



**Assessment of Women's Safety
in Ride-Sharing Services of Dhaka City**

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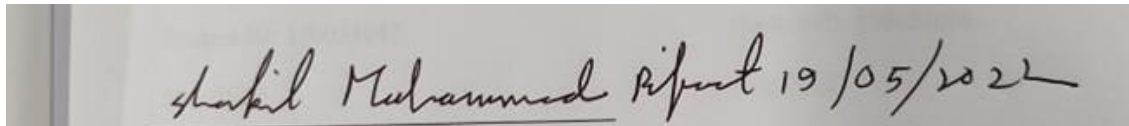
BACHELORS OF SCIENCE IN CIVIL ENGINEERING

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PROJECT APPROVAL

This is to certify that the dissertation entitled “**Assessment of Women's Safety in Ride-Sharing Services of Dhaka City**” was **submitted** by Md. Alvi Abdal, Raiful Md. Rafsanjani, And Md. Sajed Rahman has been approved as partial fulfilment of the requirement for the Degree of Bachelor of Science in Civil Engineering at the Islamic University of Technology (IUT).

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DECLARATION

We declare that the undergraduate research work reported in this thesis has been performed by us under the adept supervision of Professor Dr. Shakil Mohammad Rifaat. Appropriate precautions have been taken to ensure that the work is original. This work has not been plagiarized and submitted elsewhere for any other purpose (except for publication).

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DEDICATION

We dedicate this thesis to our parents, who have sacrificed their valuable time, livelihood, and effort over many years to ensure that we could be who we are today. They have motivated and encouraged us to fulfil our engineering ambitions without ever looking back. We shall be eternally grateful to them.

We would also like to express heartfelt gratitude to our respected supervisor Professor Dr. Shakil Mohammad Rifaat for his continuous support and inspiration, without whom this work would not be possible.

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“In the name of Allah, the Most Gracious, the Most Merciful.”

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Abstract

Women's safety in transportation facilities has always been a significant concern worldwide. Sexual harassment has gotten a lot of attention as a social and legal issue over the previous two decades. According to Action Aid Bangladesh, 84 percent of all female commuters are subject to verbal and physical harassment in Bangladesh. It's important to note that the official statistics do not reflect that much because many intimidations and violence against women go unreported.

As ride-sharing services become more prevalent in Bangladesh, ensuring women's safety is increasingly necessary. Not many studies have focused on the safety and security of women availing ride-sharing services, particularly in developing countries. Moreover, very few studies have explored the relationship between women's socio-economic, demographic, and travel characteristics with experiencing abuse and harassment. Moreover, the past studies rarely explored situations where verbal abuse and harassment occurred to women using ride-sharing services. The study's objective is to examine the effect of demographic, socio-economic, and travel characteristics on safety and security issues and in which situations women commuters are experiencing abuse and harassment in ride-sharing services. To determine how and which cohort of women in ride-sharing services are subjected to harassment, a questionnaire survey form will be developed for 150 participants. The respondents will be selected randomly from different socio-economic and demographic backgrounds to capture the real safety scenario of women using ride-sharing services. Based on interviews and literature review, three potential forms of harassment were found, i.e., verbal, physical, and gestural. The count data model will establish a relationship between dependent variables, i.e., verbal, physical, and gestural harassment experienced by a commuter, and independent variables (i.e., respondents' socio-economic, demographic, travel characteristics, and the surrounding environment).

Possible results will reveal in which socio-economic and demographic background women are more vulnerable from a safety perspective while commuting in ride-sharing services and in which situations are victimized more. This study will reveal that the harassment and abuse faced by women significantly vary among the respondents based on their socio-economic, demographic,

travel characteristics, and surrounding road environment, which may also be crucial determinants of being harassed. Specific findings of this study would be beneficial to the policymakers and authorities of the ride-sharing companies for taking necessary measures to improve the existing safety and security provided to the passengers. Bangladesh Road Transport Authority (BRTA) can also use the findings of this study to formulate policies for ride-sharing service providers to improve woman's safety and security for these app-based services.

Keywords: Ride-sharing service, women safety, security, count data model, socio-economic, demographic.

Chapter One: Introduction

1.1 Background

Women's safety in transportation facilities has always been an important issue globally. With the flow of time, many women use various transportation facilities. In the United States in 2007, 55% of public transit passengers were women (Buehler, 2012), and (Hasson 2011) states that In France, two-thirds of public transit passengers are women, which is also true for developed countries. Even being a more significant part of the commuter population, women don't feel safe in transportation. Most women are afraid of sexual harassment and potential violence towards them, even though having strict jurisdiction against sexual violence. And in developing countries (e.g., Pakistan) where the transportation services aren't sufficient to address women's s travel needs, concerns, priorities, and preferences, due to socio-economic causes, women's safety is at stake. Due to why, women (especially young agers) have to face harassment in the form of verbal and physical innuendos, groping, leering, or even direct physical assaults inside public transport and connected spaces (Social Policy and Development Centre (SPDC), Pakistan, 2014). The claim seems to be more assertive in the context of another developing country, Bangladesh, as the studies Reveal that 84 percent of all female commuters are subject to verbal and physical harassment (Action Aid Bangladesh, 2016), and 94 percent of female commuting in public transport in Bangladesh had experienced sexual harassment in verbal, physical and other forms (BRAC, 2018). This has been why women avoid public transport and accept ride-sharing services, mainly app-based services. Services, namely Uber, Pathao, Sohoz ride, etc., are Bangladesh's general ride-sharing/ ride-hailing services. Through these services, women can book personal trips safer than public transport. Importance of Safety and security of ride-sharing services (Fear and anxiety about personal security are critical detractors of using public Transit (Needle and Cobb, Improving Transit Security.) Besides, these services ensure the personal safety of the passengers by multilevel screening based on criminal records and a bi-directional rating system where passengers can rate drivers and vice versa, and the consequence of negative impression is often suspension from work. (Safety guide, Uber for business).

Thus, ride-sharing services take passenger safety issues more seriously, directly affecting their business. Wekerle and Whitzman found that the negative perception of passengers about transit security influenced riders' decisions to use transit in New York City, Toronto, and London. Despite the allocation of so many safety guidelines, the users have complained about the safety and security level of the services. Along with some major incidents like the rape of an Uber passenger in India in 2014. (Soni, 2016; Viswanath, 2013), numerous minor incidents like verbal abuse and harassment go unrecorded. A study on ride-sharing services in Bangladesh implies that many passengers, about 23% of the responders, primarily women, avoid public transport due to security issues, especially during nighttime (Islam, Huda, Nasrin, 2019). Thus our target is to assess the critical factors behind the lack of security for women in these ride-sharing services. Studies have been performed on this issue, such as “Women's Perceptions Towards Ride-Sharing Services: The Case Of Dhaka City”, Nawsin, 2020. But thorough statistical analysis has been missing. Our research purpose is to contribute to the research gap in this context.

1.2 Scope of the study

Scope of the research includes:

- Female users of different ride-sharing services available in the country
- News and reports from local media

1.3 Objective of the study

The objective of the study consists of:

- To examine the effect of demographic, socio-economic, and Travel characteristics on safety and security issues.
- In which situations women commuters are experiencing abuse and harassment in ride-sharing services
- To determine how and which cohort of women in ride-sharing services are subjected to harassment.

1.4 Contribution of Research

Women's safety is becoming increasingly important as ride-sharing services become more common in Bangladesh. Few studies, particularly in poor countries, have focused on the safety and security of women who utilize ride-sharing services. Furthermore, few research have looked into the link between women's socioeconomic, demographic, and travel characteristics and their experiences with abuse and harassment. Furthermore, previous research rarely looked on instances of verbal abuse and harassment directed towards women who used ride-sharing services.

The goal of the study is to look into the impact of demographic, socioeconomic, and travel variables on safety and security issues, as well as how women commuters are treated in ride-sharing services. To learn more about how and which types of women in ride-sharing services are harassed.

Chapter Two: Literature Review

2.1 Ridesharing: Concept and Application:

Ridesharing is a smartphone-based service that focuses on convenience and time (Feeney, 2015; Geisberger et al., 2009). It entails the effective use of automobiles with a different form of transportation, most commonly a car and a bicycle. With the advent of IoT (Internet of Things) and smartphone technologies, the ride-sharing system may provide a flexible and straightforward communication mechanism. (Chan & Shaheen, 2012; Farin et al., 2016).

Uber, which was recently established in San Francisco, California, as a solution to the current traffic situation and consumer satisfaction, is backed by three generations of ride-sharing technologies that have evolved over five decades (DeMaio, 2009). According to the author, the first generation of bike-sharing services debuted in Amsterdam in 1965 with limited amenities and scope, revealing the scenario of today and future bike-sharing benefits.

Chan and Shaheen (2012) classified the evolution of North American ride-sharing into five periods in their study. From 1942 to the present, a premium section of society, an energy crisis, institutionalization, reliability, and the introduction of technology have all played a role. Despite the fact that ridesharing is a relatively new concept, it is rapidly gaining popularity.

2.2 Preferable App-based Ridesharing Services (Global):

Ride-sharing services like Lyft, Uber, and Sidecar arose in response to the rising gig economy, bringing fierce competition to the business in those areas. In addition, the use of ride-sharing services is fast increasing.

2.3 Factors affecting ride-sharing services:

Ride-sharing services are provided in both static and dynamic modes. Users are matched based on their stated requests, according to the meaning of the term "static ride-sharing services." However, the ride-sharing system is static, and users may only contact by email, which leads to inefficient and ineffective communication. (Jahan, 2019; Saadat et al., 2018).

Dynamic (or ad-hoc) ride-sharing, on the other hand, is primarily reliant on technology and smartphones. Passengers can use these services to submit information such as their desired destination, current position, and preferred departure time. The driver enters information such as the automobile model, license plate number, present status and destination, and departure time. Then, computer calculations assess whether a driver and a person are compatible based on their data inputs. The passenger and the driver meet at a particular location and time once the driver accepts the passenger's request. (Haddad and colleagues, 2013). The literature reviews say that although ride-sharing is not new, the dynamic ride-sharing system enabled by mobile technologies is. (Brereton and Ghelawat, 2010).

2.4 General trend of Ridesharing services worldwide:

Ridesharing is a service in which two or more trips are made simultaneously in a single car, with travel costs divided among individuals in that vehicle if the travellers' routes and time schedules match. One of the most significant benefits of ride-sharing is the opportunity to save money on transportation. (Morency 2007 and Furuhata et al. 2013)

Implementing ride-sharing aims to reduce private car ownership, traffic congestion, and greenhouse gas emissions. (Caulfield 2009, Buliung et al. 2009, Polk 2003, and Delhomme and Gheorghiu ,2016).

The Ridesharing industry is becoming a booming sector all over the world. The impact of this sector is increasing rapidly on the overall economy and development of the country.

2.5 Safety conditions of ride-sharing services:

The advent of ride-sharing services accessible throughout the globe has made it easier for customers to travel via app-based services. Furthermore, with the emergence of such services, one concern that has been evoked is passenger safety, particularly in nations with weak legal authorities. But several news articles and reports have been found about passengers being harassed, assaulted, and robbed. But investigations also find out that feedback offered by some passengers may not be credible and reliable. They use these tricks to obtain free rides from the company. (Sengupta, 2016). However, because the corporation did not have complete control over the driver, vehicle, and ride, some incidents really happened, and rigorous restrictions could not be implemented. A faulty feedback mechanism has also given fuelled the flames.

Several works of literature have suggested that companies are indeed giving their efforts and taking several initiatives to fill these gaps. It is fundamental to have all potential security systems to assure rider safety from the beginning of the voyage till the destination. Any negative incident can become a significant concern in travellers' decision-making. This could influence many elements of travel options, such as mode of travel, time of day, route selection, and so on, and it can even cause a person to not travel at all.

2.6 Ridesharing in Bangladesh:

The culture of most industrialized countries, such as the United States and the United Kingdom, is substantially different from that of Bangladesh. However, in Bangladesh, the concept has taken on a whole new meaning, with users able to find a ride by picking their locations using smartphone apps and an internet connection.

Dhaka's infrastructure, road networks, and communication system also fall short of those seen in similar cities in wealthy countries. (Chowdhury and colleagues, 2016). In contrast to emerging economies, the earlier studies on ride-sharing services covered in the preceding sections mainly focused on different cities in developed countries.

As a result, emerging economies such as Bangladesh, where ride-sharing services have only lately become popular, are still unsure what they are and what they can do for them. For individuals

active in the gig economy to create their plans, an in-depth examination of the current situation and future of ride-sharing services in Bangladesh is required.

2.7 Reason for Avoiding Public Transport Services

2.7.1 In Global Perspective

Females are commonly labelled as a subset of public transit users who confront different problems than males. The fear of harassment is the most significant barrier for women riding PT. Women's worries about crime determine whether or not they utilize physical therapy and when and how they use it. Women may be afraid to use PT altogether, especially at night. Despite these reservations, women are more likely to take public transit than men. According to the Pew Research Center, women earned at least 20% less than males in 2018. As a result, they rely more on public transit as a cost-effective mode of transportation.

2.7.2 In Bangladesh Perspective

According to a questionnaire survey, 36% of the people avoid public transport to save time, while 31% feel insecure or unsafe in public transport, about 15% avoid public transport for the poor quality of public transport vehicles, 13% to avoid traffic congestion and 5% for poor or no access to public transport. This finding is surprising because, in terms of accident occurrence or safety concerns, most people regard motorcycles as a dangerous method of transportation, and public transportation, such as buses, is safer.

2.8 Women's fear of public and transit environments

Women transit commuters have substantial fears and anxieties about their personal safety. Specific social groupings are more fearful of public transportation than others. Gender is the most crucial factor in anxiety and fear of victimization in transit contexts. (Department for Transport, 2002). researchers have also discovered that the elderly, certain ethnic groups, and low-income people living in high-crime areas have higher fear of public places. Age, color, class, cultural and educational background, sexual orientation, prior victimization experiences, and disability status may significantly differ among women. (Loukaitou-Sideris, 2006). According to studies, women

in poor neighborhoods are more likely to be assaulted on the street, and non-white women are more likely to be terrified than white women. (Ross, 2000).

Nevertheless, researchers also explain that fear has its roots in different and complex causes (Alexander and Pain, 2012).

2.9 Safety issues for women in ride-sharing services

Ridesharing services have become very popular all around the world. Simultaneously, concerns about their safety, security, and harassment have arisen. However, women in developing and impoverished countries do not extensively utilize it due to safety and security concerns. A lack of prior planning to address the problems that influence women's ride-sharing decisions is one of the critical challenges to expanding ride-sharing practices in underdeveloped countries like Bangladesh. In most cultures, the women's movement has traditionally been limited to men. Gender equality is seen as a critical component in developing a sustainable transportation system. To address the growing transportation needs of the urban population, particular emphasis must be given to this area.

Females make up a substantial portion of the workforce and contribute significantly to the country's economy. Female passengers prioritize safety and security, convenience, flexibility, comfort, and cost when using ride-sharing services. Nevertheless, female passengers' safety and security are the most important concerns with ride-sharing services. Women's harassment on public transportation is a common problem, especially in South Asia and emerging nations.

The above literature concludes that physical and psychological harm, limited access to the more significant public arena, and legitimization of gender differences in society are adverse outcomes. It has a substantial impact on women's lives and obstructs the advancement of gender rights by making justice inaccessible.

2.10 Problems Faced by Women in Ride Sharing Services

Ride-sharing services are quickly being adopted by women in Dhaka for various reasons, including commuting to work, university or college, social gatherings, etc. Ride-sharing companies are increasingly providing vehicles and bikes to women in the city.

There are a lot of issues with ride-sharing services, which were intended to provide women with a sense of safety and a cost-effective travel option. Commuters have complained about drivers refusing to utilize the app and, instead of collecting people on a contractual basis, misbehaving with passengers, driving recklessly, sexually assaulting passengers, neglecting commuters' demands, cancelling rides after confirmation, and so on. Women seek higher levels of physical and emotional safety and security while travelling due to their greater vulnerability. When the co-rider or driver is a stranger, according to several studies, the gender of the co-rider or driver is the most essential factor. This is because female passengers are particularly uncomfortable travelling alone with a male stranger.

Aside from that, different studies suggested that crucial factors influence women's feelings of safety. For instance, abuse awareness, sexual orientation, financial status, mode frequency, journey duration, road lights, and cleanliness.

2.11 State of safety and security in ride-sharing services in Bangladesh

Currently, ride-sharing transportation system security is a crucial research area. Because of its convenience, ride-sharing services have become popular in Bangladesh, although security concerns have provoked adverse reactions. In terms of security, the growing popularity of ride-sharing services in Bangladesh has made measuring their efficacy and security issues difficult. In Bangladesh, unprofessional drivers, harassment and security issues for female and male passengers, lousy internet and network latency, poor and challenging applications and servers, irregular pre and post-ride prices, and so on are all common scenarios. These elements are crucial in deterring or stopping a user from pursuing it.

Some statistics regarding harassment and safety concerned

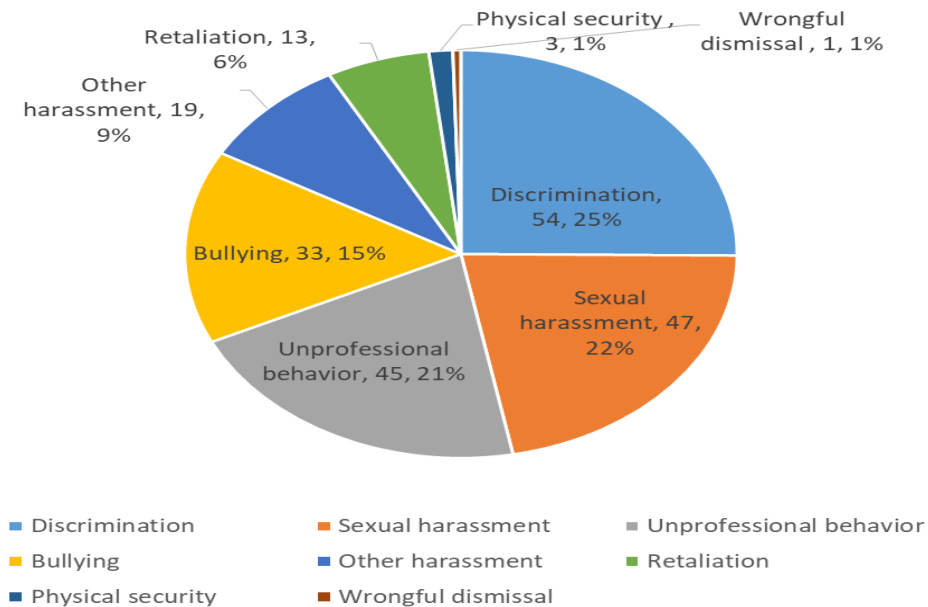


Figure 1 statistics regarding harassment and safety concerned

According to a CNN article, 103 Uber drivers have been accused of sexual harassment or assault. Indecent assault with the intent to rape has been identified in 31 drivers. During two examinations, 215 complaints of sexual assault or other allegations were identified. To address the problem, the authorities adopted the following measures: In 20 situations, employees were fired; 31 were placed in training; 7 were given final warnings, and 57 claims are now being investigated.

2.12 Examples of policy gaps in national legislation

Violence against women and girls is on the rise in Bangladesh, according to police statistics. In 2009, there were 12,904 rape, murder, abduction, and sexual harassment cases. (Bangladesh Police). There is no specific section on women's safety and security in public places in the 2011 Bangladesh National Women's Policy.

Chapter Three: Data and Methodology

For accomplishing the objective of this study, we will use regression modelling as analysis tool for attempting a statistical approach to identify the prime factors associated to occurrence of harassment towards female commuters of ride sharing services. Regression models can explain the variability of a response variable which is the frequency of harassment occurrence with respect to different explanatory factors. Main objective of using regression models in such cases are, to forecast the value of the dependent variable for individuals having some information about the explanatory variables, or to estimate the effect of some explanatory variable on the dependent variable (Molugaram, Rao,2017), hence such models will serve the purpose of our study. In this particular study, we will try to identify the effect of socio-demographic attributes, travel characteristics and situational conditions as the explanatory variable on the frequency or level of harassment. As from literature review, this study will be confined to focusing on 3 types of harassment, which are verbal, gestural and physical harassment. We will try to filter out the significant factors from a large set of factors which might be accountable for occurrence of each type of harassment, thus 3 models for each type of harassment are needed to be developed.

Data required for this study includes the frequency or level of harassment, and the socio-demographic attributes, travel characteristics and situational conditions of individual female commuters as the predictor variables. Data from secondary sources was avoided purposefully as the dataset contained very less factors and there might be a risk of being biased. Thus, we opted for first hand data collection for exploring more; consequently necessary data was collected from 150 female respondent by means of questionnaire survey. Details on preparation of the questionnaire is described afterwards.

3.1 Steps in methodology

For accurate and effective study, data collection and application of proper analysis tool is highly necessary. Data for harassment frequency and description of demographic and situational conditions has to be collected to larger extent as possibly, subsequently to be processed through appropriate statistical tool fitting the type of data for getting rational analysis. Therefore, the total methodology was divided into following 4 steps.

3.1.1 Development of questionnaire:

As stated below, the nature of this study required preparation of a comprehensive questionnaire that addresses all the factors we would like to explore. The questionnaire development process involved in three stages.

3.1.1.1 Focus group discussions with the stakeholders:

The main stakeholders of this service are the Commuters, the Riders (those who provides the service and the organization offering and monitoring the service. To get a preliminary idea about the frequency and types of harassment being reported, several riders throughout the city has been questioned. This also provided us about the idea about the frequency and categories of female commuters using the services. The rides reported of getting around daily 5 to 6 ride requests from female users on average, most of them belonging to age 20 to 30. After that, for emphasizing on the matter from the point of view of the service recipients, brief interview of 10 regular users of this services was taken.

3.1.1.2 Literature Review:

Based on the study on contemporary literature, we tried to sort out the nature and types of harassments faced by the female commuters of the ride sharing services. Along with that, the plausible reasons and factors behind these occurrences were sorted out. From similar studies in the countries with developing economy it has been observed that most of the abuses are related to verbal (e.g., teasing, indecent comments, slangs or harsh way of talking) and non-verbal communication (e.g., discomforting staring, throwing whistle, immodest gestures), along with some harassment involving physical contact (e.g., attempt to touch inappropriately, hurting physically).

As of the reasons behind safety concern, females of younger age and unemployment feel more unsafe in the ridesharing services, as reported by Meshram et.al. (2019) from a study in India. Thus we had incorporated age, profession and income as an explanatory variable.

Also sample questionnaire on relevant topic (harassment of women) were followed to prepare questions on harassment. In a study on measuring sexual harassment towards women in workplace and academia, questions on sexual comments, unwanted sexual attention, and sexual coercion were introduced as variables (Fitzgerald, Gelfand, & Drasgow, 1995; Fitzgerald, Shullman, et al., 1988). For considering the local factors and making the survey more relatable to the present context, questionnaire from the study of Nawshin (2020) was followed as a reference.

3.1.1.3 Consideration of local social behavioural pattern:

Being a country of a third-world country, the education rate is low which directly affects the society's view of women. Besides income and education level of an individual has a huge impact on their social behaviour and respect towards women. Thus, natures of harassment and potential factors can change in local context. It has been seen that, risk of facing harassment for a woman increases when she travels through a relatively low crowded place which has not been explored before. There might be effect of roadway traffic conditions on the behaviour of a rider/ service provider towards the user, as drivers become more aggressive after being in a congestion (Li et.al. 2020). Thus, we tried to find out the unexplored sides in this section of preparing question for data accumulation.

Finally, considering all the findings from the abovementioned segments, and taking idea from previous works, questionnaire for our study was developed.

3.1.2 Collection of Data from target community:

Data collection schedule has been done based on the professions of the users, as it would be easier to approach to our target respondents in this method. For each profession category, a major group/profession was targeted which may reflect the nature of the entire profession category. For example, Response was collected from university students which highly represents the category of Students, as university students are the major user of this sub section. Response from employees of govt. bank and some govt. offices were enlisted as the response for govt. service holder category. And for private sectors, responses from corporate women associated to private pharmaceuticals company and telecom company were taken as the representation of women from private corporate job. Printed questionnaire forms were provided with individual briefing before survey form distribution

3.1.3 Model Development

Responses of harassment question were converted into data for processing. Harassment frequencies, which were expressed with empirical values of Frequently, Sometimes, Rarely & Not at all were denoted with numerical values 4, 3, 2 and 1 respectively. For harassment category containing more than one questions, response values of the questions were added up to obtain a single variable corresponding to each harassment type, which will be our dependent variables. In the next step, the responses of the commuter's socio demographic characteristics, travel characteristics and situational condition regarding the trips where they were harassed, were converted into binary formal denoting 1 for a Yes/True response and 0 for a No/False response. Responses with categories were converted into categorical variable for ease of interpretation of results with reference categories. After sorting out we obtained 54 independent variables which for explaining the dependent variables.

3.1.4 Selection of Statistical Model:

As mentioned in previous section, we have denoted the dependent variables with integers, which are non- negative. As the variables are discrete, we cannot use continuous data models like Multiple Linear Regression model (MLR), probit models or logit regression models, which are most used in transportation field. Most suitable statistics to analyse these types of data would be count data models, which are widely used in different sectors for frequency analysis. Among the various models, The Poisson model is the most often used model for assessing count data. other models that may be used to model count data includes negative binomial and hurdle model and extensions of Poisson models, like Conway-Maxwell-Poisson (COM-Poisson) Models, Generalized Poisson Regression Model (GPR). Although, it is necessary that these models are thoroughly evaluated and compared before selecting one over another to manage count data as suitability of model may depend on the spread of data i.e. dispersion (Muoka, Ngesa & Waititu 2016)

3.2 Description of Models

From the studies by Khattak et. al. (2019), Shaik & Hossain (2019), Rifaat (2010), it is evident that Poisson distribution and Negative Binomial are mostly used for assessing count data models regarding traffic safety issues. Therefore, these two models will be implemented in this model. Selection of model will be based on the magnitude of over-dispersion of the data.

3.2.1 Poisson Model:

Poisson Regression Model is a log-linear model which describes the rate of any occurrence. It has been widely used in the field of transportation safety to successfully predict events like accidents, crash severity etc. Many researchers suggest that Poisson regression is more advantageous than other regression in terms of modelling different discrete distribution and constraint to predicted value to non-negative integer number (Glenberg, 1996).

The basic assumptions of Poisson distribution are:

- a) Probability of more than one event occurring in a subinterval is zero;
- b) Probability of one count in a subinterval is the same for all subintervals and proportional to the length of the subinterval; and
- c) Count in each subinterval is independent of other subintervals

From the context of our study, the event represents occurrence of harassment and each subintervals indicates each female commuter

If event n occurs according to Poisson's criteria with parameter μ_{it} , then the Poisson distribution can be written as:

$$\Pr(n_{it} | \mu_{it}) = \frac{\exp(-\mu_{it}) \mu_{it}^{n_{it}}}{n_{it}!}$$

Where,

$P(n_i)$ -probability of n frequency of harassment occurring on a passenger i

μ_i -- expected mean frequency of harassment faced by any female commuter i

And the mean parameter μ_{it} can be estimated through the following equation:

$$\ln \mu_{it} = \beta X_{it}$$

Where,

X_i -- independent variable (socio-economic, demographic & travel characteristics)

β -- coefficient describing explanatory capacity of the associated variable

In accordance to the hypothesis of Poisson distribution the variance of the data must be equal to the unconditional mean of the data, which is the prime constrain of the fore mentioned model. In many cases it was seen that frequency data shows over and under dispersion causing Poisson model to be ineffective (Lord and Mannering, 2010).

3.2.2 Negative Binomial Model:

In many cases, it has been seen that the variance of the data is significantly greater than the unconditional mean, indicating remarkably high over-dispersion. In that case the hypothesis of Poisson distribution is contradicted. Previous studies of similar type of data (frequency of violence or harassment) that negative binomial models may be a better fit to the data as over-dispersion was found to be significant (Gardner, Mulvey, & Shaw, 1995)

Negative Binomial is an improvisation of Poisson to consider the over-dispersion parameter (k) i.e. when $k \geq 0$. In such distribution, the probability of a frequency category is calculated as follows,

$$\Pr(n_{it} | \mu_{it}, k) = \frac{\Gamma(n_{it} + 1/k)}{\Gamma(1/k) n_{it}!} \left(\frac{k\mu_{it}}{1 + k\mu_{it}} \right)^{n_{it}} \left(\frac{1}{1 + k\mu_{it}} \right)^{1/k}$$

And the regression formula for obtaining μ_i for considering the over-dispersion is corrected by,

$$\ln \mu_{it} = \beta X_{it} + \varepsilon_{it}$$

Where $\exp(\varepsilon_{it})$ is the error term associated to gamma function with a mean one and variance k

3.3 Model Analysis:

Before going through statistical modelling distribution of the data was checked through histogram. Dataset shown an approximate alignment with the ideal Poisson distribution.

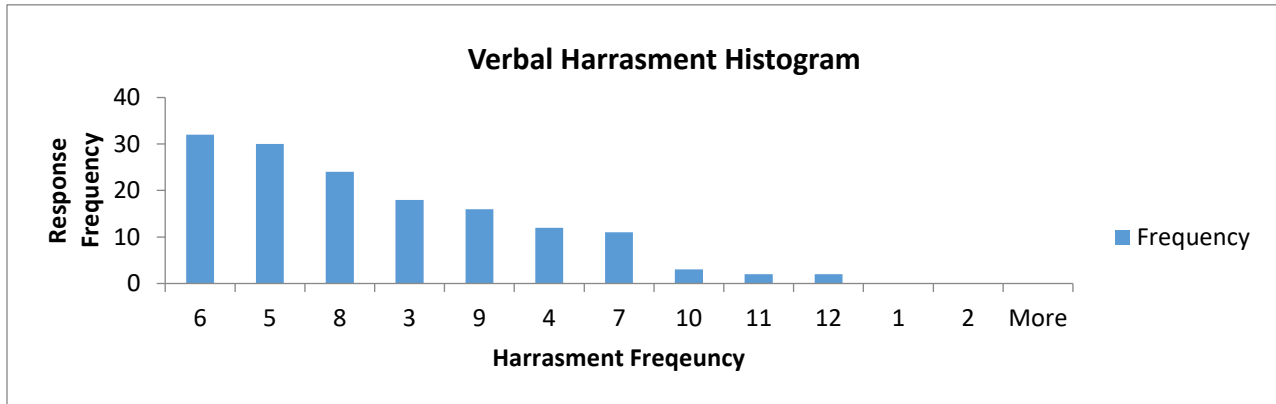


Figure 2 Verbal Harrasment Histogram

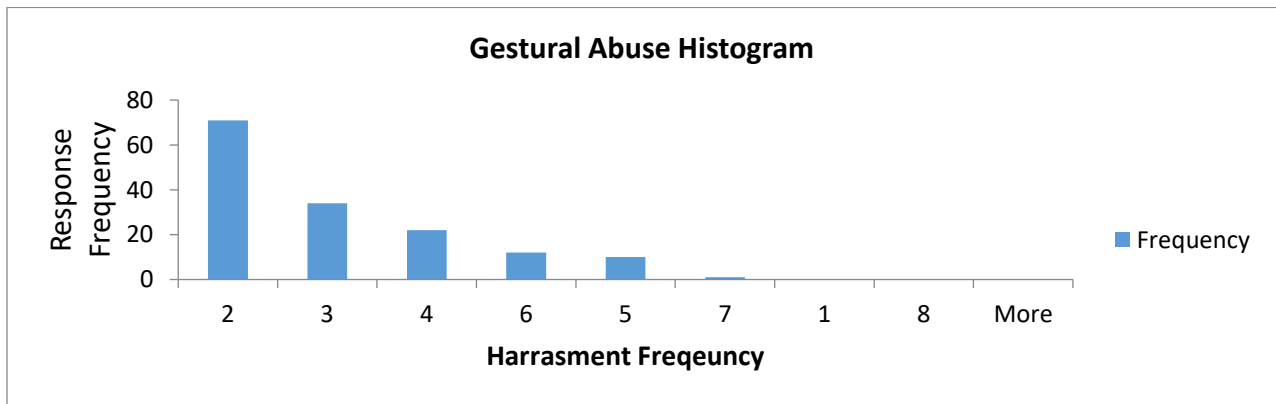


Figure 3 Gestural Abuse Histogram

Models were then prepared and run in STATA software to assess the suitability of models. As the natural tendency of this type of data is to be over-dispersed, negative binomial (NBREG) was attempted.

Within some initial run, the results showed over-dispersion parameter k , or α (in STATA) to be zero, which means variance is equal to mean.

Negative binomial regression	
Dispersion: mean	Number of obs = 150
Log likelihood = -289.9052	LR chi2(49) = 71.49
/lnalpha / = -47.3317	Prob > chi2 = 0.0197
alpha = 2.78e-21	Pseudo R2 = 0.1098
LR test of alpha=0: chibar2(01) = 0.00	Prob >= chibar2 = 1.000

Table 1 Negative Binomial Regression

Chapter Four: Result Analysis

In this chapter, we will discuss on the result focussing on the following points:

- to examine the effect of demographic, socioeconomic, and Travel characteristics on safety and security issues
- In which situations women commuters are experiencing abuse and harassment in ride-sharing services
- To determine how and which cohort of women in ride-sharing services are subjected to harassment.

In this study, we developed three models: verbal abuse, gestural abuse, and physical abuse. The results of these models were analysed using STATA. We picked the Count Data model based on the nature of the dataset and the information requirement, followed by further model appropriateness analyses. In our study, Dependent variables were discrete and non-negative. That's why Count Data Model is selected. There are 2 parts of this model. Negative binomial regression can be used for over-dispersed count data, i.e. if conditional variance $>$ conditional mean. But in our case Negative Binomial model over dispersion parameter, $K = 0$. That's why Poisson Model was selected. Here, variance = mean.

In our study we have used 90% confidence interval. That means P values that are less than or equal to 0.1 are considered statistically significant. The analysis has been done with 150 observations in total.

Variable	Coefficient	Std. error	z	P>z
VERBAL ABUSE MODEL				
Number of obs	150			
LR chi ² (9)	50.17			
Prob > chi ²	0.0000			
Log likelihood	-300.5647			
Pseudo R ²	0.0770			
Age 18 to 25	0.1742	.0878	1.98	0.047
Online Payment	0.1411	.0737	1.91	0.056
Uncrowded Area	0.1991	.0679	2.93	0.003
Travel Alone (yes)	0.1626	.0719	2.26	0.024
Travel risk (yes)	0.3350	.0707	4.74	0.000
Income <20K	-0.7545	.2497	-3.02	0.003
Affluent Area	-0.2053	.1154	-1.78	0.075
Income 20K to 50K	-0.6591	.2407	-2.74	0.006
Income 50 to 100k	-0.6391	.2390	-2.67	0.008
_cons	2.0412	.2386	8.55	0.000

Table 2 Verbal Abuse Model

Variable	Coefficient	Std. error	z	P>z
GESTURAL ABUSE MODEL				
Number of obs	150			
LR chi ² (8)	19.72			
Prob > chi ²	0.0115			
Log likelihood	-248.9486			
Pseudo R ²	0.0381			
Age 36 to 45	-0.2886	0.1508	-1.91	0.056
Private Job	-0.2903	0.1429	-2.03	0.042
Income 20k to 40k	-0.7604	0.3524	-2.16	0.031
Travel risk (yes)	0.2129	0.1050	2.03	0.043
Uber	-0.2532	0.1075	-2.36	0.018
Obhai	-0.3775	0.1725	-2.19	0.029
Income <20k	-0.8421	0.3891	-2.16	0.030
Income 50k to 100k	-0.8319	0.3552	-2.34	0.019
_cons	2.1229	0.3697	5.74	0.000

Table 3 Gestural Abuse Model

PHYSICAL ABUSE MODEL				
Number of obs		150		
LR chi ² (3)		6.95		
Prob > chi ²		0.2241		
Log likelihood		-167.0353		
Pseudo R ²		0.0204		
Private Job Holder	-0.3402	.1925	-1.77	0.077
Travel risk (yes)	0.2904	.1600	1.81	0.070
Uncrowded Area	0.1991	.1552	1.28	0.109
_cons	-0.0735	.1611	-0.46	0.648

Table 4 Physical Abuse Model

4.1 Verbal Abuse Model

In verbal abuse model, we have obtained the Pseudo R^2 value equals 0.0770. This number represents the model's overall goodness of fit. This model can explain just 7.70% of the variation in the dependent variable. Despite the fact that this value is lower, our study's goal is to emphasize the individual influence of the independent variable above the overall quality of the model. We have 9 significant variables here.

Here we can see demographic variable Age 18 to 25 has the positive coefficient value (0.1742). A positive coefficient value indicates that this age group is the most prone to verbal abuse while using ridesharing services. The explanation might be that teenage and young girls are more afraid of being victimized in public areas than older women. This finding is also supported by some previous studies including *Rosenbloom and Plessis-Fraissard, 2010*; *Silverman and Della-Giustina, 2001*. And, given the societal context of Dhaka and other similar cities, it is not uncommon for younger females to be the most vulnerable.

Similarly, positive coefficient values for situational factors such as Online Payment (0.1411), Uncrowded Area (0.1991), Travel Alone (yes) (0.1626), and Travel Risk (yes) (0.3350) suggest a higher likelihood of being verbally abused.

There is very little probability of receiving tips while paying online, and there is a hefty Cash out charge. As a result, this variable has a high likelihood of triggering verbal abuse. Besides, less awareness regarding online payments and different promotional offers triggers aggressive tendency among the drivers.

Besides, women's feelings of safety and comfort while using ridesharing were also influenced by their experiences in unfamiliar environments. Situational factors - Uncrowded Area, Travel Alone (yes), Travel Risk (yes) are also proving this sentiment of female. These factors allow drivers to behave in an unpleasant manner because there are no significant protective measures available for females in those scenarios. Some prior investigations, notably *Aditi Meshrama, Pushpa Choudhary and Nagendra Velagab, 2019* also supports this claim. Affluent Area is another demographic indicator with a negative coefficient value. That implies female passengers in rich areas are less likely to be verbally harassed since drivers regard them as having a higher social standing and will take drastic measures if a mishap occurs.

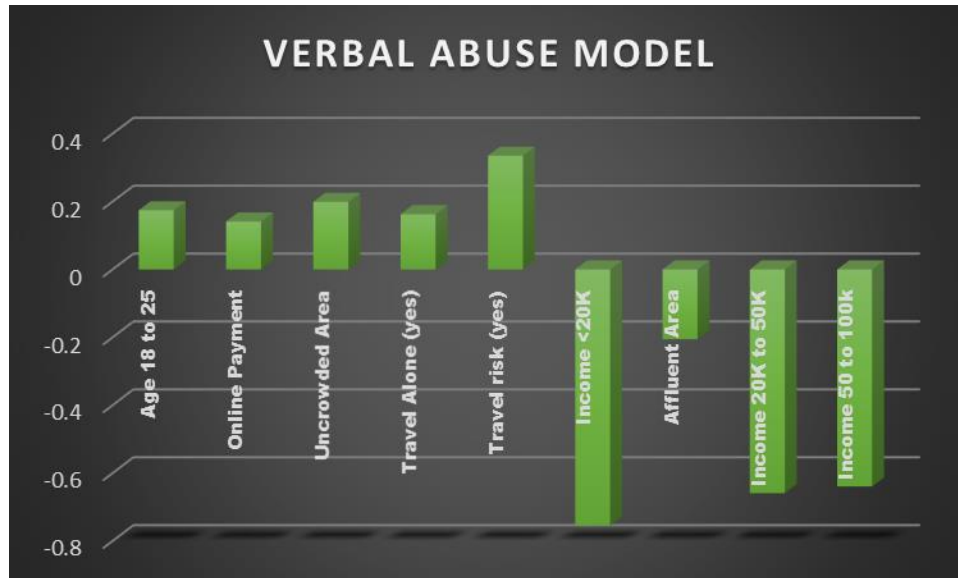


Figure 4 Verbal Abuse Model

4.2 Gestural Abuse Model

Again, in the gestural abuse model, we found the Pseudo R^2 value equals 0.0381 (less than the verbal abuse model). This value indicates the overall goodness of fit of the model. Here, only a 3.81% variation of the dependent variable can be explained by this model. However, our analysis prioritizes the individual impact of the independent variable over the overall quality of the model. We have 8 significant variables here.

Here, we can see the demographic variable Age 36 to 45 has a negative coefficient value (-0.2886). A negative coefficient value indicates that this age group is the least sensitive to gestural abuse while ridesharing. This finding also supports the claim that younger women had inferior perceptions of safety and comfort than older women. (*Aditi Meshrama, Pushpa Choudhary and Nagendra Velagab, 2019*). This might be because this age group is mature enough to pursue legal action and is more aware of their rights. Besides, private job holders with a negative coefficient value (-0.2903) are less likely to encounter Gestural Abuse and experience higher safety and comfort during the journey. Their smarter appearances and awareness of their rights contribute to their lower risk of being mistreated. Poor physical appearance causes people to have a weaker

impression of you that obviously contributes to a lesser status, and "lack of popularity might weaken personality and self-confidence" (Zuckerman, 1991).

On the other hand, situational variable Travel risk (yes) has positive coefficient value (0.2129). This suggests that females who consider ridesharing services dangerous encounter the greatest gestural abuse. Female passengers with no or very little experience of ridesharing judged it to be riskier and more uncomfortable (Nahela Nowshin, 2020). They remain tense during the trip, making them uncomfortable and frightened. It also implies that inexperience and apprehension over a lesser-known system are the major causes of greater discomfort in ridesharing. Passengers' strange and overprotective behaviour irritates drivers, who resort to unpleasant and abusive behaviour.



Figure 5 Gestural Abuse Model

4.3 Physical Abuse Model

We have a relatively low number of physical abuse observations in our research. As a result, we only have three variables that are statistically significant. Here, the resulting Pseudo R² value equals 0.0204. This model can explain just 2.04% of the variation in the dependent variable.

According to the findings of the study, employment status- private job holders with a negative coefficient value (-0.3402) are less likely to encounter physical abuse. They are less likely to be abused, rather experience higher safety and comfort during the journey due to their smarter look, awareness of their rights and consciousness about the ridesharing benefits. According to a report of *New York Times*, first impressions are crucial, and they may include both attitude and attire. The visual effect is just as significant as the verbal impression. People will immediately form opinions based on your personal appearance, which includes your facial expressions, clothing, grooming, and body language. On the other hand, two situational variables with positive coefficient values, Travel risk (yes) (0.2904) and Uncrowded Area (0.1991) increase the likelihood of female passengers being physically abused. Literature review of prior studies also confirms that, these two scenarios are high risk for female travelers. (*Aditi Meshrama, Pushpa Choudhary and Nagendra Velagab, 2019*)



Figure 6 Physical Abuse Model

Chapter 5: Conclusions and Recommendations

The principal objective of this study is to identify the factors and situations that provokes drivers to do abusive behaviour to the female commuters in ride sharing services. In order to achieve this objective, various factors from socioeconomic, demographic and situational conditions have been investigated. This study is one of the first of its kind in Bangladesh, focusing on particular forms of abuse experienced by female passengers of ridesharing services while taking into account situational, socioeconomic, and demographic characteristics.

Three models- verbal abuse, gestural abuse, and physical abuse have been developed using Count Data model (Poisson distribution). Several factors including socioeconomic, demographic and situational conditions have come out to be statistically significant variable in each of the model.

This chapter gives an overview of the important findings of this research, practical implications of the findings, future scope of the study and recommendations to improve the overall safety issues of the ridesharing services.

5.1 Summary of the key findings

This study yielded substantial unique findings on Dhaka city's Ridesharing services in terms of demographic, socioeconomic, and travel characteristics on safety and security issues. The following are the major findings of this study:

- Study finds that the most frequent of the three forms of abuse is verbal, gestural and physical abuse. Similar social and economic nations, such as India, have seen a significant number of physical abuse cases along with verbal and gestural abuse, including rape, murder, and attempted murder. However, Dhaka has not had these events.
- Female ridesharing passengers aged 18 to 25 are the most vulnerable group in society. They are the cohort most frequently harassed. This outcome was predicted given the social viewpoint and previous literature review. To improve the situation, females of a younger age should be adequately informed on their rights, safety precautions, and legal provisions.

- Again, the age group of 36 to 45 is found to be the least vulnerable segment of females in society when it comes to ride-sharing safety. This age group is mature enough to pursue legal action and is more aware of their rights.
- The study also indicated that occupation has a substantial influence on the safety and security of ride sharing for women. It influences the driver's attitude toward the passengers. Passengers with a more sophisticated and smarter appearance are more confident and secure. As a result, drivers are less likely to be abusive to passengers. In our study, we discovered that females in private job sectors encounter far less harassment owing to their bold, confident, and intelligent look.
- Payment method has been found to be a significant factor in the driver's aggressive attitude toward female passengers. In the case of cash payment, drivers have the chance to receive tips or extra money. However, online payment via various mobile transaction services reduces the likelihood of receiving those extra funds. Furthermore, there is a high cash-out charge for online payments. Besides, the ride-sharing service providers provide various promotional offers or discounts. Though these discounts encourage consumers to travel more, it is one of the major causes of the abusive behaviour of drivers.
- In the case of the verbal abuse model- demographic, socio-economic and situational factors play a significant role, including women commuters travelling alone, online payment, age (18 to 25 years), residence area, income etc.
- For the gestural abuse model, none of the situational factors were statistically significant. But socio-economic and demographic characteristics of female commuters are more prominent. [Age 36 to 45, Private Job, Income etc.]
- In the case of the physical abuse model, private job holders and uncrowded roadway conditions are significant. Since the observation of physical abuse was very low, we got less significant variables.

5.2 PRACTICAL IMPLICATION OF THE STUDY

Much emphasis should be placed to women's travel experiences, views, and difficulties in the field of transportation studies. This study has determined specific factors and situational conditions that provoke abusive behaviour to the female commuters. Besides, recommendations have been suggested to improve the overall safety issues in ridesharing services.

- **Policy Making**

In terms of policy making, this study can provide crucial guidance to ridesharing service providers. Policy regarding driver training in customer service and communication might be tailored to be sensitive to specific group of women. In Bangladesh, people are less aware and concerned about the usage of cutting-edge technologies. As a result, the key tasks are to make the services extensively popular, promote awareness, and access all over the countries with better safety and security measures. In terms of policy making, this study can provide crucial guidance to ridesharing service providers. Policy regarding driver training in customer service and communication might be tailored to be sensitive to specific group of women.

- **Situational Condition**

The primary findings of this study are several situational conditions that are triggering abusive behaviour and harassments in ride-sharing services. Evaluation of these results, identification of remedies and preventive measures, and, most importantly, strong action against the offenders must be assured. Drivers can be warned about maintaining professionalism during the situational conditions those provoke them to indulge in any kind of abuse.

- **Harassment Forecasting**

This study can aid in assessing the current status of ridesharing services in Dhaka city in terms of concerns linked to women's safety and comfort. Harassment forecasting is possible for any individual having diversified demographic, socioeconomic and travel characteristics. And this forecasting will result in improved solutions in the ride-sharing industry, eventually protecting women's safety and security.

- **Implementation of modern technology**

From the viewpoint of Bangladesh, ridesharing services may be regarded as an infant industry in need of greater government care and assistance to generate capital, technology, and management. This study suggests introducing a certain type of technology and strategies to ensure a safe and secure ride for both passengers and drivers. It is the responsibility of ride-sharing service providers and government agencies to replicate these and maintain the safest and most comfortable atmosphere during the trip.

5.3 Scope for Future Study

Safety and security are rising concerns in ride-sharing systems. When it comes to the service industry, it is the customer experience and level of service that determines its success. While tangibility, availability, and dependability are important variables to examine in service quality, employee assurance to achieve what is anticipated and to sustain the trust guaranteed in the company's objectives is critical.

Some variables that may have a substantial influence on abusive behaviour towards female passengers are eliminated in this study owing to a lack of data, which is a frequent issue in many applied studies. Large-scale research in this field can be done. It will focus on collecting the viewpoint of the most vulnerable segment of the female population, ensuring the reliability of the study. By comparing the data, future extensions of this study in multiple cities in Bangladesh will show differences in characteristics that lead to female harassment in ride-sharing services.

5.4 Recommendations

Certain precautions need to be taken to safeguard the safety of passengers especially women during and after the voyage. Nowadays, ride service providers enable GPS tracking, allowing to share location in real-time with relatives and friends. Furthermore, they have outlined a list of behaviours that may result in regulatory action against the driver or passenger. Such as Physical abuse with riders, reckless driving, breaching the traffic rules, abusive conduct or language use with the rider or driver, inappropriate behaviour with the rider after the trip is finished and so on.

It needs to be mentioned that not every policy will be effective in all cities. However, the following actions might be effective in general in sorting out a solution for safety and security concerns.

- **Installing Dash Cam**

Many cities are using camera services in public transportation to strengthen passenger and driver safety. This can also be implemented in ride sharing service for ensuring the safety and security. It not only tracks suspicious behaviour but also monitor passenger and driver behaviour at all times. This contributes to the improvement of service quality and the safety of riders.

- **Watch Dog Network**

It is also possible to create a special watchdog network. These watchdogs should be able to observe the live stream of ride-sharing cams in their immediate neighbourhood. If any 'watchdog' witnesses any unusual activity or behaviour, he/she can report it to the Watchdog network, and actions can be implemented to protect the rider's safety.

- **Distress Alarm**

A distress alarm can be offered on the ride-sharing application in situation of a harassment or security concerns. This distress alert will transmit a signal to the service provider company, along with detail information about the driver and commuter. A similar signal can be sent to the local police station for rapid help of the victim. Besides, it will also send a message to the aforementioned Watchdog network. In the event of the near proximity to the concerned rider, the watchdog network might personally attend to the scene of the occurrence.

- **Insurance Policy**

Passenger insurance options can be provided during the trip choices. The rider will have the option of selecting an insurance policy - for his trip and paying an additional fee to do so. In the event of an incident, the ride-sharing operator will ensure that the rider is rescued by someone from their firm or a third party.

- **Other Measures**

Other minor precautions might be taken to improve the rider's safety. The goal of all of this is to ensure that the rider is secure from the moment he or she begins his or her journey till the endpoint. Indoor light should be switched on during the night period. It will keep the interior visible to outside traffic, as well as it will also be helpful for the video of the ride in the dashcam.

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Appendix

Harassment and Abuse Faced by Women in Ride Sharing Services in Dhaka

As ride-sharing services become more popular in Bangladesh, it's becoming increasingly necessary to ensure women safety while using them. The goal of this study is to determine in which situation and what kind of abuse or harassment women suffer while using ride-sharing services considering their socioeconomic, demographic and travel characteristics. This survey will aid in identifying the vulnerable cohort of women who are likely to be harassed more. Based on the finding of this study, policy makers and law enforcers can formulate effective strategies to ensure safe journey for women while using ride sharing services.

Use ✓ sign for marking the best option.

Socio-demographic and travel characters:

1. Gender

- Male
- Female

2. Age range

- Below 18 years
- 18 - 25 years old
- 26 - 35 years old
- 36 - 45 years old
- More than 45 years

3. Marital status

- Married
- Unmarried

4. Educational qualification

- SSC
- HSC
- Graduate
- Post Graduate
- Diploma
- Others _____

5. Profession

- Student
- Business person
- Govt. Service holder
- Private service holder
- Housewife
- Self-Employed
- Others _____

6. What is your monthly income?

- Less than 20,000
- 20,000 to 50,000
- 50,000 to 100,000
- 100,000 or over

7. What kind of area do you reside in? (for example, Gulshan, Banani, Mohakhali, etc.)

.....

8. Which kind of house you dwell in?

- Single House
- apartment (owned)
- apartment (rented)

9. Do you own a car?

- Yes
- No

10. Do you drive/have driving license?

- Yes
- No

11. Do you use ridesharing services (like Uber, Pathao or Obhai etc.)

- Yes
- No

12. The service provider you have used often

- Uber
- Pathao
- Obhai
- Obon
- Shoroz ride
- Gariwala

- Taxiwala

13. How often do you use ride-sharing service in a month?

- 1-5 times
- 6-10 times
- 11-15 times
- More than 15 times

14. Do you find the service risky for traveling on a daily basis?

- Yes
- No

15. Do you generally use ride sharing service alone? (i.e. you were the only passenger in the vehicle)

- Yes
- No

16. Have you ever been mugged while taking the service?

- Yes
- No

Harassment perceived during Ride Sharing trip:

Verbal Harassment

1. Have you been verbally abused during a trip taken in ride sharing services.

(eg. Indecent comments, derogatory behaviour, teasing etc.)

- Frequently
- Sometimes

- Rarely
- Not at all

2. I faced asking personal questions/ making comments about appearance during a trip in ridesharing services.

- Frequently
- Sometimes
- Rarely
- Not at all

3. I feel uncomfortable to make a trip in ride sharing services for probable experience of verbal abuse.

- Frequently
- Sometimes
- Rarely
- Not at all

4. I experienced rude behaviour while suggesting to lower speed or to follow traffic rules.

- Frequently
- Sometimes
- Rarely
- Not at all

Physical abuse/harassment

1. I faced physical abuse/ harassment during a trip in ride sharing services.

(Eg. Driver touched or attempted to touch indecently , sexual assault, any physical attack)

- Frequently
- Sometimes
- Rarely
- Not at all

2. I feel uncomfortable to make a trip in ride sharing services for probable experience of physical abuse.

- Frequently
- Sometimes
- Rarely
- Not at all

Expressional\ Gestural harassment

1. I faced gestural abuse/ harassment during a trip in ride sharing services.

(eg. Explicit gesture, tendency of showing offensive material)

- Frequently
- Sometimes
- Rarely
- Not at all

2. I feel uncomfortable to make a trip in ride sharing services for probable experience of gestural abuse.

- Frequently
- Sometimes
- Rarely
- Not at all

3. I experienced that the rider captures video without my consent.

- Frequently
- Sometimes
- Rarely
- Not at all

Situational condition during facing harassment:

17. Traffic condition (during the trip when faced harassment)

- Gridlock (All vehicles standing still)
- Heavy
- Moderate
- Low

18. Used available redeem offer [during the trip when faced harassment]

- Yes
- No

19. Roadway environment while faced harassment (in terms of presence of people in surrounding) [during the trip when faced harassment]

- Uncrowded route (travel route that includes any spots that are not very crowded or dark)
- Sufficiently crowded

20. Trip time [during the trip when faced harassment]

- Early morning (6-8 AM)
- Morning peak (8-11 AM)
- Off peak (11AM -5 PM)
- Evening peak (5-8 PM)
- Night (8-11 PM)
- Late night (After 11 PM)

21. Payment method [during the trip when faced harassment]

- Online payment (Bkash, Rocket, Online Banking, Credits/Redeem offers etc.) _____
- Cash payment

22. Trip duration [during the trip when faced harassment]

- Short (less than 2 km.)
- Long (more than 2 km.)

23. Break during the trip [during the trip when faced harassment]

- Yes
- No

24. Did you give any tips to driver or not? [during the trip when faced harassment]

- Yes
- No

25. Which of the following policy do you think will be more effective to reduce the frequency and occurrence of harassment of female commuters while using ride sharing services ?

- Increase training on professional behaviour for drivers
- Add more safety features in app for reporting abuse instantly to the nearby law enforcers
- Addressing more customer feedback/ compliance and take necessary actions by the ride sharing service providers
- Imposing demerit points for drivers accused of misbehaviour /harassment with the passengers
- Others