety of water bus. Moreover, four and three distinct models will be developed for four components (i.e., cleanliness, comfort, punctuality & reliability, driver characteristics) of service quality and three components of safety (i.e., safety equipment, emergency equipment, health facility, harassment) and two aggregated models of service quality and safety will be developed respectively. Through the results of individual models along with the overall model,

the satisfactory level of the respondents will be evaluated. These models will also reveal that the satisfaction level among commuters will greatly vary based on their socio-demographic, economic and travel characteristics. The results of this study would help the BIWTC authority to take necessary measures for improving service quality and safety of water buses. Revealing stakeholders' opinions is essential for the successful implementation, continuation and expansion of this type of service

1 CHAPTER ONE: INTRODUCTION

1.1 Background

Where the modern world being busy in a race against time, traffic congestion is a major concern. The dimension of this problem is creating a mess around the world which cannot be readily fixed at all. Since increase of personal vehicles, public transport, poor traffic management system cause traffic congestion and hence, the whole world has been lagging behind the target which effects the socio demographic factors. In 2018, the US Economy lost around $87 billion caused by traffic congestion (Fleming, 2019). There have been many explications of minimizing the enigma of traffic congestion, where water bus service can be an alternative of choosing as a public transport mode for regular travelling. A study in Korea (Myung et al., 2009) showed that Korea introduced water taxi at Han River having the aim to reduce the travel time and avoid the traffic congestion. Sustainable urban transport system emphasizes more on accessibility. In UNECE's (United Nations Economic Commission for Europe) publication (Konstantinos and Wyrowski, 2015), it is suggested that accessibility of transport is being degenerated due to traffic congestion. Water bus service can eradicate the issue of traffic congestion if common mass chooses the particular service for regular travelling. Some countries again utilize the water ways for the broadening the transportation communication and trade. A statistic shows that Vietnam has targeted the water ways for the enlargement of market share, according to a study (Asian Development Bank, 2013) which will increase up to 25% by 2020.

Bangladesh also has an effective transportation system that helps to expedite the economic growth. But a study (Khan et al., 2018) noted that traffic congestion costs $3.8 billion a year in Dhaka city. The traffic situation of Dhaka city has got worsen over the decades. Different types of vehicles are accessible on road which creates traffic congestion.

MODE	Walking	Tricycle	Auto Rickshaw	Bus	Private car	Others
Percentage (%)	60	19.2	1.4	9.2	3.1	6.7

The statistics (Hossain, 2006) showed that the roadways are the dominating mode of transportation in Dhaka city and hence, traffic congestion is the most contradictory case in Dhaka city. As the dominant mode of Dhaka city is walking, statistics (Ahmed and Ahmed, 2013) revealed 2,720 accidents have been occurred within 2007-2011 which has provoked a total of 1,481 numbers of pedestrian fatal accidents with 1,562 pedestrian fatal casualties. Moreover, in a research, a study (Hoque and Hossain, 2004) showed whereas Colombo has over 7600 buses for 4.6 million people, Dhaka city has only 2000 buses for 10 million people. The transportation system of Dhaka city is multimodal including bus, private car, auto rickshaw, rickshaw, lagoon and others where public transport is a massive challenge. The aspects of public transport are required to know for the betterment of comprehensive strategies (Lierop et al, 2017). A study (Farida, 2018) showed that there exist six aspects of public transportation service - safety, security, comfort, affordability, equality, and regularity on basis of public demand; if one fails, it will discourage the commuters to use the service. With considering different types of public transport, the aspects differ in miscellaneous socio economic factors (Disney, 1998). A research on Bus Service in Dhaka city (Rahman and Nahrin, 2012) showed that among the 175 respondents of bus passengers, 88% of them are regular passenger. All the passenger found the buses are cheaper and affordable. But the passengers were not satisfied with the over-crowding situation in bus which it is quite unsatisfactory. But the travel time, waiting time, walking distance from bus stoppage, safety, cleanliness, crew behavior, comfort etc. are extremely mismanaged which does not attract the passengers at all. Due to traffic congestion, the average travel speed of the buses is exceedingly low than Dhaka Urban Transport Project (DUTP) recommended speed. Where DUTP recommended travel speed of bus is 24 kilometers per hour, the average travel speed varies in between 9.1 and 13.4 kilometers per hour (Ahmed, 2004). Everyday traffic congestion in Dhaka city is vanishing 3.2 million working hours from the city dwellers (Nabi, 2018).

As Bangladesh is surrounded by many rivers, introducing water bus service to the common mass can be considered as a resolution in traffic management system. Travelers pick swift journey instead of long, so that they prefer water transport comparing to longer travel time in bus (Cheemakurthy et al., 2018). Inland waterway service is quite environment friendly which can be a sensible solution to traffic congestion in Dhaka city. The Bangladesh Inland Water Transport Corporation (BIWTC) introduced a water bus service in 2010 from Sadarghat to Gabtoli to alleviate the traffic congestion of Dhaka city but soon it failed due to lack of proper

maintenance system. The sources accused the service possessing the poor waterbus quality, irregularities in time schedules, poor service quality and safety (Khan, 2016). The principle purpose of BIWTC is to revitalize the waterway around the Dhaka city to minimize the traffic congestion, and also is affordable which can be on the side of favor of global economy (Shajahan & Nilufar, 2013). A major concern of waterway service is the rate of accidents. An Analysis of Accidents in the Inland Waterways of Bangladesh (Uddin et al., 2016) showed that the percentage of accident due to collision is quite high (60.3%), where storm related accidents is 8.7%. Generally, accidents take place in waterways by virtue of collision, grounding, fatigue, over-loading, inclement weather and so on (Islam et al., 2015). Another conflict in waterway service is the service quality and safety. Customer satisfaction, loyalty, quality benchmark as – accessibility, reliability, responsiveness, facilities safety and security, environment, cleanliness, fare – the correlation values of the attributes carry a consistency of the particular service (Haron et al, 2015). After the failure of Sadarghat to Gabtoli waterbus service, a new service has been launched in 2016 at Hatirjheel which is being called as Dhaka's Venice. Hatirjheel water bus service is fairly popular now that reduces travel time of commuters. Kawranbazar, Rampura, Badda Gulshan such roads are very active and congested during office time. Hatirjheel water bus service can be a substitute option to ignore the congestion and cut down less travel time. But there are few negative perceptions which influences the commuters a whole lot. A study regarding Hatirjheel water bus service (Sayam, 2019) noted that a big amount of discarded plastic has usually been found with awful odor, the environment looks filthy enough which can be considered as a hindrance of the lake view. The safety equipment, emergency equipment like life jacket, first aid, health facility such factors should be considered on a safety basis of passengers.

Considering the facts that Bangladesh as an over populated country is in a vulnerable condition to overcome the traffic congestion situation where waterbus could be a friendly mode to the passengers cutting down the travel time. As the authority has started Hatirjheel water bus service as an initiative to minimize the hassle of traffic congestion, the commuters should equally cooperate with the authority to proper demeanor. The commuters should be investigated to find out the pros and cons of the service which they are considering. The perception on service and safety of waterbus should be reviewed to let the authorities know the claims of the commuters. Therefore, the demonstration on waterway service is required for the development of the service and to assemble the service for travel satisfaction.

1.2 Objective of the Study

The main objectives of this study are,

- To evaluate the satisfaction level of the commuters on the service quality and safety of the water bus service using a questionnaire survey in Dhaka City.
- To assess the impacts of respondents' socio-demographic and travel characteristics on service quality and safety of water bus service by using linear regression model.

1.3 Scope of Research

The study will analyze the effect of the socio-demographic and travel characteristics of respondents on the quality of service and safety of the water bus service using a linear regression model. One of the key focus of this study is commuter satisfaction. This paper focuses on the production of questionnaires for user's survey and the provision of quantitative statistical analysis of survey results. The evaluation of service quality and safety provides operators with details on the satisfaction of commuters with current services and their anticipated standard of service. Researchers also recognized the value of stakeholder's perceptions for improving and promoting new services. So, this is also very important for the enhancement of the water bus services in Dhaka city to save riders time in the future. The study will also try to explore the user's understanding of the waterways around Dhaka and how these water bus services will be affected by the socio-economic context, age, income, etc. of the user.

This study will focus on two broader aspects i.e. service quality and safety of the water bus service. Depending on the features, four models in terms of service quality, three models in terms of safety and two aggregated models of service quality and safety will be developed including overall service quality and overall safety. For each model linear regression model will be developed in the analysis. These models will also show that, based on respondents' socio-demographic and travel characteristics, the level of satisfaction among commuters will differ greatly.

1.4 Significance of the Research

This study will contribute to the research literature in many ways:

1. This study will indicate whether the respondents' socio-demographic and travel characteristics have any impacts on service quality and safety of water bus service.

2. The research will also help those who undertake to study how Dhaka City can make the best use of natural resources to increase the satisfaction of its inhabitants.

3. This research will develop several models of linear regression that would be useful to determine the level of satisfaction of commuters.

4. It will also notify which variables are positively related and which variables are negatively related to the above models.

5. Particularly, the study will identify the impacts of the variables on the commuters' travel characteristics.

6. The study will try to explore the user's understanding of the waterways and how these services will be affected by the characteristics of the user and also provide some avenues for potential research and analysis in this area.

Many studies show that the use of a water transport system is a means of alleviating urban traffic congestion and reducing environmental loads. It can also help to minimize the environmental burden by reducing the quantity of car exhaust (Ferguson, 1990). The standard of transit service is a factor that significantly influences travel consumer choices (Eboli & Mazzulla, 2009). Customer satisfaction represents a measure of company performance according to customer needs (Hill et al., 2003). Several studies have been done on commuter satisfaction levels. This study can add to the research that is reported in TRB (2003a, 2003b), Service quality (Eboli & Mazzulla, 2007), Service quality (Eboli & Mazzulla, 2007), Public transit user satisfaction (Tyrinopoulos & Antoniou, 2008), User perceptions (Iseki & Taylor, 2008), and User perceptions (Joewono & Kubota, 2007).

1.5 Outline of Thesis

The thesis is divided into six chapters. Led to the introduction in the first chapter, the rest of five chapters will cover the following topics:

Chapter 2-Literature Review

Factors associated with the level of satisfaction of waterbuses from the perspective of commuters reviewed in this chapter. Important details and results from these studies are also mentioned. In addition, the aspect that influences the level of satisfaction of the waterbus service is also discussed.

Chapter 3-Data and Methodology

Chapter three describes the sources of the database collect from the questionnaire used in this study as well as methodology followed in statistical analysis. This chapter also discusses the different factor of service quality and safety and the comprehensive method for a linear regression analysis.

Chapter 4-Analysis and Model Development

In this analysis, three models were produced. The nine models that have been built are discussed here and the data analysis method is included in this chapter.

Chapter 5-Results and Interpretation

This chapter introduces nine different models (cleanliness, comfort, punctuality & reliability, driver characteristics, safety equipment, emergency equipment, health facility, harassment, overall service quality, overall safety) for the purpose of this study. All the results of the analysis are seen here. Explanation of results is discussed in detail in this chapter.

Chapter 6-Conclusions and Recommendations

This chapter draws a final conclusion on the basis of the results of various literatures in terms of service quality and safety measures, if the variables are consistent in all case studies. Some directions for future research in this area are also listed.

2 CHAPTER TWO: LITERATURE REVIEW

The literature review of the thesis will be structured by considering a variety of features. First, related research that looked at the evolution of service quality measures from the customer's point of view. Second, safety indicators that could have an influence on passengers traveling by waterbus. Third, the main results of the multiple published articles on customer satisfaction studies at the level of different variables. These discussions will provide some explanation for the analysis of this study.

2.1 Issues related to Service Quality

Service quality has been conceptualized and defined as the outcome measure of the gap between customers' expected performance of service offered and its perceptions of the level of service received (Parasuraman et al.1988). The concepts of service quality are fundamental to a successful business because they are crucial to customers' decision-making (Yaya et al.2011). The main focus of this study is in terms of availability of service, accessibility of service, comfort, reliability, cleanliness, walking distance and socioeconomic factors.

2.1.1 Availability of service

Service availability is an indicator of the availability of a transport system (Elms, 1998). This opens up personal mobility for all, allowing each individual the right to go practically anywhere (The Top 10 Benefits of Public Transportation | Smart Cities Dive, 2020). The passenger's point of view, or quality of service, tests directly the passenger's perception of the availability, comfort and convenience of the services of public transport (Ap. Sorratini et al., 2008).

The availability of transit networks and pedestrian accessibility is the key issue in the planning of effective public transit, which affects the ridership significantly (Gahlot et al.2013). It is one of the most important parameters of service quality as it helps to reduce the waiting time and travel time of people. When asked, people said that the frequency of the water bus service was not equal every time. So, sometimes people have to wait for a long time which is a great problem for the service. Effective concepts of service availability were focused on data easily

and directly inserted into the operating log or automatically collected by the software-generated Automatic Train Supervision (ATS) system and reports (Elms, 1998, p. 83).

Figure 1:Availability of Waterbus Service

2.1.2 Accessibility of service

In transport planning, accessibility refers to a measure of the ease of reaching (and interacting with) destinations (Farber & Fu, 2017, p. 37). A location with "high accessibility" is one from which it is possible to reach several destinations, or to reach destinations with relative ease (Wikipedia contributors, 2020). In time geography, accessibility has also been defined as "person-based" rather than "place-based", where one would consider a person's access to some type of amenity through the course of their day as they move through space (Miller, 2005).

A successful way of minimizing the external costs and negative side effects of motorized commuting can be considered to be enhancing public transport accessibility (Saghapour et al., 2016, p. 282). Several studies have been carried out that have measured levels of access to public transit stops/stations, also limited research has been performed on measuring accessibility that incorporates population density within geographical areas. It has gained vital importance in designing and evaluating the transit system in terms of mobility and sustainability (Saif et al., 2018, p. 40).

In terms of versatility and sustainability, public transport connectivity has acquired critical significance in the design and assessment of the transit system. Moreover, researchers have revealed several impacts and correlations of the provision of public transport accessibility to the environment and daily life which would have a noticeable impact on public health and other aspects of public daily life (Saif et al., 2018, p. 40).

Figure 2: Accessibility of Waterbus Service

2.1.3 Comfort

Comfort is something that gives pleasure or a feeling of peace and simplicity. It is one of the most important determinants of public transport convenience. Despite being one of the most important determinants, convenience is often neglected in transportation systems design and assessment of operational performance (İmre & Çelebi, 2017, p. 2446). The Comfort level of the different alternatives of public transport has been empirically demonstrated to be a significant factor in traveling behavior by numerous authors (for example, Ben- Akiva et al., 2002; Cherchi and Ortúzar, 2002; or Raveau et al., 2011).

Over the past few years, the topic of passenger comfort onboard public transport has grown insignificance. Thermal comfort and indoor air quality are often a problem for the passengers during transportation (Patania et al.2012). Since many people use the public transit system in a tightly confined environment, it can cause adverse health effects due to poor indoor air quality and a lack of sufficient ventilation (Patania et al.2012). Besides, the heat produced by engines,

lighting and human bodies is so significant that excessive temperatures can dominate in the summer and if the air is not cooled, this can lead to passenger distress and complaints. The waterbus service is open so fresh air is always available and the passengers do not feel suffocation because of the engine or any other things. Moreover, the seats are also in good condition and the passengers feel comfortable. However, conventional comfort measuring approaches rely on either personal interviews (Edvardsson, 1998, p. 192) or literature surveys (Cantwell et al., 2009), which are generally labor-intensive and time-consuming, and are thus limited in terms of scalability and timeliness (Yu Lin et al.2010).

2.1.4 Reliability

Public transport system reliability is considered to be critically significant by most of the users, because passengers are adversely affected by the repercussions associated with unreliability, such as extra waiting time, arriving at destinations late or early and missing bonds, which increase their anxiety and discomfort (Bates et al., 2001; Rietveld et al., 2001). In determining mode choice, reliability has also been described as essential (Turnquist & Bowman, 1980).

According to Ap. Sorratini et al., (2008), reliability is targeted by operating companies, firstly to enhance their internal productivity and running costs are lowered and secondly, because of service enhancements, they benefit from increased patronage. They also think that while reliability is the target of each of the key interest groups, the word itself has different meanings and different interpretations for various classes and also studies have linked reliability with various aspects. The main problem of water bus is the waiting time is not always equal. Sometimes passengers have to wait a long time which becomes more annoying on the hot summer days or in peak hours. Studies relate reliability to travel time accuracy (Polus, 1978), others equate reliability with measures such as timetable adherence (Bates et al., 2001), preservation of service regularity, waiting time for passengers at stops (Turnquist & Bowman, 1980; Bowman & Turnquist, 1981), ease of catching a bus, the proportion of passengers waiting for the bus because of insufficient capacity. According to Carey (1999), measures of reliability and punctuality of scheduled public transport services are important in planning, management, operating and marketing of those services.

2.1.5 Cleanliness

Cleanliness is both the abstract state of being clean and free from germs, dirt, trash, or waste and the habit of achieving and maintaining that state ("Cleanliness," 2021). According to Vos & Hagen (2019) cleanliness is one of the main determinants of public transport's overall customer satisfaction. They also think that the perception of cleanliness by customers is not limited to cleaning only, but depends on various predictors and to maximize perceived cleanliness in different stops, a better understanding of these predictors can contribute.

According to Parasuraman et al., (1988) from previous research we know that the perception of service quality by customers is shaped by multiple dimensions, such as service reliability, service staff responsiveness, but also the cleanliness of the service environment. So, cleanliness is also one of the most important parts to evaluate the service quality of water bus service. The water bus was clean and waste bins were seen both in the water bus and at the stations. Customers do not have any complaints regarding the cleanliness of the service. According to Vos & Hagen (2019) cleanliness is approached from two distinct perspectives: cleaning quality and the perception of cleanliness by customers. Quality of cleaning is defined as the absence of dirt (i.e. dust, stains & litter) and is mostly monitored through predetermined indicators by trained inspectors, such as the cleanliness of benches, banisters and floors (Sherlock et al., 2009). The standard of cleaning reflects the objective organizational viewpoint on cleanliness and is often used to track the quality of the cleaning process by TOCs (and service organizations in general) (Vos & Hagen, 2019). According to Whitehead et al., (2007), research into predictors of the perception of cleanliness by clients is mainly exploratory and qualitative.

2.1.6 Walking Distance

According to Daniels & Mulley (2013) the key role of public transport is to ensure accessibility to activities and services. They also think that public transport planning guidelines typically define access to public transport in terms of the difference between public transport stops or the distance between stops. When there are transit stations near the community and work area, people are empowered to walk.

Research on transport planning has concentrated on mode selection, not on access to various modes, and less well-established literature on how far pedestrians walk and the factors affecting their choice of route (Weinstein Agrawal et al., 2008, p. 87). According to Corpuz et al. (2005) in Sydney, females walk more than males, that older and younger age groups walk more, and that people with low car ownership walk more. When asked many people said that they come to the stop by walking and some use buses or rickshaws to reach the stop. But the number is less who uses vehicles to reach the stop. Most of the people reach there by walking. The main reason for walking is the environment. The area is very clean and the lake view makes the environment more beautiful. From density, diversity and architecture to micro-level specifics such as ambiance and aesthetics, the many components of the built environment affect walking. Cervero et al. (2009) cited Handy et al. (2002) and Frumkin et al. (2004) to argue that permeability, footpaths, lighting, protection, density, and mixed land use are the characteristics of the built environment.

Walton and Sunseri (2010) studied that public transport users in New Zealand cities, Auckland and Wellington think that walking as an access mode to public transport to understand factors affecting the decision to walk to public transport and concluded that almost all impediments to walking found in research elsewhere disappeared except rain.

2.1.7 Socioeconomic Factors

One of the main components of enhancing the social and economic health of a community is the public transport systems in developing nations (Agarwal et al., 2017, p. 4592). Also, the development of equitable and reliable public transport services in developed countries is a difficult challenge due to high population levels.

According to Kanuganti S. et al., (2013) in developing countries, most of the people are relatively poor and thus public transport is one of the most popular modes of transport that can be accessed by the urban population. Moreover, In the short to medium term, the future of public transport ridership is likely to rely on population growth; public funding commitment to transit supply and factors that make driving more or less appealing, such as parking costs, the degree of road congestion, and the introduction of fuel taxes, tolls, and mileage-based usage fees (Mallett, 2018). The parking price affects transit ridership, where transit patronage can be

greatly increased by implementing a regular parking charge for commuters (Hess, 2001). Women have a higher probability of using PT for trip purposes other than commuting compared with men (Kuhnimhof et al., 2006, p. 43). From the questionnaire, we get to know that many female students and working women use this service as they find it safe and reliable. Personal safety has been identified as one of the most important factors in women's travel decisions (Chowdhury, 2019, p. 861). Morikawa et al. (2003) found a clear preference among those aged 18 and above for private vehicle reliance, while the older population (65 years and above) prefer bus travel in Nagoya, Japan. Chee and Farnandez (2013) found a rise in public transit ridership in households with lower incomes.

The inclusion of socio-economic variables in the study is mandatory to identify the effects on the mode of transport.

2.2 Issues related to Safety

Safety feelings have had a slight but significant positive effect on the level of public transport use (Delbosc & Currie,2012). The main focus of this study is in terms of safety, harassment, health facilities, secure equipment and GPS.

2.2.1 Climate

The sustainability and operation of transport networks in the long term would need to be increasingly considered and prepared for climate change and severe weather events (Markolf et al., 2019). The effects of climatic conditions on the use of a specific mode of transport has implications on commercial speed, scheduling and travel times (Arana et al., 2014) Climate change influences wind speeds and the direction of the wind. Temperature and precipitation fluctuations have implications for the levels of riverine water. Low water levels would force the use of only part of their maximum capacity by water transportation vessels (Koetse & Rietveld, 2009) Thus climate has a great effect on the water bus operation.

Humidity is poor during the dry season, and the level of water has decreased. So the water bus can easily get stuck or travel steadily. Due to this travel time delay, the users could have

switched to another transport mode. Many passengers travel by waterbus during the monsoon. But the numbers decline during the dry season due to the stinky water of the rivers as small buses and bulkheads can sink due to the waves it creates, the waterbus may not work at high speed (Khan, A.R,2016). Behavioral reactions to adverse weather can occur in different ways during transport. We may order them according to the well-known basic dimensions of generating trips, distribution of trips, modal choice, choice of path, temporal choice and choice of speed (De Dios Ortúzar and Willumsen, 2001).

2.2.2 In vehicle Equipment

In many low and middle income countries (LMICs) like India, South America, Vietnam and Cambodia, waterways are a popular avenue of transport. Improving the safety of water transport systems in LMICs is connected with a variety of problems, including a lack of government engagement and conflicting priorities for limited resources. (Hilling D.2003). Most of the staff who run water buses in our country are illiterate. Passengers were usually taken out of the vessel's capacity during peak hours. So there's a greater risk of falling in the water. For various reason, safety tools are expected.

The best way to avoid disaster, readily accessible and safe from water and weather, is to keep the lifejacket, buoyancy apparatus, fire extinguisher, navigational equipment in good working order. Priority can be given to the implementation of appropriate and effective measures to resolve safety issues of primary concern by identifying significant gaps in the safety of the water transport system (Jagnoor et al.2019). Moreover, passenger carelessness and lack of knowledge are thought to play a major role in accidents associated with water transport. Workers who work on-board vessels have confirmed verbally advising individuals to avoid risky actions (Jagnoor et al.2019). In terms of safety and security purposes, navigation lights must be shown between sunset and sunrise and with limited visibility. Owing to suitable lighting arrangements, most of the passengers did not choose a water bus trip in the evening.

2.2.3 Health Facilities

Ensuring adequate connectivity of public transport to health facilities in various areas is a primary concern for public health and social equity. The imbalanced geographical distribution of health facilities, however, may lead to an incorrect estimation of accessibility that is affected by both land use and transport ((Zhang et al., 2020) Only for certain types of emergencies or disasters can emergency medical vessels be successful or feasible. If all of these particular events are not likely to occur in a certain community, then it does not benefit from the services that the vessel may provide (Nachtmann & Pohl, 2013) In waterbus service first aid, drinking water, cleanliness and sanitization would be required.

The service at the water bus station is expected to differ in passenger age. So, installment of safe water service designed for drinking purposes is needed. Most individuals think that public toilet must be required from the questionnaires, excluding female one as the safety issues. Research has shown that the provision of public toilets is a crucial missing link that would allow for the development of cities that are sustainable, affordable and inclusive (Bichard at al). In addition, due to the corona virus, it is necessary to consistently clean and sanitize the waterbus for added protection and also provide the passenger with a sanitizer when entering the vessels. Working in cooperation with a number of academic organizations, the World Health Organization (WHO) has been active in evaluating access to health facilities in developing countries (Black et al. 2004).

2.2.4 GPS

The Global Positioning System (GPS) makes it possible to position an object accurately using satellite signals (Mintsis at al,2004). The Global Positioning System (GPS) is a worldwide system for radio navigation, which consists of 24 satellites and their ground stations. 24 hours a day in the world, it offers continuous three-dimensional positioning. In GIS data processing, surveying, and mapping, GPS technology has an immense number of applications (C. Hentry et al., 2011) The safety of transporting goods in urban areas depends heavily on the choice of route and the control of heavy vehicles in urban areas. The transport firm must have control over the efficiency of the driver when a passage route has been chosen (Banachowicz et al.,

2014) Therefore, it is necessary to provide a GPS waterbus service as this service allows passengers to minimize waiting time and choose the mode as they desire. The most modern and state-of-the-art technology is the use of the Global Positioning System (GPS) to track vehicles in real time (Farooq et al., 2017) The time taken by different buses on a given route is collected under various conditions over a specified time. This collected data is then used by the system and the time for buses to operate is estimated Based on data, the stakeholders can use various speeds for different time intervals ((Siddiqui et al., 2014).

From this discussion, it is highly recommended to install GPS for safety purposes in the waterbus service.

2.2.5 Harassment

Harassment restricts public transport mobility. It affects public transport riding, particularly for women in overcrowding or late-hour scenarios. There are multiple kinds of threat criteria for harassment problems, such as late hour security, verbal harassment, physical assault, perspective of illiterate people and so on. Research indicates that women made up a greater proportion of captive riders compared to men. Access to public transport is important for these women, as it provides them access to employment, academic and social facilities and the wider culture in specific (Smith, 2008).

The frequency of harassment in and around public transit is commonly documented in different research. In interview, it was found that women felt uncomfortable when they are alone in late hours and even because of lack of lighting in Waterbus. The tension and fear of using public transit also influenced their decisions to take certain rides, use certain transit lines, or ride in the transit lines for those who had few transportation options other than taking the bus or train in the evenings ((Lubitow et al., 2020). Women not only usually report higher levels of fear in relation to their travels than men, they often fear different things. For example, in the U.K., men indicated that they were concerned about the presence of groups of other men while women were concerned about a single individual, particularly when it was just a man (Crime Concern, 2004)). Inequality and attitude of individuals is the reason behind the harassment. Gendered inequalities in the use of transport open up a myriad of further concerns. This involves a disproportionate fear of victimization in public transportation spaces for females

(Kalms, N., & Korsmeyer, H.2017). Many more strategies have been given in various studies to stop this harassment. Public concern towards this fact is the key solution and is due to this dilemma in the field of public transport. Segregation is not the answer to this dilemma. It requires a transformation in the behavior and attitude of society (Ceratti, M,2014).

2.3 Issues related to Customer Satisfaction

In bus services, transfer efficiency and quality service are the top priority for customers in Athens. The service frequency, transfer distance, ticketing system, and vehicle cleanliness were the main satisfaction indicators, according to them (Rahman & Nahrin, 2012). Researchers have recognized the value of satisfaction for passengers in the sense of public transport services. Some researchers have found that the satisfaction of passengers positively influences the commitment of passengers to the usage of public transport services. (Wen 2005. Lai and Chen, 2011. Jen, 2011)

2.3.1 Fare Collection

The provision of effective and efficient public transit services requires a wide range of decisions requiring close inspection, such as the design of a network or corridor, the choice of modes of operation (e.g. bus, tram, light rail, metro), the type and level of infrastructure investment, the number of services every day or hour, the method of collection of fares and the location of stations or bus stops (Tirachini & Hensher, 2011). Fare collection schemes play an integral role in every public transport system's success or failure. Unaffordable fares and inappropriate methods of collection can lead to passenger frustration and disappointment, while more ridership can attract affordable fares, simplicity, and ease of use (BRT Planning Guide).

Two types of fare collection mechanisms take place: on-board systems, inside public transit vehicles, and outside vehicles, off-board systems. The passengers are experienced with the collection of fares off-board in the water bus system. A few number people were disappointed with the ticketing expense as well ae some people also pleased as it decreases their travel time. From Gulshan 1 to FDC costs Tk 30, FDC to Rampura costs Tk 25, Rampura to Gulshan Police Plaza costs Tk 10. Every day, about 1200 to 1500 tickets are sold, which rises during holidays

(Hassan, M. M.2019). In developing countries, the fare collection technology is currently based on the smart card system. In a variety of cities worldwide, Automatic Fare Collection (AFC) systems are in operation. In 2003, TfL launched its own: an AFC scheme that utilizes Oyster cards called RFID-based smart card tickets (Weinstein, 2009). In terms of customer loyalty, Waterbus could incorporate smart card services

.

Figure 3: Fare Collection Process of Waterbus Service

2.3.2 Information

Travel information is an important factor in the quality of public transport and can be subdivided into static, dynamic and real-time information. With the increased availability of information, the number of passengers would increase. Travel information not only contains the content of the information, but also the terms of the information. It covers the climate, layout, and ergonomics (Grotenhuis et al., 2007). The provision of information in itself does not have the potential to convince people to switch modes, although this service has been shown to be relevant in various studies and can therefore significantly contribute to overall satisfaction with the standard of public transport (Stradling et al., 2000a). Real-time displays of information showing the next departure of trains and buses are becoming more and more common at stations and stops (Kabjorn, A., 2005). The question remains whether real-time information displays at-stop boost traveler numbers, whether the displays mostly influence current users' trip making or whether the new information system really attracts new travelers (Dziekan &

Kottenhoff, 2007) Passengers offer public transit priority over other modes of transport. In the water bus system, passenger travel data, check in / out, travel generator data will make it easier for stakeholders to generate trip. For passengers own convenience, they can make travel for different purpose. The ITS system is capable of delivering information to 5 users, on-the-go, via in-vehicle information distribution, roadside installed VMS, computers for personal information and the Internet (Blythe et al., 2000).

2.3.3 Travel Time

One of the main influential factors for public transport (PT) attractiveness is saving travel time. The travel time of future PT users is more critical than it is for current users. Potential users value it as the most significant feature of the attractiveness of PT usage. As such, a common concern about routes with transfers is that poor link reliability will adversely affect the overall travel time (Stradling, 2002). In traffic modeling, the question of having to estimate speed and travel time is also present. Average speed should be accurately measured for each type and sub-type of connection and mode of transport. In the case of public transport, because of scheduling, fixed travel times are usually believed (Birr at al). Most passengers said from the questionnaires that during peak hours, the waterbus controls travel time, which allows this mode to be preferred over others.

Perceived travel time is used here as a measure of the standard of the passenger-experienced public transport service, which combines nominal travel time and conditions of travel (Haywood at al, 2017). Waiting times for transfers are either fully ignored or presumed to be constant in all transfers, such as one-half of the headway time (time interval between vehicle departures) (Tribby & Zandbergen, 2012). Passengers are willing to transfer and make trip on waterbus to avoid traffic congestion on road. Interchanges are one of the key points of contact with PT networks for passengers and are thus an important factor in their experience (Auckland Transport, 2013).

2.3.4 Psychological Behavior and attitude

Driving Psychology is still in the starting stages and is still evolving in content and process, in response to the new need to control driving behavior in an industrialized society. The

development of a safe driving attitude is one of the most important aspects of driver training and must maintain control over his emotions and actions, practice protective driving tactics and take responsibility for all driving decisions to have a healthy driving attitude (The Importance of a Safe Driving Attitude, 2014).

To promote the usage of public transit, it is of critical importance to understand individuals' psychological feelings since they play an important role in travel behavior (Golob, 2013). From a psychological viewpoint, several behavior change techniques may be used to change unsafe driver behavior, e.g. informing, persuading rewarding, punishing and also the motivation underlying the behavior determines to a large degree how successful these behavior change strategies may be (GOLDENBELD et al., 2000, p. 68). Pronello and Camusso (2011) have confirmed that there exists a dissonance between attitude and behavior when habit, which is consolidated in time, intervenes. They also found that because of the unsatisfactory public transport service, " the correct general attitude " is often inadequate to adjust the mode of choice for travelers. Ajzen and Fishbein (1980) proposed their Theory of Reasoned Action to predict and understand the individual's behavior and their opinion is most social actions are under volitional control.

3 CHAPTER THREE: DATA AND METHODOLOGY

This chapter describes the process of data collection, data formulation and methodology used in evaluating the satisfaction level of water bus services from the perspective of commuters. Linear regression models will be used to classify the various factors influencing the level of satisfaction and safety of the waterbus transport mode among users. Four models for service quality features and three models for safety features and two aggregated models of service quality and safety will be developed including overall service quality and overall safety. The formulation of these models will help us understand how these models can be used to fulfill the study's main objective; that is, to define the commuters' perspective on cleanliness, comfort, punctuality & reliability, driver characteristics, safety equipment, health facility and harassment variables will be calculate. The database sources used in this process are described before explaining the mathematical formulation of the model, its assumptions and analysis procedure.

3.1 Main Steps in Methodology

In order to achieve the objective of the study, an effective statistical model needs to be evaluated. Models will be developed using questionnaire data based on different types of commuters' perception at service quality and safety factors. Model calibrations would then be performed to find the best model among the competing ones. The result of the final model will then be evaluated to determine the vital factors that lead to the quality and safety of the service. The methodology can be divided into three main steps.

(a) Set questionnaire-based survey based on the perception of commuters for data collection. The questionnaire survey was performed by both online and offline platforms for those passengers who had to travel frequently.

(b) Selecting linear regression model to express service quality and safety as a function of various commuter's perception data such as: sitting arrangement, control and management, travel time, regularity of service, customer service, driving practice, travel cost, cleanliness, fare collection system, overcrowding, bus comfort, security, safe from accident, lighting facilities and information characteristics of different categorizations.

(c) Analysis and interpretation of the results of the model; that is, the engineering evaluation of the factors influencing the quality of service and the safety of categorizations. Finally, to verify the relative significance of the independent variables throughout the final model.

3.2 Description of Data

The survey of the questionnaire includes the perceptions of commuters. Respondents have been asked to measure their satisfaction as indicated in the questionnaire. The number of respondents was 126. On an online basis, we collected 41 responses by creating google form and on an offline basis, we collected 85 responses based on interviews. Likert-type scale was used in the questionnaire. Five stations in the Hatirjheel area (Rampura, FDC, Gulshan, Police Plaza, Badda) were selected for the questionnaire survey. These locations were visited on different days at different hours with the purpose of covering passengers from all possible destinations. Data collection was conducted form 8 - 12 am in the morning and 3 – 5 pm in the afternoon. The variable chosen to measure customer satisfaction is the quality, punctuality, reliability, safety and security of the water bus service provided by stakeholders operating in Dhaka City.

In order to identify the characteristics of customer satisfaction, a questionnaire survey was performed for those passengers who had to travel frequently. The questionnaire consisted of eight main sections. Part A covers demographic details of the passengers containing questions about respondent's age, occupation, income, survey location and users most frequently used routes. Part B is about cleanliness service quality. It includes questions about flooring, passenger seats, vessels, waterbus stops, handrail, guardrail cleanliness. Part C is about comfort. It includes questions about enough seating arrangements, seating positioning, smell, crowdedness, driving practices, capacity, natural ventilation, temperature. Part D is about punctuality and reliability. It involves concerns about quality control and management between various bodies, waiting time – both at bus stops and during travel, customer service and travel time and schedule. Part E is about the characteristics of the driver. It includes questions about the character of the driver, the skill, the experience, the attitude among the passenger. Part F involves safety equipment. It contains questions about arranging sufficient life jackets, buoyancy apparatus, GPS positioning, lighting facilities. Part G involves health services. It

contains concerns about promoting first aid, sanitizer, clean drinking water, public toilet. Part H is about harassment. It contains concerns about the chances of pocketing/hijacking, the experience of physical and verbal violence.

The demo of the questionnaire-based survey based on the perception of commuters is given below:

1. What is your sex?
   - Male
   - Female

2. What is your age? _____

3. What's your educational qualification? _____
4. What is your profession?(i.e., Student, Businessman, Private Service, Government Service, Housewife etc.) _____

5. What is your monthly income? _____

6. What is your marital status?
   - Married
   - Unmarried

7. What is your major mode of travel?
   - Bus
   - Waterbus
   - Rickshaw
   - Uber / Pathao
   - Private car
   - CNG
   - Walking
   - Motorcycle
   - Bicycle
   - Tempo

8. Which mode do you take to reach waterbus station? (i.e., walking, rickshaw, bus, private car, tempo etc.) ? _____
9. What's your home location?(i.e., Banani, Badda, Gulshan, Mohakahali etc.) _____
10. No. of family members_____
11. Where is your job location? (i.e., Banani, Badda, Gulshan, Mohakahali etc) _____
12. Do you/your family own a private vehicle?
    - Yes
    - No
13. Do your other family members also use waterbus?
    - Yes
    - No

14. How much money do you spend in each month for transportation purpose? _____

15. Have you ever involved with an accident taking water bus service? (Af Wahlberg, 2002)
- Yes
- No

16. Have you experienced harassment(verbal, physical abuse, bullying etc.) while taking the water bus service?
- Yes
- No

17. Do you find the service risky for traveling on a daily basis?
- Yes
- No

18. Have you ever faced out of order/broke down of waterbus during your journey?
- Yes
- No

19. Does the overall service of the water bus satisfy you?
- Yes
- No

20. Does the service minimize your travel time? (Wardman, 2014)
- Yes
- No

21. Does the number of stops should be reduced along the route? (Agnieszka and Adam, 2015)
- Yes
- No

22. Do you think that position of the bus on its route should be identified by electronic devices for ensuring better services? (Lee and Lee, 2015)
- Yes
- No

23. Do you drive car?
- Yes
- No

24. Do you think that some seats should be reserved for women? (Rahman, 2010)
- Yes
- No

25. Do you think that the sanitizer should be provided to the waterbus? (Nepoleon,2020)
- Yes
- No

26. According to your judgement what is the main problem of water-bus service?(Choose only one option)

- Not Clean
- Safety
- Frequency
- Not maintaining time table
- Uncomfortable
- Other(Please specify _____)

27. Have you ever faced mugging in waterbus?

- Yes
- No

28. Do you happy with the current ticket purchase system of waterbus?

- Yes
- No

29. Main reason of choosing waterbus(select only one option)

- Avoid traffic congestion on roads(Pu et al., 2017)
- Cheap
- Comfortable
- Reliable
- Safe

(1) Cleanliness in terms of Service quality

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I often feel that the floors are dirty and slippery. (Faskerty et. al., 2012)					
2. I often feel that the advertising panels and graffiti on the shelters, walls is eye-shoring. (Eboli and Mazzulla, 2012)					
3. I often feel that the passenger seats are broken and not clean. (Gao et. al., 2016)					
4. I often feel that the water bus stop is not clean. (Coffel, 1995)					
5. I often feel that the handrail, guardrails are broken and not cleaned. (Faskerty et. al., 2012)					

(2) Comfort in terms of Service quality

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I think that the seats are not comfortable and there is not enough space. (Nathanail, 2008)(Rahman, 2010)(Andaleeb, 2007)					
2. . I think that the seating position(arrangement of seats) is not good. (Sam et al., 2018)					
3. I feel uncomfortable as the conductor often forces passengers to take the service while the water bus is fully overloaded. (Farida, 2018)					
4. I often feel that water buses are smelly and crowded. (Eboli and Mazzulla, 2012)					
5. I think that the water bus is not well driven(i.e., sudden brakes, over speeding etc.) and not gives a comfortable ride. (Gao, 2016)					
6. I think that the bus is not quiet, not properly ventilated(air circulation) and not maintaining a comfortable temperature(feeling hot due to engine heat). (Eboli and Mazzulla, 2012)					
7. I think that the bus stoppages have not adequate seating arrangement and capacity. (Eboli and Mazzulla, 2011)					

(3) Punctuality and Reliability in terms of Service quality

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I think that the water bus does not reach to the destination on time. (Rudnicki, 1997) (Strathman et. al., 1999), (Kimpel, 2001)					
2. I think that the waiting time for the bus is long. (Agnieszka and Adam, 2015)(Ettema et al., 2012)					
3. I think that the bus service is not regular and not always on time. (Yaakub and Napiah, 2011)(Friman, 2004)(Wardman, 2014)					
4. I think that the timetable in the bus stop is not error free. (Wachs, 1976)					
5. I think that the alighting time takes long					
6. I feel unsafe as the bus often breaks down on the middle of the water. (Kathuria et. al., 2019)					
7. I think that the seats are not always available for the passengers. (Vuchic, 2005), (Ceder, 2007)					

(4)Driver Characteristic and Service Quality

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I often feel that the behavior and attitude of the water bus driver is not friendly(rude). (Rahman,2010)					

2. I often feel that drivers lack a very good knowledge and skill of driving vessel. (Huq and Dewan,2006)					
3. I often feel that driver is not concerned about travel timing. (Van Exel and Rietveld, 2010)					
4. I often feel unsafe that driver is using mobile phone while driving the waterbus. (Gras et al, 2007)					

(5) In-vehicle Safety Equipments

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
1. I often feel unsafe that service provider does not use modern navigational equipments. (Azad, 2009)					
2. I often feel unsafe that GPS is not used for positioning. (Azad, 2009)					
3. I often feel unsafe due to lacking of lifejacket/ buoyancy apparatus . (Qustberg et al, 2014)(Biswas et al,2017)(De L.S,1962)(Jagnoor et al, 2019)					
4. I often feel unsafe that lighting arrangements are not adequate in the waterbus. (Mcgoldrick,M.B, 1956)					
6. I feel unsafe that fire-fighting tools have not been kept in case of removing fire from the waterbus. (Coughlin ,1994)					
7. I feel unsafe that emergency rescue brochure /announcement is not available in the waterbus. (Farida ,2008)					

(6) Health Facilities in terms of Safety

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I often feel unsafe about lack of first aid kits in the waterbus. (Farida , 2008)					
2. I feel unsafe because waterbuses are not cleaned and sanitized daily. (Nepoleon,2020)					
3. I feel discomfort because safe drinking water is not available in the waterbus. (Chowdhury,2018)					
4.I feel discomfort because public toilet service is not available in the waterbus. (Genet et al,2020)					

(7) Harassment in terms of Safety

Instruction: Please read the questions carefully. Draw Tick mark (✓) whether you agree or disagree with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. I often feel unsafe about being harassed by the driver or helper or other passengers. (Tokay and Shioma, 2017).					
2. I often feel unsafe in transit when I am alone. (Vanier and De Jubainville, 2017)Junger, 1987					
3. I often feel unsafe about possibility of being physically & verbally abused when I travel by waterbus. (Siddiqi, 2004)					
4. I often feel unsafe about possibility of experiencing pickpocketing/mugging while traveling by the water bus. (Tokay and Shioma, 2017)					

The questionnaire-based surveys were further analyzed using both Microsoft Excel software and Statistical analysis for the STATA 15 software.

3.3 Statistical Model

The main objective of the statistical model is to classify the deterministic function of the method.

$$Y = f(X) \tag{3.1}$$

When the dependent variable Y is a function of a set of independent variables X. The regression analysis of the above-mentioned type shall be analyzed.

(a) whether the variations found in the data are consistent with theoretical assumptions; and

(b) the relationship between a quantitative dependent variable and one or more quantitative or qualitative independent variables.

In the analysis, the Y represents the quality of service and safety attribute and the X represents the age, income, job location, material status, etc. of the respondent. In our analysis, the majority of the dependent variables are continuous. Linear regression analysis was used for this purpose in the study.

3.4 Linear Regression Model

Linear regression is one of the most used statistical and econometric methods. It is sufficient for modeling a wide range of relationships between variables. Expectations of linear regression models are sufficiently met in many practical applications. The output of regression models is relatively easy to interpret and communicate with others.

3.4.1 Assumptions of the Linear Regression Model

Linear regression is used to model a relationship between a continuously dependent variable and one or more independent variables. There are various assumptions about the linear

regression model that should be viewed as requirements. If some of the criteria are not met, remedial steps should be taken.

Accordingly, Washington et al. (2010), the following assumptions of the linear regression model are explained.

3.4.1.1 Continuous Dependent Variable Y

The assumption in regression is that the solution is continuous; that is, it can take any value within a range of values. A continuous variable is measured on the scale of the interval or ratio. While it is sometimes performed, the regression of the ordinal response variables is wrong. For example, count variables (non-negative integers) should be analyzed with Poisson and negative binomial regression. Modeling nominal scale-dependent variables (discrete variables that are not ordered) requires discrete output models.

3.4.1.2 Linear-in-Parameters Relationship between Y and X

The structure of the regression model requires that the relationship between the variables is necessarily linear –a straight-line relationship between the dependent variable Y and the independent variables. The simple linear regression model is given by:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \varepsilon_i \tag{3.2}$$

In this algebraic expression of the simple linear regression model, the dependent variable Y is a function of a constant term β_0 and a constant β_1 times the value X_1 of independent variable X for observation i, plus a disturbance term εi. The subscript i corresponds to the individual or observation, where i = 1, 2, 3…..n. In most applications the response variable Y is a function of many independent variables.

Random sampling is a necessary assumption to make inferences about the population of interest. In certain cases, random assignment can be used instead of random sampling. Other sampling schemes, such as stratified and cluster samples, can be used in the regression modeling process.

3.4.1.3 Observations Independently and Randomly Sampled

Random sampling is a necessary assumption to make inferences about the population of interest. In certain cases, random assignment can be used instead of random sampling. Other sampling schemes, such as stratified and cluster samples, can be used in the regression modeling process.

3.4.1.4 Uncertain Relationship between Variables

The difference between a straight-line equation and a linear regression model is the addition of a stochastic, disturbance, or disturbance term. This concept of disturbance consists of many elements of the process being modeled. It which contain variables that have been omitted from the model. It contains random variations inherent in the underlying data-generating process.

3.4.1.5 Disturbance Term Independent of X and Expected Value Zero

The requirements of the disturbance term ε can be written as follows:

$$E[\varepsilon_i] = 0 \tag{3.3}$$

And

$$VAR[\varepsilon_i] = \sigma^2 \tag{3.4}$$

Equation 3.4 indicates that the difference between measurements of the disturbance term is independent. This is referred to as the assumption of homoscedasticity and means that the net effect of model instability, including unobserved effects, measurement errors, and real random variance, is not systematic.

3.4.1.6 Disturbance Terms Not Auto Correlated

This requirement is written as follows:

$$\mathrm{COV}\,[\varepsilon_{i,}\,\varepsilon_{j}] = 0 \text{ if } i \neq j \tag{3.5}$$

Equation 3.5 indicates that disturbances are separate from observations. Normal violations of this assumption happen when individual observations are repeated. Generalized least squares or other correction methods are needed when disturbances are correlated across observations.

3.4.1.7 Regressors and Disturbances Uncorrelated

The process is called as the erogeneity of the regressors. When the regressors are exogenous, they are not associated with the term of disturbance. Exogeneity means that the values of the regressors are determined by the "outside of the model" influences. Therefore, Y does not directly affect the value of the exogenous regressor. In mathematical terms, this requirement translates to

$$\mathrm{COV}\,[X_{i,}\,\varepsilon_{j}] = 0 \text{ for all } i\ and j \tag{3.6}$$

When a significant variable is endogenous (depending on Y), alternative methods, such as instrumental variables, two-and three-stage minimum squares, or structural equation models, are needed.

3.4.1.8 Disturbances Approximately Normally Distributed

While there is no condition for estimating linear regression models, the disturbance conditions must be approximately normally distributed in order to make inferences about the parameters of the model. In this respect, the central limit theorem allows an accurate inference of the characteristics of the statistical parameters.

3.4.2 Regression Fundamentals

Regression seeks to provide details and properties on the parameters in the population model by inspecting the characteristics of the sample-estimated betas, how they behave and what they can tell us about the sample and thus the population.

The linear regression model thought to exist for the entire population of interest is

$$E\left[Y_i \mid X_i\right] = E\left[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots + \beta_{p-1} X_{p-1,i}\right] \quad (3.7)$$

The population model is a theoretically postulated model whose parameters are undefined, constant and beta-denoted. Population N is likely to be finite at any given time. Parameters (betas) are constant terms that represent the true relationship between the independent variables X1, X2..., Xp–1 and the dependent variable Yi. The true population model contains p parameters in the model, and there are n observations.

The unknown disturbance term for the population regression model (Equation 3.7) is given by

$$\varepsilon_i = Y_i - \hat{Y}_i = Y_i - E\left[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots + \beta_{p-1} X_{p-1,i}\right] \quad (3.8)$$

Regression is based on the notion that knowledge is learned about the population's unknown and constant parameters (betas). The sample is used to estimate random beta variables that fluctuate from sample to sample. Numerous methods are in place to estimate the parameters of the true population model on the basis of sample data, including the least squares and the maximum probability.

Accordingly, Washington et al. (2010), the following description is explained.

3.4.2.1 Least Squares Estimation

Least squares estimation is a commonly employed estimation method for regression applications. It requires a minimum (least) solution of the squared disturbances. OLS seeks a solution that minimizes the function Q (the subscript for observation number is not shown)

$$Q_{min} = \sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2_{min} = \sum_{i=1}^{n}(Y_i - (\beta_0 + \beta_1 X_i))^2_{min}$$

$$= \sum_{i=1}^{n}(Y_i - \beta_0 - \beta_1 X_i)^2_{min} \quad (3.9)$$

The values of β_0 and β_1 that minimize function Q are the least squares of the approximate parameters. Of course, β_0 and β_1 are population parameters and are unknown, so estimates B0 and B1 are obtained, which are random variables that vary from sample to sample. By setting the β_0 and β_1 partial derivatives of Q equal to zero, the minimum squares of the approximate parameters B0 and B1 are obtained:

$$\frac{\partial Q}{\partial \beta_0} = -2\sum_{i=1}^{n}(Y_i - \beta_0 - \beta_1 X_i) = 0 \quad (3.10)$$

$$\frac{\partial Q}{\partial \beta_1} = -2\sum_{i=1}^{n} Xi\ (Y_i - \beta_0 - \beta_1 X_i) = 0 \quad (3.11)$$

Solving these equations using B0 and B1 to denote the estimates of β_0 and β_1, respectively, and rearranging terms yields

$$\sum_{i=1}^{n} Yi = nB_0 + B_1 \sum_{i=1}^{n} X_i \quad (3.12)$$

$$\sum_{i=0}^{n} XiYi = B_0 \sum_{i=1}^{n} X_i + B_0 \sum_{i=0}^{n} X_i^2 \quad (3.13)$$

Solving simultaneously for the betas in Equations 3.12 and 3.13 yields

$$B_1 = \frac{\sum_{i=0}^{n}(Xi - \bar{X})(Yi - \bar{Y})}{\sum_{i=0}^{n}(Xi - \bar{X})^2} \quad (3.14)$$

$$B_0 = \frac{1}{n}(\sum_{i=0}^{n} Yi - B_1 \sum_{i=0}^{n} Xi) = \bar{Y} - B_1 \bar{X} \quad (3.15)$$

3.4.2.2 Maximum Likelihood Estimation

The previous section showed the development of the OLS estimators by minimizing the Q function. Another common statistical estimation approach is called the estimation of maximum probability, which results in the estimation of highest likelihood.

$$f(x_1, x_2, \ldots\ldots, x_n, \theta) = \prod_{i=1}^{n} f(x_i, \theta) = L(\theta \mid X) \quad (3.16)$$

For the regression model, the likelihood function for a sample of n independent, identically, and normally distributed disturbances is given by

$$L = (2\pi\sigma^2)^{-n/2} \text{ EXP } [-\frac{1}{2\sigma^2}\sum_{i=1}^{n}(Y_i - X_i^T\beta)^2]$$

$$L = (2\pi\sigma^2)^{-n/2} \text{ EXP } [-\frac{1}{2\sigma^2}(Y - X\beta)^T (Y - X\beta)] \quad (3.17)$$

As is usually the case, the logarithm of Equation 3.17, or the log likelihood, is simpler to solve than the likelihood function itself, so taking the log of L yields

$$LN(L) = LL = -\frac{n}{2} LN(2\pi) - \frac{n}{2} LN(\sigma^2) - \frac{1}{2\sigma^2}(Y - X\beta)^T (Y - X\beta) \quad (3.18)$$

Maximizing the log likelihood with respect to β and σ2 reveals a solution for the estimates of the betas that is equivalent to the OLS estimates, that is $B = (X^T X)^{-1} X^T Y$

3.4.3 Regression Model Goodness-of-Fit Measures

According to Washington et al. (2010) goodness-of-fit GOF statistics are useful in comparing findings across studies and comparing contrasting models. Three tests of the GOF model are discussed: The R-square, the modified R-square and the generalized F test. Sum of squares and mean squares are fundamental for both regression and variance analysis. The sum of square errors (disturbances) is given by

$$SSE = \sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 \quad (3.19)$$

The regression sum of squares is given by

$$SSR = \sum_{i=1}^{n}(\hat{Y}_i - \bar{Y})^2 \quad (3.20)$$

And the total sum of squares is given by

$$SST = \sum_{i=1}^{n}(Y_i - \bar{Y})^2 \quad (3.21)$$

The SSE is the variation of the fitted regression line around the observations. The SSR is the variation of the fitted regression line around, and SST is the total variation — the variation of each observation around. It also can be shown algebraically that SST = SSR + SSE. Mean squares are just the sum of squares divided by their degrees of freedom. SST has n-1 degrees of freedom, because 1 degree of freedom is lost in the estimation of Y. SSE has n – p degrees of freedom, because p parameters are used to estimate the fitted regression line. Finally, SSR has p – 1 degrees of freedom associated with it. As one would expect, the degrees of freedom are additive such that n – 1 = n – p + p – 1. The mean squares, then, are MSE = SSE/ (n – p) and MSR = SSR/ (p – 1). The coefficient of determination, R-squared, is defined as

$$R^2 = \frac{[SST - SSE]}{SST} = \frac{SSR}{SST} = 1 - \frac{SSE}{SST} \quad (3.22)$$

R^2 may be thought of as a proportionate reduction of the overall variance of the independent variables (X). It is generally interpreted as the proportion of total variance explained in X. When SSE = 0, $R^2 = 1$, and all variances are clarified by the model. If SSR = 0, $R^2 = 0$, and there is no relation between X and Y. Since R^2 can only be increased when variables are applied to the regression model. (SST remains the same, and SSR can only increase even if statistically insignificant variables are added), the modified measure, R^2 adjusted, is used to account for the degree of freedom of change due to the different number of model parameters, and allows the reduction of R^2 adjusted as new, theoretically insignificant variables to be added. The adjusted measure is considered to be superior for comparing models with different numbers of parameters. The adjusted coefficient of multiple determinations is

$$R^2_{adjusted} = 1 - \frac{\frac{SSE}{n-p}}{\frac{SST}{n-1}} = 1 - \left(\frac{n-1}{n-p}\right)\frac{SSE}{SST} \quad (3.23)$$

The following guidelines should be applied:

- The adjusted R^2 of 0.40 in one study can be called "good" only if it represents an improvement over similar studies and the model offers new insights into the underlying data-generating process. Improvement in the R^2 can be achieved. Adjusted value without having a greater analysis of the phenomenon being studied.
- The absolute values of the adjusted measures R^2 and R^2 are not adequate measures to determine the consistency of the model. The 0.20 R^2 model of a phenomenon with a large proportion of unexplained variance could represent a breakthrough in the current level of understanding.
- Large values of R^2 and R^2 modified may be due to data objects. Small variations in independent variables can result in inflated values. Extreme outliers can also inflate the values of R^2.
- R^2 and R^2 modified assume a linear relationship between response and predictor variables. In certain cases, R^2 may be reasonably wide and indicate a strong linear fit when the true relationship is curvilinear.
- The adjusted values of R^2 and R^2 are bound by 0 and 1 only when the intercept term is used in the regression model. When the intercept is forced through zero, the adjusted values of R^2 and R^2 may exceed 1 and more caution is required when interpreting them.

Another measure for assessing model fit is the generalized F test. This approach is a general and flexible approach for testing the statistical difference between competing models. For convenience, the sum of square errors for the full model is denoted as

$$SSE_F = \sum_{i=1}^{n} (Y_i - \hat{Y}_{Fi})^2 \quad (3.24)$$

Where the predicted value of Y is based on the full model.

A reduced model is then estimated, which is a viable competitor to the complete model. For the competing or reduced model, the sum of squared errors is calculated.

$$SSE_R = \sum_{i=1}^{n} (Y_i - \hat{Y}_{Ri})^2 \quad (3.25)$$

SSE_R can only be minimized by adding variables to the model, thus $SSE_R \geq SSE_F$. If the two total of square errors are the same, then the complete model did little to boost the fit of the model. Conversely, if additional variables add significance to the regression, the model shall

have ample additional explanatory power. In the generalized F test the null and alternative hypotheses are as follows:

$$H_0 : \text{all } \beta_K = 0 \tag{3.26}$$

$$H_0 : \text{all } \beta_K \neq 0 \tag{3.27}$$

In this test the null hypothesis is that all of the additional parameters in the full model (compared to the reduced model) βk are equal to zero.

When the null hypothesis is true (making the F test a conditional probability), the F* statistic is approximately F distributed, and is given by

$$F^* = \frac{\frac{SSER - SSEF}{dfR - dfF}}{\frac{SSEF}{dfF}} \approx F(1 - \alpha; df_R - df_F, df_F) \tag{3.28}$$

Where $df_F = n - p_F$ and $df_R = n - p_R$ (n is the number of observations and p is the number of parameters). In order to calculate this test statistic, the number of square errors for the two models is first calculated, and then the F* statistic is compared to the F distribution with the corresponding numerator and denominator degrees of freedom. Specifically,

$$\text{If } F^* \leq F(1 - \alpha; df_R - df_F, df_F) \text{ , then conclude } H_0$$

$$\text{If } F^* \geq F(1 - \alpha; df_R - df_F, df_F) \text{ , then conclude } H_a$$

(3.29)

The generalized F test is very useful when comparing models of different sizes. If the difference in size between the two models is one variable, the F test results equal to the t test. Following Montgomery and Runger (2003) the hypotheses of t-test are

$$H_0 : \beta_1 = \beta_{1,0} \tag{3.30}$$

$$H_1 : \beta_1 \neq \beta_{1,0} \tag{3.31}$$

Where we have assumed a two-sided alternative and the t-statistics is

$$T_0 = \frac{\widehat{\beta 1} - \beta 1,o}{\sqrt{\widehat{\sigma^2}/S_{xx}}} \quad (3.32)$$

Follows the t distribution with (n-2) degrees of freedom under H0:β1=β1,0. We would reject H_0:$\beta_1=\beta_{1,0}$ if

$$| t_0 | > t_{\alpha/2,\, n-2} \quad (3.33)$$

Where to is computed from Equation 3.33. The denominator of Equation 3.33 is the standard error of slope. So, we could write the test statistic as

$$T_0 = \frac{\widehat{\beta 1} - \beta 1,o}{se(\widehat{\beta 1})} \quad (3.34)$$

4 CHAPTER FOUR: ANALYSIS AND MODEL DEVELOPEMENT

4.1 Introduction

Seven different models (four models in terms of service quality and three models in terms of safety) have been conducted in this research study; cleanliness, comfort, punctuality-reliability, driver's characteristics, safety equipment, health facilities, harassment model, and also two aggregated model of service quality and safety. The analysis has been developed from the perspectives of user passengers. These models have been conducted since they carry out distinct characteristics as well as promote the water bus service.

Linear regression model has been used to compute the service quality and safety of the water bus service. Different findings may be obtained that may influence the policy recommendation for the promotion of water bus service.

4.2 Model Development

Model Development is a challenging task which is done by selecting all the relevant factors for the required model. There have been seven individual models and two overall models according to service quality and safety respectively. Selecting the relevant factors in response of each model were quite a tough thing to accomplish the goal. Linear regression model has been used to analyze the study as described in chapter three. All the assumptions and the mathematical formulas of the analysis have been discussed in that chapter.

Following the research study, total 29 factors have been considered in the total models. The factors have been categorized into two broad sectors; Socio-demographic characteristics and Travel characteristics and experiences. These factors have been shown in Table 4.1 under these two broad categories.

Table 1: Summary statistics of Waterbus

Variables	Mean	Std. Dev.	Min	Max	Description of Variable
Socio-demographic characteristics					
Gender	0.603	0.491	0	1	Male=1. Female=0
Age					
Age less twenty five	0.484	0.502	1	0	If age is <25=1; otherwise=0
Age twenty five to forty five	0.373	0.486	0	1	If age is ≥ 25 but <45=1; otherwise=0
Age forty five to sixty five	0.135	0.343	0	1	If age is ≥ 45 but <65=1; otherwise=0
Age greater than sixty five	0.008	0.089	0	1	If age is ≥65=1; otherwise=0
Education Qualification					
Primary	.063	0.245	0	1	If education is primary=1; otherwise=0
SSC	0.032	0.176	0	1	If education is SSC=1; otherwise=0
HSC	0.286	0.454	0	1	If education is HSC=1; otherwise=0
Graduate	0.389	0.489	0	1	If education is Graduate=1; otherwise=0

Postgraduate	0.198	0.400	0	1	If education is Postgraduate=1; otherwise=0
Other	.032	0.176	0	1	If education is other=1; otherwise=0
Profession					
Student	0.452	0.450	0	1	If Profession is Student=1; otherwise=0
Businessman	0.103	0.305	0	1	If Profession is Businessman=1; otherwise=0
Private Service	0.349	0.479	0	1	If Profession is Private Service=1; otherwise=0
Housewife	0.024	0.153	0	1	If Profession is Housewife=1; otherwise=0
Self-Employed	0.016	0.125	0	1	If Profession is Self-Employed=1; otherwise=0
Other	0.056	0.230	0	1	If Profession is Other=1; otherwise=0
Monthly Income					
Income less ten thousand	0.373	0.486	0	1	If income is <10000 Tk=1; otherwise=0
Income ten to twenty	0.167	0.374	0	1	If income is ≥ 10000 TK but

					<20000 tk =1; otherwise=0
Income twenty to forty	0.175	0.381	0	1	If income is ≥ 20000 TK but <40000 tk =1; otherwise=0
Income greater forty	0.286	0.454	0	1	If income is ≥ 40000 =1; otherwise=0
Material Status	0.357	0.481	0	1	Married=1. Unmarried=0
Home Location					
Solvent area	0.579	0.496	0	1	Banasree, Rampura, Badda, Tejgoan, Gulshan, Aftabnogor, Bashabo, Shadatpur
Average solvent area	0.214	0.412	0	1	Shantinagar, Mohakhali, Banglamotor, Panthopath, Kakrail, Motijheel
Less solvent area	0.183	0.388	0	1	Uttara, Mirpur, Mugda, Dhanmondi, Kuril, Azimpur, Bashundhara
Economically disadvantaged area	0.024	0.153	0	1	Narayangonj, Zatrabari
Family Member					

Member less than three	0.063	0.244	0	1	If member is<3=1; otherwise=0
Member three to five	0.786	0.412	0	1	If member is ≥ 3 but <6=1; otherwise=0
Member more than five	0.151	0.359	0	1	If age is ≥6=1; otherwise=0
Job Location					
Solvent area	0.595	0.493	0	1	Banasree, Rampura, Badda, Tejgoan, Gulshan, Aftabnogor, Bashabo, Shadatpur,
Average solvent area	0.310	0.464	0	1	Shantinagar, Mohakhali, Banglamotor, Panthopath, Kakrail, Motijheel
Less solvent area	0.048	0.214	0	1	Uttara, Mirpur, Mugda, Dhanmondi, Kuril, Azimpur, Bashundhara
Economically disadvantaged area	0.048	0.214	0	1	Narayangonj, Zatrabari
Family member use waterbus	0.302	0.461	0	1	Yes=1; No=0
Money spend in transportation					
Spend less than four thousand	0.540	0.500	0	1	If income is <4000 Tk=1; otherwise=0

Spend four to seven thousand	0.206	0.406	0	1	If income is ≥ 4000 TK but <7000 tk =1; otherwise=0
Spend seven to ten thousand	0.048	0.214	0	1	If income is ≥ 7000 TK but <10000 tk =1; otherwise=0
Spend more than ten thousand	0.206	0.406	0	1	If income is ≥ 10000 =1; otherwise=0
Travel characteristics and experiences					
Major Mode of travel					
Bus	0.365	0.483	0	1	If major mode of travel is Bus=1; otherwise=0
Waterbus	0.167	0.374	0	1	If major mode of travel is Waterbus=1; otherwise=0
Rickshaw	0.191	0.394	0	1	If major mode of travel is Rickshaw=1; otherwise=0
Uber/Pathao	0.111	0.316	0	1	If major mode of travel is Uber/Pathao=1; otherwise=0
Private Car	0.040	0.196	0	1	If major mode of travel is Private Car=1; otherwise=0

CNG	0.056	0.230	0	1	If major mode of travel is CNG=1; otherwise=0
Walking	0.016	0.125	0	1	If major mode of travel is Walking=1; otherwise=0
Motorcycle	0.056	0.230	0	1	If major mode of travel is Motorcycle=1; otherwise=0
Bicycle	0	0	0	1	If major mode of travel is Bycycle=1; otherwise=0
Tempo	0	0	0	1	If major mode of travel is Tempo=1; otherwise=0
Reach Waterbus Station					
Walking	0.286	0.454	0	1	If recach to waterbus station travel mode is Walking=1; otherwise=0
Bus	0.222	0.417	0	1	If recach to waterbus station travel mode is Bus=1; otherwise=o
Rickshaw	0.429	0.497	0	1	If recach to waterbus station

					travel mode is Rickshaw=1; otherwise=0
Private Car	0.016	0.125	0	1	If recach to waterbus station travel mode is PrivateCar=1; otherwise=0
Tempo	0.008	.089	0	1	If recach to waterbus station travel mode is Tempo=1; otherwise=0
Other	0.040	0.196	0	1	If recach to waterbus station travel mode is other=1; otherwise=0
Own Private Vehicle	0.183	0.388	0	1	Yes=1; No=0
Accident involvement in taking waterbus	0.008	0.089	0	1	Yes=1; No=0
Experienced Harassment	0.556	0.230	0	1	Yes=1; No=0
Servicing Risky	0.135	0.343	0	1	Yes=1; No=0
Faced out of order/broke down	0.048	0.214	0	1	Yes=1; No=0
Satisfy overall service	0.913	0.283	0	1	Yes=1; No=0

Minimize Travel Time	0.921	0.271	0	1	Yes=1; No=0
Reduce no of Stoppage	0.151	0.359	0	1	Yes=1; No=0
Positioning Electric device	0.802	0.400	0	1	Yes=1; No=0
Drive Car	0.063	0.245	0	1	Yes=1; No=0
Reserved seat for Women	0.762	0.428	0	1	Yes=1; No=0
Provide Sanitizer	0.968	0.176	0	1	Yes=1; No=0
Main Problem Of water bus					
Not clean	0.119	0.325	0	1	If main problem is Not clean=1; otherwise=0
Safety	0.087	0.283	0	1	If main problem is Safety=1; otherwise=0
Frequency	0.175	0.381	0	1	If main problem is Frequency=1; otherwise=0
Not maintaining time table	0.357	0.481	0	1	If main problem is Not maintaing time table=1; otherwise=0
Uncomfortable	0.008	0.089	0	1	If main problem is Uncomfortable=1; otherwise=0
Other	0.254	0.437	0	1	If main problem is other=1; otherwise=0

Faced Mugging	0.008	0.089	0	1	Yes=1; No=0
Satisfy with Ticket price	0.770	0.423	0	1	Yes=1; No=0
Main Reason Of choosing Waterbus					
Avoid traffic congestion on road	0.754	0.432	0	1	If main reason of chossing waterbus is avoid traffic congestion on road=1; Otherwise=0
Cheap	0.024	0.153	0	1	If main reason of chossing waterbus is Cheap=1; Otherwise=0
Comfortable	0.190	0.394	0	1	If main reason of chossing waterbus is Comfortable=1; Otherwise=0
Reliable	0.008	0.089	0	1	If main reason of chossing waterbus is Reliable=1; Otherwise=0
Safe	0.024	0.153	0	1	If main reason of chossing waterbus is Safe=1; Otherwise=0

Here, as some factors are represented in the categorical approach, numerous dichotomous or binary (0 or 1) variables are considered to measure the consequences. As shown in the context, educational qualification is divided into six categories; Primary, SSC, HSC, Graduate, Postgraduate and Other. If a passenger's educational qualification is HSC, then the input will

be denoted as 1, otherwise 0. And the system is the same for all the categories. Here, the point to be noted is that the mean value of the dichotomous variable is simply the proportion of the sample which belongs to a specific category. As per the information, the mean value of the HSC is 0.286 which demonstrates that 28.6% of the passengers' educational qualification is HSC.

In terms of percentage shares of the various categories, some of the contributing factors are also indicated. In this case, as the sum of categorical data has to be 1 or 100%, the model must omit one of the categories and use it as a reference or base case to compare the other estimated categorical data. As shown in the context, when the educational qualification is to be estimated as considered categorical data, one of the variables needs to be omitted as a reference like postgraduate and the other variables of the category like primary, SSC, HSC, graduate, and other will be interpreted as relative to postgraduate. Again, when it comes to interpreting the results, the positive signs of the coefficients **β** indicate the greater significance in the models where the negative signs indicate the converse effect.

Again, some factors are presented as continuous variable. For instance, the mean value of age group of passengers represents the average of age of people taking the service.

5 CHAPTER FIVE: RESULTS AND INTERPRETATION

5.1 Introduction

The purpose of this chapter is to justify how the factors affect the water bus service in terms of socio-demographic characteristics and travel characteristics.

Total seven models (four models in terms of service quality and three models in terms of safety) have been developed in this research study. Linear regression model has been used to compute the significance of the variables.

5.2 Result Analysis

The statistical research findings are shown in Table 5.1. The following models show a moderate goodness of fit statistic that is analyzed by the comparatively lower p-value of F test and moderate R-square along with adjusted R-square. The point to be noted that only those variables have been held in the models with at least ninety percent confidence level.

Passengers' age is immensely significant in this study. Passengers' age has been divided into four groups which are Age less twenty-five, Age twenty-five to forty-five, Age forty-five to sixty-five and Age greater than sixty, depending on their travel experiences and behavior. The result shows that the group of Age twenty-five to forty-five is more involved with taking the service in terms of safety equipment model (β= 1.750, p= 0.025) and harassment model (β= -1.663, p= 0.033). It can be said that people in this age category feel casually safe and more convenient to use the service, even regardless in the dark hour. Another variable of the age category is Age forty-five to sixty-five. People about age forty-five to sixty-five do not prefer this service, they are more likely to take other modes like private car, rickshaw, uber/pathao for the safety according to the aggregated value of safety (β= 7.726, p= 0.002).

Students show positive attitude towards water bus service. The result shows that the possibility of students taking the service is higher according to the following models; cleanliness (β= -

5.277, p= 0.000), comfort (β= -6.219, p= 0.000), punctuality-reliability (β= -4.467, p= 0.000), health facility (β= -1.249, p= 0.042), harassment (β= -5.917, p= 0.000) and the aggregated model of service quality (β= -12.934, p= 0.000) model. The service reduces the traffic time which may be beneficial for students from time saving perspective. People in the business profession do not take the service as they prefer private car or other modes rather than the water bus service itself. Again, students who are graduate are significant for the punctuality – reliability (β= -1.847, p= 0.038) model as they are self-sufficient and the cost is less considering to other modes.

When it comes to the transportation model, people use those modes that are found convenient and easy to travel. Different types of modes have been explored in this study; bus, waterbus, rickshaw, uber/pathao, private car, CNG, walking, motorcycle, bicycle, tempo and others. Among these, Uber/Pathao is more likely significant than other variables. In terms of cleanliness (β= -2.751, p= 0.016), comfort (β= -2.716, p= 0.021), and aggregated service quality (β= -7.3008, p= 0.046) model, Uber/Pathao is considered as more clean, comfortable, providing better service quality and holds a large amount of significance for choosing it over other vehicles.

There is always an alternative mode to reach at the destination. Some people choose public bus, some prefer private car, and so on. Before choosing a vehicle, passengers have reasons why to pick it. The reasons behind choosing water bus over other vehicles are the following; to avoid traffic congestion on road, cheap. Comfortable, reliable, safe, and so on. Among them, to avoid traffic congestion is the significant one according to the aggregated service quality (β= -7.517, p= 0.007) model. (Kondo & Hirose, 1993) showed that as traffic in road is unpredictable, people choose water bus to take the fast service in travel.

But water bus service faces some major problems that may affect the overall service quality and safety such as Not clean, Safety, Frequency, not maintaining time table, Uncomfortable and Other. Among them, frequency of water bus is one of the highly placed problems in response of cleanliness (β= -2.587, p= 0.010), comfort (β= -2.638, p= 0.004), safety equipment (β= -3.622, p= 0.003 and harassment (β= -1.493, p= 0.054) model. (Van Nes et al., 1988) showed that any of public service needs to fulfil the demand for passengers. In case of water bus service, passengers do feel the lack of frequency of the buses. It makes the passengers wait for longer time. Another highly placed problem is Not clean. Passengers often feel the

untidiness of water bus in accordance to the cleanliness (β= -2.944, p= 0.009), health facility (β= --2.417, p= 0.002), overall service quality (β= -1.493, p= 0.054) as well as overall safety (β= -6.078, p= 0.087) model. Again, maintaining time-table of water bus is a major concern of the passengers. This variable is significant (β= -1.617, p= 0.044 for cleanliness model and β= -1.522, p= 0.078 for punctuality-reliability model) in terms of the analysis. Other than that, the variable uncomfortable is insignificant in the analysis.

Passengers from solvent area do not usually take water bus service. They prefer other modes rather than water bus. In terms of safety equipment (β= 2.369, p= 0.009) and harassment (β= 1.080, p= 0.079) model, it reduces the significance of solvent area. Again, people who live in Less solvent area usually take the service as the living cost is low as well as the service cost and the result is significant for the harassment (β= -1.827, p= 0.007) model.

Table 2:Linear Regression Model in term of Service Quality and Safety

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
	(Cleanliness)	(Comfort)	(Punctuality-Reliability)	(Driver Characteristic)	(Overall Service Quality)	(Safety Equipment)	(Health Facilities)	(Harassment)	(Overall Safety)
Number of observation	126	126	126	126	126	126	126	126	126
F test	8.86	12.13	6.28	9.42	13.05	7.86	4.62	15.72	11.25
R-squared	0.5654	0.5629	0.4002	0.5000	0.5808	0.4549	0.3289	0.6460	0.5663
Adj R-squared	0.5017	0.5165	0.3365	0.4470	0.5363	0.3970	0.2577	0.6049	0.5160
First value = β value, Second value = [p value]									
Socio-demographic Characteristics									

Gender	-	-	1.944 [0.038]	-	-	-	-	1.433 083 [0.034]	5.119 [0.002]
Age									
Age less twenty five	-	-	-	-	-	-	-	-	-
Age twenty five to forty five	-	-	-	-	-	2.9821 79 [0.001]	-	- 1.6636 18 [0.033]	6.334 [0.000]
Age forty five to sixty five	-	-	2.673 [0.049]	2.037 [0.04]	-	-	-	-	7.726 [0.002]
Age greater than sixty five	-	-	-	-	-	-	-	-	-
Education Qualification									
Primary	-	-	-	-	-	-	-	-	-
SSC	5.82 [0.003]	4.181 [0.044]	-	-	-	6.7769 [0.006]	- 3.6164 2 [0.010]	4.186[0.015] 789	-
HSC	2.502 [.004]	1.617 [0.084]	-	-	-	-	-	-	-
Graduate	-	-	-1.847 [0.038]	-	-	-	-	-	-
Postgraduate	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	11.377	-	-	-	-

					[0.000]				
Profession									
Student	-5.277 [0.000]	-6.219 [0.000]	-4.467 [0.000]	-	- 12.934 [0.000]	-	- 1.2495 [.042]	- 5.9178 [0.00]	-
Businessman	-	-	-	2.891 [0.014]	-	-	-	-	-
Private Service	-	-	-	1.809 [0.008]	-	-	-	-	-
Housewife	-	-	-	-	-	-	-	-	-
Self-Employed	-	-	-8.282 [0.017]	-	-16.06 [0.070]	-	-	-	-
Other	2.435 [.106]	-	-	-	-	-	-	-	11.701 [0.000]
Monthly income									
Income less ten thousand	-	-	-	-	-	-	-	1.750 547 [0.025]	-
Income ten to twenty	-	-	-	-	-	-	-	-	-
Income twenty to forty	-	-	-	-	-	-	-	-	-
Income greater forty	-	-1.888 [0.043]	-3.740 [0.001]	-	-	-	- 1.2788 [0.051]	-	-
Material Status	-	-	-	-	-	-	-	-	-

Home location									
Solvent area	-	-	-	-	-	2.369529 [0.009]	-	1.080962 [0.079]	-
Average solvent area	-	-	-	-	-	-	-	-	-
Less solvent area	-	-	-	-	-	-	-	-	-
Economically disadvantaged area	-	-	-	-	-	-	-	-	-
Family Member									
Member less than three	-	-	-	-	-	-	- 2.4513 [0.023]	-	-
Member three to five	-	-	-	-	-	-	-	-	-
Member more than five	-	-	-	-	-	-	-	-	-
Job Location									
Solvent area	-	-	-	-	-	-	-	-	-
Average solvent area	-	-	-	1.287 [0.053]	-	-	-	-	-
Less solvent area	-	-	-	-	-	-	- 1.82777	-	-

							[0.007]		
Economically disadvantaged area	-	-	-	-	-	-	-	-	-
Family member use waterbus	-	-	-	-	-	-	-	-	-
Money spend in Transportation									
Spend less than four thousand	-	-	-	-	-	-	-	-	-
Spend four to seven thousand	-	-	-	-	-	-	-	-	-
Spend seven to ten thousand	-	-	-	-	12.749 [0.016]	3.97192 [0.052]	2.376502 [0.042]	3.82296 [0.007]	9.5413 [0.007]
Spend more than ten thousand	-	-	-	-1.789 [0.020]	-	-	-	-	-
Travel characteristics and experiences									
Major Mode of travel									
Bus	-	-	-	-	-	-	-	1.239202 [0.046]	-
Waterbus	-	-	-	-	-	-	-	-	-

Rickshaw	-	-	-	-	-	- 2.106066 [0.019]	- 1.20559 [0.074]	-	-
Uber/Pathao	-2.751 [0.016]	-2.716 [0.021]	-	-	- 7.3008 [0.046]	-	-	-	-
Private Car	-	3.413 [0.059]	-	-	20.407 [0.022]	-	-	-	14.037 [0.022]
CNG	-	-	-	-	-	-	-	-	-
Walking	-	-	-	-	-	-	-	-	11.176 [0.058]
Motorcycle	-	-	-	-	-	-	-	-	-
Bicycle	-	-	-	-	-	-	-	-	-
Tempo	-	-	-	-	-	-	-	-	-
Reach Waterbus Station									
Walking	-4.348 [0.006]	-	-	-	-	-	-	-	-
Bus	[0.006]	-	-	-	-	-	-	-	-
Rickshaw	-4.380 [0.004]	-	-	-	-	-	-	-	-
Private Car	-	6.404 [0.019]	9.460 [0.008]	-	-	-	-	-	-
Tempo	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-

Own Private Vehicle	-	-	-	-	-	- 2.074746 [0.071]	-	-	-
Accident involvement in taking waterbus	-	-	-	-	-	-	-	--	-
Experienced Harassment	-3.154 [0.059]	-4.274 [0.007]	-	-3.821 [0.012]	- 13.527 [0.014]	- 5.189329 [0.015]	- 2.21537 [0.042]	- 5.32968 [0.000]	- 11.441 [0.002]
Servicing Risky	-3.538 [0.001]	-2.570 [0.017]	-	-1.890 [0.040]	-	-	-	- 1.800716 [0.049]	-
Faced out of order/broke down	-4.056 [0.022]	-	-	-2.635 [0.093]	-9.560 [0.101]	- 4.608755 [0.041]	-	- 6.733485 [0.000]	- 12.348 [0.002]
Satisfy overall service	-	-	-	-	-	-	-	-	-
Minimize Travel Time	-	-	-	-2.011 [0.086]	-	-	- 1.86474 [0.043]	-	-

Reduce no of Stoppage	-	-2.951 [0.006]	-2.151 [0.082]	-2.961 [0.002]	-7.236 [0.031]	-	-	-	-
Positioning Electric device	1.436 [0.109]	-	3.346 [0.004]	-	-	- 2.165117 [0.049]	1.180251 [0.062]	-	--
Drive Car	-	-	-2.961 [0.105]	-2.876 [0.022]	-	-	-	-	-8.589 [0.007]
Reserved seat for Women	-1.400 [0.091]	-	-3.188 [0.002]	-1.604 [0.025]	-6.086 [0.029]	- 2.193605 [0.031]	- 1.6134 [0.007]	- 1.5412 [0.028]	-7.053 [0.000]
Provide Sanitizer	-	-	-	-	-	-	-	-	-
Main Problem Of water bus									
Not clean	-2.944 [0.009]	-	-	-	-6.078 [0.087]	-	- 2.41724 [0.002]	-	-6.403 [0.007]
Safety	-	-	-	-	-	-	-	-	-
Frequency	-2.587 [0.010]	-2.638 [0.004]	-	-	-	- 3.622194 [0.003]	-	- 1.493572 [0.054]	-
Not maintaining time table	-1.617 [0.044]	-	-1.522 [0.078]	-	-	-	-	-	-
Uncomfortable	-	-	-	-	-	-	-	-	-

Other	-	-	-	-	-	-	-	-	-
Faced Mugging	-	-	-	-	-	-	-	-	-
Satisfy with Ticket price	-	-	-	-	-	-	-	-	-
Main Reason Of choosing Waterbus									
Avoid traffic congestion on road	-	-	-	-	-7.517 [0.007]	-	-	-	-
Cheap	-	3.784 [0.100]	-	-	-	4.542465[0.104]	-	-	-
Comfortable	-	-	-	-	-	-	-	-	3.579 [0.063]
Reliable	-	-	-	-	-	-	-	-	-
Safe	-	-	-	-	-	-	-	-	-

Money spent in transportation is a significant factor of water bus service. In general, passengers who spend seven to ten thousand in transportation are more likely does not take the service. The analysis for the following models; Overall Service Quality (β= 12.749, p= 0.016), Safety Equipment (β= 3.971, p= 0.052), Health Facilities (β= 2.376, p= 0.042), Harassment (β= 3.822, p= 0.007), Overall Safety (β= 9.5413, p= 0.007) with 90% confidence interval, explain that higher money spenders prefer other modes like private care, rickshaw, uber/pathao rather than waterbus as they are not comfortable with the water bus service.

According to the passengers, water bus minimizes the travel time (Kondo & Hirose, 1993). In terms of Driver's characteristics (β= -2.011, p= 0.086) and Health facility (β= -1.864, p= 0.043) model, water bus rescues people from traffic congestion and reduce their travel time. This is

the major positive significance of water bus service. Again, passengers do not feel the service risky at all according to the result analysis for cleanliness (β= -3.538, p= 0.001), comfort (β= -2.570, p= 0.017), driver's characteristics (β= -1.890, p= 0.040) and harassment (β= -1.800, p= 0.049) model. Despite the water route, the authority has all the safety equipment and facilities which provides very promising water bus service.

Experiencing harassment in a transportation mode is a serious concern regardless any gender. Passengers in water bus service are fully satisfied with the water bus service. The factor is possibly significant for almost all the following models; cleanliness (β= -3.154, p= 0.059), comfort (β= -4.274, p= 0.007), driver's characteristics (β= --3.821, p= 0.012), safety equipment (β= -5.189, p= 0.015), health facility (β= -2.215, p= 0.042), harassment (β= -5.329, p= 0.000) even in aggregated model of service quality (β= -13.527, p= 0.014) and safety (β= -11.441, p= 0.002) also. Again, faced out of order/broke down of water bus is another important factor. From the result analysis, it can be said that passengers are quite content with the service regarding this factor as they have not faced this kind of situation in response of cleanliness (β= -4.056, p= 0.022), driver's characteristics (β= -2.635, p= 0.093), safety equipment (β= -4.608, p= 0.041), harassment (β= -6.733, p= 0.000) model with the aggregated model of service quality (β= -9.560, p= 0.101) and safety (β= -12.348, p= 0.002).

Women's security in public transit is a major consideration. So, reserved seat for women is quite necessity for the women. Almost maximum of the passengers replied positively according to this factor which is significant for almost all the models; cleanliness (β= -1.400, p= 0.091), punctuality-reliability (β= -3.188, p= 0.002, driver's characteristics (β= -1.604, p= 0.025), safety equipment (β= -2.193, p= 0.031), health facility (β= 1.613, p= 0.007), harassment (β= -1.541, p= 0.028) and the aggregated model of service quality (β= -6.086, p= 0.029) model.

5.3 Summary Findings

The study aimed to increase the awareness of the service qualities and safety of the water bus in terms of socio-demographic characteristics and travel characteristics and experiences. The

service went through some observations by assuming some relevant factors. A fair comparison of the significance of different factors has been shown in Table 5.3 for this water bus service.

Table 3: Effect of Different factors on Waterbus Mode

Factors	Significance on Different Models								
	Cleanliness	Comfort	Punctuality-reliability	Driver Characteristic	Overall Service Quality	Safety Equipment	Health Facilities	Harassment	Overall Safety
Socio-demographic characteristics									
Gender			+					+	+
Age									
Age less twenty five									
Age twenty five to forty five						-		-	+
Age forty five to sixty five			+	+					+
Age greater than sixty five									
Education Qualification									
Primary									
SSC	+	+				+	-	+	
HSC	+	+							
Graduate			-						

Postgraduate									
Other					+				
Profession									
Student	-	-	-		-		-	-	
Businessman				+					
Private Service				+					
Housewife									
Self-Employed			-		-				
Other	+								+
Monthly Income									
Income less ten thousand								+	
Income ten to twenty									
Income twenty to forty									
Income greater forty		-	-				-		
Material Status									
Home Location									
Solvent area						+		+	
Average solvent area									

Less solvent area							-		
Economically disadvantaged area									
Family Member									
Member less than three							-		
Member three to five									
Member more than five									
Job Location									
Solvent area									
Average solvent area				+					
Less solvent area									
Economically disadvantaged area									
Family member use waterbus									
Money spend in transportation									

Spend less than four thousand									
Spend four to seven thousand									
Spend seven to ten thousand					+	+	+	+	+
Spend more than ten thousand				-					
Travel characteristics and experiences									
Major Mode of travel									
Bus								+	
Waterbus							-		
Rickshaw						-			
Uber/Pathao	-	-			-				
Private Car		+							
CNG									
Walking									+
Motorcycle									
Bicycle									
Tempo									
Reach Waterbus Station									
Walking	-								
Bus	-								
Rickshaw	-								

Private Car		+	+		+				+
Tempo									
Other									
Own Private Vehicle						-			
Accident involvement in taking waterbus									
Experienced Harassment	-	-		-	-	-	-	-	-
Servicing Risky	-	-		-				-	
Faced out of order/broke down	-			-	-	-		-	-
Satisfy overall service									
Minimize Travel Time				-			-		
Reduce no of Stoppage		-	-	-	-				
Positioning Electric device	+		+			-	+		
Drive Car			-	-					-

Reserved seat for Women	-		-	-	-	-	-	-	-
Provide Sanitizer									
Main Problem Of water bus									
Not clean	-				-		-		-
Safety									
Frequency	-	-				-		-	
Not maintaining time table	-		-						
Uncomfortable									
Other									
Faced Mugging									
Satisfy with Ticket price									
Main Reason Of choosing Waterbus									
Avoid traffic congestion on road					-				
Cheap		+				+			
Comfortable									+
Reliable									
Safe									
Positively Significant -, Negatively Significant +, Insignificant (Blank)									

6 CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The main objective of the study is to define the factors influencing the water bus service for the betterment of the service. As the service is new, people should know more about the service and preach the goodness of it. Both socio-demographic and travel characteristics have been explored in response of achieving this desired target. The linear regression model has been used to find out the affecting factors of the service. In order to fulfill the purpose of this research work, seven models (four models in terms of service quality and three models in terms of safety) and two overall models in terms of overall service quality and overall safety have been established. Multiple significant factors have come out to be important in the study. Some of them are universally significant, while others are significantly related to relevant studies.

This chapter provides a summary of this study's significant results. Based on the impacts of the factors on waterbus service considered in the report, the results are thoroughly discussed

6.2 Conclusions

From the research study, people are greatly getting benefitted and saving their precious time by taking the water bus service. The result shows that the main reason to take the service is to avoid the traffic jam. In Dhaka city, traffic congestion is a major concern and the water bus service provides a preferable alternative to travel.

The area classification has a huge impact on the option of the mode of transportation. From the analysis, it seems like people from solvent area do not take water bus service rather taking other modes of traveling. On the contrary, people from less solvent area greatly depend on this particular mode as the service is cheap and also, comfortable. The service quality is very standard and so, commuters get encouraged to take the service regularly. Again, the service is very safe according to the respondents. They do not have to worry about their safety even if when it comes to the women. Even in dark hours, there are enough lighting systems to travel by it. Life jackets, emergency tools, everything needed for health facility are provided during the service.

In promoting water bus service, age is another significant issue for policymakers. It was found from the study that people who are twenty-five to forty-five, are possibly taking the service more compared to other age ranges.

The accident rate of the waterbuses tends to zero and the commuters are really satisfied with the service. The service is not risky at all. Harassment is a term that is being occurred more often in public transit, but among the respondents, none had experienced while taking this service or waiting in stoppage. Even the ticketing system is quite smooth and fair. From the ticketing system to the service fare of the mode, the commuters are satisfied with the whole service.

The main obstacle of the service is not maintaining the schedule. Sometimes, the waiting time frustrates the passengers and makes them bound to take another mode of travel which is a disadvantage of the water bus service. Maintaining the timetable should be the first priority of the drivers and authority. Other than that, water bus service reflects positive impacts on the transportation system of Dhaka city.

6.3 Recommendations

In order to promote water bus service, the government and other authorities should organize campaigns to let people know more about the service. The frequency level needs to be enhanced as passengers are complaining about it more often. Near the transit stoppages, parking areas should be introduced.

During the rainy season, the water bus becomes dirtier which distracts the passengers. The authority needs to take the initiative to make the buses always clean. As the water bus service is not well-known all over the city, the authority should the best service quality so that the passengers get attracted and the number of commuters grows.

The timetable of the water bus is not followed strictly. Sometimes, the waiting time is so lengthy that frustrates the commuters. This needs to get fixed before losing a portion of passengers as providing fast service is the strength of the service.

The authority needs to provide safe drinking water booth and public toilet near stations according to the respondents. These will make the service smoother and comfortable. Again, these will also attract the new commuters to take the service.

6.4 Limitations and Future Research

Considering some limitations, the study has been carried out. In the research study, due to the lack of data, some variables that could have a major impact on the service are omitted, which is an inherent problem in many studies. In addition to the above variables, the analysis did not include the ownership, driving license, transit network, fuel price, parking price, etc.

The findings of this study will provide significant information for the policymakers and authorities for selecting the most appropriate decision in favor of the commuters, and also for the development of the service. Moreover, in order to flourish the public transportation system of Dhaka city, the results can be used. If policymakers want to encourage the water bus service, it is necessary to consider the characteristics of the service in terms of service quality and safety.

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