SERVICE QUALITY OF PUBLIC BUSES IN DHAKA CITY: A WOMEN'S PERSPECTIVE

BY

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Dedication

I would like to dedicate this thesis to my family and all my teachers who brought me up to this moment.

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Abstract

From the social and cultural perspective of Bangladesh, women's involvement in economic activities outside the residence is increasing day by day. A large number of economically active women are working in Dhaka where they make a substantial part of their total daily trips on public buses. Nowadays, measuring the service quality of public buses from the perspective of female commuters is getting importance in print and electronic media because of their security issues in case of accessing public transport. This research presents a framework to portrait the prevailing scenario of service quality of public buses in Dhaka city experienced by its female commuters. The main objective of this study is to explore the perception of the women commuters by revealing their probable grounds of dissatisfaction by identifying various factors along with their interactions in affecting the service quality of public buses. The study expects to propose solutions to overcome the problems and social constraints faced by female commuters while using public buses. The focus group of this study is mainly the university going young female students and the female commuters involved in the present workforce to the city.

This research is conducted integrating a qualitative approach with quantitative methods. The qualitative study is conducted through a semi-structured in-depth focus group discussion (FGD) involving around 50 female participants. The interviews are recorded and transcribed and the study applies text mining on transcribed data. Major complaints and compliments regarding existing service quality along with their underlying reasons, magnitudes, impacts, and consequences are extracted from text mining results. The participants' perceptions are evaluated considering seven attributes – i) reliability, ii) comfort, iii) service, iv) responsiveness and empathy, v) safety and security, vi) affordability and vii) vehicle access. This guides in developing a service quality assessment framework customized from two well-known service quality models - SERVQUAL and RESCA. Based on that, a closed-ended questionnaire survey is conducted to evaluate individual trips where the respondents evaluated various aspects of a trip they have just completed by bus and rated the overall journey as 'satisfactory' or 'unsatisfactory'. A total of 641 trips is evaluated by the respondents. In the quantitative approach, the Random Forest (RF) model is applied to the trip evaluation data to measure

the importance of various factors along with their ranking. Then, a Classification and Regression Tree (CART) is developed to understand the dominances and interactions among factors that make the overall experience of public bus trip ‘satisfactory’ or ‘unsatisfactory’ to its female commuters.

Analysis of the trip data reveals that around 67% of the respondents rate their overall trip experience to be unsatisfactory and only 33% of them are satisfied with the trip that they made with the public bus. Both the qualitative and quantitative analyses identify the boarding-alighting status and harassment issues as the most important variables which greatly influence the safety, security and comfort-related issues of female commuters. ‘Boarding alighting status’, ‘picking passengers (hurriedly/modestly)’, ‘female passenger harassment’, ‘noise status’, ‘harassment by the bus driver and/or helper’, ‘heat condition (inside temperature)’, ‘bad attitudes of male passenger’, ‘protestation against bad behavior’, ‘travel status (standing/seating/mixed)’, ‘waiting time for bus’ are identified as the top ten important variables from RF model.

Finally, several suggestions, such as providing training to the bus staff, random inspection by law enforcement authorities, introducing more seats and buses exclusively for female passengers, etc. came from the respondents. Several policy recommendations are also proposed compiling the thoughts of the respondents and recommendations from the literature that are expected to arrest the attention of policymakers and assist them to re-plan the existing public transport policy in Dhaka city and cities alike.

CHAPTER 1: INTRODUCTION

1.1 Background

Globalization, urbanization, motorization and socio-demographic transitions are four major societal trends that have profound transportation implications for women and men around the world. These four societal trends create opportunities for economic development for many countries while simultaneously throwing up the barriers to women's mobility (Rosenbloom and Plessis-Fraissard, 2009). Over the last two decades gender issue in public transportation sector has received the attention of researchers, geographer, policy makers and transportation planners as they have realized the differences in travel and activity pattern of men and women around the world (Bola and Ibrahim, 2013; Peters, 2001). The travel pattern of male and female widely varies in developing countries mainly because of the consequence of society and culture (Riverson et al., 2006; Nasrin, 2015).

Transportation is one of the main axes of social infrastructural orbit on which socio-economic development revolves around. It has extensive influence on all aspects of people's daily activities (Odufuwa, 2012). Public transportation plays a fundamental role in urban population since it creates opportunities for city dwellers to access to economic activity, facilitates family life and helps in spinning social networks (Wane, 2001). Cities and metropolitan areas are hearts of variegated activities that require well-organized convenient transportation system. A city cannot function properly without an effective transportation system. The urban transport system, considered as lifeblood of city life (Vuchic, 2003), provides access and mobility of people and commodities, connecting origins and destinations, both internal and external, to the urban area. Voluminous activities make the urban transit feasible and it is necessary that high capacity transit modes be used because of their economical, more energy efficient characteristics (Vuchic, 2003). Hence, compatible urban transport systems are indispensable for monetary activity and quality of life for the city dwellers. Inadequate and ineffective public transportation, related to networking and accessibility issues, limits the users' choices to access facilities and

employment opportunities (Pojani and Stead, 2015). An effective public transportation system contributes to rapid economic progress and enhances the social life of a city.

Generally, public transit facility refers to the service provided by government or private organizations to the citizens for ensuring the easy accessibility to daily activities. The common people avail this service by paying a definite amount of fare. In city areas of developed countries, typical public transit facilities are the bus, trolleybus, light rail transit (LRT), metro, regional rail operating on prescribed lines/routes on established and announced schedule (Vuchic, 2003). Buses are the most versatile and the cheapest mode of public transportation with the flexibility to serve a variety of access needs (Rahman et al., 2017), which run on streets covering an extensive network throughout both inside and outside of the urban area. Often bus is considered as a mode that can surpass many traffic issues including traffic congestion, decrease travel time and increase dynamism within the urban and rural activities (Kamba et al., 2007). Bus service renders an important function for the movement of a substantial number of people in developing cities that increases the mobility requirements due to rapid urbanization (Rahman et al, 2017). In many developing countries of Africa, Asia, and the Middle East, the urban passenger transport market has experienced a major shift towards private motorization due to a variety of economic, political, and societal reasons (Sen, 2016). The transport demand is growing in parallel with the rapid increase of populations in urban areas in South Asian countries. Among them, specifically India, Sri Lanka, Bangladesh, Nepal, Afghanistan, Iran, Maldives, and Bhutan, nowadays, face a notable transport and mobility challenge (Jain, 2013). Dhaka, one of the most densely populated developing megacities in South Asia, offers a very insufficient, inefficient, nonproductive, unsafe and overcrowded public transit service (Rahman, 2010; Karim and Mannan, 2008; Haque et al., 2012; Rahman et al., 2017). The deficit is exposed extensively between the supply and demand of public transport with the expansion of the city (Rahman and Nahrin, 2012). Unfortunately, the existing status of bus services does not attend the mobility needs of the population sufficiently (Gallagher, 2016, Mannan and Karim, 2001). Existing bus services are mostly untrustworthy, troublesome, uncomfortable, or even unsafe.

Transport policies and people's travel pattern have strong impressions on the social, economic, and environmental development of a country. Because of a greater variety of social classes, economic situations and cultural backgrounds in the urban context of developing countries, there are likely to be greater differences in travel patterns between male and female members of the same household (Peters, 2001; Riverson et al., 2006). People's travel behaviors are influenced by residential location choice (Choocharukul et al., 2008). Gwilliam (2003) stated that the perception of vulnerability influences travel patterns as well. For the last two decades, the researchers are giving attention to the relationship between transit service quality and people's accessibility (Minocha et al., 2008). A very few researches have been focused on identifying differences and similarities in the travel pattern of men and women or highlighted the less accessibility of women to public transport, especially in rural areas. Several studies on service quality of public buses have been done but ignored the gender dimension. Research on gender aspects of urban transport in developing countries is less extensive than in developed countries (Peters, 2001). Therefore, this research presents a framework to portrait the prevailing scenario of the service quality of public buses in the context of a developing city through the eyes of its young female users. This specific focus on female travellers is expected to highlight the variance in gender-based aspects that will reveal the female travellers' experience with present service quality of public buses. From the perspective of culture and social structure in Bangladesh, women's activities outside the home are significant. The majority of women have a notable presence in the social, educational, economic, political and cultural sectors. (Islam et al., 2016). Hence, women are involved in a substantial part of the total daily trips and this propensity is hoped to exacerbate in future.

1.2 Problem Statement

Despite dependency of a substantial number of passengers on public buses (Karim et al., 1999) of Dhaka city, very few studies have been done looking into their service quality from the perspective of female users. In fact, insufficient literature is available on service quality of bus or public transport in South Asian cities. Probably the main reason behind it is that the cities in Global South are facing more problems

to provide adequate transport facilities to meet up the passengers' demand and hence there are limited efforts or resources for improving the quality. Most of the studies on public transport dealt with operational performance indicators (see Ahmed, 2004; Firdious, 1984; Hasan, 1996; Tanaboriboon and Nath, 1996) rather than exploring the passengers' opinion about the ride quality, not even in perspective of female commuters. Andaleeb et al. (2007) found no comprehensive study on customer satisfaction with public transportation services in Bangladesh. His study highlighted the passengers' inclination on comfort, exchange of buses, staffs' behavior and government supervision only, but showed the insignificance of passengers' perception regarding ride quality, co-passengers' behaviors, and insecurity issues. Rahman and Nahrin (2012) investigated the experience and satisfaction of the public on bus journey and their overall expectations about bus services. Although this study was not specifically conducted to understand women's perspective or preferences, in a previous study the first author touched the issue of 'women only' bus service where he explored the existing route, frequency, and service quality of the 'women-only' bus and investigated the reasons behind not sustaining the service in the past or lessons learnt from the previous failures (Rahman, 2010).

Hence, service quality of public transport has been an important subject for the researchers as it is recognized as one of the most challenging areas for transportation industries (Govender, 2014; Wijaya, 2009; Giannopoulos, 1989). Measuring service quality is difficult as it involves a great deal of subjectivity (Govender, 2014). Quality public transport can ensure greater mobility of people and thus help the citizens to participate in the socio-economic development (Govender, 2014). At present measuring service quality of public buses from the perspective of female commuters is getting importance in print and electronic media because of the security and safety issues in accessing public transport as more women are getting involved in activities outside the home. Hence, improving the service quality of public transport has become a rising issue (Wijaya, 2009) in perspective of gender dimension that has got the attention of researchers over the last few decades. As compared to the high-income working women, low-income women face more troubles in terms of transportation (Nasrin, 2015) and they have to depend mostly on the public transport system. Hence, the policymakers are expected to give emphasis on ensuring the availability and safe

public transportation system for women and such systems are expected to be designed reflecting the needs, perceptions and preferences of women. For that, an exploratory research is essential to assess the service quality of public buses in Dhaka city from the perspective of its female bus users.

1.3 Why Dhaka city is chosen as study area

The study area of this research is Dhaka city, the capital of Bangladesh. The developing countries of the Global South are mostly classified into three categories by indicators: low income, low-middle income, and upper-middle income (World Bank, 2009). Bangladesh has recently been graduated as a lower-middle income class, declared by World Bank (2019) in 2015 and is headed to leave the Least Developed Country category of United Nations by 2024, propelled by achievements in health and education sector, lower vulnerability and a flourishing economy (Gay, 2017). Participation of women in the labor market has made a great contribution to the economic growth of the nation and the trend is deemed as essential to maintain prosperity. Women in labor force have increased from 9.8 million in 2003 to 16.8 million in 2013 (World Bank, 2016). According to the Bangladesh Bureau of Statistics (BBS, 2017) the present female literacy rate of aged 15 years or older is 65.3% and in urban areas, it is 74.3%. The largest proportion of the working-age population lives in urban areas (69.8%) whereas 66.7% covers the rural population (BBS, 2018). BBS (2017) advocates that the number of the economically active women is increasing rapidly. Labor Force Survey (LFS) report (BBS, 2018) shows that in 2017 the total number of economically active population of age 15 years or older is 63.5 million, of which 20 million are women, about 35 % of the total labor force. According to Statistical Pocket Book 2017 (BBS, 2017), the economically active female labor force has increased from 17.2 million in 2010 to 20 million in 2017. Also, the female employment status has changed positively from 54.1 million in 2010 to 60.8 million in 2017. Of them, in urban areas, 41.0% of female youth are employed which is much greater than the male youth employment rate of 28.8% (BBS, 2018). In addition, more female (91.8%) are employed informally than that of male (82.1%). The contribution of informal employment in urban areas is 13.1 million (77.3 %), and in rural areas, it

is 38.6 million (88.1%). In rural areas, 13.1 million (93.3 %) of the females are informally employed whereas 4.0 million (87.3 %) female in urban areas. Hence, the statistics show that the involvement of the female labor force in economic activities is increasing day by day. Of them, a large number of economically active women are working in the capital. The garment sector in Dhaka city alone employs about 70% of the total female labor force in the city (Shefali, 2000). The trend indicates a positive increase in female labor force participation in the future, with women competing directly with men. Moreover, a substantial number of female students live in Dhaka city as most of the government and private universities in Bangladesh are situated here. Hence, women contribute a substantial part of the total daily trips and the trend is expected to increase steadily in the near future.

Women's involvement in economic activity is directly related to their mobility and subsequent transportation demands. It is expected that a substantial share of these demands will be served through public transport in order to ensure sustainability. However, the current transportation scenario in Dhaka city is quite grim. In a recently conducted Dhaka Structure Plan-2016-2035 (DTCB, 2010), it has been observed that on an average working day about 21 million trips take place in Dhaka city. This high mobility need is attributed to high population density, which is 45,000 persons/sq. km at present (RAJUK, 2016). Aside from walking and cycling, public transport is the only means of travel for the majority of the city dwellers. From the recent surveys conducted while preparing the Revised Strategic Transport Plan (RSTP-2015), it was found that more than 60% of travellers use public transport for their journey to work. The number of daily trip production and trip rates as per gender and age group accordingly indicates that 20.9 million trips by man and 9.1 million trips by woman are being generated per day within the study area while trip rates of man and woman are 2.26 and 1.18 per person per day respectively (RSTP-2015).

Like in other Asian cities, the majority of trips in Dhaka are served by public transport and non-motorized transport modes (NMT) or para-transits because a significant number of people cannot afford personal vehicle due to lower income level (Rahman and Nahrin, 2012). At present, the rickshaw is one of the primary travel modes of the city dwellers. The average length of the bus trip is 5.6 km higher than

rickshaw trip of 2.1 km and the modal share of public transport is expected to increase significantly by 2035 whereas the modal share of rickshaw trip will decrease by 20% (RAJUK, 2016). Statistics also support this claim as the modal share of trips on public transport in Dhaka has increased from 44% in the Strategic Transportation Plan study (STP- 2005) to 60% in the recently updated study (RSTP-2015). Considering these facts and figures, this research focuses on how to find a place for young female trip makers' in the future public bus system.

1.4 Purpose and Objectives

The aim of this research is to lead the ways to achieve gender equality in the public transportation system. For that, the study has set the following specific objectives:

a. To explore the perception of the women commuters in Dhaka city by revealing their probable grounds of dissatisfaction.
b. To bring out suggestions incorporating women's opinion on how to improve the service quality of public bus in Dhaka city.
c. Formulate recommendations to transport policymakers and planners for further planning considering the gender issues to overcome the inequities.

This research can be considered as one of the pioneering studies in this theme as it will explore the women's perception regarding the service quality of the public transport system in a developing mega city.

1.5 Scope of the Study

The specific scope of this study is to find out the service level of existing public bus services plying on the roads of Dhaka city. The focus group of this study is mainly the university going young female students and the female commuters which make up a substantial part of the capital city's workforce

1.6 Layout of the Thesis

This study has been structured into five chapters. The **Chapter 1** proceeds with a general introduction which is meant to serve as the groundwork to build the entire thesis. In this chapter, readers are also introduced with the problem statements, the aim of the research along with the specific milestones the study endeavors to achieve which are laid out in the form of objectives. Also, this chapter describes the study area, defines its scope and lays out a blueprint of how this thesis is organized. **Chapter 2** presents a comprehensive literature review to present the state-of-the-art in this research topic which eventually will lead to identifying the research gaps. **Chapter 3** is composed of detail methodology employed in this research. Apart from presenting the overall workflow to explain how each activity undertaken in this research integrates, a brief description of each model and their rationale for being chosen in this study are also presented in this chapter. **Chapter 4** discusses the analysis and results. And finally, **Chapter 5** complies the main findings of the research and discusses policy intervention that can be considered to improve the public bus service quality in the eyes of its female users. Furthermore, the final chapter tries to outline the limitations of this study along with its future prospects.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Globalization, the most momentous turning of the 21st century, has extensive impacts on all aspects of society. The two major elements of globalization are the shifting of some industrialized service sectors from developed to developing countries and the migration of workers from poorer to wealthier states for having better economic amenities (Rosenbloom and Plessis-Fraissard, 2009). This exchange of activity dominates the transportation system around the world. Shifting of industries from high-wage to low-wage countries opens up the door for employment opportunities for women (Leinbach, 2000), which generates new travel needs and patterns. Simultaneously, the international immigration of male labor force throws the challenge towards the sender nations for taking responsibilities of those families supervised by women alone (Rosenbloom and Plessis-Fraissard, 2009). Hence, women play multiple roles both inside and outside households (Shefali, 2000; Zohir, 2003). The mobility needs of women have gradually been changed during the last several decades. Moreover, the women empowerment issue is getting importance around the world, because nowadays more women are joining to the workforce contributing to the economic growth of nations positively and their mobility is becoming obligatory (Rosenbloom, 2006; Mahadevia, 2015). Therefore, women are generating a significant number of trips on a regular basis even in the developing world where they have comparatively less freedom than men.

In context to the above description, this chapter has been planned to sketch the issues of women commuters around the world revealed by various researchers in different times. Moreover, the chapter reviews the literature on public transport facilities in Dhaka city with special focus on women's issue in public transportation. The source of literature has been scientific databases of manuscripts, conference proceedings, books, research papers, and articles, dissertations, etc. relevant to this study. Furthermore, policy measures, undertaken by different nations in context to

their problems in the transportation sector, are also discussed to reveal the possible way out for transport problem confronted by women commuters in Dhaka city.

2.2 Public Transport in Bangladesh

Bangladesh, with about 160.8 million inhabitants at an annual growth rate of 1.37 per annum on one of the largest delta of 56977 sq. miles (BBS, 2017), is one of the most densely populated countries in the world. Dhaka, the capital city of Bangladesh, serves as the center of all administrative, commercial, educational and cultural activities (STP-2005; Nasrin, 2015; Niger, 2013). Being the administrative, commercial and cultural capital, this mega city plays a major role in socioeconomic development of the country. Hence, Dhaka offers greater employment opportunities compared to other cities. This urbanization trend accelerates the recent population growth as economic opportunities attract a large number of migrants from rural areas and small towns (Sen, 2016). Gallagher (2016) explored that within the last four and a half decades the metropolitan population has increased exponentially from 3 million in 1971 to around 18 million at present and the current population density is almost double or treble to that of Tokyo, London, and Shanghai, and is one-third higher than Kolkata and Mumbai. He suspected that Dhaka's population will jump by another 50%, reaching a milestone of 26 million in 2035 over a twenty-year time-span beginning from 2015. Strategic Transport Plan (STP-2005) for the Dhaka Metropolitan Area estimated that this volume of the population will reach 36 million by 2024 with a density of 13,545 persons per square kilometer. This ever-increasing population has resulted in traffic congestion in the metropolitan area and poor urban services. Unplanned urbanization, congested development, diversified earnings, reliance on non-polluting modes, poor quality roads, heavy traffic congestion, uncoordinated institutional structure and lack of legal potency to enforce law and regulations are the basic characteristics of a developing city (National Research Council, 1996) and Dhaka possess all of those characteristics (Nasrin, 2015). The rapid expansion of the city and growth of its population with increased and versatile urban land use patterns (Haque et al., 2012) have headed to a great demand for

transportation (Rahman, 2008) as well as numerous transport problems in the city (Sarma, 2009; Mahmud et al., 2012).

The transportation system of Dhaka city is predominantly road-based (Rahman and Nahrin, 2012) with various travel modes - both motorized and non-motorized (Haque et al., 2012), with limited use of waterways and railways. No mass transit system like metro-rail or bus rapid transit (BRT) systems (Rahman and Nahrin, 2012; Jain, 2013) serve the large city with huge travel demand (Rahman et al., 2017). The city lacks well-organized, properly scheduled bus system (STP-2005). Buses are the main mode of transportation for the middle and lower income group in the city (Rahman et al., 2017) carrying almost 1.9 million passengers per day (Haque et al., 2012). The STP (2005) categorizes urban transports into minibuses (41%), microbuses (30%), large buses (13%), auto tempo/laguna maxi (12%), and staff and school buses (4%). In Bangladesh, motorized traffic is growing rapidly, the number of personally owned motorcycles and cars are growing rapidly which rose by 200% and 250% respectively over the period of 8 years from 2003 to 2011 (BRTA, 2012). On the contrary, despite the rising demand for public transport services, the number of buses and minibuses are not growing significantly (Haque et al., 2012). A small number of public buses only around 3% of total motorized vehicles ply on road (BRTA, 2012). Hence, the present scenario of passenger transport of this metropolitan city shows the incapacity of the existing bus services to fulfill the growing demand (Rahman et al., 2017). Again, as per indications of Road Maintenance and Management System (RMMS, 2004) a well-planned city should have 25% of total area for its road network, whereas Dhaka has only 9% available area for road space among which only 6% pavement space is available for the Dhaka City Corporation (DCC) (Mahmud et al., 2012). Moreover, none of the city roads has an exclusive bicycle lane and safe pedestrian walkways (Haque et al., 2012; Munira and Santoso, 2017). Mahmud et al. (2012) analyzed from the RMMS data that the 1286 km long road network of DCC comprises of 61 km primary, 108 km secondary, 221 km connector, 573 km local and the remaining being narrow roads. RSTP (2015) estimated that the number of trip generation per day will be around 51.2 million by 2035 which is 1.72 times higher than the trip generation rate surveyed at 2014 (Gallagher, 2016). The average trip length was found to be 5.4 kilometers (STP-2005).

RSTP (2015) recorded the average trip length each mode: 3.6 km for Rickshaw, 8.7 km for CNG, 9.7 km for Bus, 7.4 km for Motorcycle and 8.7 km for car & Taxi. Despite the rapid growth of motorized traffic in Dhaka, non-motorized transport still remains the dominant mode for the city dwellers especially for middle and low-income groups (Haque et al., 2012). Above 40% of the city's trips are performed by walking and rickshaw, representing about 73% trips on foot by the low-income group while 59% of rickshaw trips are made by the middle-income group (DTCB, 2010). The significance of non-motorized trips is clearly evident as they are used by 97% of the city dwellers (Haque et al., 2012).

The city buses are operated by both a government organization and a number of private companies. The private sector is dominating and provides a monopoly service (95% of total bus services) compared to public sector operation (Rahman, 2011). Bus services available in Dhaka city can be classified into two groups: counter service bus and local service bus (Rahman and Nahrin, 2012; Niger, 2013; Jain, 2013). Counter service buses stop at their specified stoppages for boarding and alighting of passengers, where passengers can buy tickets just before boarding into the bus. Very few counter service buses are air-conditioned. In contrast, local service buses, having no specified stoppage, stop anywhere on the route for boarding and alighting of passengers and the bus conductor in general collects fare from passengers on board. Buses often remain heavily overcrowded because of the gap between supply and demand (Rahman and Nahrin, 2012). However, a few seating service buses, operating on a few fixed routes, allow boarding of passengers based on the availability of empty seats. These buses also stop at the specified stoppages for boarding and alighting of passengers and the passengers in general pay their fare on-board. Insufficient room for female passengers, only 6 seats in each bus, have been reserved but nothing much for disabled people or senior citizens (Rahman, 2010).

Rapid unplanned congested urbanization process, high vehicular population growth and that of the mobility, inadequate transportation facilities and policies, diverse traffic mix with over gathering of non-motorized vehicles, absence of reliable public transport system and inefficient traffic management practices have resulted in a significant deterioration of traffic and environmental problems in Dhaka

metropolitan (Haque et al., 2012). Various researches (Rahman, 2010; Karim and Mannan, 2008; Rahman and Nahrin, 2012; Hasnine, 2011) claimed that the present bus services are inefficient, unproductive, and unsafe due to non-specific schedule, long waiting time, delay on plying, long boarding time, overloading, uncomfortable seating arrangement, inadequate ventilation, excess fare, long walking distance from the residence or workplace to bus stoppages, inadequate traffic management and so on. According to Mahmud et al. (2012), Dhaka city's traffic system is one of the most chaotic ones in the world. Moreover, manually controlled signals system without proper automated system (Rahman et al., 2017), narrow road spaces, no separate lanes for public transport, overtaking tendency of drivers and inadequate manpower to monitor these violations (Sen, 2016) also create prolonged traffic congestion. Hence, road users in Dhaka city are forced to undergo physical stress and suffer financial losses in terms of man-hours lost in the streets on working days. An investigation by Dhaka Transport Coordination Board (DTCB) in 2010 revealed that traffic congestion in Dhaka resulted in a loss of approximately $1.68 billion a year (Dhaka Mirror, 2010), which is expecting a sharp increase in the following years.

Public buses with a negative reputation for being unreliable, inadequate, slow, overcrowded, and unsafe, are nonstandard to meet commuters' demand (Munira and Santoso, 2017). An extensive deficit is exposed between the supply and demand of public transport with the expansion of the city (Rahman and Nahrin, 2012). However, this deficit results in the deterioration of accessibility, service level, security, comfort, and operational competence, instigating amplified expenses, waste of time, air pollution and psychosomatic stress, and asserting a severe threat to the economic sustainability of the city and its environment (Haque et al., 2012).

2.3 Women & Public Transport

Turner and Fouracre (1995) mentioned that the travel pattern of women changes significantly with the adjustment of social circumstance in their life progression. Hamilton et al.'s (2005) study revealed non-homogeneous nature because of variety in their travel pattern which is led by their ages, terrestrial location, socioeconomic class and ethnicity, employment and parenting status. On the contrary,

men's travel pattern remains almost even throughout their whole life (Turner and Fouracre, 1995). There is variance in travel pattern between men and women (McGukin and Nakamoto, 2004) because of different economic and societal roles and responsibilities and activities in the aspect of gender inequality (Rosenbloom, 2006; Peters, 1999). People make choices among different modes of transport keeping in mind the issues such as their purpose of travel, fare expenses, comfort and convenience and characteristics of a vehicle. Hence, understanding the travel pattern of urban people and the reasons for choosing one transport mode over another are important features to assess the quality of service.

In the Global South, women's travel-patterns are categorized by accelerating the changes in mobility-patterns and gender gaps that decrease with the increase of income (Rosenbloom and Plessis-Fraissard, 2009) whereas women in developed countries have substantial auto-mobility, but the gender gap remains in licensing and vehicle use. The travel pattern of working women is more complex than that of men in both developed and developing countries as working women are involved not only in the outside job but also in household activities (Duchene, 2011; Turner and Grieco, 2000). These twofold responsibilities make them travel more frequently for executing various household responsibilities such as childcare duties and taking parents to doctors or health care facilities, shopping, visiting relatives and so on, than working men (Anand & Tiwari, 2006; Wachs, 2009; Hjorthol, 2008; Rosenbloom and Plessis-Fraissard, 2009). Inequity exists regarding access to private motorized vehicles in developing countries where women get less access to these vehicles than men because of societal norms about women's appropriate travel behavior (Peters, 1999; Zohir, 2003; Rosenbloom and Plessis-Fraissard, 2009; Turner and Fouracre, 1995). In Western countries, the basic differences in travel patterns are that women make more trips but ones of shorter average distance and have less access to cars (Hanson and Johnston, 1985; Rosenbloom, 1998; Heine et al., 2001). Even though women have more complicated travel patterns and make more household and family support trips, their mode choice is less flexible and they use public transport to a higher degree i.e., they are more often captive riders than men (Hanson and Johnston, 1985; Rosenbloom, 1987; Buhr, 1999; Preissner and Hunecke, 2002; Hunecke, 2000; Heine et al., 2001; Nobis and Lenz, 2004).

Women are more concerned about their safety issues while using public transport than men (Tarigan et al., 2010). In urban areas, fear and anxiety about personal security hinders women's mobility (Krieg et al., 2009), especially fear of sexual assault, attack, robbery, harassment, and verbal abuse have great influence on their travel decision (Buvinic et al., 1999), particularly at night (Sham et al., 2012). Anand and Tiwari (2006) described in their paper that women are often the targets of sexual harassment while walking or riding public transit and this situation may be aggravated due to insufficient lighting and narrow lonely paths connecting from home to bus stops. According to Gwilliam (2003), even female passengers are generally more vulnerable to physical attack or sexual assault often by the bus staffs or other male co-passengers in public transport. Anand and Tiwari (2006) asserted that basic reasons behind these problems are the lack of adequate pedestrian infrastructure on busy roads, nonexistent or badly designed pedestrian crossings, the poor location of bus stops and shelters, and high entry steps on buses.

Women in the Global South suffer from far worse transportation problems than the developed nations in Global North. Studies around the world show that women have limited access to a better mode of transport (Riverson et al., 2006; Rosenbloom and Plessis-Fraissard, 2009; Peters, 2013). Women value time more than men because of their extended job responsibilities. Adetunji's (2013) research found that in Nigeria men enjoy the freedom to use private transport predominantly, whereas women mainly have to depend on public transport. Astrop et al.'s (1996) study revealed that women commuters in Pune usually depend on pedestrian means to travel shorter distances and on buses to travel long distances, whereas, men commuters mainly use scooters and motorcycles to meet the travel demand. Peters' (2002) research revealed that in developing countries as compared to men, women generate fewer trips and use less expensive modes of transport. According to Peters (2002), owing to the patriarchy, poverty, and policy regarding transport planning, women have insufficient entrance to transport services. Venter et al. (2007) stated that low-income females face more difficulties at the time of travel because of having restricted access to all modes of transports, hence mostly they choose walking as their mode of travel. In contrast with low-income female travellers, middle-income or high-income female commuters possess more capacity to avail or own a private vehicle that ensures

their maximum comfort, flexibility, safety, and security (Nasrin, 2015). In another study, Peters (2013) postulated the people's travel behavior of Dhaka city by comparing the gender-segregated travel patterns of five different developing cities where she found that compared to men absolutely there are no modes of transport available for women, therefore either they have to walk or depend on public modes of transport. Dhaka's social structure restricts the travel choices of female service-holders, the most unprivileged group of commuters, compared to males within the same income bracket (Nasrin, 2015). Women prefer more separation from men and are unlikely to travel in overcrowded buses with other male passengers (Rahman, 2010). That's why their preference for "women only" buses is higher in Dhaka, compared to Pune (Peters, 2013).

Rosenbloom and Plessis-Fraissard (2009) have discovered two versions of the same story of women's mobility by examining their travel patterns in both developed and developing countries around the world. The study revealed that women, irrespective of their pecuniary development, have less access to better or faster transportation means, exhibit diverse and more complex travel patterns than men. Recently, these women mobility issues have got importance in light of huge involvement of women in employment sector as they have to rely more on public bus which is not even safe for them (Sham et al., 2012). The differences and travel demands are largely ignored or even made worse by policy responses and government programs. According to Fernando (1999), understanding the women's transport needs as well as the social, economic and cultural factors that facilitate or obstruct women's ability is very vital to introduce new policies and technology that may ease the path of women accessibility to public transport.

2.4 Transportation Services for Women and Bangladesh

According to Peters (1999), women in Dhaka face cultural constraints in accessing public transport because of social seclusion. In Bangladesh, despite being a conservative country from the perspective of social structure and religious norms, at present women's activities outside the home are significant. The majority of women have a notable presence in the social, educational, economic, political and cultural

sectors (Islam et al., 2016). Women involvement in economic activities creates mobility and transportation demands for accessibility. Though public transport is not gender-sensitive due to societal culture and religious norms, inappropriate policies and investment make a difference in accessibility needs of women (Sen, 2016). Public transport environment is not comfortable for women. Moreover, the inadequate number of public buses in Dhaka City mostly remains over-crowded that resists the accessibility of many people, particularly the elderly or disabled and the women (Rahman, 2010). In contrast, deficiency of public transportation is lessened partially by para-transits that provide door to door mobility and services. These also connect inaccessible and congested neighborhoods (Jain, 2013). Majority of the women take advantage of these para-transits for their daily activities outside the household. But for long distant travel female commuters have to rely on public buses.

The condition of the existing bus services in the metropolitan is very poor. Passengers, mostly women, are facing problems while travelling by bus. An evaluation report of Swedish International Development Cooperation Agency (SIDA) in 2006 revealed that in Dhaka city women's dignity and security are at risk travelling on crowded buses as they face the dangers of physical touching and uncivilized behaviour from drivers, ticket inspectors and other male passengers (Rahman, 2010; Islam et al., 2016). Zohir's (2003) case study of Dhaka found out the lack of proper co-ordination between the gender-enabling environment and the transport sector. In Dhaka, eve teasing and harassing women in crowded buses are very common and women commuters face problems of getting in and off the bus while overcrowding as they cannot compete with male commuters (Rahman, 2010; Jain, 2013; Zohir, 2003; Islam et al, 2016). A study by development organization BRAC revealed (2018) that around 94% of women got sexually harassed while travelling in public transport, where males belonging to the relatively older age group of 41-60 years were identified as the major offenders. The bus drivers do not stop the buses properly while picking passengers from different stoppages, even they stop the buses in middle of the road and in such situation while boarding the buses conductors touch women's back intentionally or hold their hand to help them from falling from the bus (Islam et al., 2016). Whereas this situation can easily be prevented by halting the bus properly at the curb of the road. Rahman (2010) revealed that most of the cases drivers show

reluctance to carry women commuters as they are slow mover, have more security issues, take more space, and need a complete halt for boarding or alighting and even they often announce ‘no seats for women are available’ to avoid women passengers. And despite having few seats reserved only for women in buses, often those are occupied by male passengers demanding ‘equal rights’; neither the co-passengers nor the bus staffs take an attempt to make them available for women riders (Islam et al., 2016). Therefore, the regular female commuters always need to wear a rigorous appearance and maintain a sharp tongue from finding a bus to getting a comfortable seat safe from all kinds of unpleasant circumstances (Khan and Chakma, 2015).

However, to avoid such uncomfortable situation, women are forced to look for alternative options such as walking long distances or hiring CNG (compressed natural gas) auto rickshaw or taxi with high fares (Rahman, 2009; Sen, 2016; Shefali, 2000) and non-motorized three-wheelers (SIDA Evaluation report, 2006). A World Bank study revealed that in Dhaka 35% of female commuters relied on cycle-rickshaws as their sole mode of transport (Peters, 1999). A study conducted by ADB concluded that walking is the only mode of daily travel for approximately 13% of the surveyed working women (ADB, 2012). The same study also revealed that approximately 12% of the women respondents had to change the workplace and 11% of the women had to quit their jobs because of transport issues, which resulted in severe household income loss. Despite of being easier modes, these para-transit facilities could not ensure secure, safe, and comfortable travel for women passengers or the mobility-impaired group as well (Abir and Hoque, 2011; Rahman, 2010; Nasrin, 2015). Furthermore, fares of those para-transits are much higher than the bus which sometimes become unaffordable to low or middle-income female group (Nasrin, 2015; Shefali, 2000). Hence, this combination of unsafe, unaffordable and inaccessible transport system, both bus and para-transits, has certainly restrained women's access to work, education and necessary social services (Jain, 2013).

According to Nasrin (2015), low-income female commuters are the most underprivileged group of commuters in Dhaka. Nasrin (2015) also revealed that Dhaka’s road and transport system is seriously lacking in equity in case of driving personal car, because female commuters driving their own car or ride a bike or

motorcycle mostly face harsh comments from other road users whereas male commuters feel free to drive their personal cars without facing any negative comments from others. Also, because of income constraints, not all female commuters can own a private vehicle. Though public bus services only for women were introduced several times by the Bangladesh Road Transport Corporation (BRTC) during the last four decades; none of those operations could exhibit longer sustainability for various reasons. However, present transport services are very inadequate not only for women but also for the large group of the population of this city. Hence, this inadequate transport services adversely affect everybody's day to day activities, especially women commuters face particular mobility constraints (Shefali, 2000).

Accessibility to public transportation is an important concept in mobility plans and even in assessing the quality of service provided to the users. Numerous researchers have highlighted the importance of passengers' perceptions as passengers are the real judges of the received service. But women accessibility to public buses as well as the service quality issues of public buses in Dhaka city are poorly treated and still the less researched area by researchers and policymakers.

2.5 Service Quality Model for Public Transportation

Extensive research has endeavored on different aspects of service quality providing a comprehensive conceptual foundation. Level of Service (LOS), a tool for assessing the quality of all service attributes, influences the consumers' perception to make difference between their expectation and perception of service (Gronroos, 1984; Parasuraman et al., 1988). Formerly the concept of LOS had been practically used in perspective of highways; the researchers, well headed, dilated it to other sectors of transportation (Rahman et al., 2017). Botzow (1974) is among the pioneers who applied the LOS concept in evaluating the service quality of the public transit system. Transportation Research Board under the Transit Cooperative Research Program (TCRP) in 1999 published a handbook which gave an elaborate definition of Service Quality. According to TCRP Report-47 (1999), Service quality can be assessed by taking into account the customer perceptions and expectations, or by a range of simple disaggregate performance measures which can be used for assessing the transit

agency's capability of offering services that can meet customers' expectation. A transit performance measure can be a quantitative or qualitative factor that evaluates a particular aspect of transit service (TCRP Report-47, 1999) and each performance measure contains a series of indicators (Eboli and Mozulla, 2010).

Performance measures qualitatively determine the consequences of factors such as travel time, speed, cost, service-type or any particular facility that are delivered to the consumer under the stated conditions (Wright and Ashford, 1989). Currie (2003) defines the following three major groups of factors:

• Performance elements affecting users (i.e. operating speed, reliability, safety);

• Service quality (i.e. convenience and simplicity of use, aesthetics, cleanliness, behaviour);

• Price or the fare rate that the users pay for the service.

Miscellaneous factors such as service frequency, operating speed, reliability, safety, line capacity, productivity, and utilization (Vuchie, 1981), security, consistency, attitude, integrity, status, availability, and training of service providers are necessary to evaluate the service quality (Sasser et al., 1978). Several researches have revealed that reliability (maintaining time schedule) is an influential factor (Hensher et al., 2003; König, 2002; Edvardsson, 1998; Bates et al. 2001; Disney, 1999) whereas convenience and comfort such as inside cleanliness, seat availability, light and air condition, ventilation, seating arrangement, are well-known arguments (Anable, 2005). Horsu and Yeboah (2015) introduced 'driver behaviour' as a service quality dimension in their research.

Perceived service quality has been ascertained as a global judgment or attitude involved with the advantage of a service (Zeithaml and Bitner, 2000). Several researchers have familiarized some indexes of service quality measurement. Gronroos (1982) has explained two dimensions of customer's perceptions of any service, named practical quality (i.e. the 'service') and serviceable quality (i.e. approach of providing the 'service'). Sasser et al. (1978) proposed three different features (levels of material,

facilities, and personnel) all dealing with the process of service delivery. Subsequently, Gronroos (1990) documented six definite extents that help to measure service quality viz., professionalism and efficiency, reliability and trustworthiness, attitudes and manners, accessibility and flexibility, deliverance, and acquaintance and credibility. Lehtinen and Lehtinen (1982) deliberated three dimensions viz., physical quality, corporate quality such as company's image and reputation; and interactive quality i.e. interactions between service personnel and customers. Parasuraman et al. (1988) developed a Multiple-Item Scale model, named SERVQUAL, for measuring service quality by detecting the difference between customers' anticipation and discernments of the performance of the service using 22 items and five-dimensions. The dimensions are: reliability, assurance, tangible, empathy, and responsiveness. The SERVQUAL model has been extensively applied in different contexts across different sectors to measure customer satisfaction. Even, various scales have also been replicated, adapted and manifested to measure services by taking SERVQUAL as a base, viz., SERVPERF (Cronin and Taylor, 1992) for hotels, clubs and travel agencies; DINESERV (Stevens et al., 1995) for food and beverage establishments; LODGSERV (Knutson et al., 1990) for hotels; SERVPERVAL (Petrick, 2002) for airlines; SITEQUAL (Yoo and Donthu, 2001) for online-based shopping; E-S-QUAL (Parasuraman et al., 2005) for electronic services; SELEB (Toncar et al., 2006) for educational services; HISTOQUAL (Frochot and Hughes, 2000) for legendary houses; LibQUAL (Cook et al., 2001) for library ; and ECOSERV (Khan, 2003) for ecotourism. In contrast, McKnight et al. (1986) developed the RECSA model that is delineated from reliability, extent of service, comfort, safety, and affordability. They suggested that service quality dimensions should be considered as the sum of general attributes. A Customer Satisfaction Index (CSI), implemented by Bhave (2002), is calculated by using an importance weighting based on an average of 1, where the customers accredit a weighting and evaluate each service attribute. Each weighting is divided by the average of all weightings expressed by customers. Then, a weighted score for each attribute is computed as a product of score and average weighting score defines the CSI.

Measuring service quality is difficult as it involves a great deal of subjectivity (Govender, 2014) However, while dealing with the service quality of transportation

studies, mainly used SERVQUAL and RESCA. In most cases, the authors adjusted these models according to their study context. A summary of some studies are presented as follows:

- Knutsson (2003) compared the rider quality of Swedish transport services with public transport standards by using a Swedish rider quality index proposed by Knutsson (1998). He conducted a questionnaire survey on 2,200 riders and used Logit model for analysis.

- Randheer et al. (2011) inspected the service quality of public transport in India by applying the SERVQUAL scale to conduct a survey among the regular public transport users.

- Barabino et al. (2012) applied a customized form of SERVQUAL method complying the EN 13816, a European standard on service quality in public transport, to develop a quality evaluation tool for transport operators to certify the offered service. The study location was the Cagliari city in Italy and the study revealed a high degree of importance placed on attributes of public transport facilities such as on-board security, bus reliability, cleanliness and frequency.

- Govender's (2014) study explored commuters' perception by applying McKnight et al.'s (1986) RECSA method on the bus and mini-bus or taxi service in South Africa and he collected the data through a questionnaire survey. This study revealed that the overall quality of the bus service is better than that of minibus taxi.

- Another study on the bus service quality in South Africa is that of Valkazi and Govender (2014) where the authors used RECSA model and applied structural equation modeling to analyze the data collected from bus commuters in Johannesburg through a questionnaire. The study identified that the bus commuters' perceptions get influenced by factors such as reliability, service, comfort, and safety.

- Pakdil et al. (2014) used SERVQUAL scale in a case study on a national highway passenger transportation firm in Europe that involves qualities such as tangibles, reliability, responsiveness, assurance, and empathy. Through analysis, the authors discovered that customers expect competent and empathetic attitude from employees, error-free service and technical specification of the transport. This study proposed some improvements in the quality of highway passenger transportation services by applying Quality Function Deployment (QFD).

- Islam et al.'s (2014) study was based on Malaysia in which SERVQUAL was the model involving five criteria: service, access, availability, time and environment. Applying the multiple regression method, they found that the service dimension has an influence on customer service.

- Horsu and Yeboah (2015), by adapting the RESCA model, identified the impact of service quality on customer satisfaction in case of minicab taxi services in Ghana. Through multiple regression analysis, the authors found that continuous service, comfort, affordability, and reliability have a significant positive influence on customer satisfaction.

- Mikhaylov et al. (2015) also applied the SERVQUAL model to discover the quality gap of customers' expectations and perceptions on public transportation services in the city of Kaliningrad, Russia. The study outcomes apprehend the largest expectations-perceptions' gap in the service environment and the factors within the assurance dimension deleteriously influence the overall assessment of the service quality of public transportation.

- Rouf et al. (2019) applied the customized format of a service quality model combining the both SERVQUAL and RESCA model, where the paper tried to discover the perceptions of university going female students on service public quality of public buses of Dhaka city, Bangladesh.

Through literature review, very few studies are found that adapted quantitative approach along with the mathematical and statistical techniques such as descriptive statistics, general hypothesis, regression analysis, binary logistic regression (Rahman et al., 2017; Joewono and Kubota, 2007), logit model (Knutsson, 2003), factor analysis and ordered logit model (Tyrinopoulos and Antoniou, 2008), multiple regression analysis (Islam et al., 2014; Horsu and Yeboah, 2015), discrete choice model, path analysis (Joewono and Kubota, 2007), structural equation modeling (Stuart et al., 2000; Eboli and Mazzulla, 2007; Vilakazi and Govender, 2014), multinomial logit model (Nurul-Habib et al., 2009) and quality function deployment (Pakdil et al., 2014) to identify the desired service qualities of different kinds of transports.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Research is a vigilant deliberation of a study regarding a particular problem using scientific methods (Rajasekar et al., 2013). Earl Robert Babbie (1998), a renowned sociologist of America, has defined research as:

> "… a systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods."

It is an approach to search for a better knowledge of the relationships among human, space, place and environment (Sen, 2016). Kitchin and Tate (2000) defined research as a coherent set of rules and procedures that can be used to look into a phenomenon or situation. Every research has some aims and intentions that regulate the choice of methodology. The baseline of methodology is shaped by the theoretical framework. According to Warf (2006):

> "Methodology is a meso-level theoretical construct that allows researchers to translate their philosophical and theoretical assumptions into data".

This chapter sketches the discussions on the research methodological approach followed in this study which has been designed amalgamating qualitative research approach with quantitative methods from the field of information science. Qualitative study focuses on people's behavior, belief, knowledge and attitude (Hossain, 2011). These days, qualitative research is applied in different disciplines of science. The quantitative part of the study will have twofold use – in one hand, it will evaluate/reaffirm/nullify the findings of the qualitative research, on the other hand, it will associate the findings of the qualitative research with numbers – enabling to identify their extent and impact. This chapter explains the sources of primary and

secondary data, techniques employed for data collection along with brief description of the qualitative and quantitative methods applied in this thesis.

3.2 Work Flow of the Research

The overall workflow followed in this research is outlined with **Fig. 3.1**.

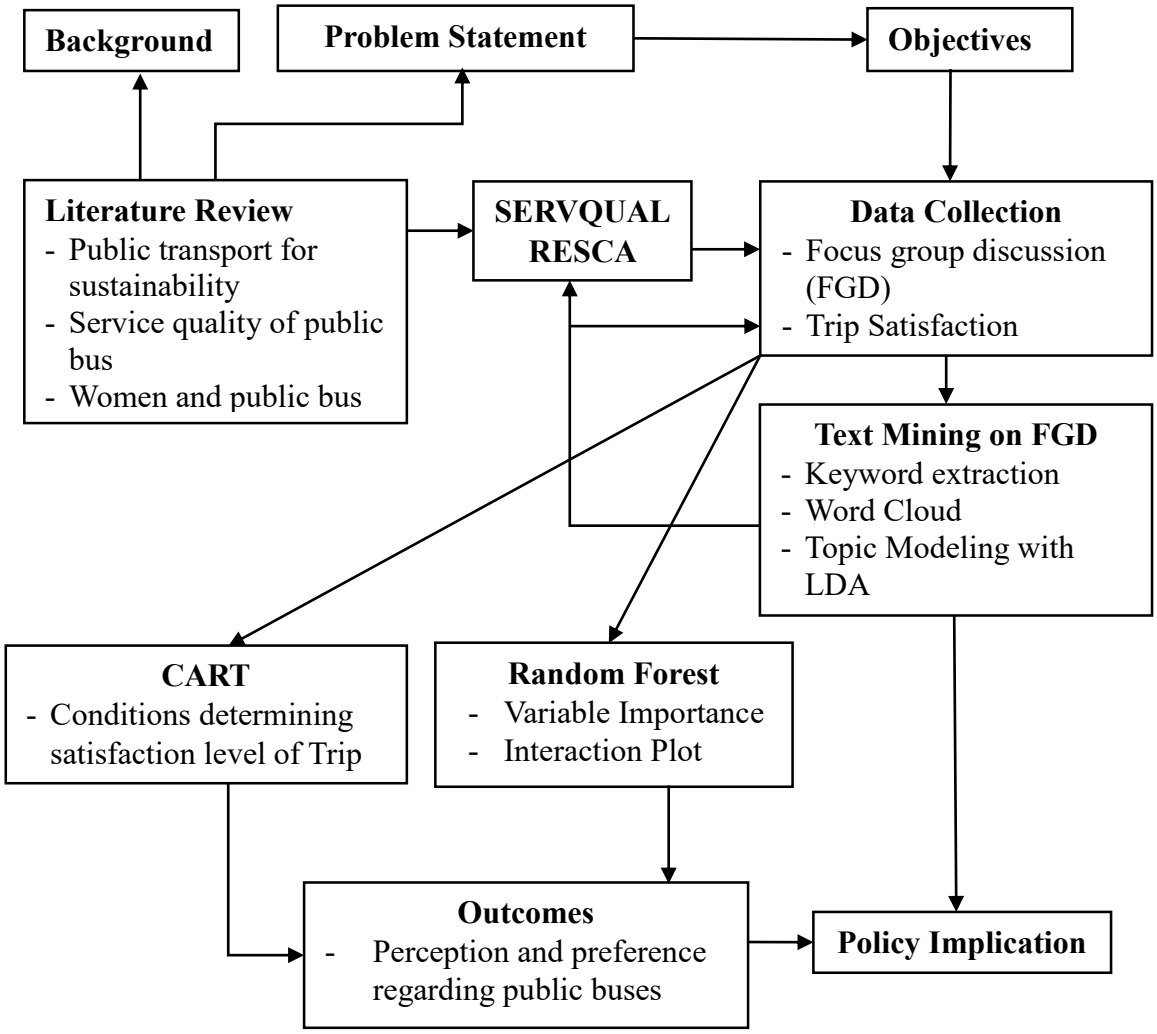


Fig. 3.1: Overall Workflow

The methodology can be broken down into several components. At first, a comprehensive and thorough literature review is conducted (**Chapter 2**) in order to obtain a clear idea about the background and the existing research gaps relating to women, public bus and service quality. From that, the objectives of this study are determined. The analysis involved in this study is broadly categorized into two groups – qualitative and quantitative – both requiring their own data collection. Based on the

two popular service quality models, namely SERVQUAL and RESCA, a focus group discussion (FGD) is conducted involving young university and office going female bus users. The findings are summarized based on qualitative approach, which are further verified with various text mining approaches, such as, word cloud preparation and topic modelling. This eventually led to evaluating trips as ‘satisfactory’ or ‘not satisfactory’ through a large-scale survey based on the factors identified through the FGD and text mining.

3.3 Qualitative Study

The qualitative data in this study is collected through a focus group discussion (FGD). This transcribed data of the qualitative study are further evaluated through text mining to interpret and justify the outcomes of the qualitative study. The qualitative part of the study can be broadly divided into two parts. The first part involves developing a framework to assess the service quality through interviews that suites the needs of the study area. The second part involves conducting a semi structured interview which was transcribed and used as input for text mining. The following sections briefly explains the methodological approach for this.

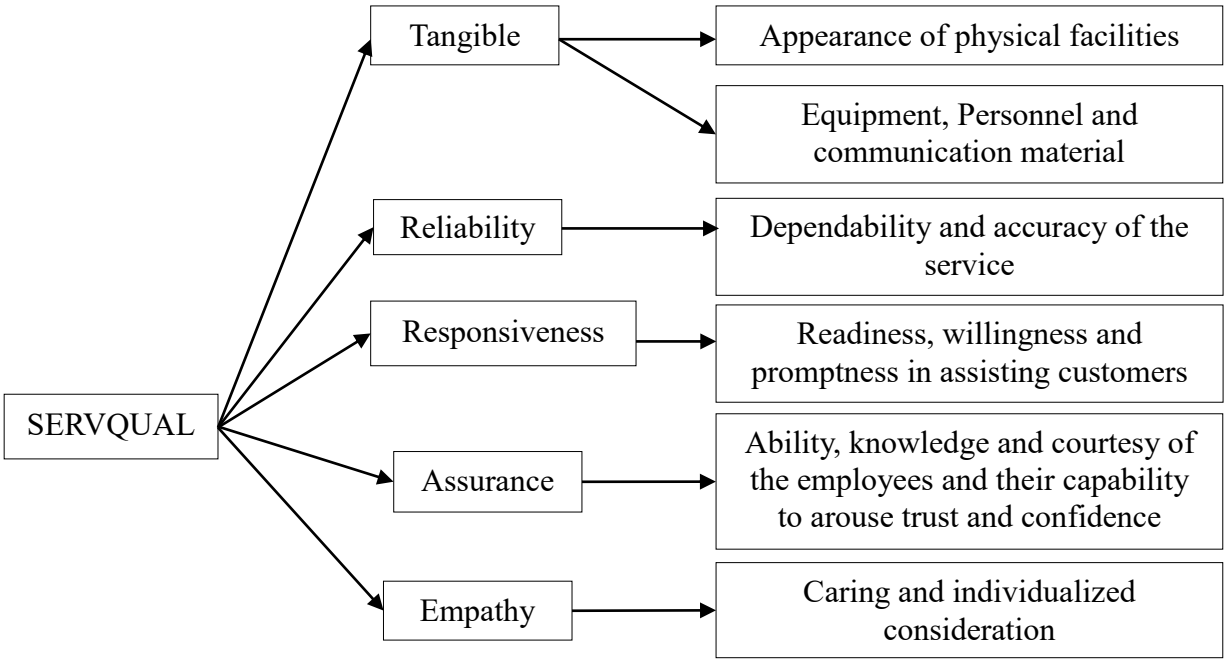
3.3.1 Focus Group Discussion (FGD)

For focus group discussion, in this study, the snowball sampling method was applied to track down and choose the interviewees. This non-probability sampling method is extensively adopted in qualitative research (Hossain, 2013; Hossain and Rokis, 2014; Hossain, 2017). According to Cavana et al. (2000), snowball sampling is aptly exercised if the elements in the population contain specific features and information. Snowball sampling commences with finding a possible interviewee who has much knowledge and experience about the research issue. Then, after interviewing the first person, the researcher requests the first interviewee to pick out some other persons from his/her familiar circles who can be interviewed. The researcher may seek help from the first interviewee to get familiar with the other interviewees introduced by the first one. Then, after taking the interviews of these new interviewees, again the researcher may seek help from them for taking the chance of getting access to some

other persons who can be interviewed. Thus, snowball sampling complies a friend-to-friend network (Hossain, 2017). In this study, at first, a university going female student (who is a regular user of the local bus service in Dhaka city) was chosen. After taking her interview, she was asked to tag some of her female friends who are also the regular users of these bus services in Dhaka city. Accordingly, the same strategy was applied for choosing the interviewees who are involved in different jobs or service sectors. The interviewees willingly gave their interviews. Following this snowball sampling method semi-structured in-depth four focus groups discussions (FGD), two for female students from different universities of Dhaka city and two for service women from different organizations were undertaken, where around 50 participants took part. The FGDs were conducted by a moderator (the author of the thesis). All of the participants were regular public bus users. Though there is no rule of thumb for determining sample size of qualitative interview data, literatures suggest that quantity of interviews that makes to reach data saturation depends on various factors involving scope, target audience, researchers, resources and the research audience (Bonde, 2013; Baker & Edwards, 2012). Creswell's (1998) recommendations range 5-25 interviews for a factual study and 20-30 for a grounded theory research. Kuzel (1992) advocated six to eight interviews for a homogeneous sample and twelve to twenty data sources for confronting to research objectives. Around twelve or less than twenty interviews should be sufficient to reach to the data saturation in such type of study, aims at understanding the common perception and experiences among a group of homogeneous individuals (Guest, et al. 2006, Crouch and McKenzie, 2006). Bernard (2000) observation tells that thirty-sixty interviews are mostly chosen for ethnographic studies, while Bertaux (1981) voted for fifteen interviews as the minimum adoptable sample size in qualitative research. Since in our case the participants groups contain only female individuals that fulfill the conditions of data saturation, hence 12-15 individuals took part in each focus group discussion. In these semi-structured interviews, the participants were asked about the service quality of public buses in Dhaka city and the interviewer attempted to comprehend and penetrate the perceptions of the interviewees by discussing the existing facilities, problems faced by female travellers and the suggestions leading to possible solutions to those issues raised in the focused group discussions. With permission, the interviews were

recorded and transcribed. Then major complains and compliments regarding the existing service quality of public buses along with their underlying reasons, magnitudes, impacts and consequences were extracted.

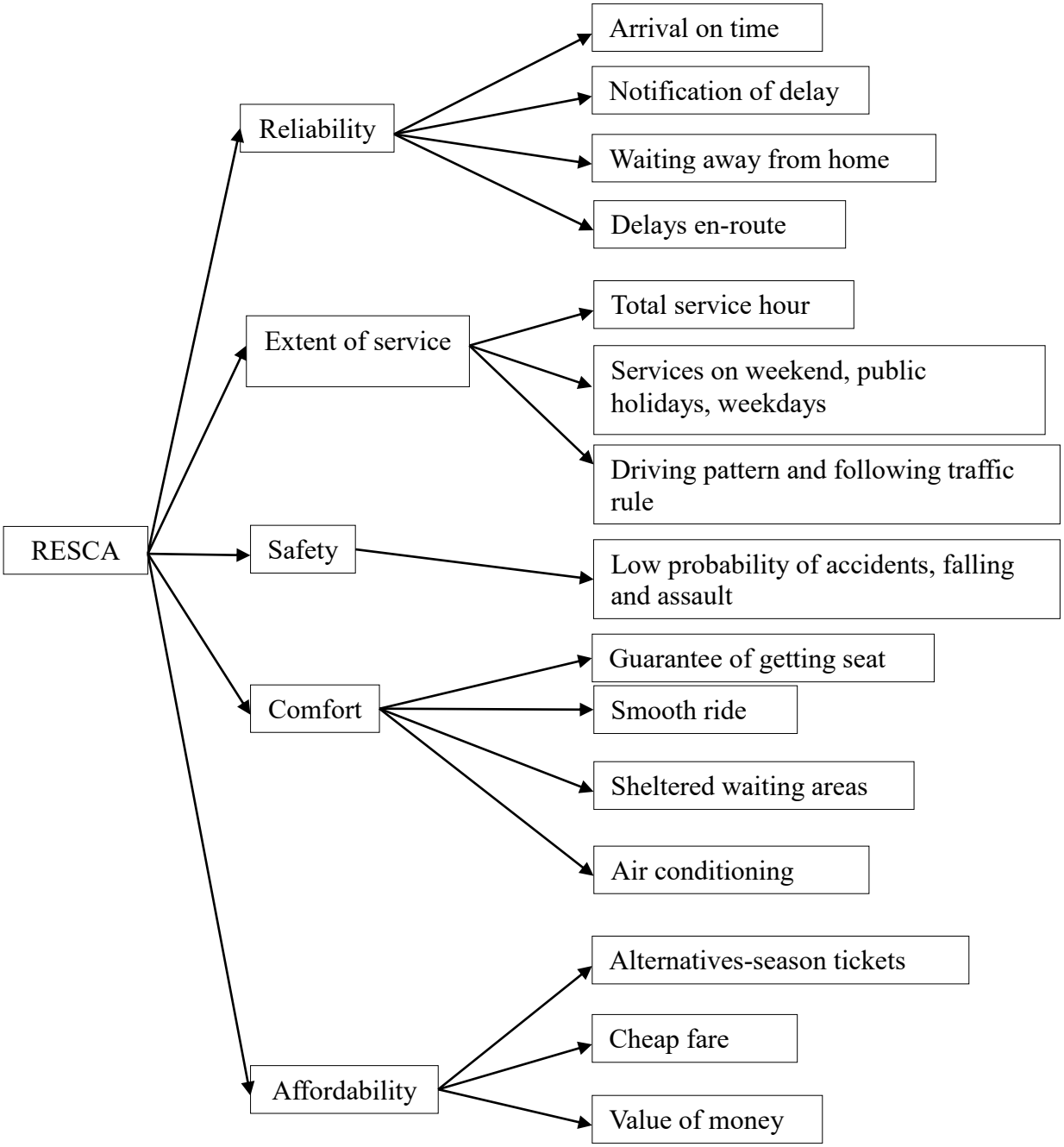
Before conducting the FGD, a semi-structured discussion outline was developed on the basis of existing literature. From the review of prior research, it was observed that the two most applied models in service quality research in transportation studies are: SERVQUAL model (Parasuraman et al., 1988) and RESCA model (McKnight et al., 1986) or their customized forms modified according to the context of the research. There are five dimensions in the SERVQUAL model (**Fig. 3.2**):



(Source: Parasuraman et al., 1988)

Fig. 3.2: SERVQUAL Model

On the other hand, the RESCA model also contains five dimensions (**Fig. 3.3**):



(Source: McKnight et al., 1986)

Fig. 3.3: RESCA Model

In this study, the characteristics of both models have been combined and modified according to the context of female travellers of Dhaka city.

By taking consent from the participants, the interviews of the FGDs have been recorded and transcribed. In some cases, if the participants felt uncomfortable talking about sensitive issues, they would ask to stop recording. In those cases, notes were taken. As the discussion outline contained some sensitive questions, none of the participant's name was recorded. The duration of each focus group discussion ranged from 45 minutes to 1 ½ hour. Then the recorded data was transcribed manually (through pen and paper) following the guidelines by Hossain (2013). The transcribed data was in Bengali as it is the mother tongue of the participants. The responses of the interviewees were analyzed in a thematic manner as per the interview guide as well. Eventually, the transcribed data was then translated into English for performing text mining and topic modelling. The guiding questions of the semi-structured interview are presented with **Appendix A**.

3.3.2 Text Mining and Topic Modelling

Text mining is conducted on transcribed interviews. Text mining, a functional method which is originated from a generic scientific branch named data mining or knowledge discovery in text (KDT), can be used for identifying valid, original, important, and comprehensible patterns in unstructured data (Das et al., 2016; Dang and Ahmed, 2014; Vidhya and Aghila, 2010), or semi-structured (Weiss et al., 2010) data sets such as emails, full-text documents and HTML documents (Sundari and Sundar, 2017). Text mining mainly helps to extract information and knowledge from unstructured textual databases (Vidhya and Aghila, 2010; Talib et al., 2016). Talib et al. (2016) explained both the theoretical aspect and application-oriented methodologies of text mining. In this process information in a document is extracted by using keyword extraction method and a particular keyword represents compact information (Das et al., 2016). This process is followed by some visualization output namely bar plot, word cloud, and word association plot from the corpus of the documents. Word cloud shows one dimension of information with a varying font size of the words that correspond to n-frequency (Das et al., 2016). In this study, word clouds are produced by using the open source R software packages "SnowballC" by Bouchet-Valat (2015) and "wordcloud" by Fellows (2014) for each of the dimensions of the newly developed service quality model obtained combining SERVQUAL and

RESCA model. Here, “tm” package by Feinerer and Hornik (2018) is used for text mining.

Topic modeling is then performed with Latent Dirichlet Allocation (LDA) method (Blei et al., 2003) to discover the unstructured topics in the document. The LDA algorithm is an autonomous probabilistic model of a corpus that applies bag-of-patterns representation to discover clusters of topics in unstructured corpus where topic is characterized by a distribution of words (Blei, 2012). Being a generative statistical unsupervised model LDA doesn’t require any prior annotations; instead topics are generated from the document-word statistical data itself. LDA represents documents as a random mixture of latent topics where each topic is regarded as a distribution over words of certain probabilities (Blei, 2012).

Numerous simplifying assumptions were made in this basic model of Blei et al. (2003). The LDA probabilistic model assumes that each document, of a corpus of N number of documents, is a probabilistic mixture of K topics. These probabilities are delimited in a document topic vector T_d of K length. The LDA output is a (N × K) matrix T containing $P(k_K \mid d_N)$, the probability of d document belonging to the topic k:

$$T = \begin{pmatrix} T_1 \\ \vdots \\ T_N \end{pmatrix} = \begin{pmatrix} P(k_1|d_1) & \cdots & P(k_K|d_1) \\ \vdots & \ddots & \vdots \\ P(k_1|d_N) & \cdots & P(k_K|d_N) \end{pmatrix}$$

Each topic kϵ K is ascertained by a probabilistic distribution over the vocabulary of size Q_d. A topic explains how aptly it is to observe a word conditional on that topic. For example, documents regarding physics might have a high probability for words such as “particle”, “quantum”, etc, while the most frequent words in documents regarding public-transportation service could be “passenger”, “bus”, “waiting-time”, “comfort”, etc. The word probability vectors of each topics are remained in a matrix z_k of dimension Q_d × K.

$$z_k = (z_1 \quad \ldots \quad z_K) = \begin{pmatrix} P(w_1|k_1) & \cdots & P(w_1|k_K) \\ \vdots & \ddots & \vdots \\ P(w_{Q_d}|k_1) & \cdots & P(w_{Q_d}|k_K) \end{pmatrix}$$

The probabilities $P(w_{Q_d}|k_K)$ in the z_k vectors explain how likely a word Q_d to be observed from the vocabulary conditional on topic k. In this way, the z_k vectors agree to evaluate the contents of each topic, since LDA does not provide any additional topic levels.

The LDA algorithm, discussed above, explains the process of how the topics of this study were explored through text mining as follows:

1) First, N (a corpus) is assumed to be a set of documents where d=1, 2, …N. Here in my study d is the transcribed data of each FGD and N is the set of all transcribed data i.e. 4 numbers of FGDs. The documents are produced with Q number of words by following the Poisson distribution. Each document contains Q_d words;

2) Then topic mixtures (T) of K topics are chosen from N corpus performing dirichlet distribution. For each document topic proportions, $T \sim Dir(\lambda)$ where λ is prior on the per-document topic distribution and word distribution of each topic is also determined by dirichlet distribution i.e., $z_k \sim Dir(\beta)$ for k= 1, … , K where β is prior to per-topic word distribution;

3) LDA generates each word w_{di} -
   i) by picking up topics performing multinomial distribution, i.e. topic t_{di} ~ multinomial (T); here t_{di} is the topic extracted from a document e.g. 'unreliable delay in case of waiting time' could be a topic extracted from one interview or document.
   ii) then by using the topic to generate the word (according to the topic's multinomial distribution), i.e. choosing a word $w_{di} \sim$ multinomial $(\beta_{t_{di}})$ from $P(w_{di}|t_{di}, \beta)$; e.g. 'waiting' could be a word from the topic (t_{di}) described in 3(i).

As Q_d is independent of all the other data generating variables (T and z_k), the randomness of Q_d is ignored in the subsequent development. A k-dimensional dirichlet random variable T can take values in the $(k-1)$- simplex, (k-vector T lies

in the (k-1)- simplex if $T_n \geq 0$, $\sum_{n=1}^{k} T_{n=1}$), and has the following probability density on this simplex is:

$$P(T|\lambda) = \frac{\Gamma(\sum_{n=1}^{k} \lambda_i)}{\prod_{n=1}^{k} \Gamma(\lambda_i)} T_1^{\lambda_1 - 1} \dots T_k^{\lambda_k - 1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.1)$$

Here, the parameter λ is a k-vector with components $\lambda_n > 0$, and where $\Gamma(x)$ is the gamma function. Given the parameters λ and β, the joint distribution of a latent class mixture T, a set of Q_d latent classes t_{di}, and a set of Q_d features w_{di} is given by:

$$P(T, t_{di}, w_{di}|\lambda, \beta) =$$
$$P(T|\lambda) \prod_{i=1}^{Q_d} P(t_{di}|T) P(w_{di}|t_{di}, \beta) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.2)$$

Here, $P(t_{di}|T)$ is simply the probability density of the topic t_{di} conditional on mixed topics assignment for each unique word i in document d of length n such that $\sum t_{di}^{n} = 1$. And, $P(w_{di}|t_{di}, \beta)$ is the probability to observe a specific word conditional on the topic assignment of the word and word probability of the given topic. After, integrating over T and summing over t_{di} results in (eq.3.3) the probability of word w_{di}:

$$P(w_{di}|\lambda, \beta)$$
$$= \int P(T|\lambda) \left(\prod_{i=1}^{Q_d} \sum_{t_{di}} P(t_{di}|T) P(w_{di}|t_{di}, \beta) \right) dT \dots\dots\dots\dots\dots\dots\dots\dots (3.3)$$

The results of topics probabilities along with the words conditional on that topic assignments obtained from text mining are explained in Chapter-4.

After taking the product of the marginal probabilities of single document, the probability of a corpus is obtained as:

$$P(N|\lambda, \beta) \prod_{d=1}^{N} \int P(T_d|\lambda) \left(\prod_{i=1}^{Q_{dd}} \sum_{t_{did}} P(t_{did}|T_d) P(w_{did}|t_{dd}, \beta) \right) dT_d \dots\dots\dots\dots\dots\dots (3.4)$$

Fig. 3.4 illustrates the graphical model of LDA where the hyper-parameters λ and β are corpus-level parameters, assumed to be sampled once in the process of generating a corpus. The variables T_d are document-level variables, sampled once per document.

Finally, the variables t_{did} and w_{did} are word-level variables and are sampled once for each word in each document.

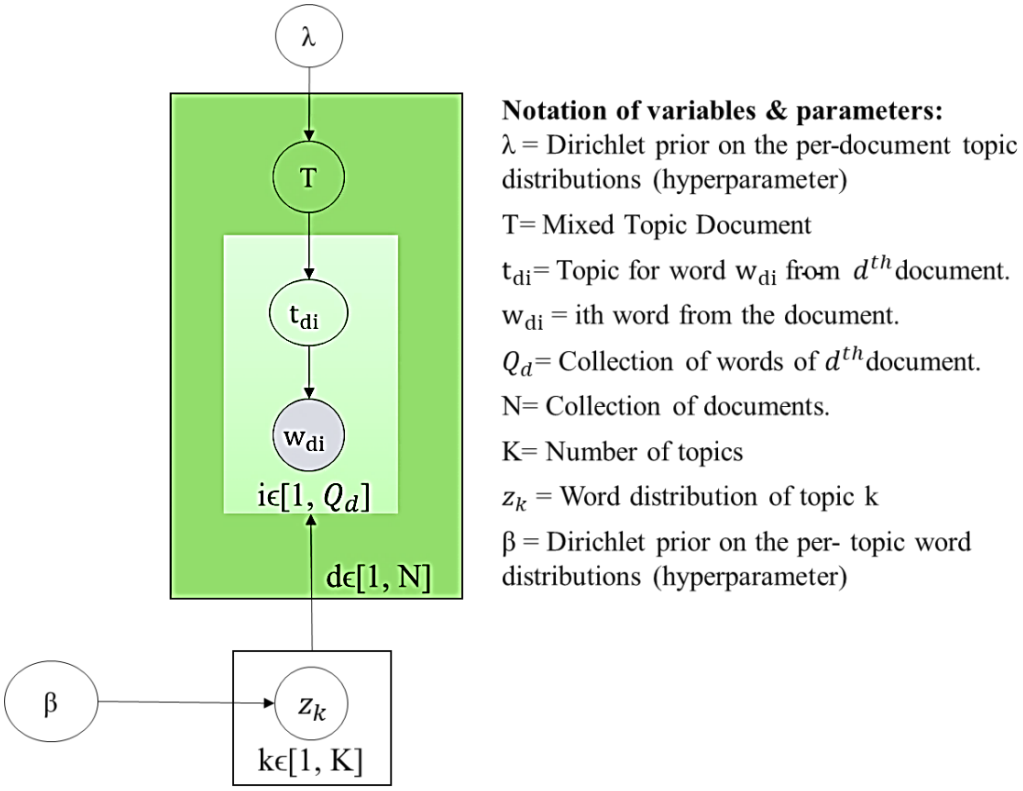


Fig. 3.4: Graphical Model Representation Of LDA

(Reproduced from the source: Blei et al., 2003)

LDA inference can be performed by variational expectation-maximization (VEM) algorithm or by Gibbs sampling (Grun and Hornik, 2011). In this study, the later one would be applied for inferring document distribution T and topic-word distribution z_k. Here λ and β actually are acting as hyperparameters of LDA because the statistical inference from LDA algorithm is extensively influenced by the choice of hyperparameters to fit with real model.

In this study, the open source software "R" is used for developing the topic models from the transcribed data obtained from focus group discussions. The "topicmodels" package by Grun and Hornik (2011) is used for LDA and "Mallet" package by Mimno (2015) to obtain the probability of topics in documents and

probability of words in topics. Separate models are constructed for each dimension of the newly proposed service quality model where each topic contains ten words.

Combining the outputs of text mining and topic modelling, sentences from the transcribed documents for each dimension has been extracted and reviewed for drawing qualitative inferences of the service quality dimensions

3.4 Quantitative Study

Quantitative study is an organized way of collecting data and analyzing it to draw conclusions. Unlike qualitative research, this research method uses a computational, statistical and similar method to collect and analyze data. Quantitative data is all about numbers. This research often involves a larger sample size to assist in obtaining accurate results. Quantitative research adopts the close-ended questions method (Neuman, 2014) as the researchers naturally look at measuring the extent and gathering reliable statistical data.

3.4.1 Trip Data

After identifying and confirming variables defining the service quality of public buses from the women's perspective through qualitative study in the context of Dhaka city, a set of attributes has been chosen for quantitative research. Subsequently, a questionnaire has been developed accommodating all these attributes to assess service quality by rating each bus trip. Finally, the overall service quality rating is used as the outcome variable and the attributes are employed as information variables to develop a service quality estimation or evaluation model. The questionnaire is presented in **Appendix B**. The questionnaire consists of nine main parts. Part A covers demographic information containing questions about the respondent's age, occupation, purpose of travel and frequency of using the public bus services. Part B is about reliability that includes questions regarding the presence of bus-representatives at the stoppage, the information provided by the representative, waiting time for bus and stoppage duration. Part C contains the questions about service such as availability of bus, travel status and driving practice or pattern, etc. Part D highlights the questions about safety and security related issues of female

passengers such as boarding alighting facilities, female passenger harassment by driver, conductor/ helper as well as by male passengers, events of mugging, stealing or pick-pocketing, etc. Part E is about passengers' affordability regarding fare, whether excess fare is collected from the female passengers, etc. Part F reflects the comfort related issues such as facilities at bus stoppage and inside the bus. Part G asks the responsiveness and empathy-related questions, for instance, attitude of the bus driver, conductor/helper and other male passengers, towards female passengers as well as the compassion of male passengers towards female passenger when harassment takes place. Part H requests the participants to rate their overall trip as either satisfactory or dissatisfactory. It is to be mentioned that before going for the survey a pilot survey was conducted with five respondents taking a sample questionnaire where the response variables was set in five scale: Dissatisfied, Less satisfied, Neutral, Satisfied and Very satisfied. But the respondents got confused with the three scales of response variable: Less satisfied vs Neutral or Neutral vs Satisfied and they felt difficulty to make coherence to the response variable with their perception. So that, the questionnaire was modified and only two scales- 'Dissatisfied' and 'Satisfied' were kept in response variable for the convenience of data collection and further analysis. Finally, Part I, the last segment, welcomes any suggestion from respondents on how to improve the public bus services in Dhaka for its female commuters.

3.4.2 Exploratory Mathematical Analysis

3.4.2.1 Classification And Regression Tree (CART)

Classification and Regression Tree (CART) is a method of generating decision trees (Breiman et.al., 1984) that can work with heterogeneous data both numerical and categorical. Decision trees are important data mining techniques used for classifying new data and predicting the class of a variable. A decision tree is a hierarchical learning model of nonlinear function f with input space x and target space y, $y = f(x)$, that explores complex input-output relations without any prior assumptions on the data (Crowley, 2017). In case of class classification, the target variable y is categorical ($y \in \{C1, C2, ...\}$), whereas for regression target variable is numerical ($y \in R$). CART

is inherently nonparametric (according to Thomas Plapinger (2017) - "A Non-parametric method means that there are no underlying assumptions about the distribution of the errors or the data. It basically means that the model is constructed based on the observed data.") that divides the data space into two subsets recursively using different attributes as splitters and develops a decision tree which contains internal decision nodes and finally reaches to terminal nodes ended with a stopping variable that has been satisfied. Each internal decision node accomplishes a test $q(x_t)$ that splits the data x_t at node t to its child nodes. Each leaf node is assigned a class label of y representing the local partition of train data (x).

The root node contains the whole training data (x) and the data then splits into n parts (n children) by applying a test question at the root node. The splitting of data aims to achieve more homogeneous clusters. Each child node is checked if it is reached to a terminal or leaf node and the partitioning process is iteratively continued until good enough partitions are obtained. The real life data possess a large number of examples with a large set of attributes. In that case, some evaluation measure called impurity measures, of the goodness of a split are used to determine the best way to split the data. Entropy (**Eq. 3.5**) or Gini diversity index (Breiman et al., 1984) (**Eq. 3.8**) can be used as an impurity measure in different decision tree algorithms.

Eq.3.5 is used to measure the impurity of a node t by using entropy for k class classification problem:

$$\text{Entropy, (t)} = -\sum_{i=1}^{k} p(i|t)\log_2 p(i|t) \quad \text{.....(3.5)}$$

and total impurity after splitting Entropy′ is:

$$\text{Entropy}', (t) = -\sum_{j=1}^{n} \frac{N_t^i}{N_t} \sum_{i=1}^{k} p(i|t) \log_2 p(i|t) \quad \text{.....(3.6)}$$

where the probability of class C_i at node t can be calculated with $P(C_i|x,t) \equiv p_t^i = \frac{N_t^i}{N_t}$. Here, N_t is the number of training cases that fall to parent node t and N_t^i is the number of instances at child node (t^i) which belongs to class C_i. The information gain (Δ), based on the concept entropy, is a way to determine the goodness of a split.

Information gain (Δ) is the anticipated amount of decrease in impurity gained by dividing set S into n number of subsets by considering attribute A. Here, impurity at parent node is basically the entropy of C_i class before splitting and the impurity at node t^i is the entropy after splitting.

$$\text{Information gain, } \Delta = \text{Impurity at Parent node} - \{\sum_{j=1}^{n} \frac{N_t^i}{N_t} \left(\text{Impurity at node } t^i\right)\} \quad \ldots(3.7)$$

Generally, the attribute which gives the highest information gain is considered at the node to split the data that leads to the minimum impurity measure after splitting. The best split depends on the degree of impurity of child nodes i.e. smaller the degree of impurity as the degree of impurity of a parent node is the same for all test conditions. Literatures suggest that entropy and information gain are used in ID3, C4.5 and C5.0 decision tree algorithms (Wikipedia, 2020 and Patil et al., 2012)

For classification task, Gini diversity index or Gini index is another impurity measure of how often a randomly chosen element from the set would be incorrectly labeled if it was randomly labeled according to the distribution of labels in the subset. It reaches its minimum (zero) when all cases in the node fall into a single target category. In case of CART algorithm at node t, the impurity function based on the Gini index criterion assigns a training example to a class C_i with the probability $p(C_i|t)$. The estimated probability that the item is actually in class j is $P(C_j|t)$. Therefore, the Gini Index at node t is explained by the following eq.3.8:

$$\text{Gini Index, } i(t) = \sum_{i=1}^{k} \sum_{j=1, j\neq i}^{k} P(C_i|t)p(C_j|t) = 1 - \sum_{j=1}^{K} (P(C_j|t))^2 \quad \ldots\ldots\ldots\ldots(3.8)$$

Misclassification error at node t can be calculated by considering the maximum value among impurity measures (Entropy value or Gini Index) obtained from the **Eq. 3.5** and **Eq. 3.8**. The **Eq. 3.9** explains how misclassification error is calculated.

$$\text{Misclassification error, } (t) = 1 - \max_i [p(i|t)] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.9)$$

By comparing the degree of impurity of the parent node (before splitting) with the degree of impurity of child node (after splitting), we can examine how a test

condition executes. The larger difference between those two values of degree of impurity indicates better test condition.

Letting a decision tree to grow fully may end up overfitting, where the training error keeps decreasing while validation error no longer improves or get worse (Crowley, 2017). To avoid overfitting, pre-pruning or post-pruning method is applied to prune the tree in appropriate size by obtaining a sequence of nested sub-trees. Pre-pruning stops growth of tree early when the split can't be improved much. Pre-pruning can be implemented according to some pre-defined heuristics (e.g. impurity lower than some threshold, or reaching pre-defined maximum depth, etc.). And by pre-pruning, it may not be possible to get the full structure of the tree. Post-pruning allows the tree to grow fully first, and after that it removes some sub-trees which do not improve the information gain substantially. Post-pruning can be performed by using a validation set or applying some significance test (e.g. C4.5). Usually, post-pruning leads to better results than the pre-pruning. However, post-pruning is computationally more expensive than pre-pruning (Crowley, 2017).

There are various pruning algorithms to prune the tree. Here, in this methodology, the binary tree can be adopted using the Gini index (**Eq. 3.8**) as the splitting criteria and a cost-complexity algorithm for pruning the tree, because Gini index tries to favor a split into one small pure node and a large impure node (Breiman et al., 1984). Moreover, Gini index, unlike entropy, is not computationally intensive as it doesn't involve logarithm function used to calculate entropy in information gain. In our study CART is adapted to determine the status of impact of various, factors or variables, considered in this study, on satisfaction level of the service receivers from public bus services in Dhaka city. Here, trip survey data with 20 independent variables (see Chapter 4) and one output or dependent variable, 'Trip rate' with two class- 'Satisfied' & 'Dissatisfied', is used in CART analysis and Gini Index values, calculated in CART algorithm, select split variables in nodes and help to make the decision tree. For example, in this study 'Waiting time' is a variable among twenty independent variables. This variable has eight sub-criterias- '0 mins', '1-5 mins', '5-10 mins', '10-15 mins', '15-20 mins', '20-25 mins', '25-30 mins', and 'more than 30 mins'. Gini index calculation for this variable-

Independent Variable	Dependent Variable		Total cases	Gini index = $1 - \{\text{P(Satisfied)}^2 + \text{P(Dissatisfied)}^2\}$
Waiting Time	Trip Rate			
	No. of Satisfied	No. of Dissatisfied		
0 mins	39	21	60	$1 - \left\{\left(\frac{39}{60}\right)^2 + \left(\frac{21}{60}\right)^2\right\} = 0.5157$
1-5 mins	61	75	136	$1 - \left\{\left(\frac{61}{136}\right)^2 + \left(\frac{75}{136}\right)^2\right\} = 0.4947$
5-10 mins	56	93	149	$1 - \left\{\left(\frac{56}{149}\right)^2 + \left(\frac{93}{149}\right)^2\right\} = 0.4691$
10-15 mins	20	87	107	$1 - \left\{\left(\frac{20}{107}\right)^2 + \left(\frac{87}{107}\right)^2\right\} = 0.3039$
15-20 mins	13	55	68	$1 - \left\{\left(\frac{13}{68}\right)^2 + \left(\frac{55}{68}\right)^2\right\} = 0.3092$
20-25 mins	6	31	37	$1 - \left\{\left(\frac{6}{37}\right)^2 + \left(\frac{31}{37}\right)^2\right\} = 0.2717$
25-30 mins	4	23	27	$1 - \left\{\left(\frac{4}{27}\right)^2 + \left(\frac{23}{27}\right)^2\right\} = 0.2524$
more than 30 mins	6	51	57	$1 - \left\{\left(\frac{6}{57}\right)^2 + \left(\frac{51}{57}\right)^2\right\} = 0.1883$
			$\sum$= 641	

We then weight and make sum each of the splits based on the baseline or proportion of the data. Hence, gini index for the variable 'Waiting time' is-

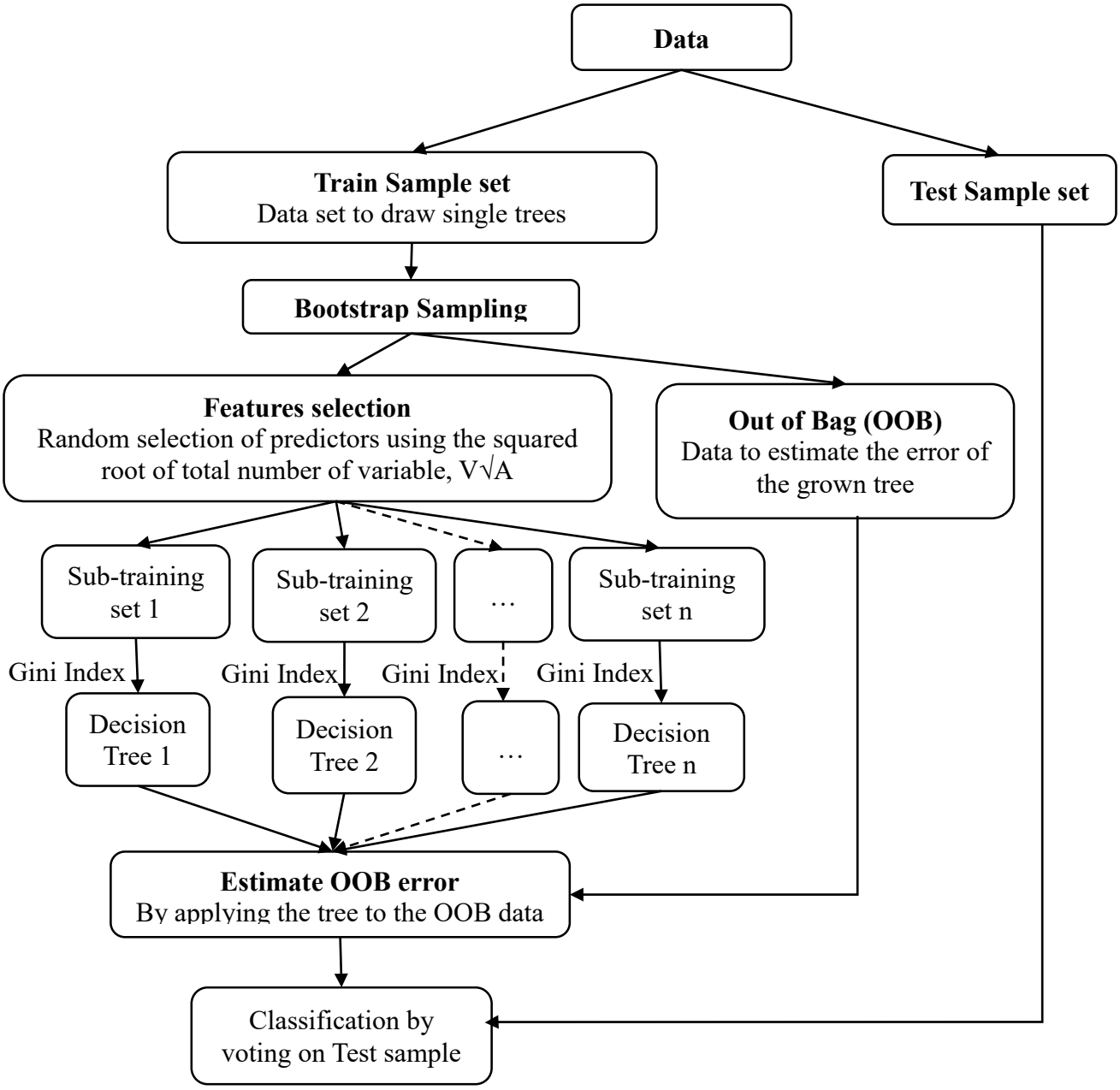
$$\text{Gini Index}_{(Waiting\ time)} = \left(\frac{60}{641} * 0.5175 + \frac{136}{641} * 0.4947 + \frac{149}{641} * 0.4691 + \frac{107}{641} * 0.3039 + \frac{68}{641} * 0.3092 + \frac{37}{641} * 0.2717 + \frac{27}{641} * 0.2524 + \frac{57}{641} * 0.1883\right) = 0.3890$$

Similarly, gini index values of other variables are calculated (**Appendix-D**) and the variable 'Boarding-alighting status' possesses the lowest Gini value among all other variables. As lowest value of gini index decides the split variable at a node, hence here in this case 'Boarding-alighting status' is the split ariable at root-node of the decision tree (see Fig-4.30 in Chapter 4). Similarly, split variables for other nodes are decided through calculating gini index values.

The probable outcomes obtained from CART analysis will be the values of the standardized importance of independent variables which will reflect the impact on predictor variables of the model and will help to find out the probable ground of overall satisfaction or dissatisfaction level of service quality of public transport from women's perspective. At the same time, the model is expected to be able to reveal the cluster of various attributes in relation to their association with the level of service quality of public buses in Dhaka city assessed by the female passengers. In this study, 'rpart' (Therneau et al., 2018) package of R program will be adopted to construct the CART.

3.4.2.2 Random Forest (RF)

RF is a method in an ensemble of supervised learning algorithm that performs classification and regression based on the aggregation of large number of decision trees (CART). RF makes assessment and rankings of variables showing numeric values, called Variable Importance Measures (VIMs), with respect to their ability to predict the response. It has validated the high competency of handling multi-co-linearity issue of large feature spaces through generating two groups of datasets (train and test) from original data using two popular ensemble methods- boosting (Schapire et al., 1998) and bagging (Breiman,1996) combined with the idea of random selection of attributes. In a word it is called Bootstrap (**Fig. 3.5**).



(Modified from the source: Boulesteix et al., 2012)

Fig. 3.5: Random Forest Algorithm

In RF, the decision trees are constructed from a training data set and internally validated to yield a prediction of the response given the predictors for future observations i.e. test set. Each tree is constructed with a different bootstrap sample of randomly selected V attributes from total A attributes from the original data. Some heuristics to choose the number of variables are using the square root of the total number of variables ($V = \sqrt{A}$) or taking $\log_2$ ($V = \log_2 (A)$) (Hastie et al., 2008). The

variable, possessing the highest information gain among the all attributes, is selected as the root node where the data is splitted into n-child nodes. When the training set for the current tree is drawn by sampling with replacement, about one-third of the cases are left out of the sample. This out-of-bag (OOB) data is used to get a running unbiased estimate of the classification error as trees are added to the forest. Here the individual tree is formed using a random selection of attributes at each node to regulate the split. More specifically, each tree is governed by the values of a random vector sampled independently and with the same distribution for all trees in the forest. In the case of classification, the most popular class is returned after counting the votes from each tree.

To elucidate the concept of RF, let *S* be a complete dataset with *P* predictors and *N* observations and *T* the total number of trees in the RF. Suppose, S_b be the b^{th} bootstrap sample generated by randomly selected n samples with replacement from S. According to RF principle, about one-third of the data left out of the bootstrap sample i.e. S-S_b is the OOB data which is not used for the construction of b^{th} tree. Next, for the b^{th} tree T_b, instead of growing a CART tree with *P* predictors, p predictors are selected randomly from P predictor space ($P > p$) at every node and the best splitter among *p*, capable of producing two maximum pure nodes, is used to split the node at each level. Then the new data is run down through each and every tree and the class of new data is the class of the leaf of each tree where it ended up. The final class of the data is calculated by aggregating the predictions of the *T* trees by majority voting. At each and every iteration the OOB datasets are used to calculate the misclassification rate r_b of the tree T_b by running down the S-S_b dataset into T_b. The r_b of all the T trees are aggregated to calculate the OOB error rate. The values of the j^{th} predictor of P predictors in S-S_b are permuted and the new dataset is used to calculate the misclassification rate r_b^j. Here, $|r_b - r_b^j|$ is the variable importance V_j of the j^{th} variable in the b^{th} tree. The process is repeated for *T* trees and the final variable importance is calculated by averaging V_j of each variable (j = 1 to P). RF makes assessment and ranking of variables showing numeric values, called Variable Importance Measures (VIMs), with respect to their ability to predict the response. Its superiority over various statistical methods is due to its high competency in handling

the multicollinearity issue of large feature spaces. In this study, four variable importance measuring methods of RF, namely, Mean Decrease Accuracy (MDA), Mean Decease Gini (MDG), Mean Minimum Depth (MMD) and Times a Root (TAR), are employed to identify the most important attributes deciding between a public bus trip being satisfactory or unsatisfactory to female passengers. Mean decrease in accuracy is usually described as "the decrease in model accuracy from permuting the values in each feature". The MDA of a variable is determined during the OOB error calculation phase by calculating to what extent the accuracy of the random forest decreases due to the permutation of a single variable. Therefore, variables with large MDAs are more important for the classification of the data. The MDG coefficient indicates a measure of how each variable contributes to the homogeneity of the nodes and leaves in the resulting random forest. Each time a particular variable is used to split a node, the Gini Index values for the child nodes are computed and compared to that of the original node. The changes in Gini values are summed for each variable and normalized at the end of the calculation. Variables in nodes with higher purity have a higher decrease in the Gini coefficient. Another VIM is MMD i.e. mean of the minimum depth of variable which is used as root node splitter. MMD for a variable in a tree is the depth of node that splits on that variable and is the closest to the root of the tree. A lower value of MMD indicates high impact value of the variable that helps to split the node which is closest to the root node. Times a root (TAR) is calculated by noting down the number of times the root node was split using a particular variable. Again, a higher value of TAR represents higher importance of the variable.

The ‘randomForest’ (Breiman and Cutler, 2018) package of the R programme was employed to implement RF and ‘randomForestExplainer’ (Paluszynska and Biecek, 2017) package is used to get the numeric values to variable importance measures and their rankings.

CHAPTER 4: ANALYSIS AND RESULTS

4.1 Introduction

This chapter presents the major findings from both the qualitative and quantitative data analysis conducted in this study. The qualitative study conducted through focus group discussion involving young female commuters of Dhaka city and identified the factors reflecting their perception, preference and expectation from public bus service. This guided in developing a service quality assessment framework customized for young female public bus users in Dhaka city. Based on that, a questionnaire was prepared for conducting individual trip survey where the respondents evaluated various aspects of a trip they had just completed by bus and rated the overall journey as 'satisfactory' or 'unsatisfactory'. This trip evaluation data was collected for quantitative analysis where Random Forest (RF) was applied to measure the importance of various factors along with their ranking. Then, using the most important factors, a Classification and Regression Tree (CART) was developed to understand the dominances and interactions among factors that make the overall experience of public bus trip satisfactory or unsatisfactory to its female commuters. Finally, various recommendations provided by the respondents to improve the existing service quality were compiled for policy recommendations.

4.2 Findings From Qualitative Study

4.2.1 New Service Quality Dimensions

At the beginning of this empirical study, a pilot study was conducted with five university going female students on the basis of both SERVQUAL (Parasuraman et al., 1988) and RESCA (McKnight et al., 1986) models. During these interviews, the interviewees highlighted some new and special issues that were included in the model as new dimensions. Therefore, in this study, the characteristics of both of these models were combined and modified according to the context of female travellers in Dhaka city. In total, seven dimensions were taken into consideration. These are: (1) Reliability, (2) Comfort, (3) Service, (4) Responsiveness & Empathy, (5) Safety &

Security, (6) Affordability and (7) Vehicle Access. The dimensions along with their corresponding attributes are listed in **Table 4.1**.

Table 4.1: Service Quality Dimensions and Attributes

Dimension	Attribute
Reliability	Availability or arrival information
	Notifications of delays
	Delays/d-tour/incomplete route
	Few delays while on the vehicle
Comfort	Guaranteed seat
	Smooth ride
	Air conditioning and good ventilation
	Sheltered waiting areas with seating arrangement
	Noise
	Cleanliness
Service	Service on weekdays
	Service on weekends and public holidays
	Driving pattern
	Following traffic rule
Responsiveness and Empathy	Caring & Individualized attention
	Courtesy of employee
	Willingness of employee to help
	Appearance of personnel
	Procedure for follow-up on complaints
Safety & Security	Safe boarding and alighting
	Injury due to sudden braking and accelerating
	Probability of mugging/stealing/pick pocketing
	probability of assault
Affordability	Fare amount
	Fare distribution
	Fare collection
Vehicle access	Easy passage through aisle
	Height of steps
	Number of steps
	Facility to carry stuff

4.2.2 Focus Group Discussion (FGD)

After developing service quality attributes from SERVQUAL and RESCA model, four semi-structured and in-depth Focus Group Discussions (FGD) were conducted to gain deep discernments in terms of the experience of using transportation by the female road users of Dhaka city. Among the four focused groups, two for

female students from different universities of Dhaka city and two for service women from different organizations were undertaken where around 50 participants, who are regular public bus users, took part. They were asked about the service quality of public buses in Dhaka city. A moderator (author of the thesis) attempted to comprehend and penetrate the perceptions of the participants by discussing the existing facilities, problems faced by female travellers and the suggestions related to possible solutions to those issues raised in the focused group discussions. The major complains and complements regarding existing service quality of public buses along with their underlying reasons, magnitudes, impacts and consequences were extracted. Some of the pictures were captured during focus group discussions are presented with **Fig. 4.1**.

(a) Service-holder Group

(b) Student Group

Fig. 4.1: Selected Photography Taken During Focus Group Discussion

4.2.3 Text Mining & Topic Modelling Results

Text mining was conducted on the transcribed document of focus group discussion to extract information by applying keyword extraction method (Das et al. 2016) where a particular keyword represents compact information. This process was followed by the visualization of output in the word cloud plot from the corpus of the

documents. Word cloud shows one dimension of information with varying font size of the words that corresponds to n-frequency (Das et al., 2016). After that, topic modeling was performed for each of the seven dimension of service quality separately following the Latent Dirichlet Allocation (LDA) algorithm (Blei et al., 2003) to discover the concealed topics. The outcome of the text mining in the form of word cloud construction and topic models for each of the attributes of service quality are described below:

4.2.3.1 Perception Regarding Service Quality

The findings are presented through outcomes of text mining from the focused group discussions on the basis of the seven service quality dimensions and their corresponding attributes as outlined in **Table 4.1**. A specific strategy has been followed in explaining the outcomes of word cloud and topic modeling. The sentences having the most frequently occurring words were extracted and evaluated to understand the underlying message that they carried. In the same way, sentences having the words mentioned in each topic were extracted from the transcription to understand the context of the message.

Reliability

The focus group discussion suggests that the interviewees narrated their overall experience related to reliability of public buses as quite unreliable and unsatisfactory. The word cloud reveals a similar story as. The most predominantly occurring words during the focus group discussion include: ‘waiting time’, ‘traffic jam’, ‘route’, ‘information’, ‘service’, ‘representative’, ‘delay’ and ‘frequent’ as illustrated by **Fig. 4.2**. Digging through the transcribed sentences having these words reveal that the waiting time at stops is often unpredictable and the interviewees mainly attribute it to the traffic jam of Dhaka city where maintaining time for a bus service becomes extremely difficult. Some of the respondents reported that at times their waiting time may exceed even 30 minutes. However, in most of the occasions, there are no representatives from the operators available to talk at the bus stops. Even if they are present, often they can’t provide any information regarding bus arrival. The female passengers attributed the service that the bus operators are providing as poor.

Another reason for long waiting time is the alteration of regular route mainly due to traffic jam along the designated route. In such cases the drivers improvise by changing the routes instantly which in most cases results in missing many of the predefined destinations. Such situations particularly affect the female passengers more as they face difficulties into getting a new bus as the conductors show extreme reluctance to let female passengers in if 'female only' seats are occupied. The interviewees suggested the occurrence of such situations to be frequent. For topic modeling, two most widely discussed topics were identified as presented with **Table 4.2**. The probabilities of topics along with the words' probabilities (in the parenthesis) were determined through the equations 3.2 and 3.3 described in Chapter 3. Here, the probability values of words belong to a topic describe the rationale of those words on selecting that topic. The first topic deals with the issue of long waiting time, unpredictable delay, absence of operator's representatives or their inability to respond reliably about the arrival time of buses when they are present, etc. as reverberated through the word clouds as well. Topic 1 also attributes the delay due to the traffic jam of Dhaka city. The topic also discusses about the issue of lack of female seats and identifies the local buses to have the highest reliability issues. However, the topic-2 focuses on the information services such as route information, tarfficjam alert, arrival information, change in regular route, etc.

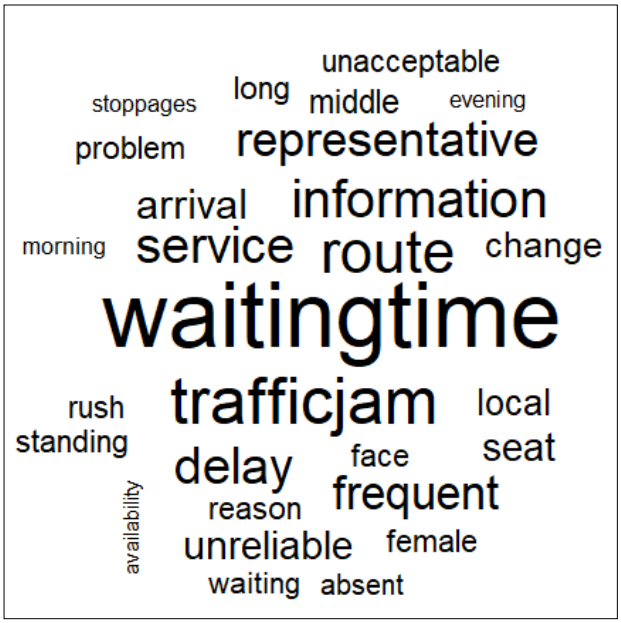


Fig. 4.2: Word Cloud On Reliability Issues

Table 4.2: Topic Models On Reliability Attribute

Probable Topics	Words distribution with probabilities	Topic Probability
Topic-1	Waiting time (0.1867), delay (0.0924), representative (0.0906), unreliable (0.0659), seat (0.0641), trafficjam (0.0577), local (0.0522), local(0.0522)	0.531
Topic-2	Route (0.1274), information (0.1108), service (0.1077), frequent (0.0932), arrival (0.0787), trafficjam (0.0777), change(0.0580), long (0.0528)	0.468

Comfort

In focus group discussion, the interviewees enunciated the perceived issues regarding ride comfort in public buses where their most concern was to get a seat. The word cloud also exposes the same story. The most frequently accentuated words in the focus group discussion include: ‘seats’, ‘behavior’, ‘female only’, ‘horn’, ‘shelter’, ‘male’, ‘driver’, ‘helper’, ‘standing’ and ‘dirtiness’ as showed by **Fig. 4.3**. Digging through the transcribed sentences having these words reveal that getting a seat during peak hour is very difficult for female passenger as the buses remain over-crowded and the ‘female only’ seats are already occupied. Hence quite often female passengers have to travel standing in crowded bus during rush hour which causes much discomfort to them (**Fig. 4.4**). Some of the respondents reported that male passengers

seldom honor their seats for standing female passengers. Even at times a male passenger, who is occupying the ‘female only’ seat, may starts to argue if he is requested to leave that seat. In such situations, female passengers do not get sufficient support from driver, helpers or co-passengers. Some of the interviewees attributed the seating arrangement of public buses as uncomfortable. They opined that the spaces between the rows are so narrow that someone cannot sit comfortably. It causes pain to their legs (**Fig. 4.5**). Even the adjacent seats are so congested that female passenger feels quite uncomfortable while they have to sit beside a male. Moreover, the ‘female only’ seats are placed at the front part of the bus beside the engine (**Fig. 4.6**) and that cause much discomfort due to heat emitted from engine. Also, interviewees expressed enormous annoyance about the interior environment of buses because most of the public buses are extremely dirty. The passengers feel that the bus drivers and conductors do not care about the cleanliness of the interior of the bus. However, sometimes passengers are responsible to make it dirty (**Fig. 4.7**). Bus stoppages also remain dirty and there is fewer shelter facility with insufficient seating arrangement (**Fig. 4.8**).

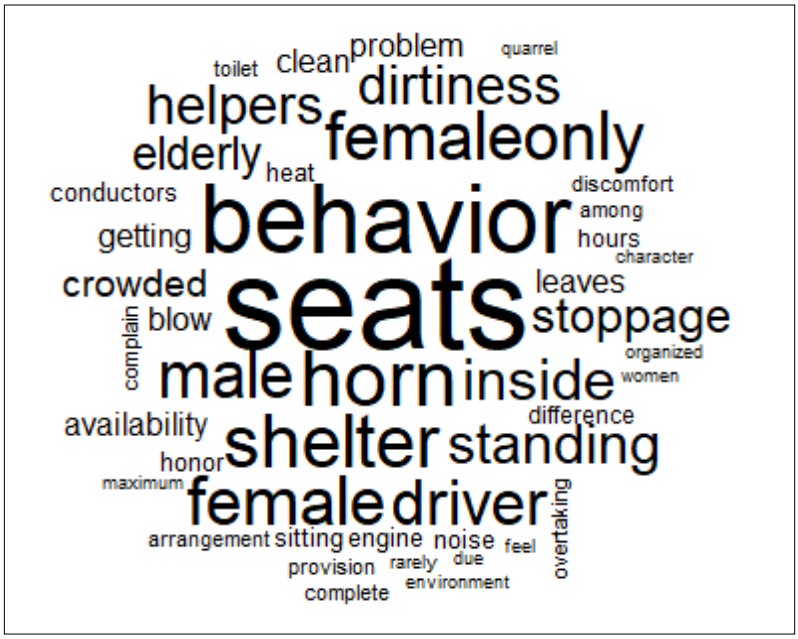


Fig. 4.3: Word Cloud On Comfort Issues

Fig. 4.4: Female Passengers Travelling Standing Inside The Bus

Fig. 4.5: Narrow Space Between Two Rows

Fig. 4.6: Location Of 'Female-only' Seats Inside The Bus

Fig. 4.7: Inside Environment Of Public Bus In Dhaka City

Fig. 4.8: Bus Stoppage Scenarios At Dhaka City

For topic modeling, two most widely discussed topics were extracted as presented in **Table 4.3**. Here Topic-1 and Topic-2 reveal the factors related to ride comfort quality of public buses in Dhaka city. The first topic deals with the issue of

seat availability, travel standing in crowded bus, male passengers' attitude towards female counterparts, dirtiness inside the bus, etc. as resonated through the word clouds as well. On other hand, second topic deals with the issue of shelter at stoppage and environment, female-only seats, bus staffs behaviors, driving approaches, etc. Both of the topics mainly highlight the issues of seat quality, availability of 'female only' seats in crowded bus, attitudes of male passengers and bus staffs towards female passengers specially while standing inside a crowded bus. Also, ride comfort deals with the driving pattern, shelter provision and environment at the bus stoppages.

Table 4.3: Topic Models On Comfort Attribute

Probable Topics	Words distribution with probabilities	Topic Probability
Topic-1	Seats (0.3932), standing (0.0991), male (0.08), crowded (0.0587), dirtiness (0.0543), femaleonly (0.0514), heat (0. 0404), behavior (0.0367)	0.524
Topic-2	Driver (0.1855), femaleonly (0.1605), stoppage (0.0936), seats (0.0702), helpers (0.0686), horn (0.0587), shelter (0 .0476), noise(0.0339)	0.476

Service

The interviewees attributed the service provided by the bus operators as unsatisfactory. Their services in weekdays do not meet the passenger demand. Moreover, many of the bus operators practice reckless over speedy driving patterns, most of the time they involve in race by overtaking each other on busy lane, frequently apply hard breaks that make female passengers more vulnerable to injuries. Over-speedy driving causes crushes causing harm to passengers and other vehicles as well. However, all of the aforementioned issues were discussed in the FGDs and the most repeatedly accentuated words included: 'peak', 'seat', 'getting on', 'getting off', 'hard braking', 'driving pattern', 'female passengers', 'running', 'speed', 'frequently', as are shown in **Fig. 4.9**, and subsequent topic models, represented in **Table 4.4** were developed by performing text-mining on transcribed sentences. The first topic deals with the issues related to service during peak hour such as driving pattern, seat availability, etc. On the other hand, the second topic highlights the issues related to

boarding-alighting and behavior of conductors/helpers towards female passengers specially while they get on and off from a bus.

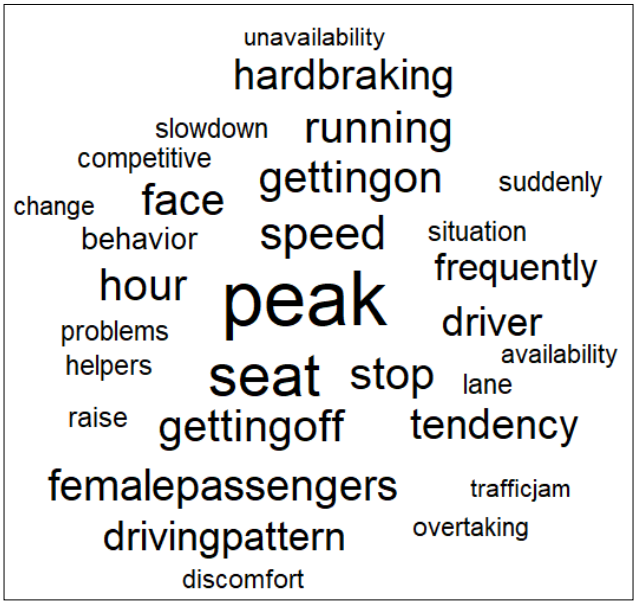


Fig. 4.9: Word Cloud On Service Issues

Table 4.4: Topic Models On Service Attribute

Probable Topics	Topic words distribution with probabilities	Topic Probability
Topic-1	Peak (0.1289), seat (0.0972), hardbraking (0.0635), tendency(0.0628), drivingpattern (0.0615), frequently (0.0555), speed (0.0549), raise(0.0547)	0.633
Topic-2	gettingon(0.1196), gettingoff(0.1185), running(0.1173), femalepassengers(0.1139), driver(0.0912), behavior(0.0416), helpers(0.0399), slowdown(0.0297)	0.366

Responsiveness and Empathy

During focus group discussion, the interviewees opined that in most of the cases female passengers get ill-treatment from bus drivers and helpers. Mostly, staffs of the public buses do not have any formal education and even they are not trained enough about how to behave with female passengers. Digging through the transcribed document the following word cloud (**Fig. 4.10**) and topic models (**Table 4.5**) are found that reveal the issues mentioned above. The word cloud shows the most frequently emphasized words such as ‘seat’, ‘female’, ‘reserved’, ‘male passengers’, ‘helper’, ‘standing’, ‘attitude’, etc. Topic-1 attempts to sketch the seating facility for

standing female passengers and attitudes of helpers towards them during the time of pick, ride and drop. On the other hand, Topic-2 deals with the issues that a pregnant female face during traveling by public bus.

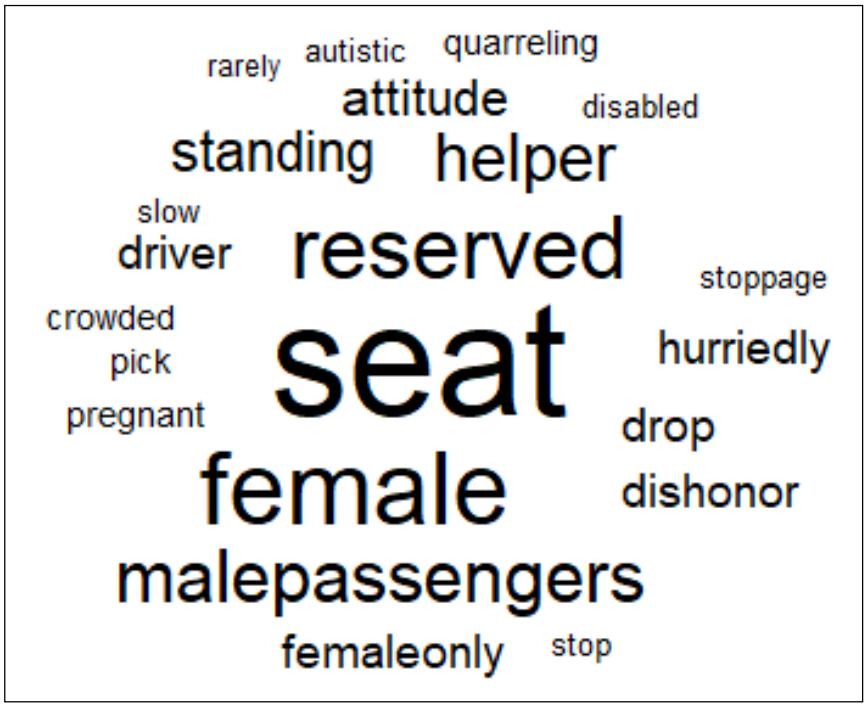


Fig. 4.10: Word Cloud On Responsiveness and Empathy Issues

Table 4.5: Topic Models On Responsiveness and Empathy Attribute

Probable Topics	Topic words distribution with probability values	Topic Probability
Topic-1	female(0.2431), seat(0.2161), helper(0.1343), standing(0.1097), femaleonly(0.0827), attitude(0.0564), pick(0.0405), slow(0.039), comfort(0.0096)	0.503
Topic-2	seat(0.1925), malepassengers(0.1611), dishonor(0.0806), driver(0.079), drop(0.0781), hurriedly(0.0717), crowded(0.0419), pregnant(0.0403), attitude(0.0371)	0.497

Safety and Security

Interviewee's assertion explains that physical harassment pre-eminently occurs with female in public buses where both helpers and male passengers are the perpetrators. In such incidents, if the victim tries to protest against harassment, the bus staffs or even the co-passengers often oppose her, i.e. impeach the victim. On most of the cases, the victim does not protest at all thinking that if she protests then

everyone will know about the incident of her harassment and that would be a matter of shame for her. The text-mining results also reveal a similar story. The following word cloud (**Fig. 4.11**) represents the safety issues discussed during FGDs which includes words such as 'harass', 'male passenger', 'female passenger', 'stoppage', 'unsafe', 'sexual', 'helpers', 'environment' , 'getting down', 'attitude', etc. in the larger font. Simultaneously, from the topic models (**Table 4.6**), Topic-1 and Tpoic-2 show the factors of unsafe environment at the bus stoppages as well as inside the bus specially during getting on and off from bus. Here, physical or sexual harassment by other male passengers and bus helpers got highlighted as the key factor in Topic-2. Concurrently, Topic-1 shows that event of hijacking and mugging make bus stoppage environment unsafe especially at night and when the bus is much crowded.

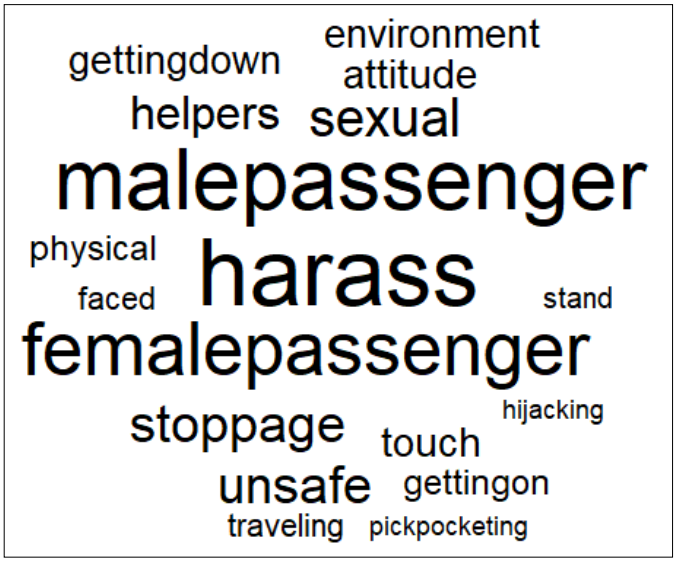


Fig. 4.11: Word Cloud On Safety and Security Issues

Table 4.6: Topic Models On Safety and Security Attribute

Probable Topics	Topic words distribution with probability values	Topic Probability
Topic-1	stoppage(0.1908), unsafe(0.1883), environment(0.1206), gettingon(0.1081), femalepassenger(0.0704), hijacking(0.0704), night(0.0228), mugging(0.0153), crowded(0.0128)	0.339
Topic-2	malepassenger(0.1572), harass(0.1549), femalepassenger(0.0994), sexual(0.0891), helpers(0.0728), touch(0.0625), attitude(0.0602), gettingdown(0.0532), physical(0.0498)	0.663

Affordability

Though the interviewees did not complain much about being afford able to the bus fares, their perception describes that unreasonable fare is collected in respect of service. The word cloud also reveals a similar story of fare collection. The word cloud deals with the most frequently occurring words during the focus group discussion that includes: ‘fare’, ‘bus’, ‘proper’, ‘follow’, ‘argue’, ‘conductor’, ‘local’, ‘seating’, ‘unreasonable’ as represented in **Fig. 4.12**. Finding out from the transcribed sentences, in the FGDs, containing these words reveal that often there are no ticketing services in public buses in Dhaka city, and passengers have to pay fare on board. The interviewees’ observation explains that the bus conductors or helpers do not follow the fare chart or law properly. On most of the cases, they try to collect excess fare from female passenger if she is unaccompanied as well as unaware about the actual fare amount. In that case, if anyone protests against collecting excess fare then the conductor makes argument with the passengers. For topic modeling, mostly extensively discussed two topics were represented in **Table 4.7**. The first topic deals with the fare collection issues that involve the unreasonable fare distribution of local buses. Simultaneously, Topic-2 discusses about the excess fare collection in seating service buses than that of local buses. Both topics reveal the attitudes of bus conductors during fare collection whether the fare is reasonable or not.

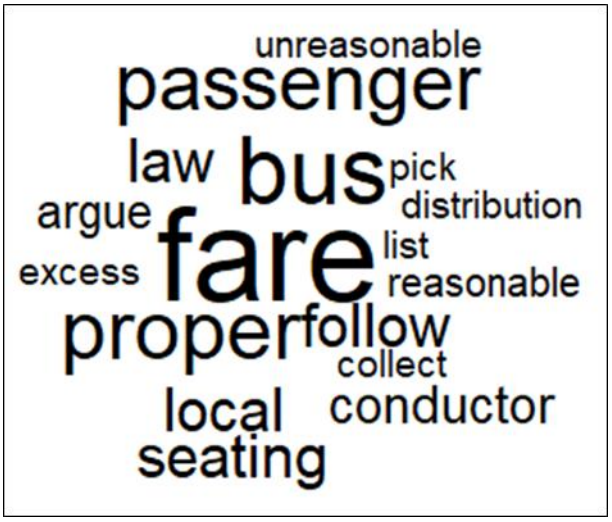


Fig. 4.12: Word Cloud On Affordability Issues

Table 4.7: Topic Models On Affordability Attribute

Probable Topics	**Topic words distribution with term probabilities**	**Topic Probability**
Topic-1	fare(0.2079), passenger(0.1762), follow(0.1268), conductor(0.1011), collect(0.0655), distribution(0.0635), unreasnable(0.0615), local(0.0457)	0.448
Topic-2	bus(0.1788), service(0.1546), seating(0.1031), fare(0.0902), law(0.0806), argue(0.0693), local(0.0661), excess(0.0532)	0.552

Vehicle Access

The text mining outputs from the transcribed sentences on 'Vehicle Access' from focus group discussion as presented in the world cloud (**Fig. 4.13**) includes: 'aisle', 'narrow', 'door', 'female', 'embarrassing', 'space' and 'stoppage'. Seeking back for the transcribed sentences holding these words, disclose that the aisle space is so narrow that even two passengers cannot move without avoiding the touch. Maximum time the public buses remain overcrowded and the aisle space is occupied by the passengers. In such situation, female face difficulty to get into the bus and get embarrassed to move inside the crowded bus (**Fig. 4.14).** For topic modeling, above issues got highlighted by two topics as presented in **Table 4.8.** Topic-1 mainly highlights the issues that create embarrassing situation for female specially during moving inside the bus as physical touch with other passengers cannot be avoided due

to the narrow aisle space. On the other hand, Topic-2 deals with the issues of boarding and alighting as drivers do not stop the bus properly and helpers standing at the door try to hold the female passengers showing the excuse of helping them out. Both topics disclose the barrier for female passengers to access to the public buses.

Fig. 4.13: Word Cloud On Vehicle Access Issues

Fig. 4.14: Difficulties To Boarding Into Bus

Table 4.8: Topic Models On Vehicle Access Attribute

Probable Topics	Topic words distribution with probability values	Topic Probability
Topic-1	space(0.12642), narrow(0.09445), aisle(0.06409), embarrassing(0.06409), helper(0.06409), stoppage(0.06409), touch(0.06409), female(0.05609), unavoidable(0.03212)	0.603
Topic-2	driver(0.09693), move(0.09693), passenger(0.09693), stop(0.08726), cross(0.04859), door(0.04859), gettingdown(0.04859), slowed(04859), standing(0.04859)	0.397

Overall Output From Focus Group Discussion

Combining these outputs from word clouds and topic models, sentences from the transcribed documents were extracted and reviewed for drawing qualitative inference. A single word cloud construction (**Fig. 4.15**) from the whole focus group discussions (combining the four FGD) draws a picture of service quality of public buses in Dhaka city that includes: ‘seat’, ‘female’, ‘driver’, ‘male passengers’, ‘female only’, ‘leave’, ‘stoppage’, ‘helper’, ‘female passenger’, ‘peak’, ‘problem’, ‘face’,

‘reserved’, ‘representative’, ‘waiting time’, etc. Digging through the transcribed documents possessing those words expose that female passenger faces problems in getting a seat during peak hour as all reserved seats for female only are occupied and male passengers seldom leave seats for female. Respondents reported that during peak hour they have to wait for long time for the bus, sometimes waiting time exceeds even 30 minutes. They also highlighted about absence of representatives of bus operators and bus arrival info at the stoppage. Some of the respondents spoke out about the attitudes of driver, helper or male passengers toward female passengers. Simultaneously three most probable topics have been extracted from the transcribed document of focus group discussion represented in **Table 4.9**. Three of the topics deal with the issues of seat availability during peak hour, attitudes of bus representative, driver, helper and male passengers towards female, and physical harassment by bus helper during getting on and down.

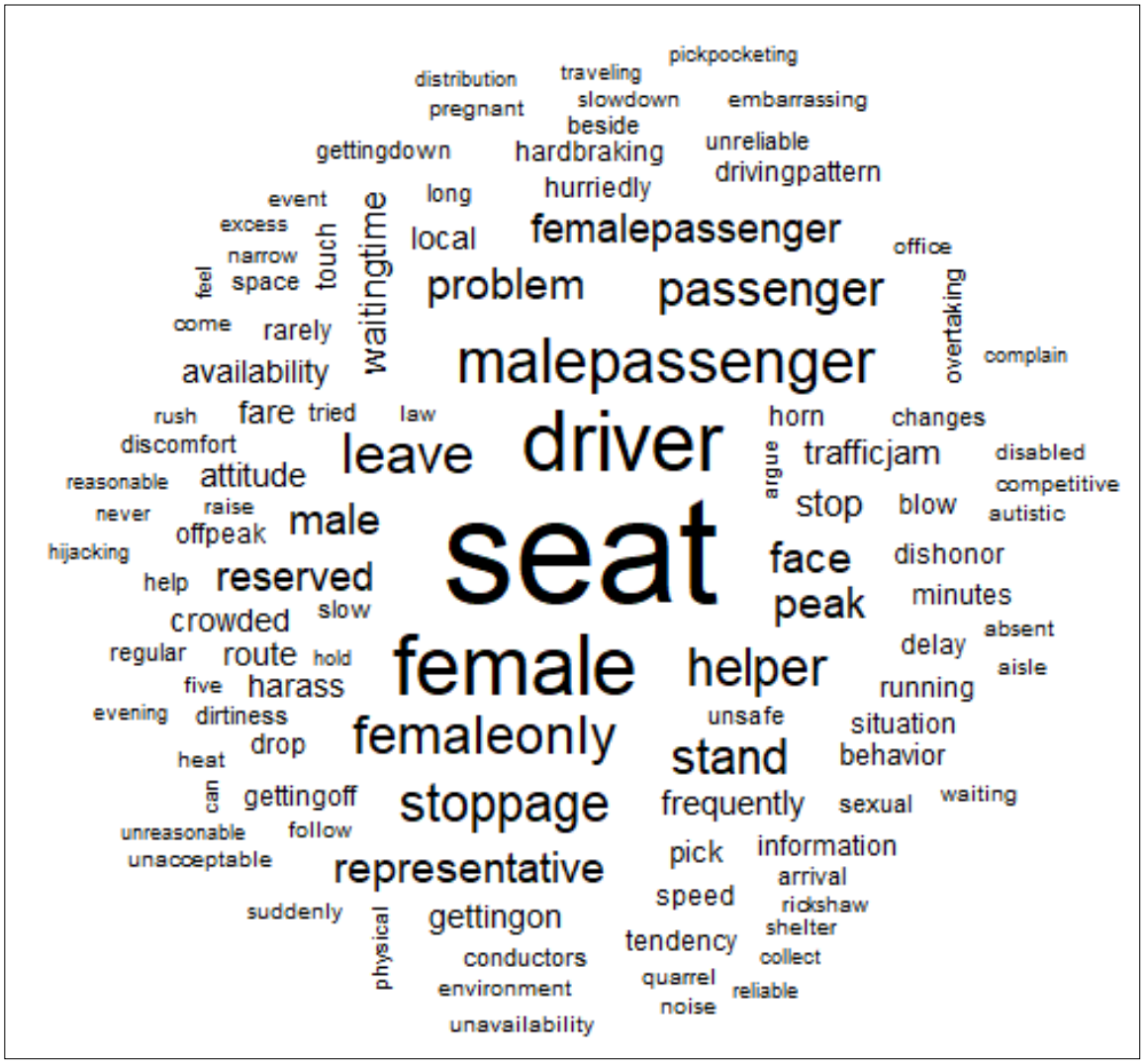


Fig. 4.15: Word Cloud Representation On Service Quality Of Public Bus

Table 4.9: Overall Topic Modelling

Probable Topics	Topic words distribution with probability values	Topic Probability
Topic-1	seat(0.285), driver(0.1508), malepassenger(0.1258), information(0.0256), pick(0.0248), helper(0.0192), unreliable(0.019), dirtiness(0.0169), shelter(0.0155), speed(0.0153)	0.376
Topic-2	femaleonly(0.1686), peak(0.1173), femalepasseneger(0.0857), helper(0.0665), representative(0.0508), stoppages(0.0428), hurriedly(0.0396), dishonor(0.034), gettingdown(0.0233), unacceptable(0.0197)	0.300
Topic-3	stand(0.169), helper(0.0907), driver(0.0838), gettingon(0.0671), harass(0.0607), behavior(0.0585), waitingtime(0.0363), unsafe(0.034), long(0.0327), physical(0.0281)	0.271

4.3 Findings from Quantitative Study

4.3.1 Trip Data

Sample size is the very important component of any research study. Initially we have mentioned that, Dhaka city is our study area and the survey population are the female residents who use public buses for their daily economic and social activities. According to RSTP 2015, in Dhaka city around 30 million trips occur on an average working day where 9.1 million trips are generated by female. So, it is very cleared that our population size is very large. Hence, we need to determine a representative sample for our large population. Here, we have considered Cochran's (1977) formula to calculate the required sample size for our trip rate survey. Assuming the maximum degree of variability (50%) for this large population and taking 99% confidence level (as the only female are taken as the respondents) with ±5% margin of error, the calculation of required sample size is as follows-

Sample size, $n_0 = \frac{z^2 pq}{e^2}$

$= \frac{2.58^2 * 0.5 * 0.5}{(\pm 0.05)^2}$

$= 665.64 \cong 666.$

here,

p = degree of variability = 50%= 0.5;

q = 1-p = 0.5;

e = margin of error = ± 5% = ±0.05;

z = critical value of 99% confidence level = 2.58

From the above calculation we come to know about the required sample size and we rounded it upto 670 nos. of sample. Hence a total of 670 trips were evaluated by young female public bus users between October, 2017 and March, 2018 through the questionnaire developed considering the newly proposed seven aspects of service quality of public buses. In this case survey samples were picked through both random selection and snowball (Hossain, 2017) sampling methods. Among 670 nos. of trip data 20 samples were found incomplete while analyzing and we consider them as non-responsive samples. Finally, after deducting the 29 nos. of non-responsive samples we got total 641 nos. of trip data that were completed by female commuters.

The demographic statistics of the participants is presented with **Fig.4.16**. Among the participants, 322 were undergraduate or graduate students and the remaining 319 were service holders. They age range of the participants were between 20-40 years and 51% of them were between 20 to 30 years old. Around 64% of the respondents use public buses 5 or more days a week. Only 10 percent of the participants reported to use bus only once a week. Of the 641 trips, 44% were for education, 32% were work trips and 7% were shopping trips. The remaining 17% trips were classified as other personal trips.

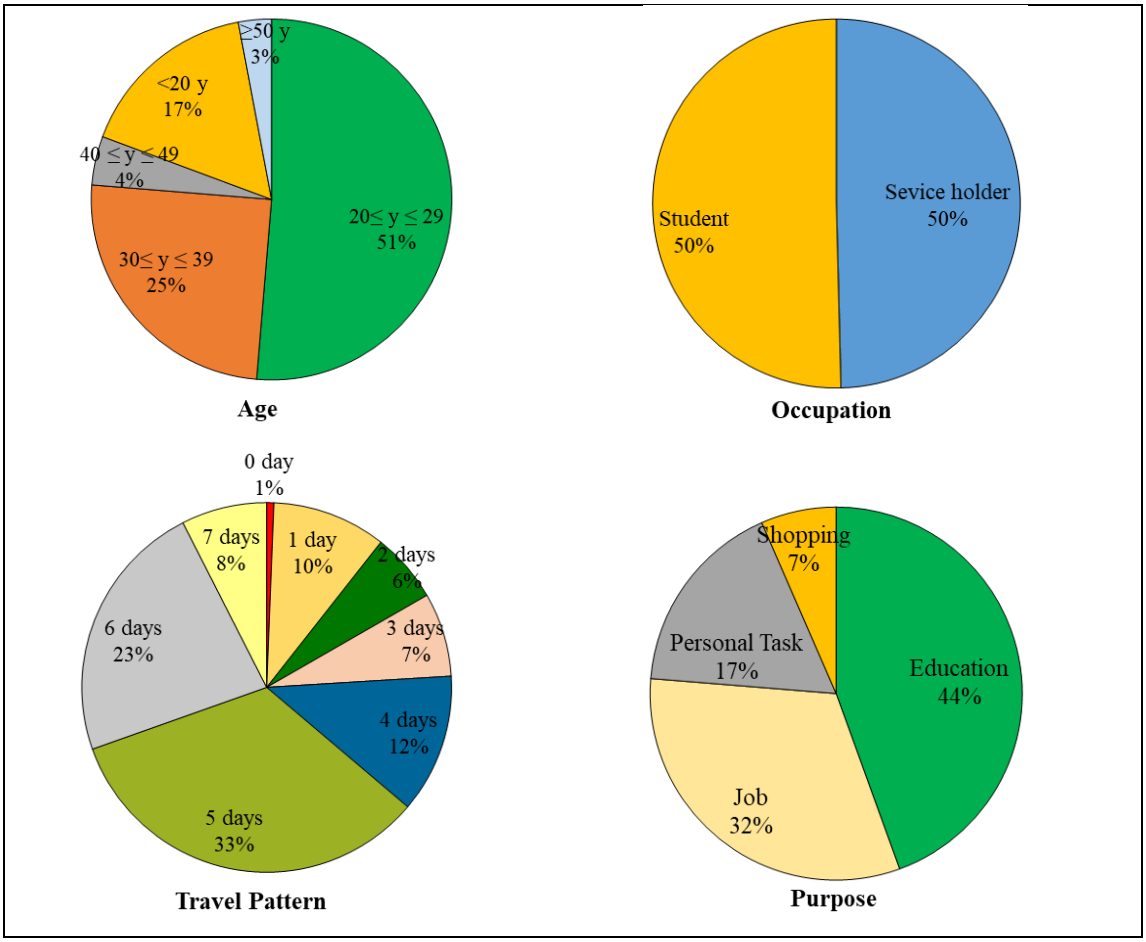


Fig. 4.16: Demographic Statistics

4.3.2 Descriptive Analysis

Analysis of the trip data revealed that around 67% of the respondents rated their overall trip experience to be unsatisfactory and only 33% of them were satisfied with the trip that they made with public bus as illustrated by **Fig. 4.17**.

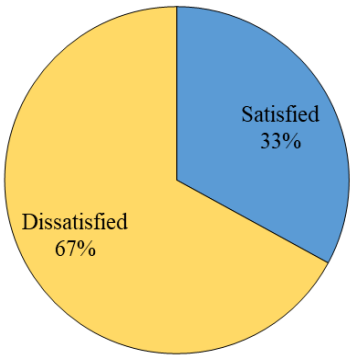


Fig. 4.17: Overall Trip Rating

Regarding reliability (**Fig. 4.18**), for 66% of the surveyed trips the respondents did not see any representative from the bus company at stops. Even when they were found, on 85% occasions they could not provide any information regarding bus arrival time. The participants had to wait longer than 10 minutes in 55% occasions. Even during the trip, in 30% cases the buses made stops longer than 5 minutes in intermediate stations.

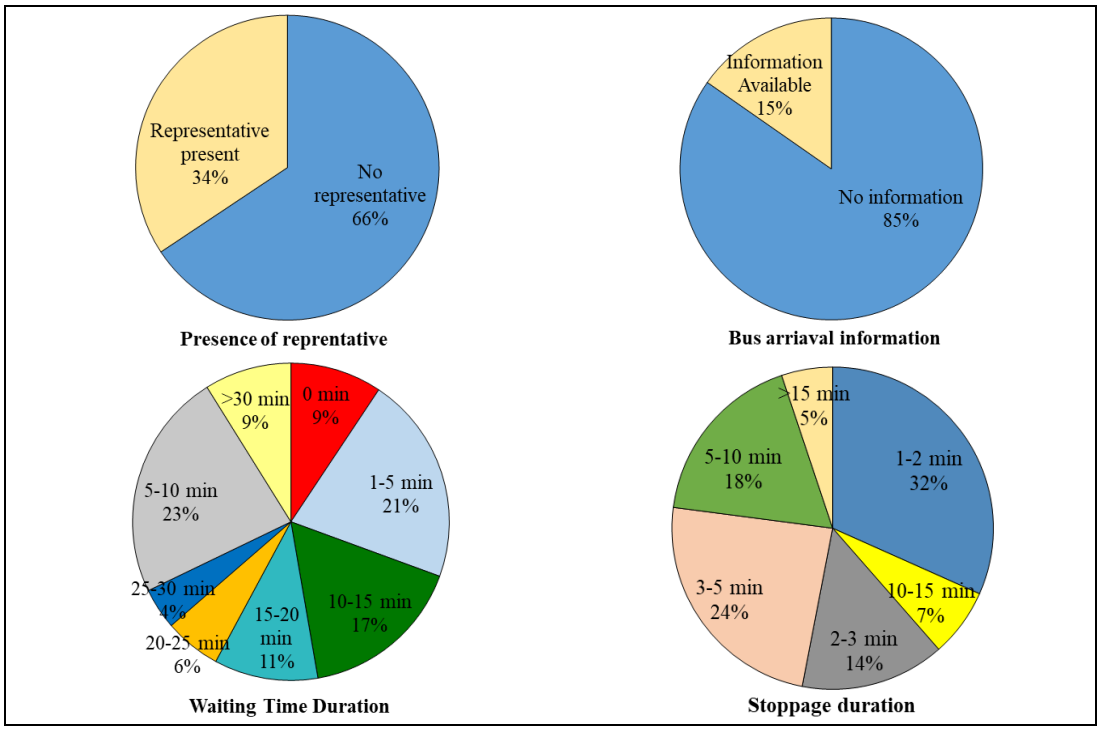


Fig. 4.18: Statistics Regarding Reliability Issue

From the point of view of service (**Fig. 4.19)**, the participants felt that they found an appropriate bus to ride in 42% of their trips. However, on 45% cases they

saw that the drivers or conductors denied female passengers from boarding as the 'female only' seats on the bus were full though there were empty general seats or standing capacity still available. About 18% of the respondents could remain seated in a 'female only' seat and 26% of the participants could manage a 'general' seat throughout their trip. However, the remaining 56% had to either remain standing or could manage seat for a portion of the trip.

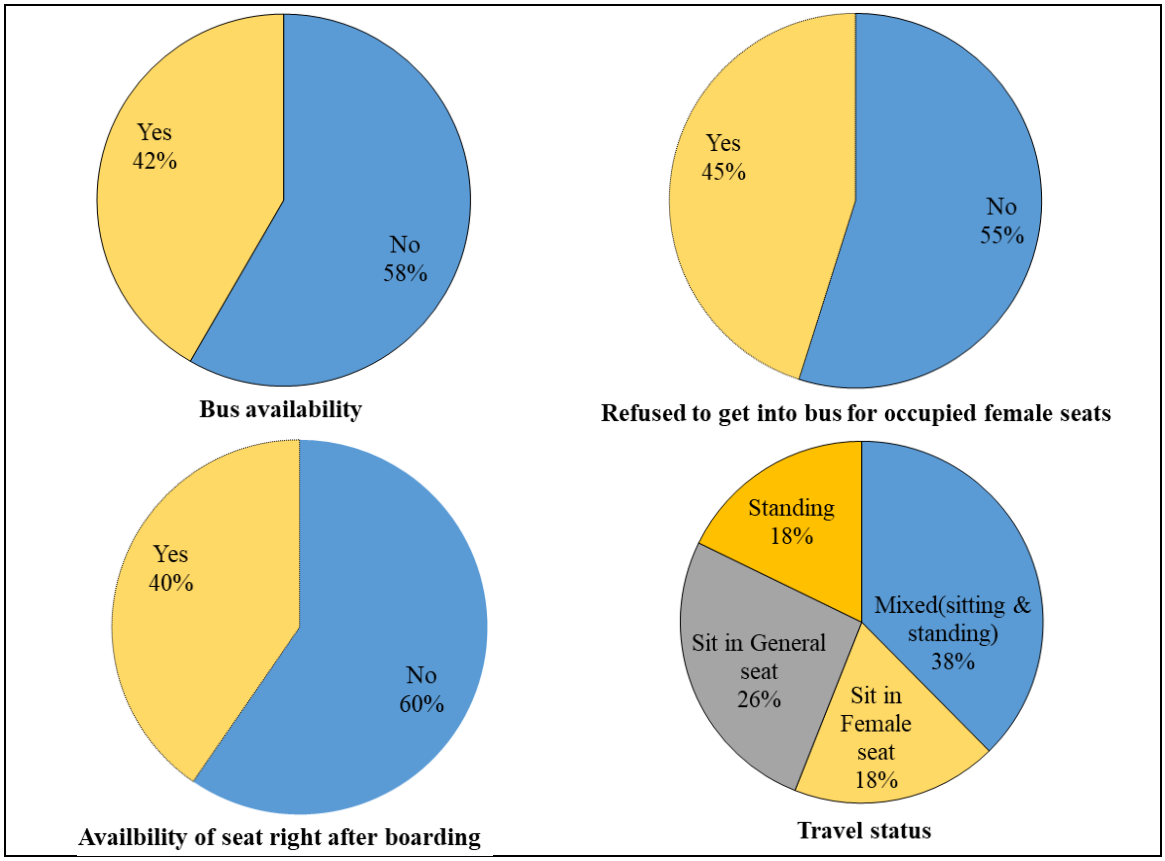


Fig. 4.19: Statistics Regarding Available Service Issue

The participants were highly displeased with the driving behavior and almost 99% of them had some issues with driving (**Fig. 4.20)**. They mentioned that on around 55% trips the drivers were over speeding (O.S.) or performing risky maneuvers to overtake (O.T.). About 26% of the participating passengers reported that the drivers had tendency to accelerate suddenly or apply hard break (H.B.). Also, on 42% occasions the bus drivers broke some kinds of traffic rules. However, it will be unfair to blame the drivers only for this situation as on 26% of such incidents, the

respondents reported that the male passengers also insisted the drivers to break rules so that they can reach their destinations faster.

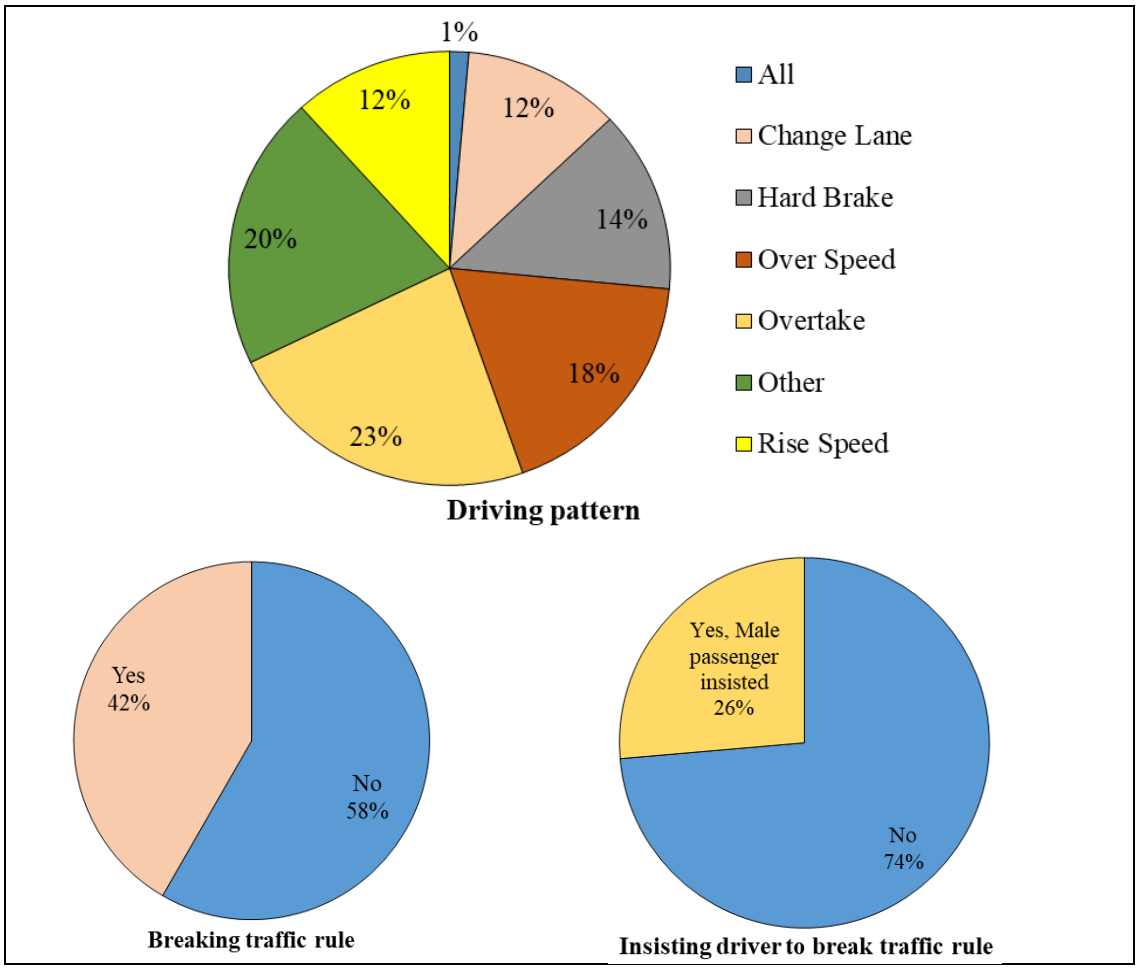


Fig. 4.20: Statistics Regarding Driving Pattern

The picture of the status of young female bus users in Dhaka city that got depicted through data from personal safety and security point of view was grim (**Fig. 4.21**). Women found it hard to board or alight buses as in only 26% cases the drivers stopped the bus properly. But in rest of the time, the drivers were either not stopping the bus properly (44%) or picking up passengers in running condition (30%) which made boarding specially risky and difficult for the female passengers. The conductors also exhibited similar attitude as in the survey, 68% time the female participants complained that the conductors were picking up passengers hurriedly.

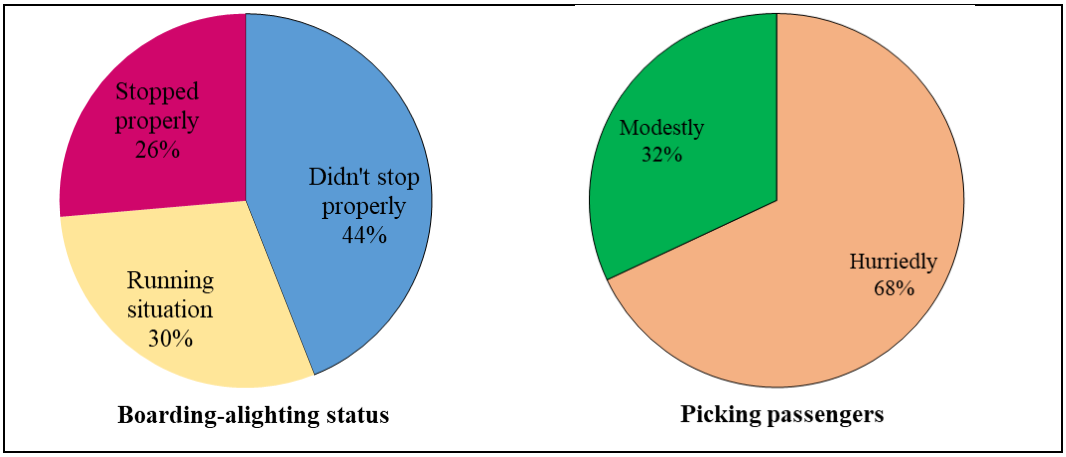
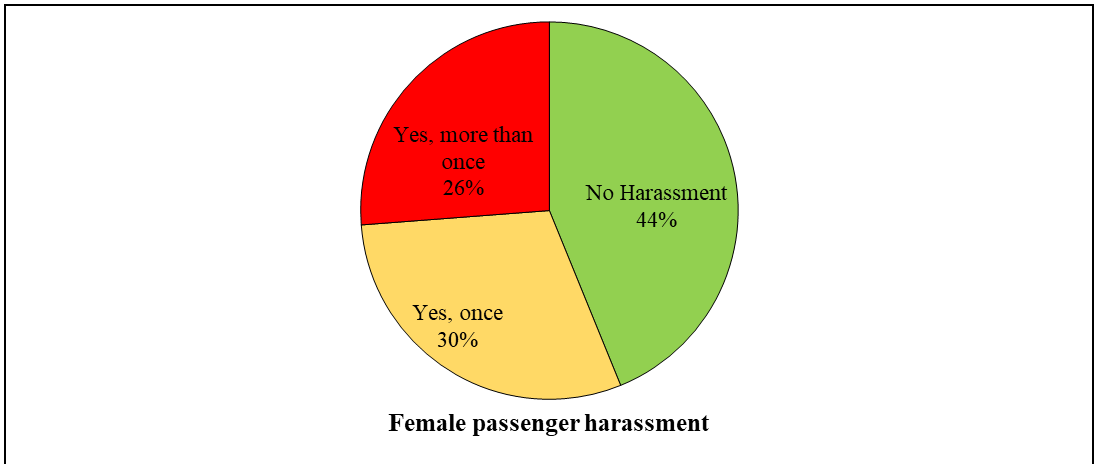


Fig. 4.21: Statistics Regarding Safe Boarding- Alighting

As presented by the responses in the survey, harassment in buses towards young female passengers by drivers, conductors as well as passengers was widespread (**Fig. 4.22**). Around 56% times during their trip the respondents saw women being subjected to harassments of which 26% times they observed it taking place more than once during their journey. In 29% occasions the drivers or conductors verbally abused female passengers and in 10% cases they physically touched female passengers. Male passengers are often equal partners in crime as the participants saw them physically harassing female passengers in 19% trips and in 21% occasions, they verbally abused female passengers. In 5% of the 641 surveyed trips, the respondents saw mugging, stealing or pick-pocketing taking place where female passengers were victims. In such situations, female passengers get little support from the drivers, conductors or fellow passengers. Often the blame is on them for not being careful and vigilant enough.



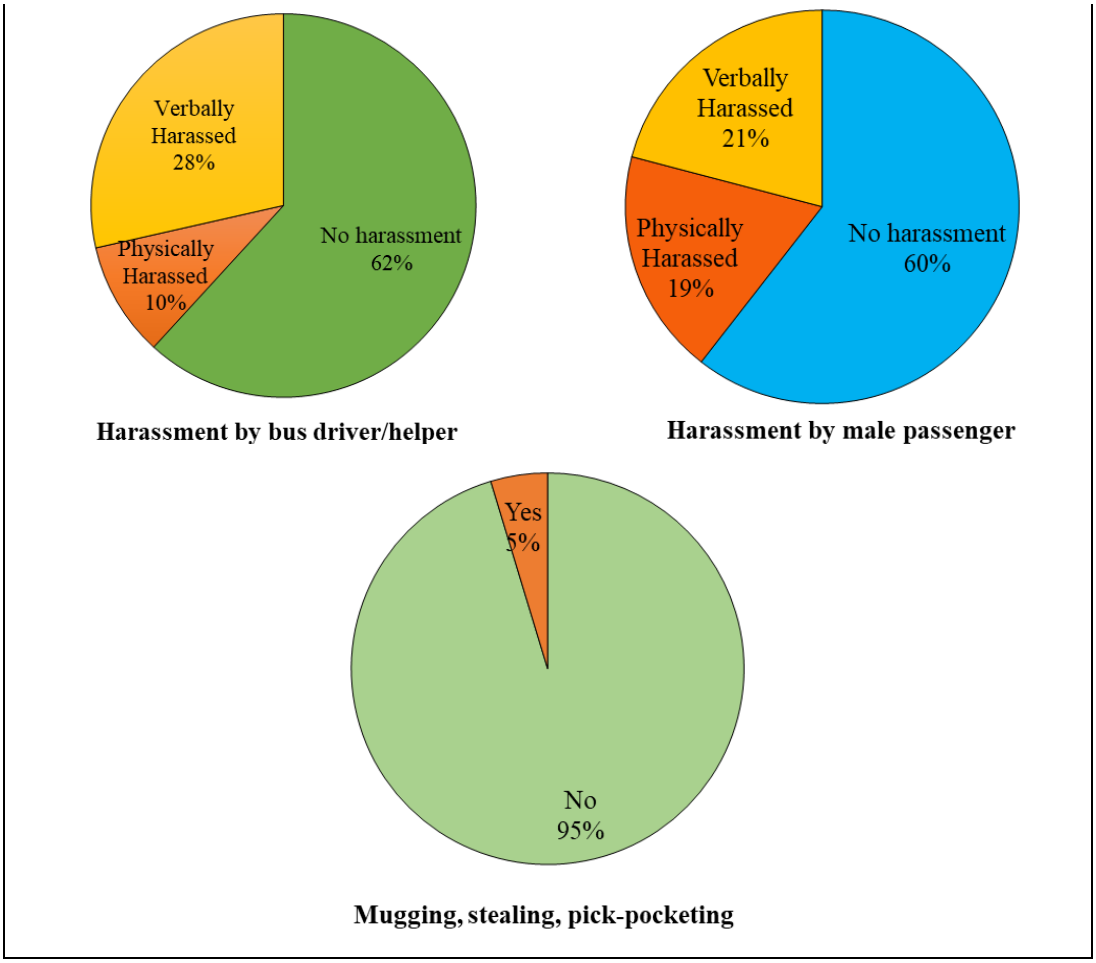


Fig. 4.22: Statistics Regarding Female Passenger Harassment Issue

Fig. 4.23 explains that, in around 84% occasions, when female passengers get harassed, rather than getting help, they get reprimanded by drivers, conductors and fellow male passengers. In case of physical harassments, the respondents reported that only in 8% situations they saw the victims protesting. Unfortunately, in such situations, in about 12% cases both male and female passengers stood by the victim. It was also noticed that female passengers are very much reluctant to move forward and help a harassed and protesting female passengers (10%). When the victims complain, only in 18% cases their objections are taken as complains.

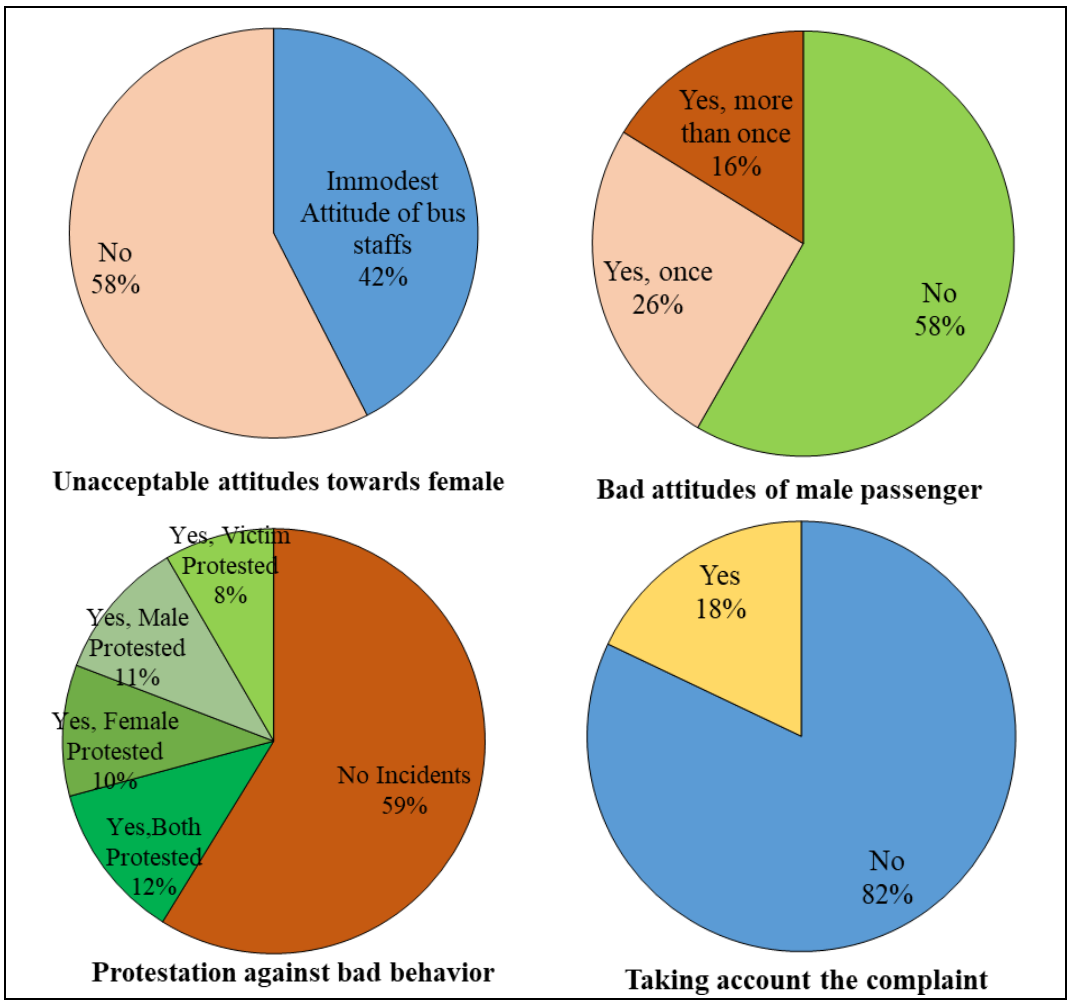


Fig. 4.23: Statistics Regarding Responsiveness and Empathy Issue

In the survey, the respondents rated various aspects of comfort (**Fig. 4.24**). On 70% of their trips they saw no proper shelter at bus stops; toilets were nearby only in 8% of the bus stops; they found the interior of the buses to be either very dirty (31%) or dirty (44%); the buses were in general crowded (56%) or very crowded (27%); they were noisy (56%) or excessively noisy (26%) and also the heat inside was reported to be intolerable in 47% of the surveyed trips.

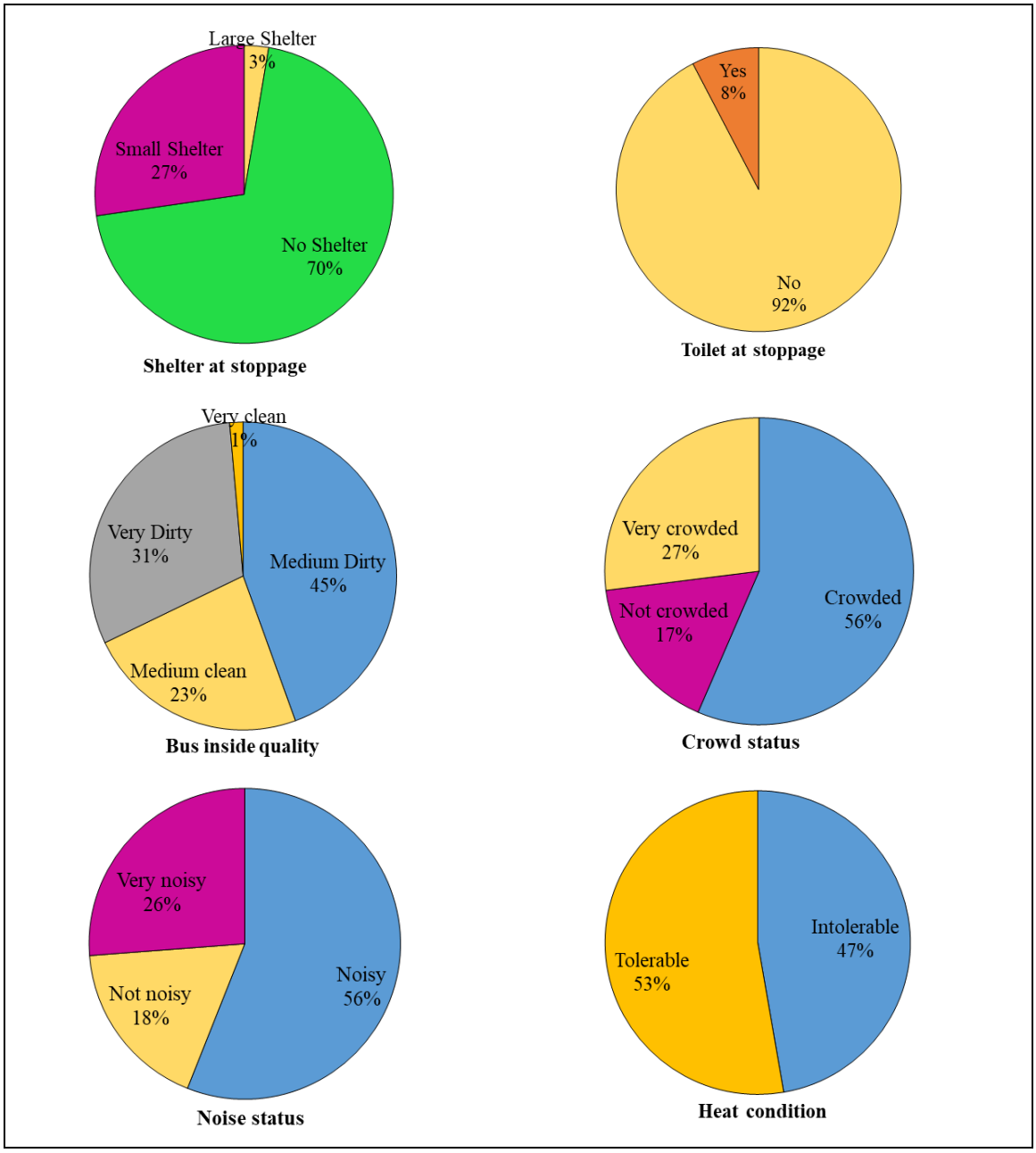


Fig. 4.24: Statistics Regarding Comfort Issues During Travelling

Some other interesting aspects of trip also got revealed in the survey, such as, on 31% occasions the respondents saw conductors asking for higher fare than the usual from female passengers (**Fig. 4.25**), taking the chance that they may not know the actual fare.

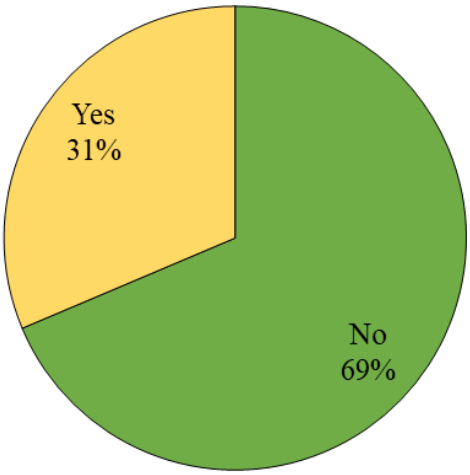


Fig. 4.25: Excess Fare Collection

4.3.3 Random Forest (RF) Model

RF was applied on the dataset directly to identify the high impact variables using four different variable importance measures (VIMs). The dataset contained the assessment of 641 trip records based on 30 attributes, i.e., predictor variables. The outcome variable was dichotomous in nature defining whether the user was satisfied with the overall aspects of her trip. Prediction accuracy of RF can be boosted by generating a large number of bootstrapped trees based on random samples of variables, each time considering only a subset of variables, as well as using a portion of the dataset at a time. Selection of number of subset of variables and the size of the training dataset involves iteration to optimize model performance. Boulesteix et al. (2012) recommend to use √p number of variables at a time where 'p' is the independent variable space. Therefore, in this study, in the initial iteration, five (√p =√30=5.47≈5) variables were selected randomly for each tree construction which were increased/decreased in successive iterations. In the R programme RF model by default takes 500 trees to generate the forest, but here in this model 1000 trees have been predefined for forest generation to improve predictive accuracy of the model. At each time, 60% to 80% of the dataset was randomly selected to construct trees and each RF model constructed a forest consisting of 1000 trees. Subsequently, to minimize the OOB error rate, model is tuned by several iterations and finally it is defined that, 63.2% of the sample is, drawn by random sampling of boostrap method, used as train dataset and rest as test set can be a best match for this model

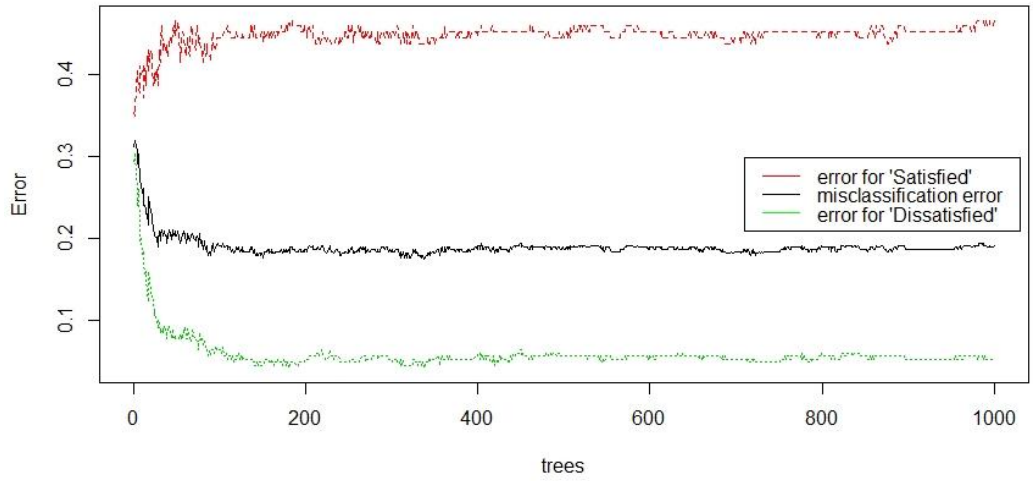


Fig. 4.26: Random Forest Accuracy Curve

and any of the 4 variables out of 30 can be selected for each tree which indicates lowest (18.63 %) value of OOB error rate. It was interesting to observe that the model could predict 'dissatisfied' bus users with around 95% accuracy, however, the error rate in classifying the 'satisfied' group was around 45%, suggesting that the feeling of dissatisfaction was coherent whereas the respondents found it difficult to comprehend why they were satisfied with the service or it may have been influenced by exogenous variables. The model achieved overall accuracy of around 85%. Table 4.10 shows the confusion matrices both for train and test dataset of RF model with misclassification error and RF model accuracy curve is shown in Fig. 4.26).

Table 4.10: RF Model Output

Confusion matrix: Train set	**Prediction**		
	Satisfied	Dissatisfied	Misclassification error
Satisfied	76	61	0.44525547
Dissatisfied	15	256	0.05535055
Confusion matrix: Test set			
Satisfied	44	5	0.10204082
Dissatisfied	30	154	0.16304348
Model Accuracy : 0.8498 ≈ 85%			

The results of VIMs, illustrated in **Fig.4.27**, make the ranking of variables according to the explanation of MDA, MDG, MMD and TAR. The MDA of a variable is determined during the OOB error calculation phase by calculating to what extent

the accuracy of the random forest decreases due to the exclusion (or permutation) of a single variable. Therefore, variables with large MDAs are more important for classification of the data. Here, **Fig.4.27** explains that the 'Boarding-alighting status' possess the highest value of MDA (29.32) among all variables. Again, the MDG defines a measure of how each variable contributes to the homogeneity of the nodes and leaves in the resulting random forest. Each time a particular variable is used to split a node, the Gini index values for the child nodes are calculated and compared to that of the original node. The changes in Gini are summed for each variable and normalized at the end of the calculation. Variables that result in nodes with higher purity have a higher decrease in Gini index value and here **Fig.4.27** shows that 'Boarding-alighting status' has the higher MDG (14.14) than that of other variables. Another VIM is MMD i.e. mean of the minimum depth of variable which is used as root node splitter. Minimal depth for a variable in a tree is the depth of node that splits on that variable and is the closest to the root of the tree. A lower value of MMD indicates high impact value of the variable that helps to split the node. From **Fig.4.27**, it is seen that 'Boarding-alighting status' possess the lowest value of MMD (2.95) among all other variables i.e. 'Boarding-alighting status' is used as splitter at the closest node to the root. Times a root (TAR) is calculated by noting down number of times the root node was split using a particular variable. Here, again 'Boarding-alighting status' stood first for TAR (131) i.e. this variable has been used as the root node splitter maximum number of times. Analyzing the results of VIMs, the variables that were found to be ranked within top 15 in all four VIMs were identified: Boarding alighting status, Picking passengers, Female passenger harassment, Noise status, Harassment by bus driver and/or helper, Heat condition, Bad attitudes of male passenger, Protestation against bad behavior, Travel status, Crowed status, Waiting time for bus, Stoppage duration, Bus inside quality, Driving pattern, Unacceptable attitudes towards female passengers. The variables that made within the top 15 list in at least three methods were a subset of the aforementioned 15 variables and such 10 variables are: Boarding alighting status, Bus inside quality, Picking passengers, Female passenger harassment, Noise status, Harassment by bus driver and/or helper, Bad attitudes of male passenger, Protestation against bad behavior, Waiting time for bus, Travel status. From these outputs of VIMs, it is clear that 'Boarding-alighting

status' is the top most concerned issue to female passengers in case of travelling by bus, because 'Boarding-alighting' is closely interrelated to physical safety-security, comfort, vehicle access, and reliability as mentioned by the respondents during survey. Rankings of other variables also have impacts on response variables accordingly.

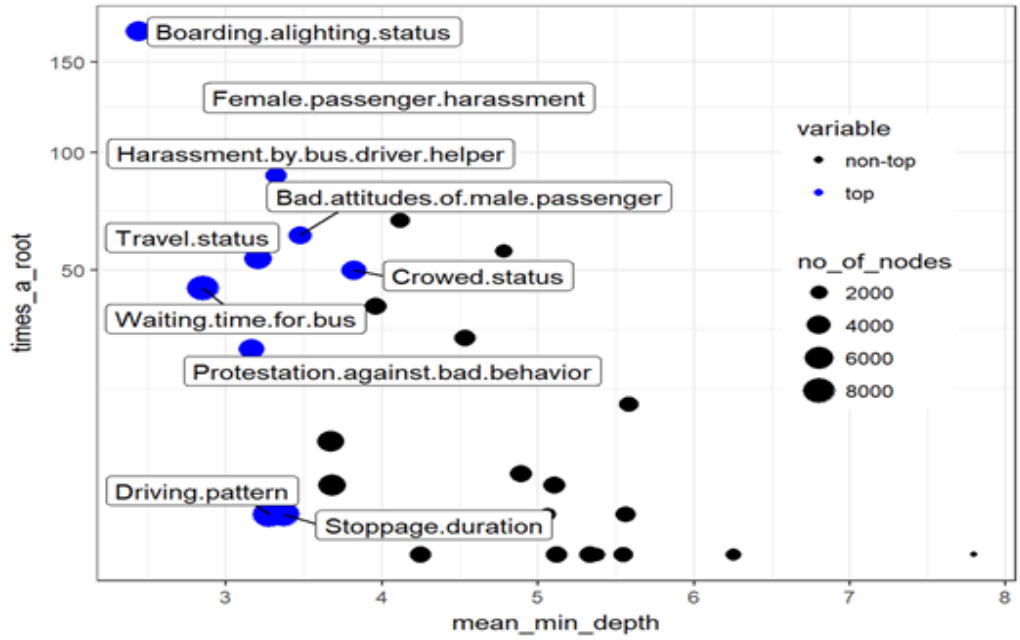
Variables	MDA	MDG	MMD*	TAR
Boarding alighting status	29.32	14.14	2.95	131
Bus inside quality	24.06	10.86	3.44	15
Picking passengers	21.01	8.15	3.91	108
Female passenger harassment	20.89	8.44	3.43	123
Noise status	20.69	7.84	3.59	22
Harassment by bus driver helper	17.18	6.01	4.11	64
Heat condition	15.81	5.28	4.37	54
Bad attitudes of male passenger	15.74	6.58	3.86	57
Unacceptable attitudes towards female	15.23	5.13	4.48	59
Protestation against bad behavior	13.74	7.76	3.32	56
Harassment by male passenger	13.34	5.07	4.38	58
Breaking traffic rule	12.02	3.99	4.87	12
Travel status	11.73	8.34	3.42	59
Driving pattern	10.69	13.27	3.21	6
Crowed status	9.69	5.83	4.03	37
Waiting time for bus	8.67	13.00	3.03	40
Refused to get into bus for occupied female seats	8.21	4.07	4.97	12
Availbility of seat right after boarding	7.62	4.11	5.28	47
Refuse female passenger	7.22	3.41	5.27	17
Insisting driver to break traffic rule	6.82	2.87	5.33	1
Excess fare collection	5.40	2.91	5.57	3
Bus availability	4.74	2.74	5.60	13
Shelter at stoppage	4.32	3.58	4.91	0
Stoppage duration	3.50	10.24	3.47	1
Follow regular route	3.22	2.88	5.52	0
Taking account the complaint	2.92	1.81	6.02	0
Toilet at stoppage	2.67	1.97	5.91	2
Bus arriaval info	1.40	1.47	6.39	0
Presence of reprentative	1.28	2.72	5.58	3
Mugging stealing pick pocketing	0.28	0.42	8.62	0

*Lower values are better

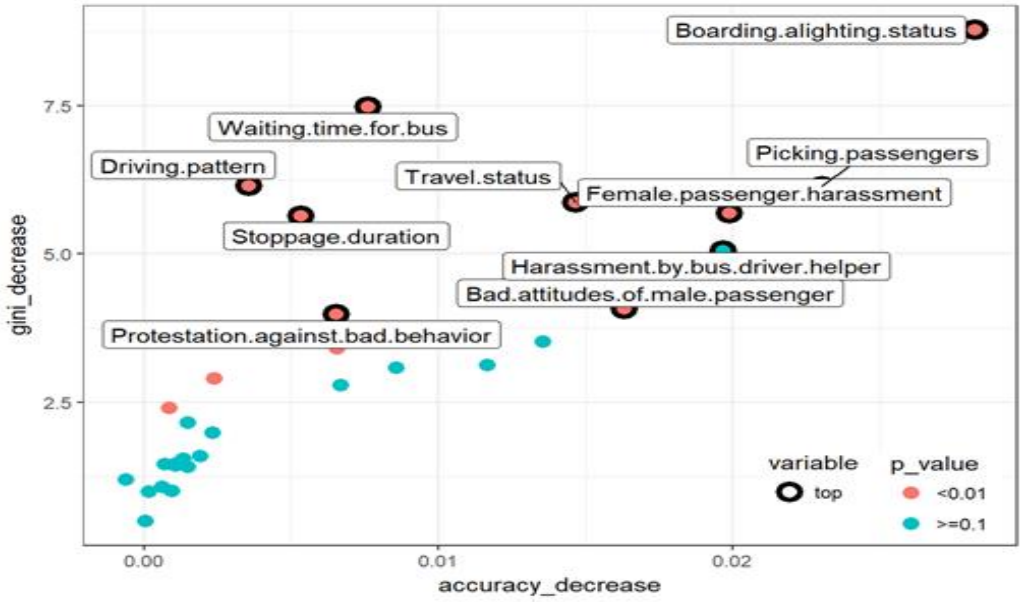
Fig. 4.27: Variable Importance Plot

Next, two multi-way importance plots were produced as presented with **Fig. 4.28(a) and (b)**. **Fig. 4.28(a)** utilizes the mean depth (MMD) of first split on the variable, the number of trees in which the root is split on the variable, i.e.TAR and, total number of nodes in the forest that split on that variable as inputs. Mean minimum depth (MMD) is represented with x-axis, times-a-root (TAR) with y-axis and no. of nodes in terms of diameter of solid circle. Then it labeled 10 variables which scored the best when it comes to these three measures by taking the sum of the ranks for those

measures and presented them with blue solid circles. The variables are: boarding alighting status, female passenger harassment, harassment by bus driver and/or helper, bad attitudes of male passenger, travel status (standing/seating/mixed), crowed status, waiting time for bus, driving pattern, stoppage duration and protestation against bad behavior. The diagram depicts that top variables have lower value of MMD (less than 4.00) and contain higher number of trees at the root node (more than 40) where related variable is used for splitting the node. They are used in maximum number of nodes as splitting node at roots of the trees in the forest. Also, other than waiting time for bus, driving pattern and stoppage duration, all other variables were within top 15 important variable lists in all four VIMs. **Fig. 4.28(b)** presents two importance measures that were derived from the role that a variable play in prediction with the additional information on the p-value based on a binomial distribution of the number of nodes split on the variable assuming that variables were randomly drawn to form splits. It suggests that if a variable is significant then it is used for splitting more often than that would be the case if the selection was random. In the diagram, x and y axis represent mean decrease accuracy (MDA) and mean decrease gini (MDG) respectively and top variables are represented with circles having dark black borders. The circles representing the variables were color coded where pink solid circles suggested that the variables had p-values less than 0.01, i.e., they were more efficient in predicting the outcome variable from a new dataset. The outcome found all to be significant from the top variable list in **Fig. 4.28(a)** except 'Harassment by bus driver and/or helper' and 'Crowed status'. Also, picking passengers (hurriedly/modestly), not emerged in **Fig. 4.28(a)**, was identified as a significant top variable.



(a)



(b)

Fig. 4.28: Multi-way Importance Plot

The **Fig. 4.29** reports 30 top interactions represented by conditional MMD which was calculated based on the depth of the second variable, considering all the possible values that it could take, in a tree of which the first variable was a root, i.e., a subtree of a tree from the forest. The horizontal red line marks the minimal value of

the depicted statistic among interactions for which it was calculated. For instance, for the 1st case, i.e., the interaction ‘Boarding alighting status: Driving pattern’ in a tree means that ‘Boarding alighting status’ was found to be the root splitting variable highest number of time where ‘Driving pattern’ emerged as the 2nd immediate splitter. For the first case, the combination occurred in 719 nos. of trees and the conditional mean depth was calculated to be 1.95 when the unconditional mean depth was 3.096, i.e., these two variables jointly can reveal more information than what they can individually. Other interactions in **Fig**. **4.29** can be interpreted accordingly. A detailed chart of all possible interactions is explained in **Appendix C**.

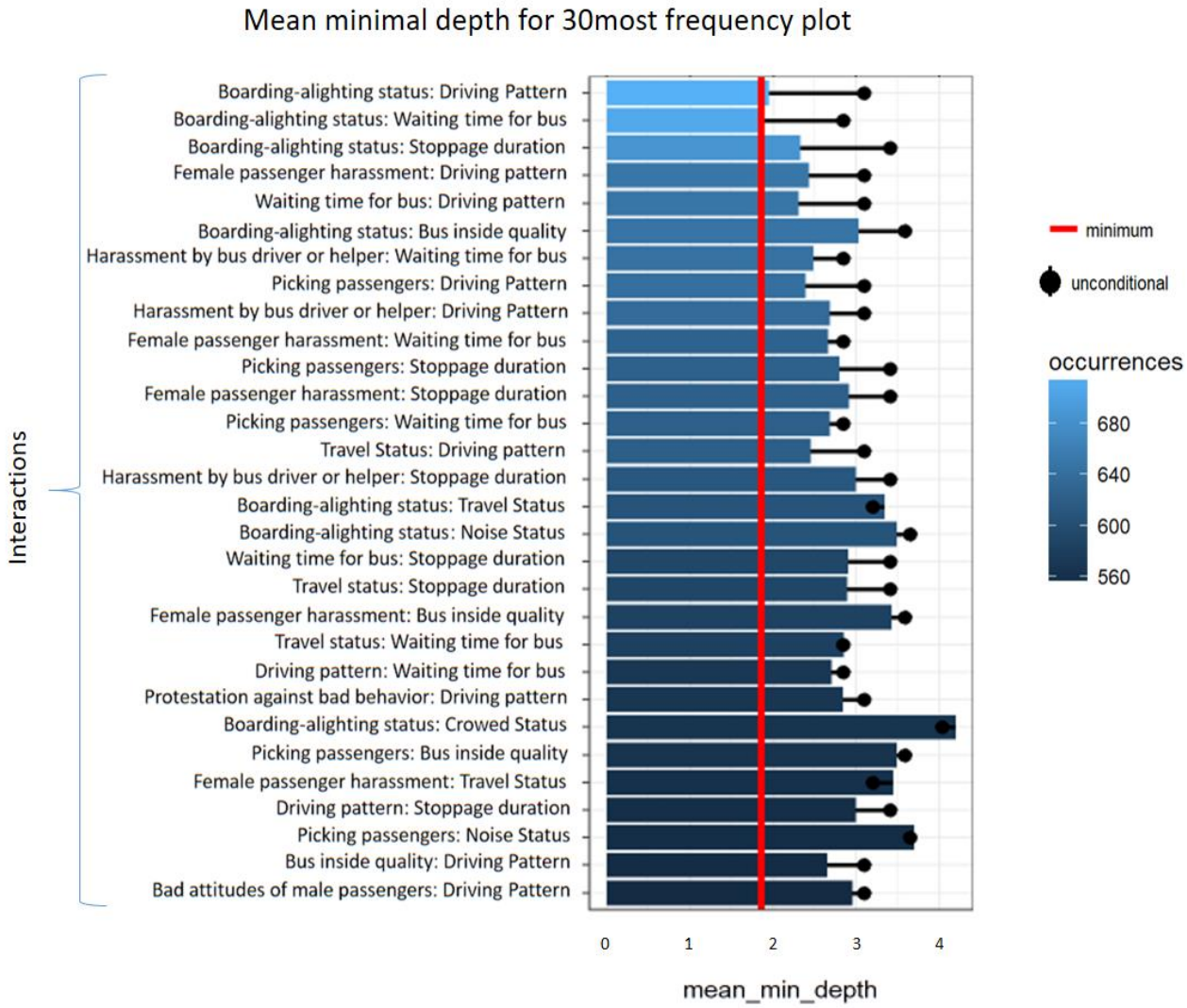


Fig. 4.29: Interaction Plot In Terms Of Frequency Of Occurrence

4.3.4 Classification And Regression Trees (CART)

Summing the rankings from the four VIMs, the top twenty variables were identified to construct the CART tree and unfold the interactions among attributes that defined the satisfaction and dissatisfaction of female public bus users from a trip that they have completed. The selected attributes are (in order from highest importance to the lowest): boarding alighting status, bus inside quality (cleanliness), picking passengers (hurriedly/modestly), female passenger harassment, noise status, harassment by bus driver and/or helper, heat condition (inside temperature), bad attitudes of male passenger, unacceptable attitude towards female, protestation

against bad behavior, harassment by male passenger, breaking traffic rule, travel status (standing/seating/mixed), driving pattern, crowed status, waiting time for bus, refused to get into bus for occupied female seats, availability of seat right after boarding, refuse female passenger and stoppage duration. To keep the tree size convenient, rather than growing the tree up to maximum depth where each terminal node consists of a pure class, a minimum split rule was followed where a node got split only when it held at least 10 data points so that subsequent child nodes had at least 1/3rd of those data points (Raihan et al, 2017).

The results of CART analysis are illustrated by **Fig. 4.30** where each node is numbered in a circle. If the parent node is 'n' then the left and the right child nodes are numbered as '2n' and '2n+1', respectively. In Node 1 '211/430' represents that 211 respondents rated their overall trip experience to be 'Satisfactory' whereas 430 respondents were 'Dissatisfied' with their trip experience. The 'Boarding alighting status' within parenthesis is the splitting variable of Node 1 and the letter 'c' on top of Node 2 suggests boarding alighting status is 'c' for all the data in Node 2 (explanation is given below the figure) whereas letters 'a' and 'b' on top of Node 3 indicate that all the data in that node have boarding alighting status to be either 'a' or 'b'. Out of the twenty input variables, CART used only eleven of those to construct the tree. They are: boarding and alighting status, female passenger harassment, availability of seat right after boarding, refuse female passenger, harassment by bus driver or helper, waiting time for bus, travel status, stoppage duration, harassment by male passenger, driving pattern, heat condition.

Several interesting patterns come out from the CART diagram unveiling situations that lead to female bus users liking or disliking their trip experience. According to the respondents boarding alighting status is the single most important variable as 66.8% female passengers were happy with the service quality when the bus stopped properly to load and unload passengers (Node 2). Subsequently, at Node 3, about 79.3% respondents expressed their dissatisfaction as the bus didn't stop properly, rather kept moving while the (female) passengers were boarding or alighting from the bus. The share grows up to 90.5% when they experience harassments (themselves or see it happening to another female passenger) by bus

driver or conductor in the form of inappropriate physical contacts or verbal abuse (Node 7). However, when no harassments took place from the driver or conductor, if the waiting time for bus was longer than 15 minutes, 83.9% respondents expressed that they were unhappy with the service quality (Node 13). In a similar situation when the waiting time was less than 15 minutes and they got to seat on a 'female only' or 'general' seat, almost half the passengers (52.2%) belonging to this category became pleased with the service quality tough 71.3% female passengers become dissatisfied when they had to remain standing at least at some parts of their journey (Node 25). Dissatisfaction rate surged up to 78.1% when incidents of male passengers harassing female passengers verbally or physically took place (Node 51). However, if such things didn't happen and the interior temperature of the bus was tolerable, 87.5% respondents belonging to this group were satisfied with the service quality. For the respondent groups in Node 24, their satisfaction level jumped up to 73.3% if the buses had made stops less than 5 minutes at each stop (Node 48). From Node 49, 98 and 99, it can be observed that female passengers felt more uncomfortable (78.6%) in situations when the drivers were conducting too many overtaking maneuvers or changing lanes frequently as compared to driving at very high speed or suddenly increasing speed (72.2% respondents reported to be still satisfied in such situations). Now, going back to Node 2, when it further got split with 'female passenger harassment' variable, 70% respondents exhibited dissatisfaction when they saw (or experienced themselves) female passengers being harassed (Node 5). When no such incidents were noticed, 81.1% respondents were satisfied with the service quality. The satisfaction level rose up to 89.1% when they also got seat right after boarding (Node 8). However, if they did not get seat and observed female passengers being refused to be boarded as there were no female only seats available, 87.5% of them become dissatisfied (Node 19). It can be noted that for the same group of respondents, when they did not see the conductors refusing female passengers to board in such situation, 72.7% respondents felt satisfied with the service quality (Node 18).

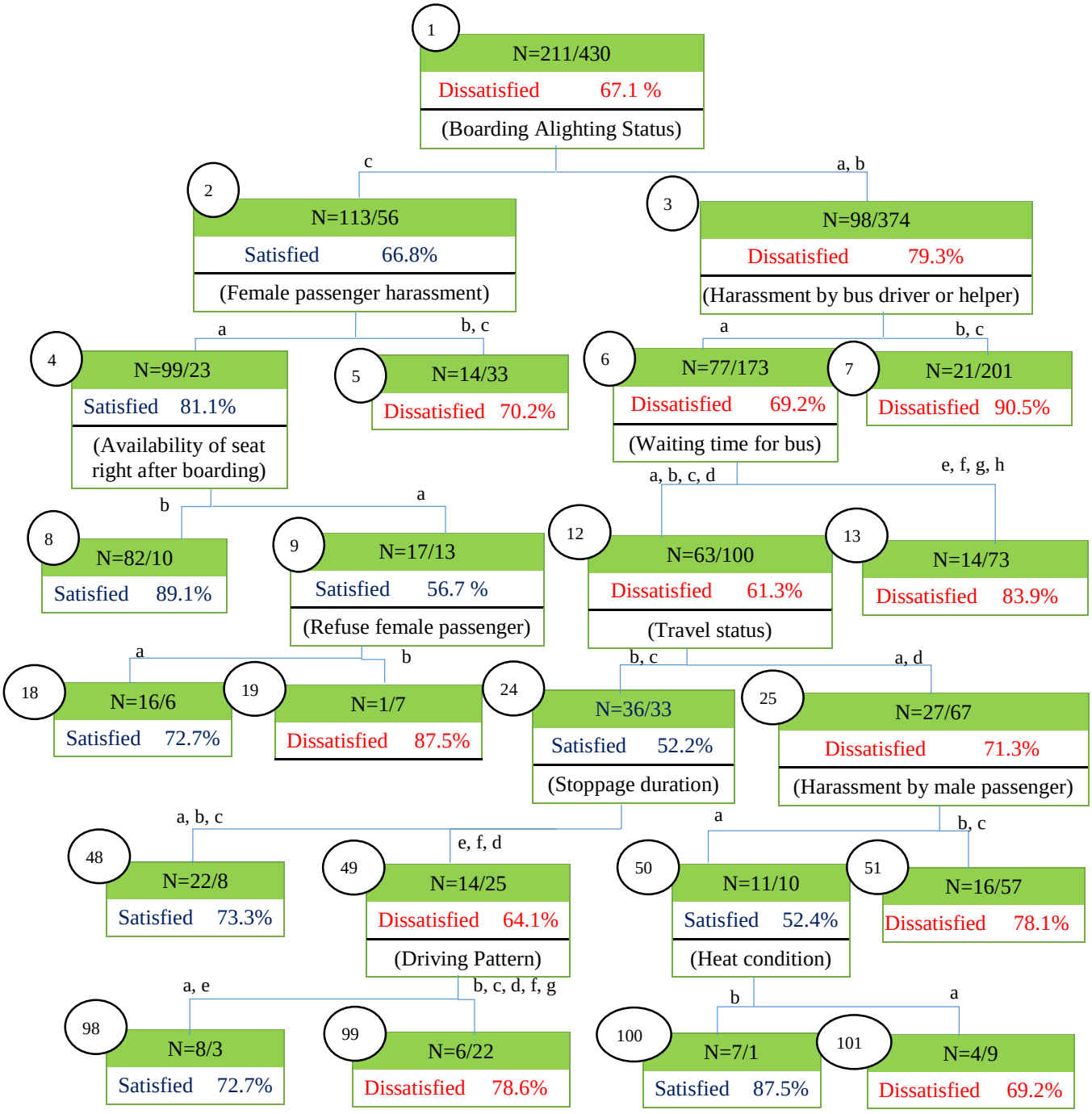


Fig. 4.30: Tree from CART Analysis

Note: Boarding-alighting status: a= Driver didn't stop the bus properly, b= Driver picked passengers on running situation, c= Driver stopped the bus properly; Female passenger harassment: a= No harassment, b= Yes, once, c= Yes, several times; Harassment by bus driver or helper: a= No harassment, b= Yes, Physically touched or harassed, c= Yes, Verbally harassed; Availability of seat right after boarding: a= No, b= Yes; Refuse female passenger: a== No, b= Yes; Waiting time for bus: a=0 min, b= 1-5 min, c= 5-10 min, d= 10-15 min, e= 15-20 min, f= 20-25 min, g= 25-30 min, h= more than 30 min; Travel Status: a= Standing, b= Sitting in female seat, c= Sitting in general seat, d= Mixed, standing and sitting; Stoppage duration: a= 1-2 min, b= 2-3 min, c= 3-5 min, d= 5-10 min, e= 10-15 min, f= more than 15 min; Harassment by male passenger: a= No harassment, b= Yes, Physically touched or harassed, c= Yes, Verbally harassed; Driving pattern: a=Over speedy, b= Overtaking tendency, c= Changing lane frequently, d= Hard-braking tendency frequently, e= Raising speed suddenly, f= Other, g= All; Heat condition: a=Intolerable, b= tolerable

4.4 Recommendations from Respondents

The interviewees of the FGD as well as the respondents of the trip survey provided various suggestions which can uplift the image of public bus service to its female passengers, if implemented. **Table 4.11** summarizes these problems along with line of actions to improve the situation and service quality of the public buses as recommended by the respondents.

Table 4.11: Major Problems With Service Quality Of Public Buses And Probable Solutions

Issues	Problems	Suggestions by Respondents
Service, Reliability, and Vehicle access	1. Buses do not stop properly during boarding and alighting; 2. They pick up passengers hurriedly;	- Implementation of traffic law strictly - Government monitoring proper execution of traffic law - Training bus drivers and conductors properly on how to

Issues	Problems	Suggestions by Respondents
	3. Female passengers get refused to be boarded because of unavailability of 'female-only' seats; 4. Seats are not available right after boarding; 5. Have to travel standing, 'female only' seats are insufficient.	deal with female passengers in a civilized society. - Ensuring enough seats for female passengers - Increasing human guardianship, e.g., police officers – specially the female police officers. - Arranging random inspection by law enforcement authorities. - Provide information on upcoming bus at bus stops real time bus schedule at online
Safety & Security, comfort, and Responsiveness & Empathy	1. Female passengers get harassed inside bus, at waiting areas, etc. 2. Bus drivers and conductors harass female passengers; 3. Male passengers harass female passengers.	- Increase bus quantity - Introducing time-table and increase human guardianship, e.g. police officers, and ensuring that the time-table is being followed. - Increasing seats for female passengers - Increasing facility and security for female
Reliability, and Service	1. Waiting time for buses is too high; 2. Makes prolonged stops at intermediate stoppages.	- Stop blaming victim; encourage reprimanding the perpetrators. - Introducing complain box for reporting and recording such events.
Service, and Comfort	1. Drivers exhibit risk taking behavior and driving style has issues with comfort	- Installing CCTV camera inside the bus and stoppages. - Encouraging victims to protest.

Issues	Problems	Suggestions by Respondents
	2. Air temperature is high inside bus	- Advance ticketing facility for female passengers. - Running campaigns against incivilities and bad manners towards female passengers. - Strictly enforcing measures against aggressive driving and violation of traffic rule. Concept of mobile court could be introduced here. - Introducing more AC buses and providing curtains in the window for the non-AC buses. - Providing shelter with surveillance in waiting areas. - Increasing the inside quality of bus - Drivers' training programs. - Creating awareness among passengers regarding safety. - Ensuring traffic rules - Drivers should be dutiful - Increasing avenues of reporting and recording.

4.5 Conclusion

From the above qualitative and quantitative analysis, it is prominently exposed that women in Dhaka city are very much dissatisfied with existing service facilities of public buses. The RF model also carefully identified the probable factors that influence the female road users' perception about existing service quality of public

buses. According to the RF model, 'Boarding- alighting status' is found as the most important variable which greatly influence the safety, security and comfort related issues of female commuters. Moreover, from focus group discussion it was revealed that the current practice in Bangladesh exposes the female passengers to greater threat of being harassed during the time of boarding and alighting from bus where perpetrators can be both the conductors and male passengers. Often, the female passengers have identified the conductors, standing blocking the door while boarding and alighting, to be the main source of sexual abuse. Even, such incidents have greater probability to occur in overcrowded bus where male passengers are standing blocking the aisle. Even, the participants unanimously complained about the behavior and attitude of the bus drivers and conductors towards them. In general they don't pay hid to the complains made by female passengers; do not stop properly at stops while boarding and alighting which is particularly risky for women; are not supportive to women when they become victims of theft, verbal or physical abuse.

Interestingly, several of the major issues that came out, such as, not stopping properly for boarding or alighting, picking up passengers hurriedly, long waiting time along with prolonged stops at intermediate stops, drivers taking risk and ignoring passenger comfort, excessive crowding, not getting a seat after boarding, etc. are expected to be major issues to passengers irrespective of their gender. Also, these issues are not too complex to resolve either.

CHAPTER 5: CONCLUSION

5.1 Introduction

This chapter summarizes the major findings (the objective 1) of this research and then outlines suggestions (objective 2) accentuated by the respondents as well as plausible recommendations (objective 3) drawn by various researchers in their pieces of literature. The recommendations may help policymakers, city planners, public transport operators and involved officials to improve the transport sector particularly the public transport sector. Finally, the chapter concludes with outlining the limitations and the future research scopes.

5.2 Major Findings And Suggestions

This section draws out the conclusion of major findings from this study to meet the requirements of first two objectives described in **Chapter 1**. The 3rd objective's outcomes are described in following section titled as **Policy Recommendation**.

5.2.1 Perception Of Present Service Quality:

The study's first objective was "To explore the perception of the women commuters in Dhaka city by revealing their probable grounds of dissatisfaction". The findings from this objective are as follows:

i. Respondents became extremely disappointed over the present service quality of public buses due to the following reasons (not in order of importance):
    a. No display of schedule or chart at the bus stoppages;
    b. Absence of proper ticket counters or representatives from bus operators end;
    c. Unacceptable long waiting time at intermediate stops;
    d. Sudden changing of routes results in skipping destinations of some passengers;

e. Vulnerable and unsafe boarding–alighting facility for women during travelling;
f. Insufficient designated seats for female;
g. Uncivilized attitude of the bus drivers and conductors/helpers;
h. Bad attitudes of other male passengers towards female passengers;
i. Venturesome driving pattern; and,
j. Untidy and dirty environment inside the buses.

ii. In this study, 74% of respondents have grumbled about poor and unsafe boarding-alighting facilities of public bus service as the drivers don't stop the bus completely during boarding and alighting and rather just slow down the speed.

iii. Women commuters become vulnerable of being physically touched or harassed by conductors/helpers or other male passengers more frequently while boarding and alighting. Because very often the bus conductors and helpers keep standing blocking the door, while women passengers are supposed to get in and off, to be the main source of sexual abuse.

iv. If women protest against sexual abuse, the conductors, drivers or fellow passengers do not pay hid to their complains. At times, events of blaming the victim rather than the perpetrator can also be observed.

v. Getting seats right after boarding is recognized as the top most determinant of comfort to the female passengers. Issues of scarcity of 'female only' seats as compared to demand and misconceptions about 'female seats' and 'general seats' among the male passengers and bus staffs are ascended as matter of concerns.

vi. Women feel unsafe while travelling standing inside the bus. As there are high chances of being harassed by bus helpers/conductors, even by other male passengers when young female passengers are standing at the aisle.

vii. Female passengers get exposed to a greater threat of being harassed while waiting for a long time on the road for buses.

viii. In case of unscheduled route-changing, most of the time female passengers are dropped off in the middle of their journey and other buses are decidedly unwilling to let them get into the bus if designated female seats are occupied.

ix. The behavior and attitude of the bus drivers and conductors/helpers towards female passengers are often labeled as objectionable in this research.

Hence, this high disgruntlement over accessibility for women along with women's foremost concern over the safety and security issues indicated that the city is failing to ensure a safe travel environment for women.

5.2.2 Suggestions From Respondents

To improve the present scenarios of present service quality of public buses some valuable suggestions were drawn to attention by the respondents during the focused group discussions and trip survey that meets the objective-2 of this study, which is "…to bring out suggestions incorporating women's opinion on how to improve the service quality of public buses in Dhaka city". The following suggestions have been drawn from this study that were heavily accentuated by the participants during the survey (not in order of importance):

i. Bus drivers and conductors/helpers should be trained up properly on how to deal with female passengers in a civilized society.
ii. Enough seats for female passengers should be ensured.
iii. Surveillance should be increased by law enforcement authorities to make ensure that traffic rules are being properly followed by the bus drivers as well as by the passengers.
iv. Penalties should be enforced against aggressive driving and violation of traffic rule; concept of mobile court could be applied here.
v. Complain box or a hotline should be introduced for reporting and recording events of harassment, disrespectful attitudes of bus staffs with passengers, risky driving, traffic rule violation, etc.
vi. Initiative to increase human guardianship and to stop blaming and encourage reprimanding the perpetrators should be in place.
vii. Running campaigns against incivilities and bad manners towards female passengers to create awareness among passengers regarding safety can improve the existing situation.

viii. A properly maintained bus time-schedule should be introduced at each bus stoppages and all bus-operator companies should have their ticket counters at bus-stops. Advance ticketing facilities could be introduced.

ix. Interior of bus including various facilities geared towards improving the security, convenience and comfort for female passengers should be put in place.

x. Introducing more AC buses and providing curtains in the window for the non-AC buses can substantially improve the perception of comfort for female passengers.

5.3 Policy Recommendation

Dhaka city's transportation is unplanned and overburdened (DTCA, 2015). It is not designed considering gender, age, income level or other characteristics of the consumers. Here, transportation operation is mainly dominated by the private bus companies/ operators. Very little portion of total market share is possessed by government transport authorities (Sen, 2016). Therefore, severe dissociation of ownership pattern in private sector restrains appropriate management, monitoring, co-ordination, policy making and resources development for investment in the sector. Although transport policy not being gender sensitive, sometimes gender issues are required to consider in policy making because of social structure, norms and culture. Hence, ensuring urban transport policy and programs is a big challenge here.

The current services of public transport in Dhaka city aren't women-friendly by any means. In this study, few comprehended featured issues that women face in public transports are conventional in nature and detailed broadly by significant works of writing from different societies of distinctive statistic and financial characteristics. Nonetheless, a considerable number of issues likewise rose which doesn't have a huge nearness in literatures. Positive changes of such circumstances can be possible, if more female transport-planners get involved in transportation policymaking as they can include the issues of sexual harassment in urban transport policy and can

contribute to improve travel environment of public bus for female passengers in this manner (Loukaitou-Sideris, 2010). In any case, to be effective, the line of activities to be introduced in this composition needs dynamic interest from the transport organizations, government administrations, and law implementation offices, associations identified with social advancement, researchers, organizers, architects and obviously the consumers of public transports.

Arisen issues with respect to the service quality dimensions, decided in this study, could be addressed by formatting and implementing proper policies. Aside from aiding in fathoming the issues that the female face in using public transport in Dhaka city, the following recommendations (**Table 5.1**) have been formulated from this study so that the respective stakeholders can update the existing urban transport policy considering the issues specially gender sensitive issues.

Table 5.1: Policy Recommendations In Respect To Issues In Public Transport

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
Reliability issues: – Long waiting time. – No display of schedule or chart at the bus stoppages. – Do not follow any proper time-schedule for stoppages. – Female passengers get refused to be boarded as ‘female-only’ seats are not available.	– Introducing time-table and ensuring that the time-table is being followed. – Providing information on next bus at bus stops; make real-time bus schedule available in smartphones. – Increasing surveillance (Jubainville and Vanier, 2017). – Increasing number of public buses and assuring seat for every passenger.	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC) – Dhaka Transport Cooperation Authority (DTCA) – Dhaka Metropolitan Police (DMP) – Transport Owners Association (TOA)

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
– Insufficient designated seats for female. – Seats are not available right after boarding.	– Advance ticketing facility for female passengers. – Conducting route-based demand study and increasing 'female-only' seats thereby. – Introducing more buses exclusively for female passengers can only be adopted as a short-term intervention (Gekoski et al., 2015). – Providing more mode choice options to female travellers (Stanko, 1995).	
Comfort Issues: – Un-shaded waiting areas. – Untidy and dirty environment inside the buses. – Overcrowding and air-temperature inside the bus is high. – Driver exhibit risk taking behavior and driving style has issues with comfort.	– Simple policies such as designated waiting area with shades, transparent bus shelters, and emergency complains service and alternative services and routes such as request-stop programs for women travellers (Shreya, 2013). – Introducing more AC transports and providing shades or curtains in the	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC) – Dhaka Transport Cooperation Authority (DTCA) – Dhaka Metropolitan Police (DMP) – Transport Owners Association (TOA)

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
	window for the non-AC transports.	
Service Issues: – Venturesome driving pattern.	– Strictly enforcing of law against aggressive driving and violation of traffic rule, – Improving business model of public buses so that drivers do not need to compete with each other to get more passengers. – Training program for drivers and conductors/helpers on road regulations.	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC) – Dhaka Transport Cooperation Authority (DTCA) – Dhaka Metropolitan Police (DMP) – Transport Owners Association (TOA)
Responsiveness & Empathy issues: – Uncivilized attitude of the bus drivers and conductors/helpers; – Bad attitudes of other male passengers towards female passengers.	– Running campaigns against incivilities and bad manners towards female passengers. – Awareness programs for women about their rights (Ball and Wesson, 2017) – Training bus drivers and conductors' professionalism and how to deal with female passengers in a civilized society.	– Transport Owners Association (TOA) – Ministry of Women and Children's Affairs – Women's Development Forum

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
Safety & Security issues: – Vulnerable and unsafe boarding–alighting facility. Drivers do not stop buses properly during boarding and alighting and they pick up passengers hurriedly. – Female passengers get harassed (inside bus, at waiting areas, etc.) by bus drivers/conductors/helpers and even by male co-passengers.	– Training program for drivers and conductors/helpers on road regulations and gender awareness to change their attitudes towards passengers (Zohir, 2003) – Awareness programme to increase human guardianship (Loukaitou-Sideris, 2010; Yavuz and Welch, 2010); Practice to stop victim blaming; encourage reprimanding the perpetrators. – Increasing surveillance (Jubainville and Vanier, 2017); – Initiatives to increase the practice of complaining against unwanted touch or sexual harassment (Latane and Darley, 1970). – Introducing avenues of reporting and recording experiences and complains, such as hotlines, texting and phone apps should be	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC) – Dhaka Transport Cooperation Authority (DTCA) – Dhaka Metropolitan Police (DMP) – Transport Owners Association (TOA) – Ministry of Women and Children's Affairs – City Corporations

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
	introduced (Gekoski et al., 2015). – Creating complain-outlets through social media where complains against harassment can be reported. – Providing "women only" buses; reserving 25% seats for women; and expanding seating-only Two-door buses, front door should be used for women passengers boarding -alighting and back door should be kept for men only (Zohir, 2003). – Installing CCTV camera at the waiting areas of bus stoppages as well as inside the buses.	
Affordability issues: – No ticket counter or fare chart is displayed. – Fare is collected inside the bus without any ticket.	– Proper fare-chart should be displayed at the bus stoppages as well as inside the bus. – e-ticketing system could be introduced so that there would be no chance of excess fare collection.	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC)

Issues/Problems in Public Transport	Policy Recommendations	Responsible Stakeholders to Implement
– Sometimes conductors collect excess fare.		– Dhaka Transport Cooperation Authority (DTCA)
Vehicle access issues: – So narrow aisle space that two passengers cannot pass without avoiding touching. – Helpers block the boarding-alighting space standing at the door.	– Re-design the bus to improve the facilities such as expanding aisle space and relocating the assigned seats for ladies. – Guaranteeing a seat for each passenger which inevitably will restrain commuters from remaining on the aisle.	– Bangladesh Road Transport Authority (BRTA) – Bangladesh Road Transport Corporation (BRTC) – Dhaka Transport Cooperation Authority (DTCA)

At the same time, long-term activities ought to be taken on to change the societal patterns that apply various conditions for people (Ceccato and Paz, 2017). It was intriguing to note during the survey that a significant number of respondents opined that if the general issues identified with reliability, comfort, safety, security, and empathy can be tended to, at that point the greater part of the female-explicit issues will likewise get settled.

Alongside, scientists intensely accentuated on structure a provocation free safe environment through proper plan and design (Gekoski et al., 2015) adopting entire journey approach by planning more secure avenues and person on foot walkways (Natarajan, 2016); improving lighting conditions (Loewen et al., 1993); keeping the transportation offices very much kept up and orchestrating cautions if there should be an occurrence of crisis (Gekoski et al., 2015); and so forth. To accomplish this, Keddy (2015) prescribed to 'alerting future transport planners to gender-based genuine dangers to individual security'. At long last, existing literatures intensely advocates for mindfulness creation and women empowerment as a major aspect of a long-term

workable arrangement which can be accomplished through constantly bringing issues to light about undesirable sexual activities in public places alongside when they may happen (Ball and Wesson, 2017) through talks/workshops (Natarajan et al., 2017); running efforts against incivilities and terrible habits towards female travellers (Vanier and Jubainville, 2017); offering self-protection classes for ladies (Natarajan et al., 2017), and so forth. Last yet not the least, changes of societal norms ought to be gotten with the goal that a victim moves toward becoming regarded deserving of the intercession of different travellers so spectators comprehend the size of female provocation episodes and approach to help the victim (Latane and Darley, 1970).

5.4 Limitations

This study can be considered novel from several aspects. First, this study has followed both an in-depth inter-positivist approach for a qualitative method (which is the most popular method in the case of service quality related transportation research) and advanced mathematical modelling and simulation for quantitative method. Second, gender-related transportation research in Bangladesh is an under-researched area. This study can be considered as one of the first studies that explored this issue. In Bangladesh, gender discrimination is a common social problem. Also, the country is suffering from poor transportation infrastructure. Thus, this study is timely and important as it combines these two burning questions in relation to Bangladeshi society. However, the study still has some limitations that are required to be addressed.

In this study, two types of surveys were conducted: Focus Group Discussion (FDG) survey for qualitative analysis and trip survey for quantitative analysis. For FDG, it was quite challenging to gather respondents of two specific young groups - university going female students and female service holder. After that, a quantitative study was performed which needed a trip survey data where collecting a notable number of samples for quantitative analysis was a challenge. Moreover, the study area was confined within Dhaka city. Apart from that, the scope of the study is limited to young educated female passengers (age range: 20 years to 40 years) only. That is, the scope of the study did not cover the experience and opinion from illiterate and older

groups of women as well as men of all groups altogether. Apart from that, the study focuses on passengers only, i.e., the bus operators and other stakeholders involved in providing public bus services (drivers, conductors, attendants at stops, etc.), the authorities involved in formulation of regulation, and the government policymakers were not involved in this study.

5.5 Future Opportunities

As one of the first gender-based major studies in public transportation sector in Bangladesh that adopts mathematical approach, this research has substantial opportunities to carry forward in future the knowledge it has generated. This can be achieved in several ways. For example, the study can certainly be benefited from increasing the sample size and thus bolstering the statistical validity of the outcomes. Secondly, the study can expand its horizon by including children, aged, people with disability as respondents. Also, a similar study covering both the genders will further shed light on the perception and preferences of public bus users in Dhaka city. It will also be interesting to include those trip makers who do not use public buses to understand how they can be encouraged to shift to public buses. Moreover, the study focuses only on Dhaka city. Replicating the methodology for other cities in Bangladesh as well as for cities in other countries having similar cultural and socioeconomic aspects will evaluate the universality of the findings. Apart from that, in order to formulate policy measures, it is imperative to include all major stakeholders, such as, the public bus operators, transport authorities, staffs involved in service providing, policy makers, to listen to their side of the story to create a clearer picture of the situation of service quality of public buses in Dhaka city. Finally, the recommended measures need to go through financial and economic feasibility analysis to translate them into action.

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APPENDICES

Appendix A

Semi-structured Questionnaire for Focus Group Discussion (FDG)

1. How frequently do you use public transport?

2. Why do you use public transport? or what are the purposes of using public transport?

Reliability:

3. How much can you relay on the information of availability of bus given by the bus representative?

4. How much the waiting time for bus?

5. What is the reason behind of not coming in acceptable waiting time?

6. Is the representative of bus companies present in bus stoppage?

7. If there is representative present in the bus stoppage, do they give correct or reliable information about bus arrivals?

8. Is it happened anytime that the representative said the bus would arrive a within 5 min but it actually wouldn't?

9. Is it happened anytime that the buses changes its regular route?

10. Is it happened anytime that the buses changes its regular route due to not getting enough passenger?

11. When it happens, what was your reaction? Share particular incidents regarding this happening? Did or do you protest against this happening? Do the male passenger protest against this happening? or do they support if any female passenger protest against?

12. In such cases of route changing do you think that female passenger faces more problems?

13. Do you feel like protesting further?

14. How is the attitude of bus representatives (conductor/ helper) while they pick up a passenger?

15. It is said that busses do delay while picking passenger, it is frequent during rush hour specially having traffic jam. But when the road is free and less traffic there, then do they also delay standing at the bus stoppage?

16. What about the fare of the public buses? Is it reasonable or not?

17. Does such event happen ever that the bus conductors collect excess fare? If yes, then what do you do or what do the other passengers do?

Comfort and Convenience:

18. Chances or frequencies of getting reserved seats as female passenger among 10 trips:

19. Sometimes when old passengers get into bus do anyone leave seat for them?

20. When an elderly male as well as an elderly female passenger get into the bus and standing inside, is it happened sometimes that someone prefer to leave seat for elderly female passenger than male one?

21. Is there any difference to getting seats during peak and off-peak hour?

22. Do the bus drivers, helpers, conductors or other male passengers honor the reserved seats for female passenger?

23. Do the other passengers request the male passenger to leave reserved female seat who is sitting there?

24. When it is happened that you have got in a crowded bus and no seats are available, even male passengers are occupying the ladies seat and you are travelling standing inside the bus. What do you do in this situation? Do you ask male passenger to leave the ladies seat?

25. How is the bus quality? Crowded? Not crowded?

Behaviors of drivers:

26. Is the Over- speeding common in drivers' behavior?

27. What is the reason behind not running in minimum required speed?

28. Is the over-speeding a problem or not?

29. Do the drivers do hard braking frequently?

30. Do the drivers raise speed suddenly?

31. Do they change lane frequently?

32. Do the passengers protest against to such behaviors of driver?

33. Do you think that female passenger faces more problem for these over-speeding, hard-beaking and competitive behaviors of driver?

Bus Quality:

34. Is the heat of vehicle itself inside the bus a problem?

35. Is the noise of public bus a problem?

36. Which noise level is more acceptable? Premium service bus? Or the local service bus?

37. Do the drivers blow horn unnecessarily?

38. Do you use foot-over bridge while crossing the road?

39. If there escalator installed in the foot-over bridge, do you then use the foot-over bridge?

40. If the bus drives blow too much horn, does anyone protest?

Cleanliness inside the bus:

41. Is the bus clean inside?, how do you feel inside the bus?

42. Why is it dirty? Is there dirty always or don't we clean it? What does it mean we are not aware enough to keep it clean? Or our taste is bad? What does it mean?

43. Do you ever complain or not about this dirtiness? If not, the why?

44. Do you make it dirty sometimes?

45. Do you think that female dislike this dirt more than male passenger?

46. Do you think that there should be a provision of shelter for passengers at bus stoppage?

47. Is there any arrangement of toilet in the bus stoppage? If yes, then which facilities should be provided?

48. What are the existing problems in bus stoppage?

49. How is the public bus service quality for pregnant women? How much is it convenient?

50. When disabled or Autistic people use public bus, how do they face or how is everyone's reaction?

51. When babies or kids get in bus, then how is the other's behavior?

Security related to women while using public bus:

52. How is the environment of the bus stoppage at day and at night? Is it safe for women?

53. Did you ever face such an event like pick-pocketing or hijacking or something else during travelling by bus or standing at bus stoppage? If yes, then what did you do? Or what was other's reaction present there? Share your experience.

54. Is the public bus in Dhaka city safe for women?

55. What do the other passengers attitudes towards female passenger in the bus?

56. Do the female passengers face sexual harassment? Or are they abused by the bus helpers or other passengers?

57. Did you face any sexual harassment or assault during travelling by bus? Or have you seen any event like that? Share you experience.

58. Do the other passengers or male passengers protest against such sexual harassment or assault? Or what are the behaviors of other passengers in such cases?

59. Do you think that the situation is changing in behaviors of male passengers towards female passengers? Explain in perspectives both in positive and negative?

60. What are your suggestions to improve public service quality to ensure safety and secured environments for female passengers?

Appendix B

Questionnaire on Public Bus Trip

Basic information (Part A):

1. Age:
2. Occupation:
   - ☐ Student
   - ☐ Service holder
3. Travel pattern: Frequency of using public transport in a week

0 day	1 day	2 days	3 days	4 days	5 days	6 days	7 days

Date of journey: Time of journey:

Origin: Destination:

4. Purpose of trip:
   - ☐ Job
   - ☐ Education
   - ☐ Shopping
   - ☐ Personal task

Reliability (Part B):

5. Was the bus representative present in the stoppage:
   - ☐ No
   - ☐ Yes
6. Did the representative provide any information about arrival of bus:
   - ☐ No
   - ☐ Yes
7. How long did you wait for the bus?

0 minutes	1-5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	20-25 minutes	25-30 minutes	More than 30 minutes

8. What is the maximum time the bus wait a the stoppage:

1-2 minutes	2-4 minutes	3-5 minutes	5-10 minutes	10 -15 minutes	15 + minutes

Service (Part C):

Availability:

9. Did you easily get bus today?
   - ☐ No
   - ☐ Yes
10. Did you escape any bus because the female seats were occupied by other passengers?
    - ☐ No
    - ☐ Yes

☐

11. Did you get a seat right after boarding?
    - ☐ No
    - ☐ Yes

12. How did you travel?
    - ☐ Standing
    - ☐ Sitting in a female seat
    - ☐ Sitting in a general seat
    - ☐ Mixed, sitting & standing

Driving Pattern:

13. How did the driver drive?
    - ☐ Over speedy driving;
    - ☐ Over-taking tendency;
    - ☐ Changing lane frequently;
    - ☐ Hard-braking tendency frequently;
    - ☐ Raising speed suddenly.
    - ☐ Others
14. Did the driver break traffic rule?
    - ☐ No
    - ☐ Yes
15. Did the driver follow the regular route of service?
    - ☐ No
    - ☐ Yes

Safety & Security (Part D):

16. Did you see today any of the female passengers being harassed during travelling?
    - ☐ No
    - ☐ Yes, once
    - ☐ Yes, several times
17. What kind of harassment it was?
    - ☐ Physical harassment by bus conductor an driver
    - ☐ Verbal attack by bus conductor an driver
    - ☐ Physical harassment by male passengers
    - ☐ Verbal attack by male passengers
    - ☐ Mugging/stealing /pick-pocketing
    - ☐ Other
18. What about the status of boarding and alighting?
    - ☐ Driver didn't stop the bus properly
    - ☐ Driver picked passengers on running situation
    - ☐ Driver stopped the bus properly=2;
19. How did the bus conductor pick passengers from stoppage:
    - ☐ Hurriedly
    - ☐ Modestly
20. Did the bus helper/driver harass female passengers?
    - ☐ No
    - ☐ Yes, Physically touched or harassed
    - ☐ Yes, Verbally harassed

21. Did any passenger harass female passengers?
    - ☐ No
    - ☐ Yes, Physically touched or harassed
    - ☐ Yes, Verbally harassed

Affordability (Part E):

22. How much did you pay?:……..tk

23. Did the bus conductor collect excess fare from female passengers?
    - ☐ No
    - ☐ Yes

Comfort (Part F):

Bus Stoppage Quality:

24. Was there enough shelter in the bus stoppage?
    - ☐ No Shelter
    - ☐ Small Shelter
    - ☐ Large shelter
25. Was there any arrangement of toilet at the bus stoppage?
    - ☐ No
    - ☐ Yes

Bus inside quality**:**

26. How was the bus inside quality?
    - ☐ Very dirty
    - ☐ Moderately dirty
    - ☐ Moderately clean
    - ☐ Very Clean
27. Was the bus crowded?
    - ☐ Not crowded
    - ☐ Crowded
    - ☐ Very much crowded
28. Was the bus noisy?
    - ☐ Not noisy
    - ☐ Noisy
    - ☐ Very much noisy
29. How was the heat condition inside the bus?
    - ☐ Intolerable
    - ☐ Tolerable

Responsiveness & empathy (Part G):

Attitudes:

30. Did any bus refuse to take female passengers?
    - ☐ No
    - ☐ Yes
31. Did you notice unacceptable attitudes towards female passengers by driver/conductor?

- ☐ No
- ☐ Yes, Immodest attitude

32. Did any male passenger treat female passenger badly?
    - ☐ No
    - ☐ Yes
    - ☐ Several incidents
33. Did anyone protest against bad behavior of drivers or helpers or other male passengers towards female passengers?
    - ☐ No incidents happened
    - ☐ Yes, males passenger protested
    - ☐ Yes, female passenger protested
    - ☐ Yes, both male and female passengers protested
    - ☐ Yes, the victim protested
34. Did the driver or conductor listen to the complaint against harassment?
    - ☐ No
    - ☐ Yes
35. Did any passenger insist driver to break the traffic rule?
    - ☐ No
    - ☐ Yes (Male)
36. **Overall Satisfaction of the service quality or the journey (Part H):**
    - ☐ **Dissatisfied**
    - ☐ **Less satisfied**
    - ☐ **Neutral**
    - ☐ **Satisfied**
    - ☐ **Very satisfied**
37. **Suggestion to improve service quality (Part F):**
    - ☐ **Implementation of traffic law strictly**
    - ☐ **Government monitoring & proper execution of traffic law**
    - ☐ **Train up drivers, conductors, helpers regarding ethical behavior towards passengers**
    - ☐ **Ensuring enough seats for female passengers**
    - ☐ **Comments:……**

Appendix C

All Possible Interactions Among Variables From Random Forest Analysis

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
1	Availability of seat right after boarding	Bad attitudes of male passenger	5.304	263	Bad attitudes of male passenger:Availbility of seat right after boarding	4.774
2	Availability of seat right after boarding	Boarding-alighting status	5.626	399	Boarding-alighting status:Availbility of seat right after boarding	4.774
3	Availability of seat right after boarding	Bus inside quality	5.001	212	Bus inside quality:Availbility of seat right after boarding	4.774
4	Availability of seat right after boarding	Crowed status	4.919	188	Crowed status:Availbility of seat right after boarding	4.774
5	Availability of seat right after boarding	Driving pattern	5.340	228	Driving pattern:Availbility of seat right after boarding	4.774
6	Availability of seat right after boarding	Female passenger harassment	5.424	346	Female passenger harassment:Availbility of seat right after boarding	4.774
7	Availability of seat right after boarding	Harassment by bus driver helper	5.852	327	Harassment by bus driver helper:Availbility of seat right after boarding	4.774
8	Availability of seat right after boarding	Harassment by male passenger	5.213	185	Harassment by male passenger:Availbility of seat right after boarding	4.774
9	Availability of seat right after boarding	Heat condition	4.639	194	Heat condition:Availbility of seat right after boarding	4.774
10	Availability of seat right after boarding	Noise status	5.008	203	Noise status:Availbility of seat right after boarding	4.774
11	Availability of seat right after boarding	Picking passengers	5.642	335	Picking passengers:Availbility of seat right after boarding	4.774
12	Availability of seat right after boarding	Protestation against bad behavior	5.573	210	Protestation against bad behavior:Availbility of seat right after boarding	4.774

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
13	Availability of seat right after boarding	Stoppage duration	5.109	179	Stoppage duration:Availbility of seat right after boarding	4.774
14	Availability of seat right after boarding	Travel status	6.154	192	Travel status:Availbility of seat right after boarding	4.774
15	Availability of seat right after boarding	Unacceptable attitudes towards female	5.227	250	Unacceptable attitudes towards female:Availbility of seat right after boarding	4.774
16	Availability of seat right after boarding	Waiting time for bus	5.533	284	Waiting time for bus:Availbility of seat right after boarding	4.774
17	Bad attitudes of male passenger	Bad attitudes of male passenger	5.903	169	Bad attitudes of male passenger:Bad attitudes of male passenger	3.517
18	Bad attitudes of male passenger	Boarding-alighting status	4.384	499	Boarding-alighting status:Bad attitudes of male passenger	3.517
19	Bad attitudes of male passenger	Bus inside quality	4.443	293	Bus inside quality:Bad attitudes of male passenger	3.517
20	Bad attitudes of male passenger	Crowed status	4.340	272	Crowed status:Bad attitudes of male passenger	3.517
21	Bad attitudes of male passenger	Driving pattern	4.603	342	Driving pattern:Bad attitudes of male passenger	3.517
22	Bad attitudes of male passenger	Female passenger harassment	4.508	450	Female passenger harassment:Bad attitudes of male passenger	3.517
23	Bad attitudes of male passenger	Harassment by bus driver helper	4.532	457	Harassment by bus driver helper:Bad attitudes of male passenger	3.517
24	Bad attitudes of male passenger	Harassment by male passenger	4.562	275	Harassment by male passenger:Bad attitudes of male passenger	3.517
25	Bad attitudes of male passenger	Heat condition	4.092	258	Heat condition:Bad attitudes of male passenger	3.517

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
26	Bad attitudes of male passenger	Noise status	4.359	304	Noise status:Bad attitudes of male passenger	3.517
27	Bad attitudes of male passenger	Picking passengers	4.427	433	Picking passengers:Bad attitudes of male passenger	3.517
28	Bad attitudes of male passenger	Protestation against bad behavior	4.638	340	Protestation against bad behavior:Bad attitudes of male passenger	3.517
29	Bad attitudes of male passenger	Stoppage duration	4.292	306	Stoppage duration:Bad attitudes of male passenger	3.517
30	Bad attitudes of male passenger	Travel status	4.455	386	Travel status:Bad attitudes of male passenger	3.517
31	Bad attitudes of male passenger	Unacceptable attitudes towards female	4.575	327	Unacceptable attitudes towards female:Bad attitudes of male passenger	3.517
32	Bad attitudes of male passenger	Waiting time for bus	4.430	413	Waiting time for bus:Bad attitudes of male passenger	3.517
33	Boarding-alighting status	Bad attitudes of male passenger	4.244	416	Bad attitudes of male passenger:Boarding-alighting status	2.578
34	Boarding-alighting status	Boarding-alighting status	6.175	443	Boarding-alighting status:Boarding-alighting status	2.578
35	Boarding-alighting status	Bus inside quality	4.173	370	Bus inside quality:Boarding-alighting status	2.578
36	Boarding-alighting status	Crowed status	4.104	321	Crowed status:Boarding-alighting status	2.578
37	Boarding-alighting status	Driving pattern	4.098	428	Driving pattern:Boarding-alighting status	2.578
38	Boarding-alighting status	Female passenger harassment	3.986	487	Female passenger harassment:Boarding-alighting status	2.578
39	Boarding-alighting status	Harassment by bus driver helper	4.239	511	Harassment by bus driver helper:Boarding-alighting status	2.578
40	Boarding-alighting status	Harassment by male passenger	4.164	330	Harassment by male passenger:Boarding-alighting status	2.578

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
41	Boarding-alighting status	Heat condition	3.823	338	Heat condition:Boarding-alighting status	2.578
42	Boarding-alighting status	Noise status	4.252	350	Noise status:Boarding-alighting status	2.578
43	Boarding-alighting status	Picking passengers	3.881	520	Picking passengers:Boarding-alighting status	2.578
44	Boarding-alighting status	Protestation against bad behavior	4.353	381	Protestation against bad behavior:Boarding-alighting status	2.578
45	Boarding-alighting status	Stoppage duration	3.999	374	Stoppage duration:Boarding-alighting status	2.578
46	Boarding-alighting status	Travel status	3.802	482	Travel status:Boarding-alighting status	2.578
47	Boarding-alighting status	Unacceptable attitudes towards female	4.105	418	Unacceptable attitudes towards female:Boarding-alighting status	2.578
48	Boarding-alighting status	Waiting time for bus	4.082	484	Waiting time for bus:Boarding-alighting status	2.578
49	Breaking traffic rule	Bad attitudes of male passenger	4.997	359	Bad attitudes of male passenger:Breaking traffic rule	4.991
50	Breaking traffic rule	Boarding-alighting status	4.794	529	Boarding-alighting status:Breaking traffic rule	4.991
51	Breaking traffic rule	Bus inside quality	4.588	322	Bus inside quality:Breaking traffic rule	4.991
52	Breaking traffic rule	Crowed status	4.483	290	Crowed status:Breaking traffic rule	4.991
53	Breaking traffic rule	Driving pattern	4.885	352	Driving pattern:Breaking traffic rule	4.991
54	Breaking traffic rule	Female passenger harassment	4.619	497	Female passenger harassment:Breaking traffic rule	4.991
55	Breaking traffic rule	Harassment by bus driver helper	5.120	456	Harassment by bus driver helper:Breaking traffic rule	4.991
56	Breaking traffic rule	Harassment by male passenger	4.621	317	Harassment by male passenger:Breaking traffic rule	4.991
57	Breaking traffic rule	Heat condition	4.413	278	Heat condition:Breaking traffic rule	4.991
58	Breaking traffic rule	Noise status	4.684	295	Noise status:Breaking traffic rule	4.991
59	Breaking traffic rule	Picking passengers	4.828	459	Picking passengers:Breaking traffic rule	4.991

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
60	Breaking traffic rule	Protestation against bad behavior	5.035	348	Protestation against bad behavior:Breaking traffic rule	4.991
61	Breaking traffic rule	Stoppage duration	4.484	304	Stoppage duration:Breaking traffic rule	4.991
62	Breaking traffic rule	Travel status	4.767	411	Travel status:Breaking traffic rule	4.991
63	Breaking traffic rule	Unacceptable attitudes towards female	4.793	347	Unacceptable attitudes towards female:Breaking traffic rule	4.991
64	Breaking traffic rule	Waiting time for bus	4.812	418	Waiting time for bus:Breaking traffic rule	4.991
65	Bus arriaval info	Bad attitudes of male passenger	5.722	231	Bad attitudes of male passenger:Bus arriaval info	6.388
66	Bus arriaval info	Boarding-alighting status	6.038	380	Boarding-alighting status:Bus arriaval info	6.388
67	Bus arriaval info	Bus inside quality	5.174	189	Bus inside quality:Bus arriaval info	6.388
68	Bus arriaval info	Crowed status	5.170	173	Crowed status:Bus arriaval info	6.388
69	Bus arriaval info	Driving pattern	5.447	210	Driving pattern:Bus arriaval info	6.388
70	Bus arriaval info	Female passenger harassment	5.836	350	Female passenger harassment:Bus arriaval info	6.388
71	Bus arriaval info	Harassment by bus driver helper	6.268	278	Harassment by bus driver helper:Bus arriaval info	6.388
72	Bus arriaval info	Harassment by male passenger	5.331	177	Harassment by male passenger:Bus arriaval info	6.388
73	Bus arriaval info	Heat condition	4.828	167	Heat condition:Bus arriaval info	6.388
74	Bus arriaval info	Noise status	5.201	182	Noise status:Bus arriaval info	6.388
75	Bus arriaval info	Picking passengers	5.940	320	Picking passengers:Bus arriaval info	6.388
76	Bus arriaval info	Protestation against bad behavior	5.543	213	Protestation against bad behavior:Bus arriaval info	6.388
77	Bus arriaval info	Stoppage duration	5.139	157	Stoppage duration:Bus arriaval info	6.388

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
78	Bus arriaval info	Travel status	5.730	275	Travel status:Bus arriaval info	6.388
79	Bus arriaval info	Unacceptable attitudes towards female	5.584	222	Unacceptable attitudes towards female:Bus arriaval info	6.388
80	Bus arriaval info	Waiting time for bus	6.000	224	Waiting time for bus:Bus arriaval info	6.388
81	Bus availability	Bad attitudes of male passenger	5.183	328	Bad attitudes of male passenger:Bus availability	5.619
82	Bus availability	Boarding-alighting status	5.452	451	Boarding-alighting status:Bus availability	5.619
83	Bus availability	Bus inside quality	4.696	289	Bus inside quality:Bus availability	5.619
84	Bus availability	Crowed status	4.788	253	Crowed status:Bus availability	5.619
85	Bus availability	Driving pattern	5.134	293	Driving pattern:Bus availability	5.619
86	Bus availability	Female passenger harassment	5.275	434	Female passenger harassment:Bus availability	5.619
87	Bus availability	Harassment by bus driver helper	5.570	397	Harassment by bus driver helper:Bus availability	5.619
88	Bus availability	Harassment by male passenger	5.007	248	Harassment by male passenger:Bus availability	5.619
89	Bus availability	Heat condition	4.529	241	Heat condition:Bus availability	5.619
90	Bus availability	Noise status	4.955	247	Noise status:Bus availability	5.619
91	Bus availability	Picking passengers	5.351	403	Picking passengers:Bus availability	5.619
92	Bus availability	Protestation against bad behavior	5.215	297	Protestation against bad behavior:Bus availability	5.619
93	Bus availability	Stoppage duration	4.810	240	Stoppage duration:Bus availability	5.619
94	Bus availability	Travel status	5.197	354	Travel status:Bus availability	5.619
95	Bus availability	Unacceptable attitudes towards female	5.104	308	Unacceptable attitudes towards female:Bus availability	5.619
96	Bus availability	Waiting time for bus	5.486	333	Waiting time for bus:Bus availability	5.619
97	Bus inside quality	Bad attitudes of male passenger	3.792	493	Bad attitudes of male passenger:Bus inside quality	3.591

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
98	Bus inside quality	Boarding-alighting status	3.024	648	Boarding-alighting status:Bus inside quality	3.591
99	Bus inside quality	Bus inside quality	5.045	267	Bus inside quality:Bus inside quality	3.591
100	Bus inside quality	Crowed status	4.017	349	Crowed status:Bus inside quality	3.591
101	Bus inside quality	Driving pattern	3.977	455	Driving pattern:Bus inside quality	3.591
102	Bus inside quality	Female passenger harassment	3.424	584	Female passenger harassment:Bus inside quality	3.591
103	Bus inside quality	Harassment by bus driver helper	3.870	545	Harassment by bus driver helper:Bus inside quality	3.591
104	Bus inside quality	Harassment by male passenger	3.916	396	Harassment by male passenger:Bus inside quality	3.591
105	Bus inside quality	Heat condition	3.698	371	Heat condition:Bus inside quality	3.591
106	Bus inside quality	Noise status	3.912	413	Noise status:Bus inside quality	3.591
107	Bus inside quality	Picking passengers	3.484	565	Picking passengers:Bus inside quality	3.591
108	Bus inside quality	Protestation against bad behavior	3.918	466	Protestation against bad behavior:Bus inside quality	3.591
109	Bus inside quality	Stoppage duration	3.779	416	Stoppage duration:Bus inside quality	3.591
110	Bus inside quality	Travel status	3.568	517	Travel status:Bus inside quality	3.591
111	Bus inside quality	Unacceptable attitudes towards female	4.068	429	Unacceptable attitudes towards female:Bus inside quality	3.591
112	Bus inside quality	Waiting time for bus	3.673	538	Waiting time for bus:Bus inside quality	3.591
113	Crowed status	Bad attitudes of male passenger	4.360	411	Bad attitudes of male passenger:Crowed status	4.036
114	Crowed status	Boarding-alighting status	4.198	566	Boarding-alighting status:Crowed status	4.036
115	Crowed status	Bus inside quality	4.205	356	Bus inside quality:Crowed status	4.036
116	Crowed status	Crowed status	5.134	209	Crowed status:Crowed status	4.036
117	Crowed status	Driving pattern	4.408	388	Driving pattern:Crowed status	4.036
118	Crowed status	Female passenger harassment	4.117	513	Female passenger harassment:Crowed status	4.036
119	Crowed status	Harassment by bus driver helper	4.612	485	Harassment by bus driver helper:Crowed status	4.036

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
120	Crowed status	Harassment by male passenger	4.403	334	Harassment by male passenger:Crowed status	4.036
121	Crowed status	Heat condition	4.142	304	Heat condition:Crowed status	4.036
122	Crowed status	Noise status	4.271	339	Noise status:Crowed status	4.036
123	Crowed status	Picking passengers	4.222	522	Picking passengers:Crowed status	4.036
124	Crowed status	Protestation against bad behavior	4.521	380	Protestation against bad behavior:Crowed status	4.036
125	Crowed status	Stoppage duration	4.198	347	Stoppage duration:Crowed status	4.036
126	Crowed status	Travel status	4.287	461	Travel status:Crowed status	4.036
127	Crowed status	Unacceptable attitudes towards female	4.536	356	Unacceptable attitudes towards female:Crowed status	4.036
128	Crowed status	Waiting time for bus	4.338	455	Waiting time for bus:Crowed status	4.036
129	Driving pattern	Bad attitudes of male passenger	2.955	552	Bad attitudes of male passenger:Driving pattern	3.096
130	Driving pattern	Boarding-alighting status	1.949	719	Boarding-alighting status:Driving pattern	3.096
131	Driving pattern	Bus inside quality	2.654	554	Bus inside quality:Driving pattern	3.096
132	Driving pattern	Crowed status	3.145	458	Crowed status:Driving pattern	3.096
133	Driving pattern	Driving pattern	4.109	459	Driving pattern:Driving pattern	3.096
134	Driving pattern	Female passenger harassment	2.427	651	Female passenger harassment:Driving pattern	3.096
135	Driving pattern	Harassment by bus driver helper	2.683	637	Harassment by bus driver helper:Driving pattern	3.096
136	Driving pattern	Harassment by male passenger	3.202	475	Harassment by male passenger:Driving pattern	3.096
137	Driving pattern	Heat condition	3.283	420	Heat condition:Driving pattern	3.096
138	Driving pattern	Noise status	2.666	549	Noise status:Driving pattern	3.096
139	Driving pattern	Picking passengers	2.392	643	Picking passengers:Driving pattern	3.096
140	Driving pattern	Protestation against bad behavior	2.835	569	Protestation against bad behavior:Driving pattern	3.096
141	Driving pattern	Stoppage duration	2.897	524	Stoppage duration:Driving pattern	3.096
142	Driving pattern	Travel status	2.450	621	Travel status:Driving pattern	3.096

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
143	Driving pattern	Unacceptable attitudes towards female	3.119	521	Unacceptable attitudes towards female:Driving pattern	3.096
144	Driving pattern	Waiting time for bus	2.305	650	Waiting time for bus:Driving pattern	3.096
145	Excess fare collection	Bad attitudes of male passenger	5.219	322	Bad attitudes of male passenger:Excess fare collection	5.668
146	Excess fare collection	Boarding-alighting status	5.285	470	Boarding-alighting status:Excess fare collection	5.668
147	Excess fare collection	Bus inside quality	4.877	261	Bus inside quality:Excess fare collection	5.668
148	Excess fare collection	Crowed status	4.824	249	Crowed status:Excess fare collection	5.668
149	Excess fare collection	Driving pattern	5.086	302	Driving pattern:Excess fare collection	5.668
150	Excess fare collection	Female passenger harassment	5.311	437	Female passenger harassment:Excess fare collection	5.668
151	Excess fare collection	Harassment by bus driver helper	5.448	416	Harassment by bus driver helper:Excess fare collection	5.668
152	Excess fare collection	Harassment by male passenger	4.896	263	Harassment by male passenger:Excess fare collection	5.668
153	Excess fare collection	Heat condition	4.501	254	Heat condition:Excess fare collection	5.668
154	Excess fare collection	Noise status	4.803	272	Noise status:Excess fare collection	5.668
155	Excess fare collection	Picking passengers	5.376	414	Picking passengers:Excess fare collection	5.668
156	Excess fare collection	Protestation against bad behavior	5.179	311	Protestation against bad behavior:Excess fare collection	5.668
157	Excess fare collection	Stoppage duration	4.767	258	Stoppage duration:Excess fare collection	5.668
158	Excess fare collection	Travel status	5.229	361	Travel status:Excess fare collection	5.668
159	Excess fare collection	Unacceptable attitudes towards female	5.095	316	Unacceptable attitudes towards female:Excess fare collection	5.668
160	Excess fare collection	Waiting time for bus	5.161	356	Waiting time for bus:Excess fare collection	5.668
161	Female passenger harassment	Bad attitudes of male passenger	4.560	357	Bad attitudes of male passenger:Female passenger harassment	2.895
162	Female passenger harassment	Boarding-alighting status	4.349	464	Boarding-alighting status:Female passenger harassment	2.895
163	Female passenger harassment	Bus inside quality	4.565	256	Bus inside quality:Female passenger harassment	2.895

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
164	Female passenger harassment	Crowed status	4.491	243	Crowed status:Female passenger harassment	2.895
165	Female passenger harassment	Driving pattern	4.709	312	Driving pattern:Female passenger harassment	2.895
166	Female passenger harassment	Female passenger harassment	6.253	256	Female passenger harassment:Female passenger harassment	2.895
167	Female passenger harassment	Harassment by bus driver helper	4.944	429	Harassment by bus driver helper:Female passenger harassment	2.895
168	Female passenger harassment	Harassment by male passenger	4.635	265	Harassment by male passenger:Female passenger harassment	2.895
169	Female passenger harassment	Heat condition	4.128	262	Heat condition:Female passenger harassment	2.895
170	Female passenger harassment	Noise status	4.521	273	Noise status:Female passenger harassment	2.895
171	Female passenger harassment	Picking passengers	4.446	437	Picking passengers:Female passenger harassment	2.895
172	Female passenger harassment	Protestation against bad behavior	4.546	346	Protestation against bad behavior:Female passenger harassment	2.895
173	Female passenger harassment	Stoppage duration	4.432	272	Stoppage duration:Female passenger harassment	2.895
174	Female passenger harassment	Travel status	4.544	365	Travel status:Female passenger harassment	2.895
175	Female passenger harassment	Unacceptable attitudes towards female	4.437	350	Unacceptable attitudes towards female:Female passenger harassment	2.895
176	Female passenger harassment	Waiting time for bus	4.431	400	Waiting time for bus:Female passenger harassment	2.895
177	Follow regular route	Bad attitudes of male passenger	5.034	355	Bad attitudes of male passenger:Follow regular route	5.513
178	Follow regular route	Boarding-alighting status	4.913	524	Boarding-alighting status:Follow regular route	5.513
179	Follow regular route	Bus inside quality	4.667	311	Bus inside quality:Follow regular route	5.513
180	Follow regular route	Crowed status	4.789	266	Crowed status:Follow regular route	5.513

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
181	Follow regular route	Driving pattern	5.090	307	Driving pattern:Follow regular route	5.513
182	Follow regular route	Female passenger harassment	5.005	459	Female passenger harassment:Follow regular route	5.513
183	Follow regular route	Harassment by bus driver helper	5.352	442	Harassment by bus driver helper:Follow regular route	5.513
184	Follow regular route	Harassment by male passenger	4.838	280	Harassment by male passenger:Follow regular route	5.513
185	Follow regular route	Heat condition	4.505	258	Heat condition:Follow regular route	5.513
186	Follow regular route	Noise status	4.723	284	Noise status:Follow regular route	5.513
187	Follow regular route	Picking passengers	5.091	444	Picking passengers:Follow regular route	5.513
188	Follow regular route	Protestation against bad behavior	5.023	350	Protestation against bad behavior:Follow regular route	5.513
189	Follow regular route	Stoppage duration	4.597	298	Stoppage duration:Follow regular route	5.513
190	Follow regular route	Travel status	4.893	392	Travel status:Follow regular route	5.513
191	Follow regular route	Unacceptable attitudes towards female	4.980	354	Unacceptable attitudes towards female:Follow regular route	5.513
192	Follow regular route	Waiting time for bus	5.241	386	Waiting time for bus:Follow regular route	5.513
193	Harassment by bus driver helper	Bad attitudes of male passenger	4.731	295	Bad attitudes of male passenger:Harassment by bus driver helper	3.120
194	Harassment by bus driver helper	Boarding-alighting status	5.019	394	Boarding-alighting status:Harassment by bus driver helper	3.120
195	Harassment by bus driver helper	Bus inside quality	4.834	202	Bus inside quality:Harassment by bus driver helper	3.120
196	Harassment by bus driver helper	Crowed status	4.655	207	Crowed status:Harassment by bus driver helper	3.120

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
197	Harassment by bus driver helper	Driving pattern	4.864	269	Driving pattern:Harassment by bus driver helper	3.120
198	Harassment by bus driver helper	Female passenger harassment	5.109	368	Female passenger harassment:Harassment by bus driver helper	3.120
199	Harassment by bus driver helper	Harassment by bus driver helper	7.068	130	Harassment by bus driver helper:Harassment by bus driver helper	3.120
200	Harassment by bus driver helper	Harassment by male passenger	4.437	260	Harassment by male passenger:Harassment by bus driver helper	3.120
201	Harassment by bus driver helper	Heat condition	4.480	173	Heat condition:Harassment by bus driver helper	3.120
202	Harassment by bus driver helper	Noise status	4.628	248	Noise status:Harassment by bus driver helper	3.120
203	Harassment by bus driver helper	Picking passengers	4.664	372	Picking passengers:Harassment by bus driver helper	3.120
204	Harassment by bus driver helper	Protestation against bad behavior	4.803	285	Protestation against bad behavior:Harassment by bus driver helper	3.120
205	Harassment by bus driver helper	Stoppage duration	4.513	242	Stoppage duration:Harassment by bus driver helper	3.120
206	Harassment by bus driver helper	Travel status	4.990	295	Travel status:Harassment by bus driver helper	3.120
207	Harassment by bus driver helper	Unacceptable attitudes towards female	4.812	279	Unacceptable attitudes towards female:Harassment by bus driver helper	3.120
208	Harassment by bus driver helper	Waiting time for bus	4.858	321	Waiting time for bus:Harassment by bus driver helper	3.120
209	Harassment by male passenger	Bad attitudes of male passenger	4.838	335	Bad attitudes of male passenger:Harassment by male passenger	4.008

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
210	Harassment by male passenger	Boarding-alighting status	4.882	440	Boarding-alighting status:Harassment by male passenger	4.008
211	Harassment by male passenger	Bus inside quality	4.749	238	Bus inside quality:Harassment by male passenger	4.008
212	Harassment by male passenger	Crowed status	4.583	235	Crowed status:Harassment by male passenger	4.008
213	Harassment by male passenger	Driving pattern	4.666	326	Driving pattern:Harassment by male passenger	4.008
214	Harassment by male passenger	Female passenger harassment	5.270	383	Female passenger harassment:Harassment by male passenger	4.008
215	Harassment by male passenger	Harassment by bus driver helper	4.494	452	Harassment by bus driver helper:Harassment by male passenger	4.008
216	Harassment by male passenger	Harassment by male passenger	5.484	131	Harassment by male passenger:Harassment by male passenger	4.008
217	Harassment by male passenger	Heat condition	4.328	236	Heat condition:Harassment by male passenger	4.008
218	Harassment by male passenger	Noise status	4.471	283	Noise status:Harassment by male passenger	4.008
219	Harassment by male passenger	Picking passengers	4.829	415	Picking passengers:Harassment by male passenger	4.008
220	Harassment by male passenger	Protestation against bad behavior	4.813	320	Protestation against bad behavior:Harassment by male passenger	4.008
221	Harassment by male passenger	Stoppage duration	4.473	279	Stoppage duration:Harassment by male passenger	4.008
222	Harassment by male passenger	Travel status	4.721	357	Travel status:Harassment by male passenger	4.008
223	Harassment by male passenger	Unacceptable attitudes towards female	4.702	335	Unacceptable attitudes towards female:Harassment by male passenger	4.008
224	Harassment by male passenger	Waiting time for bus	4.647	389	Waiting time for bus:Harassment by male passenger	4.008
225	Heat condition	Bad attitudes of male passenger	4.873	341	Bad attitudes of male passenger:Heat condition	4.633
226	Heat condition	Boarding-alighting status	5.086	474	Boarding-alighting status:Heat condition	4.633
227	Heat condition	Bus inside quality	4.667	295	Bus inside quality:Heat condition	4.633

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
228	Heat condition	Crowed status	4.534	287	Crowed status:Heat condition	4.633
229	Heat condition	Driving pattern	4.941	315	Driving pattern:Heat condition	4.633
230	Heat condition	Female passenger harassment	5.062	428	Female passenger harassment:Heat condition	4.633
231	Heat condition	Harassment by bus driver helper	5.244	411	Harassment by bus driver helper:Heat condition	4.633
232	Heat condition	Harassment by male passenger	4.898	259	Harassment by male passenger:Heat condition	4.633
233	Heat condition	Heat condition	5.306	0	Heat condition:Heat condition	4.633
234	Heat condition	Noise status	4.726	268	Noise status:Heat condition	4.633
235	Heat condition	Picking passengers	4.844	438	Picking passengers:Heat condition	4.633
236	Heat condition	Protestation against bad behavior	5.127	303	Protestation against bad behavior:Heat condition	4.633
237	Heat condition	Stoppage duration	4.715	261	Stoppage duration:Heat condition	4.633
238	Heat condition	Travel status	4.811	392	Travel status:Heat condition	4.633
239	Heat condition	Unacceptable attitudes towards female	4.918	322	Unacceptable attitudes towards female:Heat condition	4.633
240	Heat condition	Waiting time for bus	5.085	367	Waiting time for bus:Heat condition	4.633
241	Insisting driver to break traffic rule	Bad attitudes of male passenger	4.996	328	Bad attitudes of male passenger:Insisting driver to break traffic rule	5.505
242	Insisting driver to break traffic rule	Boarding-alighting status	5.216	471	Boarding-alighting status:Insisting driver to break traffic rule	5.505
243	Insisting driver to break traffic rule	Bus inside quality	4.918	245	Bus inside quality:Insisting driver to break traffic rule	5.505
244	Insisting driver to break traffic rule	Crowed status	4.853	242	Crowed status:Insisting driver to break traffic rule	5.505
245	Insisting driver to break traffic rule	Driving pattern	5.225	270	Driving pattern:Insisting driver to break traffic rule	5.505
246	Insisting driver to	Female passenger harassment	5.298	422	Female passenger harassment:Insisting driver to break traffic rule	5.505

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
	break traffic rule					
247	Insisting driver to break traffic rule	Harassment by bus driver helper	5.372	402	Harassment by bus driver helper:Insisting driver to break traffic rule	5.505
248	Insisting driver to break traffic rule	Harassment by male passenger	4.854	253	Harassment by male passenger:Insisting driver to break traffic rule	5.505
249	Insisting driver to break traffic rule	Heat condition	4.509	230	Heat condition:Insisting driver to break traffic rule	5.505
250	Insisting driver to break traffic rule	Noise status	4.888	257	Noise status:Insisting driver to break traffic rule	5.505
251	Insisting driver to break traffic rule	Picking passengers	5.333	405	Picking passengers:Insisting driver to break traffic rule	5.505
252	Insisting driver to break traffic rule	Protestation against bad behavior	5.143	290	Protestation against bad behavior:Insisting driver to break traffic rule	5.505
253	Insisting driver to break traffic rule	Stoppage duration	4.830	231	Stoppage duration:Insisting driver to break traffic rule	5.505
254	Insisting driver to break traffic rule	Travel status	5.232	336	Travel status:Insisting driver to break traffic rule	5.505
255	Insisting driver to break traffic rule	Unacceptable attitudes towards female	5.099	300	Unacceptable attitudes towards female:Insisting driver to break traffic rule	5.505
256	Insisting driver to break traffic rule	Waiting time for bus	5.270	347	Waiting time for bus:Insisting driver to break traffic rule	5.505
257	Mugging-stealing-pick pocketing	Bad attitudes of male passenger	6.111	126	Bad attitudes of male passenger:Mugging-stealing-pick pocketing	7.812
258	Mugging-stealing-pick pocketing	Boarding-alighting status	7.279	185	Boarding-alighting status:Mugging-stealing-pick pocketing	7.812
259	Mugging-stealing-	Bus inside quality	5.520	88	Bus inside quality:Mugging-stealing- pick pocketing	7.812

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
	pick pocketing					
260	Mugging-stealing-pick pocketing	Crowed status	5.389	85	Crowed status:Mugging-stealing- pick pocketing	7.812
261	Mugging-stealing-pick pocketing	Driving pattern	6.145	79	Driving pattern:Mugging-stealing- pick pocketing	7.812
262	Mugging-stealing-pick pocketing	Female passenger harassment	6.851	143	Female passenger harassment:Mugging-stealing- pick pocketing	7.812
263	Mugging-stealing-pick pocketing	Harassment by bus driver helper	6.966	163	Harassment by bus driver helper:Mugging-stealing-pick pocketing	7.812
264	Mugging-stealing-pick pocketing	Harassment by male passenger	5.554	103	Harassment by male passenger:Mugging-stealing-pick pocketing	7.812
265	Mugging-stealing-pick pocketing	Heat condition	5.107	70	Heat condition:Mugging-stealing- pick pocketing	7.812
266	Mugging-stealing-pick pocketing	Noise status	5.568	85	Noise status:Mugging-stealing- pick pocketing	7.812
267	Mugging-stealing-pick pocketing	Picking passengers	6.527	187	Picking passengers:Mugging-stealing- pick pocketing	7.812
268	Mugging-stealing-pick pocketing	Protestation against bad behavior	6.190	87	Protestation against bad behavior:Mugging-stealing-pick pocketing	7.812
269	Mugging-stealing-pick pocketing	Stoppage duration	5.496	81	Stoppage duration:Mugging-stealing- pick pocketing	7.812
270	Mugging-stealing-pick pocketing	Travel status	6.439	121	Travel status:Mugging-stealing- pick pocketing	7.812
271	Mugging-stealing-pick pocketing	Unacceptable attitudes towards female	5.990	109	Unacceptable attitudes towards female:Mugging-stealing- pick pocketing	7.812
272	Mugging-stealing-	Waiting time for bus	6.618	117	Waiting time for bus:Mugging-stealing- pick pocketing	7.812

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
	pick pocketing					
273	Noise status	Bad attitudes of male passenger	3.934	461	Bad attitudes of male passenger:Noise status	3.657
274	Noise status	Boarding-alighting status	3.488	607	Boarding-alighting status:Noise status	3.657
275	Noise status	Bus inside quality	3.954	424	Bus inside quality:Noise status	3.657
276	Noise status	Crowed status	3.990	372	Crowed status:Noise status	3.657
277	Noise status	Driving pattern	3.939	452	Driving pattern:Noise status	3.657
278	Noise status	Female passenger harassment	3.670	551	Female passenger harassment:Noise status	3.657
279	Noise status	Harassment by bus driver helper	3.873	538	Harassment by bus driver helper:Noise status	3.657
280	Noise status	Harassment by male passenger	4.024	384	Harassment by male passenger:Noise status	3.657
281	Noise status	Heat condition	3.878	339	Heat condition:Noise status	3.657
282	Noise status	Noise status	5.249	231	Noise status:Noise status	3.657
283	Noise status	Picking passengers	3.700	556	Picking passengers:Noise status	3.657
284	Noise status	Protestation against bad behavior	4.024	454	Protestation against bad behavior:Noise status	3.657
285	Noise status	Stoppage duration	3.896	393	Stoppage duration:Noise status	3.657
286	Noise status	Travel status	3.737	508	Travel status:Noise status	3.657
287	Noise status	Unacceptable attitudes towards female	3.876	439	Unacceptable attitudes towards female:Noise status	3.657
288	Noise status	Waiting time for bus	3.580	538	Waiting time for bus:Noise status	3.657
289	Picking passengers	Bad attitudes of male passenger	5.060	282	Bad attitudes of male passenger:Picking passengers	3.102
290	Picking passengers	Boarding-alighting status	5.468	411	Boarding-alighting status:Picking passengers	3.102
291	Picking passengers	Bus inside quality	4.740	249	Bus inside quality:Picking passengers	3.102
292	Picking passengers	Crowed status	4.671	206	Crowed status:Picking passengers	3.102
293	Picking passengers	Driving pattern	5.153	249	Driving pattern:Picking passengers	3.102
294	Picking passengers	Female passenger harassment	4.910	387	Female passenger harassment:Picking passengers	3.102

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
295	Picking passengers	Harassment by bus driver helper	5.330	336	Harassment by bus driver helper:Picking passengers	3.102
296	Picking passengers	Harassment by male passenger	5.006	210	Harassment by male passenger:Picking passengers	3.102
297	Picking passengers	Heat condition	4.671	192	Heat condition:Picking passengers	3.102
298	Picking passengers	Noise status	4.824	222	Noise status:Picking passengers	3.102
299	Picking passengers	Picking passengers	7.644	0	Picking passengers:Picking passengers	3.102
300	Picking passengers	Protestation against bad behavior	5.254	258	Protestation against bad behavior:Picking passengers	3.102
301	Picking passengers	Stoppage duration	4.928	192	Stoppage duration:Picking passengers	3.102
302	Picking passengers	Travel status	5.151	306	Travel status:Picking passengers	3.102
303	Picking passengers	Unacceptable attitudes towards female	4.985	262	Unacceptable attitudes towards female:Picking passengers	3.102
304	Picking passengers	Waiting time for bus	5.430	285	Waiting time for bus:Picking passengers	3.102
305	Presence of reprentative	Bad attitudes of male passenger	5.116	349	Bad attitudes of male passenger:Presence of reprentative	5.277
306	Presence of reprentative	Boarding-alighting status	4.747	533	Boarding-alighting status:Presence of reprentative	5.277
307	Presence of reprentative	Bus inside quality	4.721	304	Bus inside quality:Presence of reprentative	5.277
308	Presence of reprentative	Crowed status	4.708	264	Crowed status:Presence of reprentative	5.277
309	Presence of reprentative	Driving pattern	5.031	309	Driving pattern:Presence of reprentative	5.277
310	Presence of reprentative	Female passenger harassment	4.858	465	Female passenger harassment:Presence of reprentative	5.277
311	Presence of reprentative	Harassment by bus driver helper	5.287	428	Harassment by bus driver helper:Presence of reprentative	5.277
312	Presence of reprentative	Harassment by male passenger	4.824	281	Harassment by male passenger:Presence of reprentative	5.277
313	Presence of reprentative	Heat condition	4.470	278	Heat condition:Presence of reprentative	5.277

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
314	Presence of reprentative	Noise status	4.833	278	Noise status:Presence of reprentative	5.277
315	Presence of reprentative	Picking passengers	4.999	462	Picking passengers:Presence of reprentative	5.277
316	Presence of reprentative	Protestation against bad behavior	5.240	314	Protestation against bad behavior:Presence of reprentative	5.277
317	Presence of reprentative	Stoppage duration	4.760	277	Stoppage duration:Presence of reprentative	5.277
318	Presence of reprentative	Travel status	5.053	373	Travel status:Presence of reprentative	5.277
319	Presence of reprentative	Unacceptable attitudes towards female	4.950	317	Unacceptable attitudes towards female:Presence of reprentative	5.277
320	Presence of reprentative	Waiting time for bus	5.006	394	Waiting time for bus:Presence of reprentative	5.277
321	Protestation against bad behavior	Bad attitudes of male passenger	4.156	379	Bad attitudes of male passenger:Protestation against bad behavior	3.289
322	Protestation against bad behavior	Boarding-alighting status	3.632	548	Boarding-alighting status:Protestation against bad behavior	3.289
323	Protestation against bad behavior	Bus inside quality	4.115	336	Bus inside quality:Protestation against bad behavior	3.289
324	Protestation against bad behavior	Crowed status	3.948	335	Crowed status:Protestation against bad behavior	3.289
325	Protestation against bad behavior	Driving pattern	3.655	442	Driving pattern:Protestation against bad behavior	3.289
326	Protestation against bad behavior	Female passenger harassment	3.821	505	Female passenger harassment:Protestation against bad behavior	3.289
327	Protestation against bad behavior	Harassment by bus driver helper	3.607	527	Harassment by bus driver helper:Protestation against bad behavior	3.289
328	Protestation against bad behavior	Harassment by male passenger	3.911	353	Harassment by male passenger:Protestation against bad behavior	3.289

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
329	Protestation against bad behavior	Heat condition	3.992	278	Heat condition:Protestation against bad behavior	3.289
330	Protestation against bad behavior	Noise status	3.820	376	Noise status:Protestation against bad behavior	3.289
331	Protestation against bad behavior	Picking passengers	3.727	504	Picking passengers:Protestation against bad behavior	3.289
332	Protestation against bad behavior	Protestation against bad behavior	5.249	255	Protestation against bad behavior:Protestation against bad behavior	3.289
333	Protestation against bad behavior	Stoppage duration	3.917	347	Stoppage duration:Protestation against bad behavior	3.289
334	Protestation against bad behavior	Travel status	3.869	451	Travel status:Protestation against bad behavior	3.289
335	Protestation against bad behavior	Unacceptable attitudes towards female	4.121	374	Unacceptable attitudes towards female:Protestation against bad behavior	3.289
336	Protestation against bad behavior	Waiting time for bus	3.630	501	Waiting time for bus:Protestation against bad behavior	3.289
337	Refuse female passenger	Bad attitudes of male passenger	5.068	320	Bad attitudes of male passenger:Refuse female passenger	4.496
338	Refuse female passenger	Boarding-alighting status	4.803	495	Boarding-alighting status:Refuse female passenger	4.496
339	Refuse female passenger	Bus inside quality	4.799	258	Bus inside quality:Refuse female passenger	4.496
340	Refuse female passenger	Crowed status	4.762	241	Crowed status:Refuse female passenger	4.496
341	Refuse female passenger	Driving pattern	4.998	301	Driving pattern:Refuse female passenger	4.496
342	Refuse female passenger	Female passenger harassment	4.946	423	Female passenger harassment:Refuse female passenger	4.496
343	Refuse female passenger	Harassment by bus driver helper	4.944	425	Harassment by bus driver helper:Refuse female passenger	4.496

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
344	Refuse female passenger	Harassment by male passenger	4.835	262	Harassment by male passenger:Refuse female passenger	4.496
345	Refuse female passenger	Heat condition	4.459	241	Heat condition:Refuse female passenger	4.496
346	Refuse female passenger	Noise status	4.713	283	Noise status:Refuse female passenger	4.496
347	Refuse female passenger	Picking passengers	4.889	424	Picking passengers:Refuse female passenger	4.496
348	Refuse female passenger	Protestation against bad behavior	5.051	303	Protestation against bad behavior:Refuse female passenger	4.496
349	Refuse female passenger	Stoppage duration	4.662	271	Stoppage duration:Refuse female passenger	4.496
350	Refuse female passenger	Travel status	4.911	377	Travel status:Refuse female passenger	4.496
351	Refuse female passenger	Unacceptable attitudes towards female	4.969	316	Unacceptable attitudes towards female:Refuse female passenger	4.496
352	Refuse female passenger	Waiting time for bus	5.020	363	Waiting time for bus:Refuse female passenger	4.496
353	Refused to get into bus for occupied female seats	Bad attitudes of male passenger	4.911	384	Bad attitudes of male passenger:Refused to get into bus for occupied female seats	5.215
354	Refused to get into bus for occupied female seats	Boarding-alighting status	4.815	545	Boarding-alighting status:Refused to get into bus for occupied female seats	5.215
355	Refused to get into bus for occupied female seats	Bus inside quality	4.771	294	Bus inside quality:Refused to get into bus for occupied female seats	5.215
356	Refused to get into bus for occupied female seats	Crowed status	4.710	274	Crowed status:Refused to get into bus for occupied female seats	5.215

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
357	Refused to get into bus for occupied female seats	Driving pattern	4.971	330	Driving pattern:Refused to get into bus for occupied female seats	5.215
358	Refused to get into bus for occupied female seats	Female passenger harassment	5.080	456	Female passenger harassment:Refused to get into bus for occupied female seats	5.215
359	Refused to get into bus for occupied female seats	Harassment by bus driver helper	5.438	433	Harassment by bus driver helper:Refused to get into bus for occupied female seats	5.215
360	Refused to get into bus for occupied female seats	Harassment by male passenger	4.827	289	Harassment by male passenger:Refused to get into bus for occupied female seats	5.215
361	Refused to get into bus for occupied female seats	Heat condition	4.460	278	Heat condition:Refused to get into bus for occupied female seats	5.215
362	Refused to get into bus for occupied female seats	Noise status	4.683	296	Noise status:Refused to get into bus for occupied female seats	5.215
363	Refused to get into bus for occupied female seats	Picking passengers	4.860	458	Picking passengers:Refused to get into bus for occupied female seats	5.215
364	Refused to get into bus for occupied female seats	Protestation against bad behavior	5.117	332	Protestation against bad behavior:Refused to get into bus for occupied female seats	5.215
365	Refused to get into bus for occupied	Stoppage duration	4.622	296	Stoppage duration:Refused to get into bus for occupied female seats	5.215

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
	female seats					
366	Refused to get into bus for occupied female seats	Travel status	4.836	423	Travel status:Refused to get into bus for occupied female seats	5.215
367	Refused to get into bus for occupied female seats	Unacceptable attitudes towards female	5.082	345	Unacceptable attitudes towards female:Refused to get into bus for occupied female seats	5.215
368	Refused to get into bus for occupied female seats	Waiting time for bus	4.863	420	Waiting time for bus:Refused to get into bus for occupied female seats	5.215
369	Shelterat stoppage	Bad attitudes of male passenger	4.621	354	Bad attitudes of male passenger:Shelterat stoppage	4.405
370	Shelterat stoppage	Boarding-alighting status	4.423	529	Boarding-alighting status:Shelterat stoppage	4.405
371	Shelterat stoppage	Bus inside quality	4.598	293	Bus inside quality:Shelterat stoppage	4.405
372	Shelterat stoppage	Crowed status	4.539	253	Crowed status:Shelterat stoppage	4.405
373	Shelterat stoppage	Driving pattern	4.646	321	Driving pattern:Shelterat stoppage	4.405
374	Shelterat stoppage	Female passenger harassment	4.425	473	Female passenger harassment:Shelterat stoppage	4.405
375	Shelterat stoppage	Harassment by bus driver helper	4.777	432	Harassment by bus driver helper:Shelterat stoppage	4.405
376	Shelterat stoppage	Harassment by male passenger	4.484	304	Harassment by male passenger:Shelterat stoppage	4.405
377	Shelterat stoppage	Heat condition	4.320	255	Heat condition:Shelterat stoppage	4.405
378	Shelterat stoppage	Noise status	4.526	286	Noise status:Shelterat stoppage	4.405
379	Shelterat stoppage	Picking passengers	4.715	440	Picking passengers:Shelterat stoppage	4.405
380	Shelterat stoppage	Protestation against bad behavior	4.724	332	Protestation against bad behavior:Shelterat stoppage	4.405
381	Shelterat stoppage	Stoppage duration	4.374	307	Stoppage duration:Shelterat stoppage	4.405
382	Shelterat stoppage	Travel status	4.749	377	Travel status:Shelterat stoppage	4.405

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
383	Shelterat stoppage	Unacceptable attitudes towards female	4.801	303	Unacceptable attitudes towards female:Shelterat stoppage	4.405
384	Shelterat stoppage	Waiting time for bus	4.738	384	Waiting time for bus:Shelterat stoppage	4.405
385	Stoppage duration	Bad attitudes of male passenger	3.443	512	Bad attitudes of male passenger:Stoppage duration	3.411
386	Stoppage duration	Boarding-alighting status	2.330	687	Boarding-alighting status:Stoppage duration	3.411
387	Stoppage duration	Bus inside quality	3.065	513	Bus inside quality:Stoppage duration	3.411
388	Stoppage duration	Crowed status	3.420	427	Crowed status:Stoppage duration	3.411
389	Stoppage duration	Driving pattern	2.999	557	Driving pattern:Stoppage duration	3.411
390	Stoppage duration	Female passenger harassment	2.910	623	Female passenger harassment:Stoppage duration	3.411
391	Stoppage duration	Harassment by bus driver helper	2.999	612	Harassment by bus driver helper:Stoppage duration	3.411
392	Stoppage duration	Harassment by male passenger	3.437	443	Harassment by male passenger:Stoppage duration	3.411
393	Stoppage duration	Heat condition	3.287	407	Heat condition:Stoppage duration	3.411
394	Stoppage duration	Noise status	3.157	487	Noise status:Stoppage duration	3.411
395	Stoppage duration	Picking passengers	2.797	624	Picking passengers:Stoppage duration	3.411
396	Stoppage duration	Protestation against bad behavior	3.259	533	Protestation against bad behavior:Stoppage duration	3.411
397	Stoppage duration	Stoppage duration	4.347	360	Stoppage duration:Stoppage duration	3.411
398	Stoppage duration	Travel status	2.892	590	Travel status:Stoppage duration	3.411
399	Stoppage duration	Unacceptable attitudes towards female	3.517	473	Unacceptable attitudes towards female:Stoppage duration	3.411
400	Stoppage duration	Waiting time for bus	2.904	591	Waiting time for bus:Stoppage duration	3.411
401	Taking account the complaint	Bad attitudes of male passenger	5.158	270	Bad attitudes of male passenger:Taking account the complaint	5.372
402	Taking account the complaint	Boarding-alighting status	5.820	374	Boarding-alighting status:Taking account the complaint	5.372
403	Taking account the complaint	Bus inside quality	5.100	192	Bus inside quality:Taking account the complaint	5.372

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
404	Taking account the complaint	Crowed status	4.973	194	Crowed status:Taking account the complaint	5.372
405	Taking account the complaint	Driving pattern	5.244	244	Driving pattern:Taking account the complaint	5.372
406	Taking account the complaint	Female passenger harassment	5.179	383	Female passenger harassment:Taking account the complaint	5.372
407	Taking account the complaint	Harassment by bus driver helper	5.510	354	Harassment by bus driver helper:Taking account the complaint	5.372
408	Taking account the complaint	Harassment by male passenger	4.953	209	Harassment by male passenger:Taking account the complaint	5.372
409	Taking account the complaint	Heat condition	4.603	195	Heat condition:Taking account the complaint	5.372
410	Taking account the complaint	Noise status	4.979	218	Noise status:Taking account the complaint	5.372
411	Taking account the complaint	Picking passengers	5.436	364	Picking passengers:Taking account the complaint	5.372
412	Taking account the complaint	Protestation against bad behavior	5.224	250	Protestation against bad behavior:Taking account the complaint	5.372
413	Taking account the complaint	Stoppage duration	4.846	191	Stoppage duration:Taking account the complaint	5.372
414	Taking account the complaint	Travel status	5.195	315	Travel status:Taking account the complaint	5.372
415	Taking account the complaint	Unacceptable attitudes towards female	5.179	260	Unacceptable attitudes towards female:Taking account the complaint	5.372
416	Taking account the complaint	Waiting time for bus	5.365	302	Waiting time for bus:Taking account the complaint	5.372
417	Toilet at stoppage	Bad attitudes of male passenger	5.416	221	Bad attitudes of male passenger:Toilet at stoppage	5.077
418	Toilet at stoppage	Boarding-alighting status	5.900	329	Boarding-alighting status:Toilet at stoppage	5.077
419	Toilet at stoppage	Bus inside quality	5.170	166	Bus inside quality:Toilet at stoppage	5.077
420	Toilet at stoppage	Crowed status	4.913	174	Crowed status:Toilet at stoppage	5.077
421	Toilet at stoppage	Driving pattern	5.314	205	Driving pattern:Toilet at stoppage	5.077
422	Toilet at stoppage	Female passenger harassment	5.301	338	Female passenger harassment:Toilet at stoppage	5.077

Sl.	Variable	root_variable	mean _min_ depth	Occurrences	Interaction	uncond _mean_ min_de pth
423	Toilet at stoppage	Harassment by bus driver helper	5.302	322	Harassment by bus driver helper:Toilet at stoppage	5.077
424	Toilet at stoppage	Harassment by male passenger	5.072	177	Harassment by male passenger:Toilet at stoppage	5.077
425	Toilet at stoppage	Heat condition	4.720	139	Heat condition:Toilet at stoppage	5.077
426	Toilet at stoppage	Noise status	5.007	176	Noise status:Toilet at stoppage	5.077
427	Toilet at stoppage	Picking passengers	5.744	294	Picking passengers:Toilet at stoppage	5.077
428	Toilet at stoppage	Protestation against bad behavior	5.499	200	Protestation against bad behavior:Toilet at stoppage	5.077
429	Toilet at stoppage	Stoppage duration	4.932	172	Stoppage duration:Toilet at stoppage	5.077
430	Toilet at stoppage	Travel status	5.561	244	Travel status:Toilet at stoppage	5.077
431	Toilet at stoppage	Unacceptable attitudes towards female	5.363	202	Unacceptable attitudes towards female:Toilet at stoppage	5.077
432	Toilet at stoppage	Waiting time for bus	5.590	258	Waiting time for bus:Toilet at stoppage	5.077
433	Travel status	Bad attitudes of male passenger	3.943	455	Bad attitudes of male passenger:Travel status	3.201
434	Travel status	Boarding-alighting status	3.338	608	Boarding-alighting status:Travel status	3.201
435	Travel status	Bus inside quality	3.986	391	Bus inside quality:Travel status	3.201
436	Travel status	Crowed status	3.958	358	Crowed status:Travel status	3.201
437	Travel status	Driving pattern	3.837	459	Driving pattern:Travel status	3.201
438	Travel status	Female passenger harassment	3.440	561	Female passenger harassment:Travel status	3.201
439	Travel status	Harassment by bus driver helper	3.809	539	Harassment by bus driver helper:Travel status	3.201
440	Travel status	Harassment by male passenger	3.997	390	Harassment by male passenger:Travel status	3.201
441	Travel status	Heat condition	3.890	334	Heat condition:Travel status	3.201
442	Travel status	Noise status	3.800	406	Noise status:Travel status	3.201
443	Travel status	Picking passengers	3.610	536	Picking passengers:Travel status	3.201
444	Travel status	Protestation against bad behavior	3.806	470	Protestation against bad behavior:Travel status	3.201
445	Travel status	Stoppage duration	3.761	405	Stoppage duration:Travel status	3.201

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
446	Travel status	Travel status	5.217	372	Travel status:Travel status	3.201
447	Travel status	Unacceptable attitudes towards female	3.981	431	Unacceptable attitudes towards female:Travel status	3.201
448	Travel status	Waiting time for bus	3.692	518	Waiting time for bus:Travel status	3.201
449	Unacceptable attitudes towards female	Bad attitudes of male passenger	5.181	268	Bad attitudes of male passenger:Unacceptable attitudes towards female	4.197
450	Unacceptable attitudes towards female	Boarding-alighting status	5.345	420	Boarding-alighting status:Unacceptable attitudes towards female	4.197
451	Unacceptable attitudes towards female	Bus inside quality	4.929	217	Bus inside quality:Unacceptable attitudes towards female	4.197
452	Unacceptable attitudes towards female	Crowed status	4.743	200	Crowed status:Unacceptable attitudes towards female	4.197
453	Unacceptable attitudes towards female	Driving pattern	4.971	273	Driving pattern:Unacceptable attitudes towards female	4.197
454	Unacceptable attitudes towards female	Female passenger harassment	5.419	353	Female passenger harassment:Unacceptable attitudes towards female	4.197
455	Unacceptable attitudes towards female	Harassment by bus driver helper	5.420	374	Harassment by bus driver helper:Unacceptable attitudes towards female	4.197
456	Unacceptable attitudes towards female	Harassment by male passenger	4.869	220	Harassment by male passenger:Unacceptable attitudes towards female	4.197
457	Unacceptable attitudes towards female	Heat condition	4.483	209	Heat condition:Unacceptable attitudes towards female	4.197
458	Unacceptable attitudes towards female	Noise status	4.940	205	Noise status:Unacceptable attitudes towards female	4.197
459	Unacceptable attitudes towards female	Picking passengers	5.242	364	Picking passengers:Unacceptable attitudes towards female	4.197

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
460	Unacceptable attitudes towards female	Protestation against bad behavior	5.230	272	Protestation against bad behavior:Unacceptable attitudes towards female	4.197
461	Unacceptable attitudes towards female	Stoppage duration	4.832	218	Stoppage duration:Unacceptable attitudes towards female	4.197
462	Unacceptable attitudes towards female	Travel status	5.260	293	Travel status:Unacceptable attitudes towards female	4.197
463	Unacceptable attitudes towards female	Unacceptable attitudes towards female	6.418	0	Unacceptable attitudes towards female:Unacceptable attitudes towards female	4.197
464	Unacceptable attitudes towards female	Waiting time for bus	5.115	330	Waiting time for bus:Unacceptable attitudes towards female	4.197
465	Waiting time for bus	Bad attitudes of male passenger	3.110	539	Bad attitudes of male passenger:Waiting time for bus	2.854
466	Waiting time for bus	Boarding-alighting status	1.856	710	Boarding-alighting status:Waiting time for bus	2.854
467	Waiting time for bus	Bus inside quality	2.920	533	Bus inside quality:Waiting time for bus	2.854
468	Waiting time for bus	Crowed status	3.279	445	Crowed status:Waiting time for bus	2.854
469	Waiting time for bus	Driving pattern	2.703	570	Driving pattern:Waiting time for bus	2.854
470	Waiting time for bus	Female passenger harassment	2.661	627	Female passenger harassment:Waiting time for bus	2.854
471	Waiting time for bus	Harassment by bus driver helper	2.482	645	Harassment by bus driver helper:Waiting time for bus	2.854
472	Waiting time for bus	Harassment by male passenger	3.425	440	Harassment by male passenger:Waiting time for bus	2.854
473	Waiting time for bus	Heat condition	3.198	414	Heat condition:Waiting time for bus	2.854
474	Waiting time for bus	Noise status	3.008	509	Noise status:Waiting time for bus	2.854
475	Waiting time for bus	Picking passengers	2.686	623	Picking passengers:Waiting time for bus	2.854

Sl.	Variable	root_variable	mean_min_depth	Occurrences	Interaction	uncond_mean_min_depth
476	Waiting time for bus	Protestation against bad behavior	3.125	534	Protestation against bad behavior:Waiting time for bus	2.854
477	Waiting time for bus	Stoppage duration	2.927	513	Stoppage duration:Waiting time for bus	2.854
478	Waiting time for bus	Travel status	2.848	583	Travel status:Waiting time for bus	2.854
479	Waiting time for bus	Unacceptable attitudes towards female	3.283	498	Unacceptable attitudes towards female:Waiting time for bus	2.854
480	Waiting time for bus	Waiting time for bus	4.081	506	Waiting time for bus:Waiting time for bus	2.854

Appendix D

Gini index values of variables used in CART for selecting root-node split variable

Independent Variables	Category	Counted Cases	No. of Dissatisfied cases	No. of Satisfied cases	Gini index = 1 - sum of (probability)^2	Calculated Gini of each category
A	**B**	**C**	**D**	**E**	**F = 1-{(E/C)^2 + (D/C)^2}**	**G = (C/ Total counted) * F**
Waiting time	0 min	60	21	39	0.455	0.0426
	1-5 min	136	75	61	0.4947	0.1050
	5-10 min	149	93	56	0.4692	0.1091
	10-15 min	107	87	20	0.3040	0.0507
	15-20 min	68	55	13	0.3093	0.0328
	20-25 min	37	31	6	0.2717	0.0157
	25-30 min	27	23	4	0.2524	0.0106
	>30 min	57	51	6	0.1884	0.0168
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3832**
Stoppage duration	1-2 min	203	133	70	0.4518	0.1431
	2-3 min	93	56	37	0.4791	0.0695
	3-5 min	154	99	55	0.4592	0.1103
	5-10 min	114	85	29	0.3793	0.0675
	10-15 min	44	29	15	0.4494	0.0308
	>15 min	33	28	5	0.2571	0.0132
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.4345**
Refused to get into bus for occupied female seats	No	352	211	141	0.4802	0.2637
	Yes	289	219	70	0.3671	0.1655
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.4292**
Availability of seat right after boarding	No	382	304	78	0.3250	0.1937
	Yes	259	126	133	0.4996	0.2019
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3956**
Travel status	Standing	114	98	16	0.2413	0.0429
	Sitting in female seat	118	55	63	0.4977	0.0916
	Sitting in general seat	168	89	79	0.4982	0.1306
	Mixed, sitting & standing	241	189	52	0.3384	0.1272

Independent Variables	Category	Counted Cases	No. of Dissatisfied cases	No. of Satisfied cases	Gini index = 1 - sum of (probability)²	Calculated Gini of each category
A	**B**	**C**	**D**	**E**	**F = 1-{(E/C)^2 + (D/C)^2}**	**G = (C/ Total counted) * F**
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3924**
Driving pattern	Over speedy driving	116	68	48	0.4851	0.0878
	Over-taking tendency	149	108	41	0.3989	0.0927
	Changing lane frequently	74	54	20	0.3944	0.0455
	Hard-braking tendency frequently	87	62	25	0.4096	0.0556
	Raising speed suddenly	75	54	21	0.4032	0.0472
	Other	131	75	56	0.4895	0.1000
	All	9	8	1	0.1975	0.0028
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.4316**
Boarding-alighting status	Driver didn't stop the bus properly	282	227	55	0.3140	0.1381
	Driver picked passengers on running situation	190	147	43	0.3502	0.1038
	Driver stopped the bus properly	169	56	113	0.4431	0.1168
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3588**
Picking passengers	Hurriedly	436	348	88	0.3222	0.2192
	Modestly	205	82	123	0.4800	0.1535
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3727**
Female passenger harassment	No harassment	281	131	150	0.4977	0.2182
	Yes, once	192	148	44	0.3533	0.1058
	Yes, several times	168	151	17	0.1819	0.0477
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3717**
Harassment by bus driver/helper	No harassment	396	214	182	0.4967	0.3069
	Yes, Physically touched or harassed	62	58	4	0.1207	0.0117
	Yes, Verbally harassed	183	158	25	0.2359	0.0673
	Total Counted =	**641**			**Calculated Gini for the variable =**	**0.3859**
	No harassment	388	217	171	0.4930	0.2984

Independent Variables	Category	Counted Cases	No. of Dissatisfied cases	No. of Satisfied cases	Gini index = 1 - sum of (probability)²	Calculated Gini of each category
A	**B**	**C**	**D**	**E**	**F = 1-{(E/C)^2 + (D/C)^2}**	**G = (C/ Total counted) * F**
Harassment by male passenger	Yes, Physically touched or harassed	119	96	23	0.3118	0.0579
	Yes, Verbally harassed	134	117	17	0.2215	0.0463
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4026**
Shelter at stoppage	No Shelter	449	310	139	0.4275	0.2994
	Small Shelter	175	110	65	0.4669	0.1275
	Large shelter	17	11	6	0.4567	0.0121
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4390**
Bus inside quality	Very dirty	197	158	39	0.3176	0.0976
	Moderately dirty	285	188	97	0.4490	0.1996
	Moderately clean	150	82	68	0.4956	0.1160
	Very Clean	9	2	7	0.3457	0.0049
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4181**
Crowed status	Not crowded	106	39	67	0.4651	0.0769
	Crowded	362	250	112	0.4273	0.2413
	Very much crowded	173	141	32	0.3015	0.0814
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.3996**
Noise status	Not noisy	114	53	61	0.4975	0.0885
	Noisy	359	239	120	0.4451	0.2493
	Very much noisy	168	138	30	0.2934	0.0769
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4146**
Heat condition	Intolerable	303	245	58	0.3096	0.1463
	Tolerable	338	186	152	0.4949	0.2610
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4073**
Refuse female passenger	No	364	204	160	0.4927	0.2798
	Yes	277	226	51	0.3004	0.1298
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4096**
Unacceptable attitudes	No	369	200	169	0.4965	0.2858

Independent Variables	Category	Counted Cases	No. of Dissatisfied cases	No. of Satisfied cases	Gini index = 1 - sum of (probability)^2	Calculated Gini of each category
A	**B**	**C**	**D**	**E**	**F = 1-{(E/C)^2 + (D/C)^2}**	**G = (C/ Total counted) * F**
towards female	Yes, Immodest attitude	272	230	42	0.2611	0.1108
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.3966**
Bad attitudes of male passenger	No	374	204	170	0.4959	0.2893
	Yes, once	163	140	23	0.2424	0.0616
	Several incidents	104	86	18	0.2862	0.0464
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.3974**
Protestation against bad behavior	No incidents happened	377	215	162	0.4901	0.2883
	Yes, male passengers protested	69	52	17	0.3714	0.0400
	Yes, female passenger protested	64	46	18	0.4043	0.0404
	Yes, both male and female passengers protested	77	70	7	0.1653	0.0199
	Yes, the victim protested	54	47	7	0.2257	0.0190
	Total Counted =	**641**		**Calculated Gini for the variable =**		**0.4075**