

# **VULNERABILITY ASSESSMENT OF MOTORCYCLE RIDING IN DHAKA CITY BY STRUCTURAL EQUATION MODELLING**

**MUHAMMAD SAIFUR RAHMAN**

**M.Sc. ENGINEERING THESIS**



**DEPARTMENT OF CIVIL ENGINEERING  
MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY  
DHAKA, BANGLADESH**

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# VULNERABILITY ASSESSMENT OF MOTORCYCLE RIDING IN DHAKA CITY BY STRUCTURAL EQUATION MODELLING

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of  
Master of Science in Civil Engineering



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# VULNERABILITY ASSESSMENT OF MOTORCYCLE RIDING IN DHAKA CITY BY STRUCTURAL EQUATION MODELLING

## DECLARATION

I hereby declare that the study reported in this thesis entitled as above is my original work and it has not been submitted before anywhere for any degree or other purposes. Further I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged and/or cited in the reference Section.

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VULNERABILITY ASSESSMENT OF MOTORCYCLE RIDING IN  
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A Thesis

By

Muhammad Saifur Rahman

DEDICATION

Dedicated to my family for supporting and encouraging me to believe in myself

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## ABSTRACT

### **Vulnerability Assessment of Motorcycle Riding in Dhaka City by Structural Equation Modelling**

In recent years, motorcycles have become one of the preferred modes of transport for commuters of Dhaka city as an alternative to car travel and public transports for its affordability and easy accessibility to reach any destination. This massive raise of the number of motorcycles has increased accidents and consequent casualties which is a growing problem for the urban dwellers of Dhaka metropolitan city. It is quite evident that motorcyclists are being forced to share the road with mixed traffic due to absence of separate motorcycle lane in road infrastructure. Thus, it has an associated safety concerns as well as psycho-social impacts on motorcyclists and other road users in Dhaka city. In view of the mixed traffic situation, the study has been intended to assess the overall vulnerability of motorcycle riding within the existing roadway characteristics and traffic management system of Dhaka city from the two-folded safety perceptions and reported behaviours of motorcyclists as well as other road users by Structural Equation Modelling (SEM).

The research methodology has been designed into three-steps procedures to develop and analyze the models. In the first step, a set of 26 and another set of 24 perceived safety concerns variables have been selected for Motorcyclists as well as Other Road Users respectively. Secondly, two sets of stated preference survey questionnaire have been administered among motorcyclists including service riders as well as other road users including pedestrians, car and public transport drivers in the Dhaka city by both field and online questionnaire survey. Then, two Structural Equation Models on the safety concerns of motorcycle riding have been generated by carrying out by 1<sup>st</sup> and 2<sup>nd</sup> Order Confirmatory Factor Analysis (CFA) method using the Stata software. Finally, both the models have been analyzed basing on the ranking values of standardized factor loading of all the latent and observed variables to determine the Most Significant/Important and Significant/Important factors related to the overall vulnerability/ safety concerns of motorcycle riding in Dhaka city.

The study has unveiled that comparing both models, all the perceived safety concerns of motorcycle riding in Dhaka city are being recognized by both Motorcyclists as well as Other Road Users. Only there are differences of perception from both ends in prioritizing or ranking the safety factors in different safety aspects. As such, in the mixed traffic

situation of Dhaka city, the five safety aspects like Road Infrastructures (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social aspects influencing riding of Motorcyclists (n4) and Traffic Rules Violation by Other Road Users (n5) are the determinant safety concerns and mutually influencing for the overall vulnerability assessment of Motorcycle Riding in Dhaka City. Amongst the 05 safety aspects, Traffic Rules Violation by Motorcyclists (0.87) is identified by both Motorcyclists and Other Road Users as the most significant safety concerns for vulnerable motorcycle riding in Dhaka city. In regards to Traffic Rules Violation by Motorcyclists, the result shows that frequent changing the lane by zig-zag driving (0.89), disregarding the speed limit by motorcycle drivers (0.89), uncertain movement of roadside parked motorcycles (0.89), using footpath by motorcyclists while stuck in traffic on main road (0.86) and overtaking any vehicle without proper precautions (0.82) are the most significant priority concerns as exhibited by the reported behaviours of motorcyclists. It is revealed in the analysis that motorcyclists' attitudes and aggressive behavioural issues are influenced by various family and psycho-social issues which lead to commit an accident. The most significant psycho-social factors are riding aggressively during social or family crisis (0.96), breaking traffic rules to reach the destination at the earliest (0.89), violating the traffic rules during office time (0.89), 'maximum income within shortest possible time' by the service riders (0.87), driving fatigue for overstressed riding time by service riders (0.87). The certain traffic rules violation by other road users (public transport drivers, private cars drivers and pedestrians) also has a significant contributing impact on vulnerability of motorcycle riding in Dhaka city. The reported behaviour of other road users like not wearing helmet or other safety gears properly by the passengers (0.89) is identified as most significant safety concerns by both Motorcyclists and other road users. The study shows that road geometry and infrastructures of Dhaka city are not user-friendly and great safety concerns of motorcycle riding. The most significant safety concerns are absence of separate lane for motorcycle in mixed traffic flow (0.88 which is rated as top priority concern by both Motorcyclists and Other Road Users) and no footpath for walking or occupied footpath for other purpose (0.81). The study also reveals that absence of road signage / non-functional signal at a junction (0.78) and presence of unmarked elevated speed breaker (0.67) are the significant safety concerns in respect of traffic management system of Dhaka city. The outcome of this research can be a good instrumental tool for formulation of safety programs and policies for a safe motorcycle riding in Dhaka city.



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## LIST OF ABBREVIATIONS

SEM	Structural Equation Model
GOB	Government of Bangladesh
CFA	Confirmatory Factor Analysis
OLS	Ordinary Least Squares
RRAM	Rider Risk Assessment Measure
TPB	Theory of Planned Behaviour
PBC	Perceived Behavioural Control
MAAP5	Microcomputer Accident Analysis Package five
ARI	Accident Research Institute
BUET	Bangladesh University of Engineering and Technology
iRAP	International Road Assessment Program
Chisq	Discrepancy Chi Square
RMSEA	Root Mean Square of Error Approximation
GFI	Goodness of Fit Index
AGFI	Adjusted Goodness of Fit
NFI	Normed Fit Index
TLI	Tucker-Lewis Index
CFI	Comparative Fit Index
SC	Safety Concerns
GIS	Global Information System
DNCC	Dhaka North City Corporation
DSCC	Dhaka South City Corporation

# CHAPTER 1

## INTRODUCTION

### 1.1 Background and Problem Statement of the Study

In recent years, motorcycles have become the one of the preferred modes of transport for commuters in Dhaka city as an alternative to car travel and public transport for its affordability and easy accessibility to reach any destination (Alam and Hoque, 2018). Motorcycles have always been one of the riskiest forms of transport on the roads of Dhaka City. In the event of an accident, a motorcycle rider is directly and fully exposed to violent impact or collision. Therefore, motorcyclists are more at risk of being killed or injured in a road traffic accident than any other type of vehicle user (Rahman, 2015). The immensely growing popularity of the motorcycle riding services is bringing new challenges for road safety due to violation of traffic rules by the motorcycle riders and lack of accountability of the ride-sharing services and their drivers (Kumar, Chun and Rahman, 2019). Thus, it is leading towards significant increase in number of crashes and therefore costing enormously in terms of losses of life and injuries (Hoque et al., 2015). Bangladesh Road Transport Authority statistics show that the number of registered motorcycles has doubled over the last eight years which covers around 46 percent of total registered vehicles. According to the Accident Research Institute of BUET, presently 20-25 percent is victims of motorcycle accidents which were 15-20 percent in three or four years back (Akter and Pervaz, 2019). The statistics indicates that motorcycle accident and fatality risk is very concerning in Dhaka city with very high motorcycle occupancy rate (Ahsan and Sufian, 2014). In this scenario, Policy-38 of Revised Strategic Transport Plan for Dhaka-2016 also emphasizes the continuous attention to the safety aspects and behaviour enforcement measures particularly for achieving the goals and targets of the Decade of Action for Road Safety, 50% reduction of deaths by 2020 (GOB, 2015). Zehra et al. (2019) emphasized that Motorcyclists are being forced to share the road with mixed traffic due to absence of separate motorcycle lane in road infrastructure. Thus, it has an associated safety concerns as well as psycho-social impacts on motorcyclists and other road users in Dhaka city. The most of the previous studies is found in recent past mainly focuses on motorcycle traffic trend analysis, motorcycle traffic volume, travel behaviour, characteristics of motorcycle accident and identification of injury patterns of hospitalized motorcyclists and development of countermeasures for their safety improvement. Hardly any study on behavioural patterns of motorcyclists and other road users as well as impacts

on each other has been found to be carried out previously in the context of Dhaka city. However, this research will emphasize on determining the vulnerability of motorcycle riding by assessing safety concern of motorcyclists and other road users through reported behaviours by Structural Equation Model within the existing roadway characteristics and traffic management system of Dhaka city.

## **1.2 Objectives of the Research**

The objectives of the study are:

- (i) To develop a structural equation model on safety concerns of motorcyclists through the reported behaviour of road users within the existing roadway characteristics and traffic management system in Dhaka city.
- (ii) To develop a structural equation model on safety concerns of other road users through the reported behaviour of motorcyclists within the existing roadway characteristics and traffic management system in Dhaka city.
- (iii) To identify the significant factors related to vulnerability of motorcycle riding in Dhaka city.

## **1.3 Significance of the Research**

In the mixed traffic situation of Dhaka city, motorcyclists are always at risk of being killed or injured in a road traffic accident being directly and fully exposed to violent impact or collision with other road users like drivers of different types of vehicles and pedestrians. The results that are obtained from this study are expected to contribute significantly towards understanding the behavioural patterns and characteristics of motorcycle riding. It is expected that the outcome of this research can be used to develop behavioural, vehicular and injury related countermeasures with identified contributing factors for motorcycle accident. Thus, it will assist in the formulation of safety programs and policies for reducing the casualties and mortalities among motorcyclists and other road users of Dhaka city. The results can also be used to conduct any further research work on road traffic accidents with remedial measures.

## **1.4 Scope of the Research**

Overall, this study aims at identifying significant factors related to vulnerability of motorcycle riding in Dhaka city. In exploring that this study examines determinants of motorcycle riders' attitudes, behaviour and analysing other psycho-social factors influencing the occurrence of traffic accidents and offences by developing Structural Equation Model. Whilst it is acknowledged that the behaviour of other road users (car & public transport drivers and pedestrian) has a marked influence on the causes of motorcycle crashes. Therefore, this study will also elicit other Road Users' opinions on high-risk riding behaviour and the psycho-social factors that contribute to the occurrence of motorcycle related accidents.

### **1.4.1 Assumptions**

A combination of increasing volume of vehicles on the road, complexity of heterogeneous mix of vehicles, poor road infrastructure, high risk-taking behaviour of general public, poor enforcement of traffic laws and lack of proper regulation and dedicated facilities for the vulnerable road users has led to increasing road traffic crashes and casualties in Dhaka city. Motorcycles often share the traffic space with fast moving cars, buses and trucks and also lack of physical protection makes motorcycle riders particularly vulnerable to being killed or injured in a road traffic crash. The significant factors of socio-economic changes like individualism, materialism, increased economic activities, degradation of social & family values by social media and fast living urban life-style have the direct as well as indirect impact on the behavioural pattern of motorcyclists and the other road users.

### **1.4.2 Limitation**

The research scope of this study is limited to the vulnerability assessment of motorcycle riding within the Dhaka city. In this research, assessment of characteristics of motorcycle accident, injury patterns of accident victims and Socio-economic effects of motorcycle riding vulnerability are beyond the purview of this study. As such, Accident Severity Analysis, Collision type and identifying accident prone area are not carried out in the study.

## **1.5 Rationale of Using Structural Equation Model**

Structural Equation Model (SEM) is a general and powerful multivariate analysis technique to find the causal effects of the exogenous variables on the endogenous variables and the causal effects of endogenous variables upon one another. SEM can handle a large number of endogenous and exogenous variables, as well as latent (unobserved) variables specified as linear combinations of the observed variables. Multiple regression, simultaneous equations (with and without error-term correlations), path analysis, factor analysis, time series analysis, and analysis of covariance are all special cases of SEM. Thus, these make SEM more useful than general linear regression for hypothesis testing and easy to express the results using path analysis diagram. SEM consists of two model components these are (1) the measurement models, an application of Confirmatory Factor Analysis (CFA) used to examine the relationship between observed variables and latent variables and (2) structural models that utilize multiple regression paths among latent variables to test specific relationships between constructs (Khan, 2016).

There are several mathematical models being used for transportation related study like ANOVA, MANOVA, discrete choice, ANSYS etc. SEM is being used in this research because SEM is a second-generation multivariate analysis technique developed due to some limitations in the traditional Ordinary Least Squares (OLS), especially when dealing with latent constructs/unobserved variables. SEM is capable of estimating a series of inter-relationships among latent constructs simultaneously in a model (Awang,2012). In fact, SEM is the most efficient method to handle the Confirmatory Factor Analysis (CFA) for measurement models, analyze the causal relationships among latent constructs (Perceived Safety Concerns of Motorcycle Riders as well as Other Road Users) simultaneously in the structural model, estimating their variance and covariance in the model. These latent constructs used in this research can only be measured indirectly through the respondent's response towards a set of items in a questionnaire. SEM also allows multiple measures to be associated with a single latent construct. It is a largely confirmatory, rather than exploratory technique. Thus, SEM will be helpful to determine validity of the model. Thus, SEM is being used in this study to model and analyze the inter-relationships among latent constructs effectively, accurately, and efficiently. More importantly, the multiple equations of inter-relationships in a model are computed simultaneously (Rahman, 2016).

## 1.6 Theoretical and Analytical Framework

A research work needs to be progressed on a defined theoretical and analytical framework to keep the work flow in the right direction. The Fig. 1.1 shows that motorcyclists are being forced to share the road with mixed traffic due to absence of separate motorcycle lane in road infrastructure of Dhaka city. Thus, it has an associated sense of insecurity as well as psycho-social impacts on motorcyclists and other road users in Dhaka city. There is a need to determine the overall vulnerability of motorcycle riding within the existing roadway characteristics and traffic management system of Dhaka city basing on the safety perceptions and reported behaviour of motorcyclists and other road users in mixed traffic situation.



Fig. 1.1: Mixed Traffic Situation in Dhaka City

The key findings in regards to the vulnerability of motorcycle riding are:

- (i) Vulnerability of motorcycle riding associates both the safety perception and reported Behaviour of Motorcyclists and Other Road Users like bus/car drivers, pedestrians etc in mixed traffic situation. At the same time, the psycho-social factors influence the attitude and behaviour of the motorcyclists while driving on the road. The factors associated with the vulnerability of motorcycle riding is depicted in Fig. 1.2.



Fig. 1.2: The Factors Associated with the Vulnerability of Motorcycle Riding

- (ii) Existing roadway geometry / characteristics of Dhaka city is not also user-friendly for safe motorcycle riding.
- (iii) Poor traffic management scenario has significant impact on motorcycle riding in Dhaka city.

## 1.7 The Outline of the Thesis

### 1.7.1 Chapter 1 : Introduction

Chapter 1 outlines the background, problem statement and objective of this particular research work. It also gives an idea about the significance of this study in the perspective of Dhaka city. Chapter 1 also discusses rationale of using SEM and analytical framework of the study. Finally, the outline of entire thesis is presented.

### 1.7.2 Chapter 2 : Review of the Literature

Chapter 2 presents a review of the previous studies on vulnerability of motorcycle riding in different cities around the world and relevant study in the context of Dhaka city, Bangladesh. It also describes the different features and applicability of SEM in the field of transportation. At the end, it gives an overview of the research work on similar field and take away for the present study on vulnerability assessment of motorcycle riding in Dhaka city.

### **1.7.3 Chapter 3: Research Methodology and Data Collection Procedure**

Chapter 3 Primarily discusses about the research methodology and also research technique of the using the Structure Equation Modeling for data analysis as suited with the objectives of the research.

### **1.7.4 Chapter 4: Result and Discussion of SEM-1**

Chapter 4 firstly describes the sample characteristics of the model-1. Then the development process of the model with Factor Analysis is being discussed elaborately and outcome results are interpreted. Finally, the key findings of developed model are highlighted with relevant study references.

### **1.7.5 Chapter 5: Result and Discussion of SEM-2 and Comparison between Two Developed Models**

Chapter 5 firstly describes the sample characteristics of the model-2. Then the development process of the model with Factor Analysis is being discussed elaborately and outcome results are interpreted. Finally, the key findings of developed model are highlighted with relevant study references.

### **1.7.6 Chapter 6: Conclusions and Recommendations**

This is the last chapter which summarizes the entire paper and draw conclusions of the study with few recommendations.



## **CHAPTER 2**

### **REVIEW OF LITERATURE**

#### **2.1 General**

Review of literature is very important before embark into the process to attain the specific objectives of the thesis work. It helps to understand and get the overall idea about the topic to work on. In view of the objective of the study, this literature review will help to identify the scope of work setting an appropriate research methodology. Thus, this chapter presents an extensive review of literatures that deal with different aspects of motorcycle riding. This chapter summarizes the findings from previous studies on vulnerability of motorcycle riding in most motorcycle-prone counties around the globe and in the context of Bangladesh. Then, it introduces the Structural Equation Modeling (SEM) technique which has been extensively used in transportation sector for vulnerability assessment. Finally, the potential application of SEM in perceived vulnerability assessment of motorcycle riding in Dhaka city is highlighted.

#### **2.2 Past Studies on Vulnerability of Motorcycle Riding**

##### **2.2.1 Effect of Motorcyclist Risk Tolerance in Accident Risk Management**

Malkhamah et al. (2018) discussed the improvement of accident risk tolerance indicators, i.e. safety factor and margin of safety, and their possible usage in speed management policies. These indicators were built based on the correlation between the results of interview and braking maneuver test. From this combine approach, using aggregated-individual and expert acceptance models, it was found that risk tolerance arose because motorcyclists accepted both the advantages and disadvantages gained from speeding, obtained through their riding frequency, duration of riding and/or accident involvement experienced. However, inappropriate speed due to miss-perception toward braking capability should be avoided. Inversely, an appropriate speed management should consider their travelling expectation.

### **2.2.2 The Influence of Motorcyclists' Attitudes on Traffic Accidents and Offences**

Wedagama (2017) aimed at identifying determinants of motorcyclists' attitudes and analyzing their influences on the occurrence of traffic accidents and offences in Denpasar, Bali. The results show that age and education level influenced learning method and experiences variables while gender did on motorcyclists' attitude. In addition, learning method and experience and motorcyclists' attitudes on the road were two significant factors respectively that negatively affected motorcyclists' involvement in traffic accidents and offences. In other words, ages, education level and gender have significant indirect influences on motorcyclists' involvement in traffic accidents and offences. The influence of gender implies that compared to females, male motorcyclists are more likely to fail giving priority and violate parking signs. In comparison with females, male motorcyclists therefore, are more likely to get involved in traffic accidents and offences. Interestingly, this study indicated that motorcyclists with a higher education were not a guarantee not to involve in traffic accidents and offences.

### **2.2.3 Chiang Mai city's transport system and role of the motorcycle**

Peraphan (2015) discussed that the recent trend towards urbanization in Southeast Asia has seen many cities grow at a phenomenal rate as people have moved away from rural areas in search of employment. Resulting pressure on city transport systems has increased traffic congestion, air pollution, and the number of traffic accidents, with correspondingly detrimental effects on the quality of life. Acknowledging the challenging nature of attaining a sustainable transport system, this research investigates the potential of the motorcycle and the shared-taxi to improve sustainability within an urban transport system. Chiang Mai was chosen as the case study; it is the biggest city in Northern Thailand and, in recent years, has experienced rapid population growth, which has resulted in worsening transport problems. Motorcycles currently outnumber cars and are the preferred means of transport for local city residents. In addition, a form of shared-taxi service, which uses converted pick-up trucks, has operated within the city and the surrounding locality for over 50 years.

#### **2.2.4 Psychosocial and Behavioral Aspects in Victims of Motorcycle Accidents**

Zehra et al. (2019) highlighted that Psychosocial and behavior aspects play a critical role in motorcycle accidents. Riders experiencing family-related or social-related stress and those with an aggressive personality are more prone to have a motorcycle accident than riders who do not have those stressors. Additional measures should be taken to raise awareness regarding these important contributing factors, including stress management in driving education. Thus, results suggest that behavioral and psychosocial factors have a major influence on the victims of motorcycle accidents and are an important cause of injury due to crashes.

#### **2.2.5 Psychological and social factors influencing, motorcycle rider intentions and behaviour**

Barry et al. (2007) studied to identify and assess the psychological and social factors influencing motorcycle rider behaviour. The primary aim of the research was to develop a Rider Risk Assessment Measure (RRAM), which would act as a tool for identifying high-risk riders by assessing rider intentions and self-reported behaviour. The first study (n = 47) involved a qualitative exploration of rider perceptions utilizing a focus-group methodology. This study identified six key aspects of rider behaviour considered to influence safety: motorcycle handling skills; rider awareness; riding while impaired or not; and the tendency to bend road rules, push limits, and ride at extreme speeds or perform stunts. Study two (n = 229) was survey-based and examined the psychological and social factors influencing these behaviours, utilizing the Theory of Planned Behaviour (TPB) and other relevant psychological constructs, such as sensation seeking and aggression. This study indicated that risky rider intentions were primarily influenced by attitudes and sensation seeking, while safer intentions were influenced by perceived behavioural control. While intentions significantly predicted all six types of behaviour, sensation seeking and a propensity for aggression emerged as significant predictors, particularly for the volitional risk-taking behaviours. The measures of intention and behaviour comprising the RRAM were not found to be significantly correlated with self-reported crash involvement, possibly indicating shortcomings in the measurement of crashes. However, significant correlations were found between the components of the RRAM and self-reported traffic offence involvement.

## **2.2.6 Factors influencing Safe and Unsafe Motorcycle Rider Intentions**

Deborah et al. (2012) discussed that the increasing popularity of motorcycles in Australia is a significant concern as motorcycle riders represent 15% of all road fatalities and an even greater proportion of serious injuries. This study assessed the psychosocial factors influencing motorcycle riders' intentions to perform both safe and risky riding behaviours. Using an extended Theory of Planned Behaviour (TPB), motorcycle riders (N = 229) from Queensland, Australia were surveyed to assess their riding attitudes, subjective norm (general and specific), Perceived Behavioural Control (PBC), group norm, self-identity, sensation seeking, and aggression, as well as their intentions, in relation to three safe (e.g., handle my motorcycle skillfully) and three risky (e.g., bend road rules to get through traffic) riding behaviours. Although there was variability in the predictors of intention across the behaviours, results revealed that safer rider intentions were most consistently predicted by PBC, while riskier intentions were predicted by attitudes and sensation seeking. The TPB was able to explain a greater proportion of the variance for intentions to perform risky behaviours. Overall, this study has provided insight into the complexity of factors contributing to rider intentions and suggests that different practical strategies need to be adopted to facilitate safer and reduce risky rider decisions.

## **2.3 Vulnerability of Motorcycle Riding in the Context of Dhaka City**

### **2.3.1 Motorcycle Traffic in Dhaka City**

Hossain (1996) discussed that Motorcycles serve as one of the modes of transport in Bangladesh and they contributed to an average of 4 percent of total motorized traffic on some major roads in Dhaka. This thesis deals with various aspects of motorcycle traffic in the study area of Dhaka city. In particular, investigation was made on traffic volume characteristics, traffic compositions and their temporal distribution. An assessment was performed on motorcycle rider's characteristics such as sex, age, occupation, trip purpose and trip length. It has also examined motorcycle accident characteristics towards suggesting safety improvements of motorcycle operation and riders. It is notable that 15 percent of motorcycle accidents occurred involving passenger cars. About 21 percent of motorcycle accidents were involved with buses and trucks. Autorickshaws, micro-buses, rickshaws and tempos were responsible for remaining accidents. About 64 percent of

motorcycle accidents occurred at straight roads, 25 percent at junctions and the remaining percent were at unknown locations. According to present analysis 68 percent of total motorcycle accidents occurred at day time and 32 percent at night time. About 53 percent of total accidents were rear-end collisions and 21 percent were side-swipe. Passenger cars were responsible for most of the rear-end collision types of motorcycle accidents. The study recommended some measures for the improvement of motorcycle operation and the safety of motorcycle riders in the study area of Dhaka city.

### **2.3.2 Motorcycle Accident and Injury Characteristics in Dhaka Metropolitan City**

Akter and Pervaz (2019) emphasized that the increase in motorcycle accidents and consequent casualties is a growing problem for the urban dwellers of Dhaka metropolitan city. The massive raise of the number of motorcycles due to the local production, cheap price and introduction of app-based ride sharing services has exacerbated the situation tremendously. This study aims to present the prevalence, causes and the characteristics of motorcycle accidents and casualties in this city area. The study analyzed police reported accident data by Microcomputer Accident Analysis Package five (MAAP5) software of Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET). The GIS tools were used to demonstrate accident scenario in different Thanas of the city area. Analysis of accident data revealed that a total of 460 motorcycle accidents took place in Dhaka Metropolitan Area from 2000 to 2014 and caused casualties of 581 people during this period. About 56.45% of the victims were riders, 24.61% were passengers and rest were pedestrians. More than 50% fatalities fell into the  $\leq 30$  age group, whereas about 32% and 14% were in 31-40 and 41-40 age group respectively. The number of rear end collisions was prominent (53.5%) in the study area. The study also revealed that in case of 94% accidents, helmets were not worn. GIS maps showed that both the Gulshan and Tejgaon Thana experienced highest motorcycle accidents and casualties. The study also recommended some measures for the improvements of motorcycle operation and the safety of motorcycle riders in the Dhaka metropolitan city.

### **2.3.3 Injury Patterns of Hospitalized Motorcyclists and Development of Countermeasures for their Safety Improvement**

Rahman (2015) highlighted that in the event of an accident, a motorcycle rider is directly and fully exposed to violent impact or collision. Therefore, motorcyclists are more at risk of being killed or injured in a road traffic accident than any other type of vehicle user. In Bangladesh Motorcycle is one of the most vulnerable motor vehicles and has a higher fatality rate per unit of distance traveled when compared with automobiles. The statistics indicates that motorcycle accident and fatality risk is very concerning in Bangladesh than other countries with very high motorcycle occupancy rate. Analysis shows that during 5 years from 2008-2012, the percentage of motorcycle related accident and casualties maintains an increasing trend and on average its share in all accident and casualties is 14% and 8% respectively. Under these circumstances the current study has been attempted to conduct detailed analysis with a view to identify distinct features of motorcycle related accident and injury in Bangladesh, Dhaka city in particular. The study aims to identify injury patterns among hospitalized motorcyclists, analyze motorcyclist's driving behavior and to explore characteristics of accident. The result shows that about half of total injury is in the right leg and more than one-fifth is in left leg. The probable cause of such leg injury may be due to the fact that motorcyclists are mainly involved in side-swipe and head-on accidents in which the legs are rubbed between vehicles or motorcycles and road. One preventive measure to protect the legs and feet might be to use Leg Guard.

### **2.3.4 Ride-sharing Service in Bangladesh: Contemporary States and Prospects**

Islam, Huda and Nasrin (2019) aimed to identify the current status and prospect of ride-sharing service in Bangladesh from the users' perspective. Data has been collected through a survey questionnaire from a sample of 164 respondents and analyzed using simple descriptive statistics. Findings show that ride-sharing services are emerging rapidly in Bangladesh as an alternative to traditional transportation because people prefer flexibility, convenience, time savings, and ease of use. The young generation is the top user of this service as they well equipped with the technologies required for this gig economy. Currently, Uber and Pathao, only two companies hold more than three-quarter of the market share because of their first mover advantage and availability in both car and motorbike segments. Further growth of this service is expected if major problems like

concern over safety and security can overcome. Thus, this study would be useful for companies understanding users' perception and improving their service quality.

### **2.3.5 Safe System Countermeasures for Vulnerable Road Users in Dhaka City**

Alam and Hoque (2018) Discussed that the vulnerable road users (VRUs) such as pedestrians, bicyclists, motor cyclist, pedal rickshaws and users of various informal motorized and non-motorized modes are victims of massive injury due to heterogeneous traffic practice in Bangladesh. In most of the cases, vulnerable road users are ignored from the planning of urban road network system. Nearly 65 percent of road traffic fatalities in Bangladesh are attributed to vulnerable road users. The share of vulnerable road users (VRUs) deaths in urban areas, particularly in Dhaka is much more staggering nearly 60 percent in 2014. Transportation by walking is mostly seen in Bangladesh and is highly vulnerable. Cycle rickshaws too cater quite significant proportion of trips (25% to 40%) in cities. Safe system is required to prevent these deaths and serious injuries occurring which has the objective of eliminating deaths and serious injuries, with the guiding principle that everyone, including planners, share responsibility for creating a safe road system.

### **2.3.6 Safer Motorcycling and Safer Roads: The Context of Bangladesh**

Hoque et al. (2015) emphasized that the staggering increase in number of motorcycles especially in Asia is leading towards significant increase in number of crashes and therefore costing enormously in terms of losses occurred by consequent deaths and injuries. In Bangladesh motorcycle crashes are a growing problem resulting from massive increase of motorcycles. There are over 1.1 million registered motorcycles in Bangladesh, representing nearly 57% of total registered motor vehicles. Motorcycles are increasing at an astonishing rate, around 500% during 1998-2013 with fleet growing at a much faster rate than other vehicles. Motorcycle crashes are claiming over 200 deaths annually and are predominantly a rural problem (nearly 70%), mostly attributable to effects of speeding. Predominant crash types are head-on, hit-pedestrian and rear-end, which together account for around 83%. Nearly three quarters of motorcyclist fatalities are attributed to non-wearing of safety helmets. Many factors contribute to motorcycle crashes with the dominance of hazards associated with road infrastructure. Recent iRAP (International Road Assessment Program) assessment of 1400 km of highways in

Bangladesh indicated the severity of road safety hazards for motorcyclists as the assessment revealed that 71% of assessed highways are 2-star or less (out of possible 5-star) indicating a relatively high level of risk of deaths and injuries. Addressing the safety of motorcycles and the riders is therefore an enormous challenge to transport engineering professionals. There is an urgent need to strengthen efforts for implementing a range of cost-effective countermeasures within the principles of safe system approach. The paper argues that the engineering safety on roads is clearly a priority issue particularly for achieving the goals and targets of the Decade of Action and motorcycle crashes and injuries cannot be prevented until safety treatments are built on the road infrastructure.

#### **2.4 Use of Structural Equation Model (SEM) as Research Technique**

SEM is a powerful multivariate analysis technique which allows establishing a set of relationship between observed and unobserved variables. SEM is a combination of factor analysis and multiple regressions. This methodology refers to a series of statistics techniques, such as factor analysis, path analysis and regression models etc. used to analyze data. Even though it is a relatively new method began in the 1970s, it has been widely applied in an extensive variety of research, including psychology, education, social sciences, economics, statistics, etc. With the development of specific packages, like LISREL and AMOS, SEM methodology has been rapidly circulated. Several applications in different contexts have been encouraged by the availability of these packages. There are two components of a SEM model, namely: a measurement model assessing unobserved latent variables as linear functions of observed variables, and a structural model showing the direction and strengths of the relationships of the latent variables. A full structural equation model is composed of three set of equations (or three sub-models): (1) a measurement model for the endogenous (dependent) variables (2) a measurement model for exogenous (independent) variables and (3) a structural model. However, a full SEM is rarely applied in practice. An SEM measurement model is used to specify a set of latent (unobserved) variables as linear functions of other observed endogenous or exogenous variables. In a full SEM, structural model is used to capture the causal influences among the latent exogenous and latent endogenous variables. If no measurement model is used, structural model captures directly the causal influences of the observed exogenous variables on the observed endogenous variables and the causal influences among observed endogenous variables. SEM, that have measurement model



only for observed endogenous variables, structural model involves latent endogenous variables rather than observed endogenous variables. Similarly for SEM with measurement model only for observed exogenous variables, structural model involves latent exogenous variables rather than observed exogenous variables. An important step before model estimation is to ensure that each component of the model is identified. Structural equation model is basically a set of simultaneous linear equations. To obtain correct parameter estimates, the set of equations must be identified regardless of the sample size.

The basic equation of structural model can be described by:  $\eta = \beta\eta + \Gamma X + \zeta$

The basic equation of measurement model can be described by:  $Y = \Lambda y + \varepsilon$

Here, X stands for exogenous observed variables. Y stands for dependent variables.  $\eta$  stands for latent dependent variable.  $\beta$  stands for coefficients of the  $\eta$  variables.  $\zeta$  stands for errors in the structural relationship between  $\eta$  and X  $\Gamma$  stands for coefficients of the X variables in the structural relationship  $\Lambda y$  stands for coefficients of the regression of y on  $\eta$  Estimation of SEM parameters is an iterative process which finally produces a best fit solution to the input data as a baseline. The iteration is based on covariance analysis with the fundamental assumption that the population covariance matrix of observed variables can be expressed as a function of unknown parameters. It tries to minimize the difference between the sample covariance matrix and the model implied covariance by estimating parameters in the model (Khan, 2016).

#### **2.4.1 The Advantages of SEM Compared to Other Methods**

SEM is capable of estimating a series of inter-relationships among latent constructs simultaneously in a model. In fact, SEM is the most efficient method to handle the Confirmatory Factor Analysis (CFA) for measurement models, analyze the causal relationships among latent constructs in a structural model, estimating their variance and covariance, and test the hypotheses for mediators and moderators in a model. Thus, latent constructs cannot be measured directly since it is only a hypothetical concept of something. The examples of latent constructs measured through a set of items in a questionnaire are: (1) Service Quality (2) Customer Satisfaction (3) Job Satisfaction (4) (5) Perceived Usefulness (6) Attitudinal/ Behavioural Patterns etc. Those constructs

cannot be measured directly like counting the number or quantity etc. The variable which could be measured directly is called the observed variable, while the variable which could not be measured directly is called latent construct. These latent constructs could only be measured indirectly using a set of items in a questionnaire. Other advantages of Structural Equation Modeling (SEM) include (Awang, 2012):

- (i) Could run the Confirmatory Factor Analysis (CFA) to reduce measurement errors.
- (ii) Could deal with the problem of multicollinearity among independent constructs.
- (iii) Could assess the fitness of measurement model, as well as the structural model.
- (iv) Could analyze the model with multiple independents, as well as multiple dependents.
- (v) Could include the mediating variable in a model and analyze its effects (mediator).
- (vi) Could analyze the effects of moderating variable in certain path of a model (moderator).
- (vii) Could model the error terms and handle the correlated errors among response items.
- (viii) Could analyze both First Order and Second Order Constructs in the structural model.
- (ix) Could include both observed variables and latent constructs in the structural model.

#### **2.4.2 Evaluating the Fitness of a Model**

In SEM, there is several Fitness Indexes that reflect how fit is the model to the data at hand. However, there is no agreement among researchers which fitness indexes to use. Hair et al. (1995, 2010 and Holmes-Smith 2006; cited by Awang, 2012) recommend the use of at least one fitness index from each category of model fit. There are three model fit categories namely absolute fit, incremental fit, and parsimonious fit. The choice of index to choose from each category to report depends on which literature is being referred. The information concerning the model fit category, their level of acceptance, and comments are presented in Table 2.1.

Table 2.1: Index Category and the Level of Acceptance for Individual Index

<b>Name of Category</b>	<b>Name of Index</b>	<b>Index Full name</b>	<b>Level of Acceptance</b>	<b>Reference Comments</b>
Absolute fit	Chisq.	Discrepancy Chi Square	$P > 0.05$	Sensitive to sample size >200
	RMSEA	Root Mean Square of Error Approximation	$RMSEA < 0.08$	Range 0.05 to 0.1 is acceptable
	GFI	Goodness of Fit Index	$GFI > 0.90$	$GFI = 0.95$ is a good fit
Incremental fit	AGFI	Adjusted Goodness of Fit	$AGFI > 0.90$	$AGFI = 0.95$ is a good fit
	NFI	Normed Fit Index	$NFI > 0.90$	$NFI = 0.95$ is a good fit
	TLI	Tucker-Lewis Index	$TLI > 0.90$	$TLI = 0.95$ is a good fit
	CFI	Comparative Fit Index	$CFI > 0.90$	$CFI = 0.95$ is a good fit

The acceptable cut-off values reported by researchers may vary depending on literatures support they are referring to. However, the following Table 2.2 presents the reference to the literatures for the widely employed fitness indexes.

Table 2.2: The References to Literatures for the Respective Fitness Index

<b>Name of Category</b>	<b>Name of Index</b>	<b>Index Full Name</b>	<b>Literature</b>
Absolute fit	Chisq.	Discrepancy Chi Square	Wheaton et al. (1977)
	RMSEA	Root Mean Square of Error Approximation	Browne and Cudeck (1993)

	GFI	Goodness of Fit Index	Joreskog and Sorbom (1984)
Incremental fit	AGFI	Adjusted Goodness of Fit	Tanaka and Huba (1985)
	NFI	Normed Fit Index	Bollen (1989b)
	TLI	Tucker-Lewis Index	Bentler and Bonett (1980)
	CFI	Comparative Fit Index	Bentler (1990)

## 2.5 Summary

Several studies on vulnerabilities and safety concerns of motorcycle riding are found in the countries where motorcycle have become most preferred mode of transportation due to rapid urbanization like Indonesia, China, Thailand, Pakistan, Malaysia and Australia etc. It is revealed that motorcycle has become a popular mode of transport especially in Asian countries and people are becoming more interested in motorcycle as an alternative to car travel and public transport for its easy accessibility to reach any destination. The staggering increase in number of motorcycles especially in Asia is leading towards significant increase in number of crashes and therefore costing enormously in terms of losses occurred by consequent deaths and injuries. Motorcycles are considered as unsafe mode of transport. Age, Education Level and Gender have indirect influence on motorcyclists' involvement on motorcycle related accidents and offence. Experience and motorcyclist's attitude have significant influence in traffic accident and offence. The behavioural and psycho-social factors have a major influence on the victims of motorcycle accidents and are on important cause of injury due to crashes. In addition to riders' attitudes, the attitudes and behaviours of other road users (particularly car drivers) need to be considered because a large proportion of motorcycle crashes result from errors made by other vehicles and often drivers claim not to have seen the motorcyclist.

In Bangladesh, motorcycle crashes are a growing problem resulting from massive increase of motorcycles. Most attributable factors are over- speeding, not wearing of safety helmets and hazards associated with road infrastructure. Massive raise of number

of motorcycles due to local production, cheap price and introduction of app-based Ride Sharing Services have worsen the situation tremendously. Despite their relative importance in traffic stream, little effort has been made to provide special facilities to cater for the need of motorcycles and consequently they are much more vulnerable. In the context of Bangladesh, there is no directly relevant literature on the vulnerability assessment of motorcycle riding by doing any kind of modelling. However, few researchers worked on some of the related issues which might give certain insights. Their works primarily focused on accident characteristic, injury pattern and identifying the causes of motorcycle related accident by using questionnaire survey. No study was found on both the perspective of motorcycle riders and other road users considering the behavioural and psycho-social factors while on road.

It is found from the literatures that SEM technique is extensively used mainly for investigating causal relationship which perfectly matches with the objective of the thesis. This technique is especially appropriate in case of investigating causal relationships among a large number of exogenous, endogenous and latent variables. Thus, a methodological study using SEM would be value-adding research work for vulnerability assessment of motorcycle riding in Dhaka city addressing the both the behavioural and psycho-social perspectives of motorcycle riders as well as other road users.

## **CHAPTER 3**

### **RESEARCH METHODOLOGY AND DATA COLLECTION PROCEDURE**

#### **3.1 General**

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In this paper, the methodology section aims to critically evaluate overall validity and reliability of the research subject by presenting data collection procedure from the study area and analyzing the data to bring out research outcome.

#### **3.2 Procedure of Research Methodology**

A three-steps methodology adopted for this research is described in the subsequent sections.

##### **3.2.1 Step-1: Selection of Variables**

The first step addresses selection of variables. The variables included in the survey are selected discussing with transport experts, academicians and various road users like drivers and pedestrians. A pilot survey is conducted to underline the difficulties in accumulating the required information from different road users. The questionnaire is then finalized considering requisite amendment identified from the pilot survey.

##### **3.2.2 Step-2: Data Collection using a Stated Preference Questionnaire**

The second step aims at data collection using a specifically designed questionnaire survey. In view of assessing safety perceptions, reported behaviour of motorcyclists and other road users in the mixed traffic condition, two sets of stated preference questionnaire survey were prepared in accordance with analytical framework of the research and selected variables. Respondents were allowed to respond following five-point Likert scale. Perceived Safety Concerns of motorcyclists focused on the reasons of feeling unsafe while driving a motorcycle on the road and psychosocial aspects influencing riding. On the other hand, the focus of Other Road Users (Car /Public Transport Drivers/

Pedestrians) was on the reasons of feeling unsafe while driving / walking on the road and Psychosocial aspects Influencing while on road. The survey questionnaire is given in Appendix A & B of this paper.

### **3.2.3 Step-3: Developing the SEM**

In the third step, the structural equation models are developed in this study. Collected data is filtered for anomalies and a series of models are developed to understand thoroughly the relationships between Perceived Safety Concerns of Motorcyclists vis-à-vis Perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City. For each empirical model, the process of model development follows the approach of trial and error in terms of accommodating variables as well as by observing the overall goodness of fit values of the respective models. At the end, all the proposed candidate models are compared and the optimal one is found out. The optimal models are the most representative one of the actual scenarios. The two Structural Equation Models on the safety concerns of motorcycle riding have been generated by carrying out by 1<sup>st</sup> and 2<sup>nd</sup> Order Confirmatory Factor Analysis (CFA) method using the Stata software. Finally, both the Models have been analyzed basing on the ranking values of Standardized Factor Loading of all the Latent and observed variables to determine the Most Important and Important factors related to the overall vulnerability/ safety concerns of motorcycle riding in Dhaka City.

### 3.2.4 Outline of the Research Methodology

An outline of research methodology is enumerated in Fig. 3.1 below:

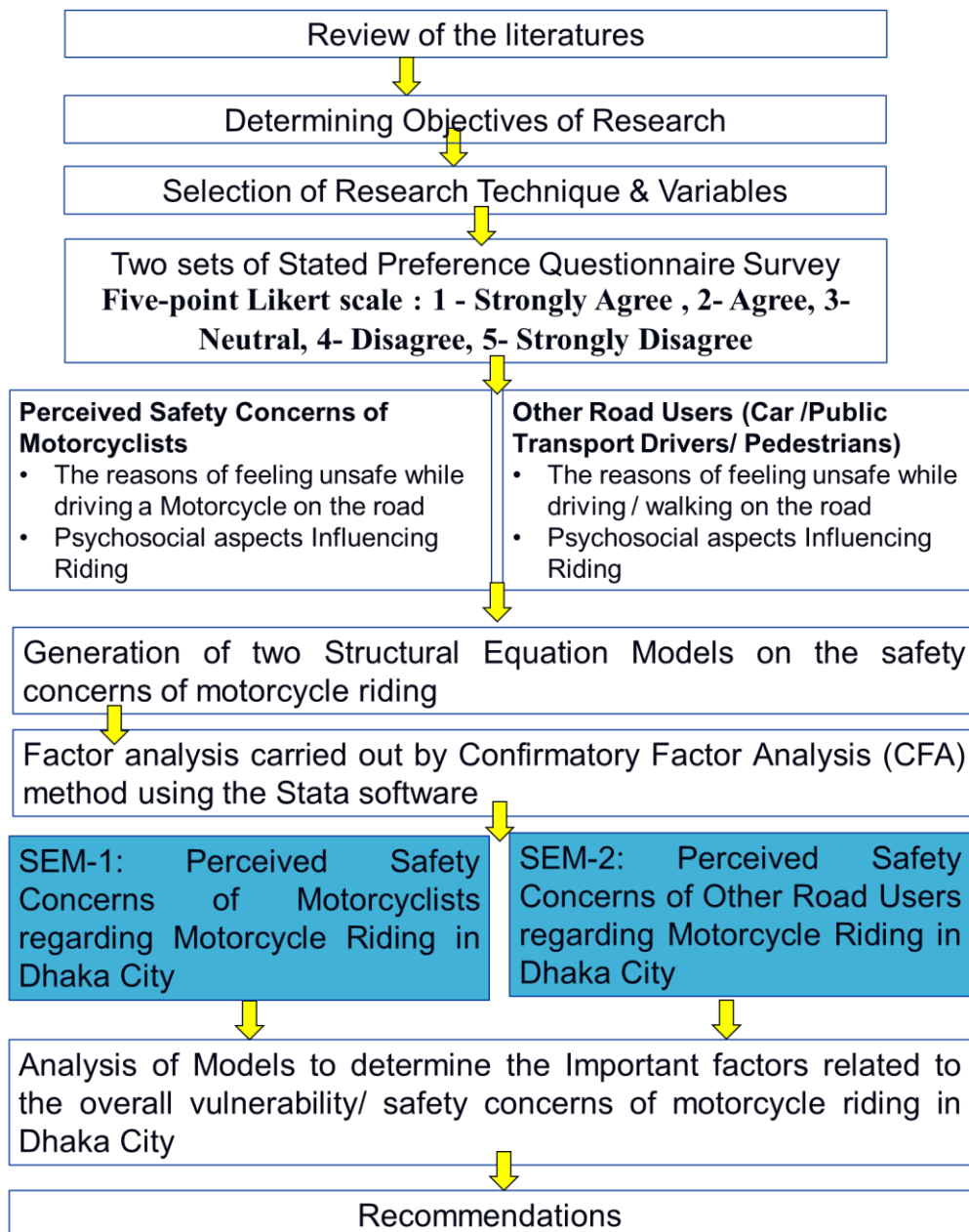


Fig. 3.1: Outline of Research Methodology



### 3.3 Identification of Safety Concerns (SC) Variables

Firstly, the identification of variables is conceptualized on safety concerns of motorcycle riding in Dhaka city firstly from existing review of literatures and then developing the analytical framework of the study. Since the study is carried out from two different safety perceptions of road users therefore variables of perceived SC of Motorcycle Riders vis-à-vis Other Road users are also varied. However, the opinions of transport experts, various focused group discussion of various stakeholders and feedback of pilot survey with face-to-face interviews had a significant effect in selecting finalized lists of variables in both cases. The conceptualization framework of Safety Concern Variables as per the research design is appended in Fig. 3.2 below:

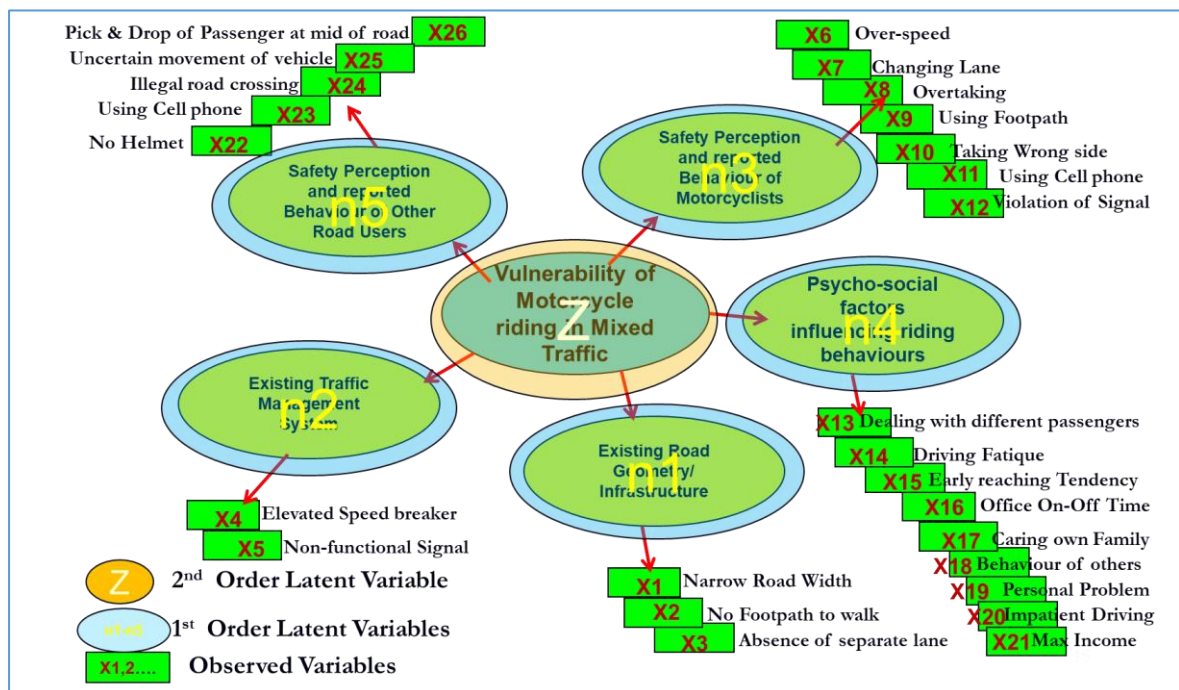


Fig. 3.2: Conceptualized Framework of Safety Concerns Variables Selection

Secondly, after detailed investigation, a set of 26 SC variables were selected for perceived Safety Concerns of Motorcyclists regarding motorcycle riding in Dhaka city and a set of 24 SC variables were selected for perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City to carry out this research. For building different models these variables are recognized as 1<sup>st</sup> Order Latent, 2<sup>nd</sup> Order latent variables and observed variables to carry out confirmatory factor analysis and subsequent development of models as best suited with research technique. Table 3.1 shows the

selected SC variables for perceived SC of motorcyclists regarding motorcycle riding in Dhaka city with their specific use and notations in the proposed structural equation model and Table 3.2 shows the selected SC variables for perceived SC of Other Road Users regarding motorcycle riding in Dhaka city with their specific use and notations in the proposed structural equation model.

Table 3.1: List of Variables for the Model-1 in respect of Perceived Safety Concerns of Motorcyclists regarding Motorcycle Riding in Dhaka City

<b>2<sup>nd</sup> Order Latent Variables</b>	<b>1<sup>st</sup> Order Latent Variables</b>	<b>Observed Variables</b>
Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z)	Road Infrastructure (n1)	Absence of separate lane for Motorcycle in Mixed traffic flow (X1)
		No footpath for walking or occupied footpath for other purpose (X2)
		Narrow road width/narrow bridge width (X3)
	Traffic Management System (n2)	Absence of road signage / non-functional Signal at a junction or roundabout (X4)
		Presence of unmarked elevated speed breaker (X5)
	Reported Behaviour of Motorcycle Riders on Traffic Rules Violation (n3)	Disregarding the speed limit by Motorcyclists when there is less traffic in road (while raining/Early morning/late Night) (X6)
		Changing the lane by Zig-zag driving by Motorcyclists while on road (X7)
		Overtaking any vehicle without proper precautions by Motorcyclists (X8)
		Using footpath by Motorcyclists while stuck in traffic on main road (X9)
		Taking wrong side of the road by Motorcyclists while stuck in traffic on road (X10)

		Using cell phone by Motorcyclists while riding motorcycle on the road (X11)
		Crossing the Junction by the Motorcyclists knowing fully well that ‘the red light is on’ or despite having ‘No Go’ signal given by Traffic Police (X12)
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	The ‘maximum income within shortest possible time’ influences the riding of the service providing riders (X19)
		The driving fatigues for over-stressed riding time influence the driving behaviour of the service providing riders (X20)
		Feeling impatience/ distracted due to rough weather/huge traffic congestion on road (X21)
		Breaking traffic rules to reach the destination at the earliest (X22)
		Try to violate the traffic rules during office going time or office break time (X23)
		Become cautious in driving whole own family is on ride (X24)
		Getting angered by another driver’s aggressive behaviour or faulty driving skill (X25)
		Riding aggressively when there are any social or financial problems in the family (X26)
		Dealing with different types of passengers throughout the day affects the driving behaviour of service providing riders (X27)
	Reported Behaviour of Other Road Users on Traffic	Illegal road crossing by pedestrians (X28)
		Not wearing helmet or other safety gears properly by the passengers (X29)

	Rules Violation (n5)	Use of mobile while driving a vehicle or Walking on the road (X30)
		Uncertain Movement /opening of the door by roadside parked vehicle (X31)
		Picking up and Dropping off the passengers by public transport Drivers in mid of the road (X32)

Table 3.2: List of Variables for the Model-2 in respect of Perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City

<b>2<sup>nd</sup> Order Latent Variables</b>	<b>1<sup>st</sup> Order Latent Variables</b>	<b>Observed Variables</b>	
Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z)	Road Infrastructure (n1)	Absence of separate lane for Motorcycle in Mixed traffic flow (X1)	
		No footpath for walking or occupied footpath for other purpose (X2)	
		Narrow road width/narrow bridge width (X3)	
		Traffic Management System (n2)	Overall Poor Traffic Management of Dhaka City (X4)
	Reported Behaviour of Motorcycle Riders on Traffic Rules Violation (n3)		Disregarding the speed limit by Motorcycle drivers when there is less traffic in road (while raining/early morning/late night) (X6)
			Frequent changing the lane by zig-zag driving of Motorcycle drivers (X7)
			Overtaking any vehicle without proper precautions by Motorcycle drivers (X8)
			Using footpath by Motorcyclists while stuck in traffic on main road (X9)

		Taking wrong side of the road by Motorcycle drivers while stuck in traffic on road (X10)
		Using cell phone while riding on road by Motorcycle drivers (X11)
		Crossing the Junction by Motorcycle drivers knowing fully well that ‘the red light is on’ or despite having ‘No Go’ signal given by Traffic Police (X12)
		Uncertain Movement of roadside parked Motorcycle drivers (X13)
		Uncertain stopping of Motorcycle at bus stoppage/ junction due to no earmarked parking for motorcycle (X14)
		Following other rider by Motorcycle drivers knowing fully well that he is violating the traffic rules (X15)
		Not caring the standard of safety helmet for the passenger by service providing Motorcycle drivers (X16)
		Picking up and Dropping off the passengers in mid of road by Motorcycle drivers (X17)
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	Service provider Motorcycle drivers are not liable about the safety of the passengers (i.e no insurance coverage) (X18)
		The ‘maximum income within shortest possible time’ influences the service providing Motorcycle drivers for rough driving (X19)

		The driving fatigue for over-stressed riding time influence the driving behavior of service providing Motorcycle drivers (X20)
	Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	Illegal road crossing by pedestrians (X28)
		Not wearing helmet or other safety gears properly by the passengers (X29)
		Use of mobile while driving a vehicle or Walking on the road (X30)
		Uncertain Movement /opening of the door by roadside parked vehicle(X31)
		Picking up and Dropping off the passengers by public transport Drivers in mid of the road (X32)

### 3.4. Study Area Profile

Dhaka being the capital of Bangladesh is one of the densely populated and rapidly growing cities in the world. The city accommodates about 10% of national and one third of the urban population. In this research, Dhaka Metropolitan Area has been selected as the study area comprising DNCC, DSCC and the old part of Dhaka. The study area covers 41 thanas of Dhaka Metropolitan Police Area which are the central part of the capital in terms of social and economic aspects. According BRTA, about 32.6% of registered vehicles of the country are plying in Dhaka city. However, these vehicles and improper traffic management is creating road safety hazard day-by-day. Study showed that, about 22% of all reported accidents of Bangladesh occurred in Dhaka metropolitan city. The condition of motorcycle safety is more crucial in the city. The number of registered motorcycles has more than doubled (182.6% increase) in Dhaka over the last decade. Low-priced, easily available different brands and increased popularity of this mode over car and public transport for its easy accessibility to reach the destination are considered as the main reason behind this growth. These motorcycles contributed up to 10% of total accidents in Dhaka city (Aktar et al., 2019).

### **3.5 Questionnaire Survey Structure**

#### **3.5.1 Study Area, Timeline, Variable Details and Data Collection Method**

A comprehensive field and online questionnaire survey were carried out within the Dhaka city from March 2020 to August 2020. The study area covered the entire Dhaka city as the respondents belong to different class of road users living in Dhaka city. The field survey was carried out by face-to-face interview at 05 different traffic junction locations of Dhaka city. The survey locations are Jatrabari, Gulistan, Farmgate, Mohakhali, Moghbazar and Neelkhat area. In view of assessing safety perceptions as well as reported behaviour of motorcyclists and other road users in the mixed traffic condition, two sets of stated preference questionnaire survey were conducted. First set of questionnaires was administered among motorcyclists including service riders attached as Appendix A. The main focus was getting the safety concerns of motorcyclists while riding on fear of traffic, roadway characteristics, present traffic management scenario and reported behavior of motorcycle riders as well as other road users. Second set of questionnaires was administered among other road users including pedestrians, car and public transport drivers in the Dhaka city with a purpose to assess the perceived safety concerns of other road users in regards to reported behavior of motorcyclists in mixed traffic conditions of Dhaka city attached as Appendix B. Each set of the questionnaire for the survey was structured into four sections. The first section aims to acquire general and Socio-economic/ Demographic Information (date of the interview, name, sex, age, occupation, Education level and Income level). Second section focused on use of Motorcycle and Riding History/ Travel characteristics of Respondents (ownership of Motorcycle / car, type of rider, frequency of using motorcycle, experience of driving motorcycle/car/public transport, experience of facing any motorcycle related accident and experience of violating any traffic rule related to motorcycle riding). The third section was oriented to the collection of opinion on the Psycho-social aspects that often Influence the driving of a Motorcyclist while on road from either perspective of a motorcyclist including service providing riders or as other road users. Here, Respondents were allowed to respond following five-point Likert scale (1 - Strongly Agree, 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly Disagree). The fourth section was designed at collecting evaluation of overall reasons of feeling unsafe in respect to motorcycle driving while either driving as a motorcyclist or driving a car/ public transport or walking as a pedestrian on the road. In

this section, the opinion of respondents was assessed on existing traffic management scenarios and roadway characteristics of Dhaka city as well as reported behaviour of either motorcycle riders or other road users (car driver, public transport drivers and pedestrians). The responses were arrayed on five-point Likert scale (1 - Strongly Agree, 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly Disagree) as like the section three.

### **3.5.2 The Sample Size**

The sample size for first set of questionnaires (administered among motorcyclists including service riders) was 306. Out of which 200 samples were collected physically in the field and 106 samples by online survey using google forms. On the other hand, sample size for second set of questionnaires (administered among other road users including pedestrians, car and public transport drivers in the Dhaka city) was 305. Of which 145 samples by physical survey and rest 160 by online survey.

## **3.6 Development of Structure Equation Models (SEM) for the Research**

### **3.6.1 SEM Model Construction**

SEM is a highly flexible technique to estimate co-relation, association, Factor loadings and Regression analysis among the observed and latent variables with residual error terms. SEM can express causal relationships between the latent nature of perceptions and the observed nature of reported behaviours as well as causal relationships among the latent variables like Psycho-social factors affecting behaviour patterns of Motorcyclists and Other Road Users. As such, SEM is found most suited with purpose of the study. Basing on the collected data, Factor analysis carried out by 1<sup>st</sup> and 2<sup>nd</sup> Order CFA method using the Stata software which facilitated in developing two structural equation models on the safety concerns of motorcycle riding. In doing so, Latent parameters will be used to determine the underlying cause of multiple observed variables. Model-1 represents Perceived Safety Concerns of Motorcyclists regarding Motorcycle Riding in Dhaka City and Model-2 represents Perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City. In order to check the fitness of the models the following Fitness Index were used as appeared in Table 3.3.



Table 3.3: Fitness Index of the Models

Name of category	Name of index	Index full name	Level of Acceptance	Reference Comments
Absolute fit	Chisq.	Discrepancy Chi Square	$P > 0.05$	Sensitive to sample size $>200$
	RMSEA	Root Mean Square of Error Approximation	$RMSEA < 0.08$	Range 0.05 to 0.1 is acceptable
	GFI	Goodness of Fit Index	$GFI > 0.90$	$GFI = 0.95$ is a good fit
Incremental fit	AGFI	Adjusted Goodness of Fit	$AGFI > 0.90$	$AGFI = 0.95$ is a good fit
	NFI	Normed Fit Index	$NFI > 0.90$	$NFI = 0.95$ is a good fit
	TLI	Tucker-Lewis Index	$TLI > 0.90$	$TLI = 0.95$ is a good fit
	CFI	Comparative Fit Index	$CFI > 0.90$	$CFI = 0.95$ is a good fit

### 3.6.2 Identification of Significant Factors

Identification of Most Important and Important Factors related to Safety Concerns of Motorcycle Riding for each model was carried out by the value of standardized factor loading of all the latent and observed variables. Finally, both the models were analyzed comparatively basing on ranking values of standardized factor loading of all the latent and observed variables to determine the Most Important and Important factors related to the overall vulnerability/ safety concerns of motorcycle riding in Dhaka City.

### 3.7 Summary

This chapter gives a detailed overview of the study methodology as well as the data collection procedure followed in the study. A three-steps methodology is adopted for this research. The first step addresses selection of variables. After detailed investigation, a set of 26 SC variables were selected for Perceived Safety Concerns of Motorcyclists

regarding Motorcycle Riding in Dhaka City and a set of 24 SC variables were selected for Perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City to carry out this research. For building different models these variables are recognized as 1<sup>st</sup> Order Latent, 2<sup>nd</sup> Order Latent Variables and Observed Variables to carry out CFA and subsequent development of models as best suited with research technique. A comprehensive field and online questionnaire survey were conducted within the Dhaka city preparing two sets of stated preference survey questionnaire. First set of questionnaires was administered among motorcyclists including service riders. Second set of questionnaires was administered among other road users including pedestrians, car and public transport drivers in the Dhaka city. The data collection process was complex and time consuming amid the COVID-19 situation prevailing in the country. Then, two Structural Equation Models on the safety concerns of motorcycle riding were generated by carrying out by 1<sup>st</sup> and 2<sup>nd</sup> CFA method using the Stata software. Finally, both the models were analyzed basing on the ranking values of sstandardized factor loading of all the Latent and observed variables to determine the Most Important and Important factors related to the overall vulnerability/ safety concerns of motorcycle riding in Dhaka City.

## CHAPTER 4

### RESULT AND DISCUSSION OF SEM-1

#### 4.1 Background/ Sample Characteristic of Respondents

In any research it is important to know the background characteristics of the target population. The assessment leads to the interpretation of results and to examine any cause- effect relationship among the study variables. Besides it helps in comparing the findings with similar characteristics in other independent survey findings. This chapter presents a comprehensive and elaborate discussion that provides a clear understanding about the background characteristic of the participant concerning motorcyclist regarding motorcycle riding in Dhaka city. The characteristics of the respondents of motorcyclists are described and analyzed in terms of following variables: age, sex, education, occupation, ownership, types of riders, experience, how frequently use, number of accidents faced etc.

Fig. 4.1 shows that 98 % Motorcyclists of Dhaka city by the respondents are male and 2% respondents only are female. So, it indicates that majority of motorcyclists of Dhaka city are male.

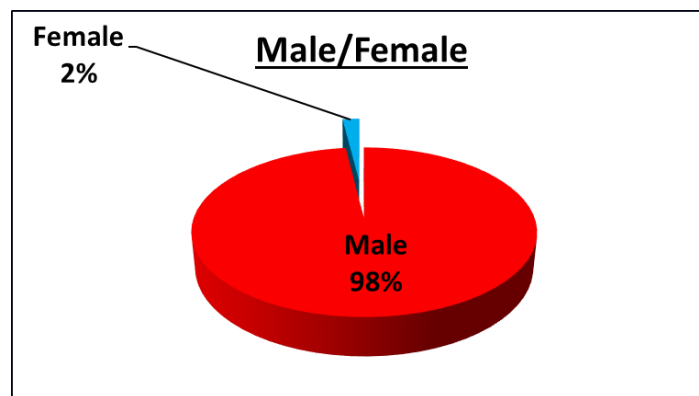


Fig. 4.1: Gender Distribution of Motorcyclists of Dhaka City by the respondents

The age distribution of motorcyclist of Dhaka city by the respondents is presented in Fig. 4.2. Here it was found that 55 % of motorcyclist of Dhaka city by the respondents belong to the age groups 20-30, 36% belongs to the age groups 31-40, 7% belongs to the age

groups 41-50, 1% of the participants who are motorcyclists belongs to the age groups 51-60, also 1% participants that have age below 20 or above and 60 that noted as blank.

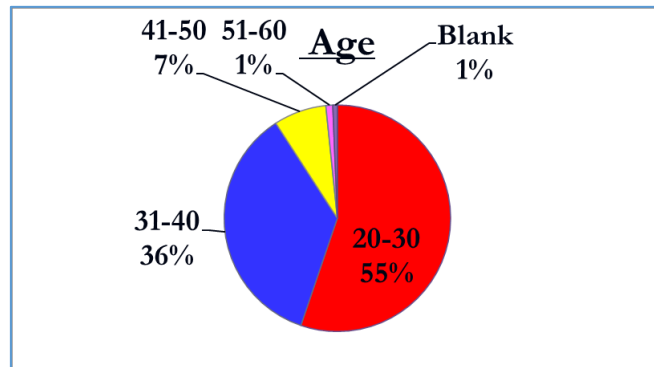


Fig. 4.2 : Age Distribution of Motorcyclists of Dhaka City by the Respondents

The educational distribution of motorcyclists of Dhaka city by the respondents is represented in Fig. 4.3. It is noticed that about 16% motorcyclists are illiterate. About 30% had passed SSC. About 37% Motorcyclists have passed HSC. Only 9% and 8% Motorcyclist have completed Graduation & Masters respectively.

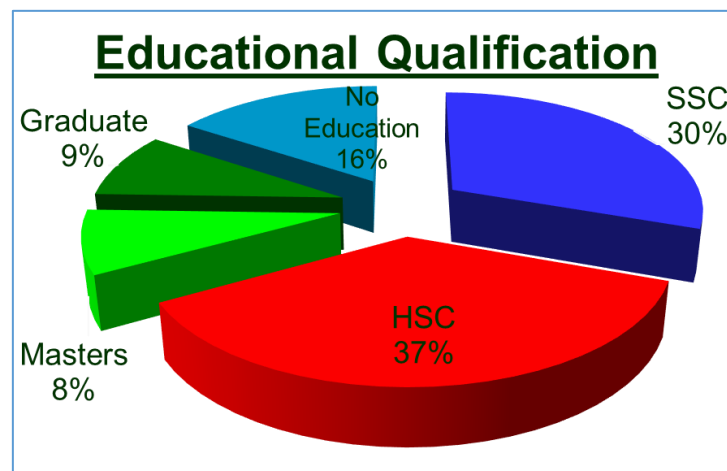


Fig. 4.3: Educational Qualification of Motorcyclists of Dhaka City by the Respondents

From Fig. 4. 4, it is found that about 28 % participant’s occupation from motorcyclists are Service Rider, about 28 % participant’s occupation from motorcyclists are Students, 19 % participants are Private Employee, 12 % are involved with Business and only 9% & 4% are Deliveryman & Govt. Employee respectively.

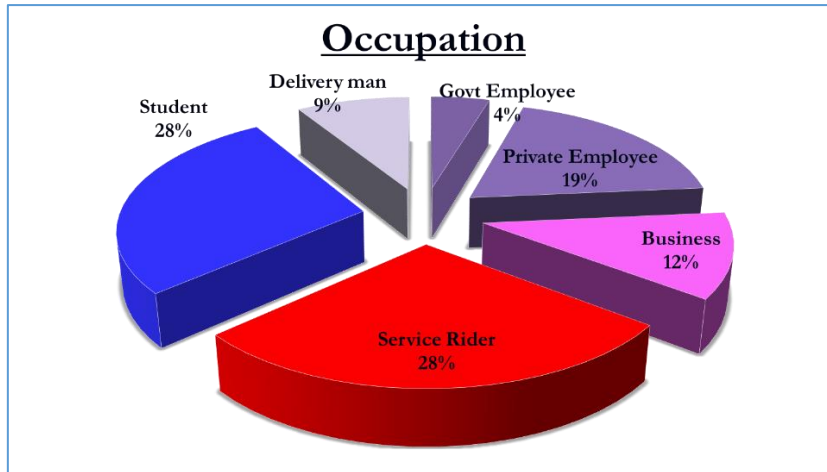


Fig. 4.4: The distribution of Occupation of Motorcyclists of Dhaka City by the Respondents

The distribution of ownership of motorcyclists of Dhaka city by the respondents is represented in Fig. 4.5. It is noticed that about 82% motorcyclists have their own motorcycle. About 15 % have been rented. Only 3% motorcyclist have no motorcycle of their own.

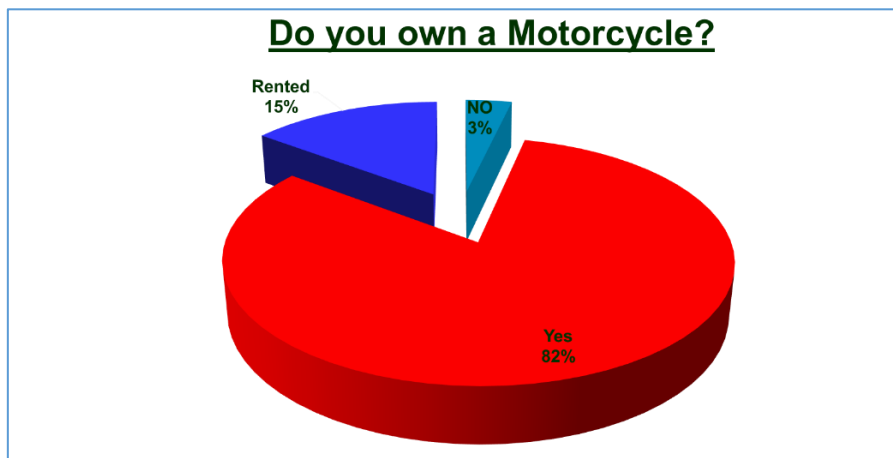


Fig. 4.5: Distribution of the Ownership of Motorcycle by the Motorcyclist Respondents

From Fig. 4.6, it is observed that about 36 % riders are both Recreational & Utilitarian. About 28 % and 23 % motorcyclists are Recreational and Utilitarian respectively. Only 13 % participants are Service or Professional riders.

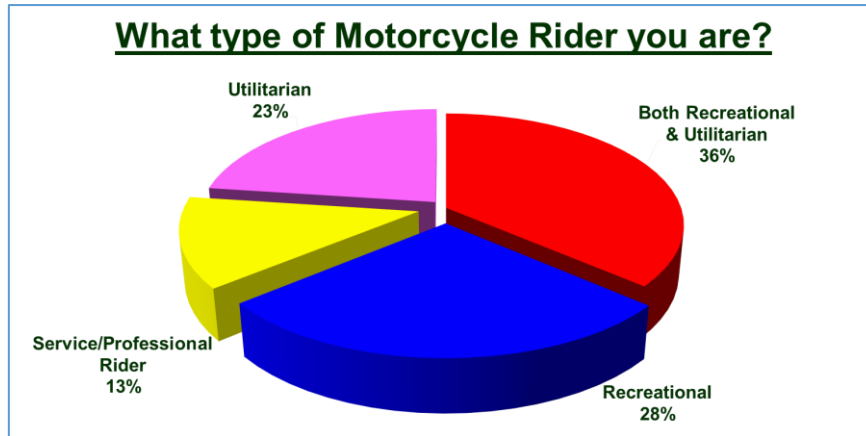


Fig. 4.6: Distribution of Different Types of Motorcycle Riders

From Fig. 4.7, it is observed that about 52 % riders have experiences more than 5 years. About 19 % and 22 % motorcyclists have experience 1-2 years and 2-5 years respectively. Only 7 % Rider have experience less than one year.

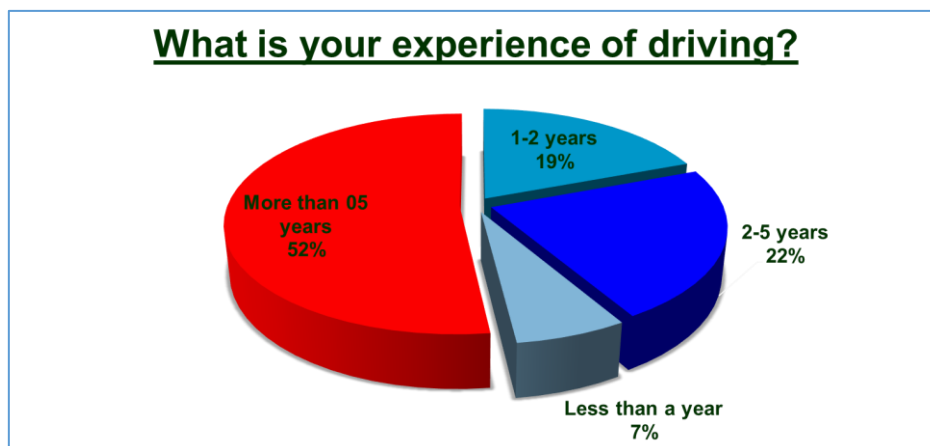


Fig. 4.7: Distribution of Experience of Driving of Motorcycle Riders

From Fig. 4.8, it is noticed that most of the rider (about 73 %) have used motorcycle every day. About 17 % and 7 % motorcyclists have used motorcycle 1-3 days in a week and occasionally respectively and only 3% rider have used motorcycle only on weekend/holidays.

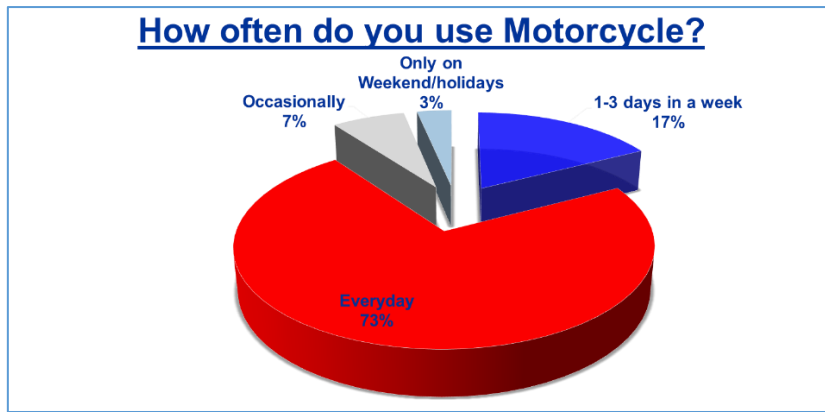


Fig. 4.8: The Distribution of How Often the Riders Use Motorcycle

From Fig. 4.9, it is observed that about 58 % rider have experienced accident two times. About 18 % motorcyclists have experienced no accident, about 16 % motorcyclists have experienced accident four times and only 8 % Rider have experienced accident 8 times in their whole life.

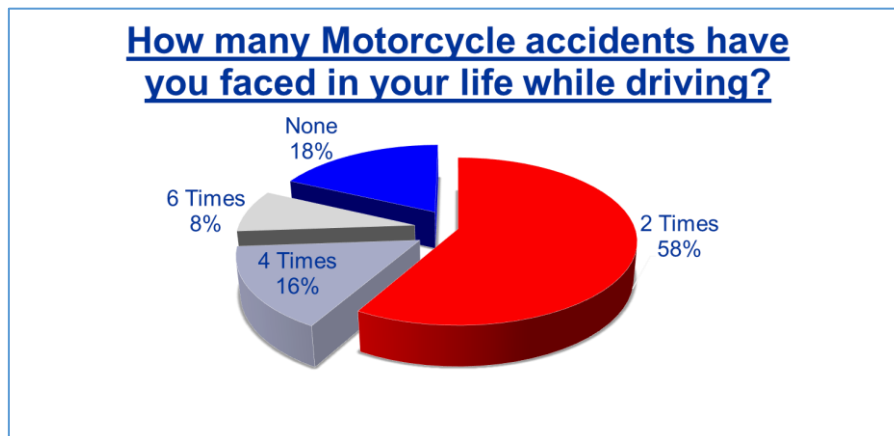


Fig. 4.9: The Distribution of Number of Times have Faced Accident by Riders While Driving

#### 4.2 Construction of SEM-1 for Perceived Safety Concerns of Motorcyclists

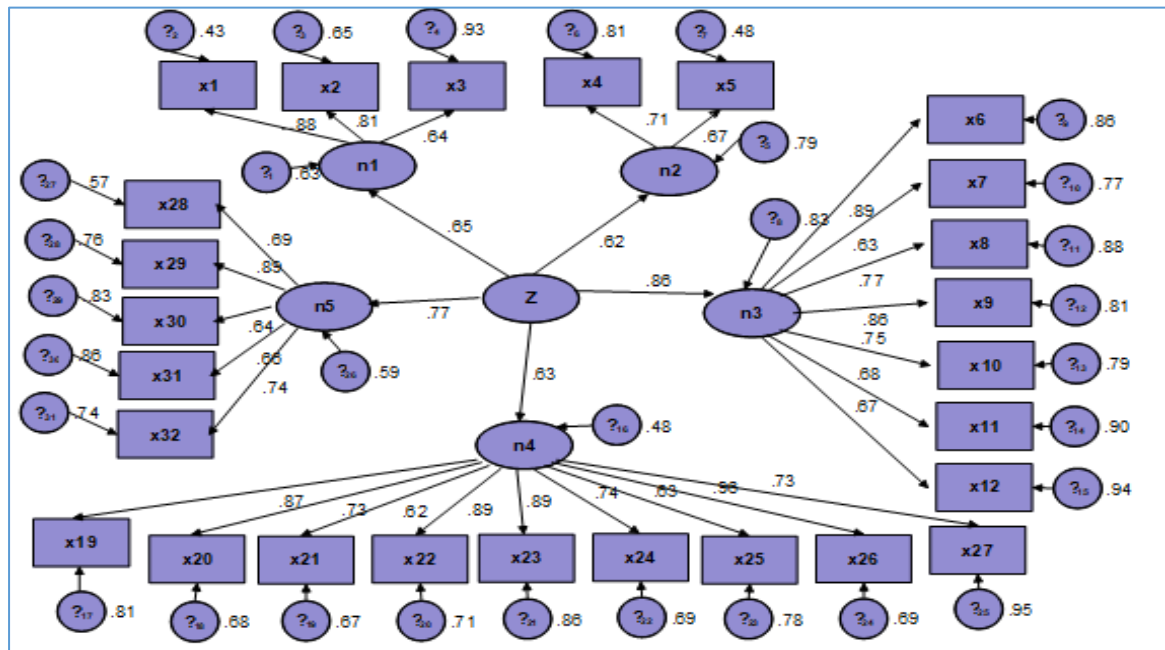


Fig. 4.10: SEM-1 showing Path Diagram of Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) with associated Latent and Observed Variables

SEM-1 shown in Fig. 4.10 represents perceived safety concerns of motorcyclists regarding motorcycle riding in Dhaka city within the existing road infrastructure geometry and traffic management system. Firstly, in assessing the Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z), 05 latent variables are being considered such as Road Infrastructure (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social aspects influencing riding of motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5). Simultaneously, associated observed variables (X1, X2.....X32) for each of the latent variables are also being considered to develop the model. Details of latent variables with associated observed variables with standardized factor loading values are shown in Table 4.1.



Table 4.1: The Latent and Observed Variables with Standardized Factor Loading

<b>Latent Variables with Notation</b>	<b>Standardized Factor Loading</b>	<b>Observed Variables with Notation</b>	<b>Standardized Factor Loading</b>
Road Infrastructure (n1)	0.65	Absence of separate lane for Motorcycle in Mixed traffic flow (X1)	0.88
		No footpath for walking or occupied footpath for other purpose (X2)	0.81
		Narrow road width/narrow bridge width (X3)	0.64
Traffic Management System (n2)	0.62	Non-functional Signal at a junction (X4)	0.71
		Unmarked elevated speed breaker (X5)	0.67
Reported Behaviour of Motorcyclists on Traffic Rules Violation (n3)	0.86	Disregarding speed limit (X6)	0.89
		Zig-zag driving (X7)	0.63
		Risky Overtaking (X8)	0.77
		Using footpath (X9)	0.86
		Taking wrong side of the road (X10)	0.75
		Using cell phone while driving (X11)	0.68
		Signal Violation at Junction (X12)	0.67
Psycho-social aspects influencing riding of Motorcyclists (n4)	0.63	'Desire for maximum income' by Service riders (X19)	0.87
		driving fatigues (X20)	0.73
		Impatient driving at rough weather/ congested road (X21)	0.62
		Breaking traffic rules to	0.89

		reach the destination at the earliest (X22)	
		Violating traffic rules during office going time (X23)	0.89
		Cautious while own family is on ride (X24)	0.74
		Angered by another driver's aggressiveness (X25)	0.63
		Riding aggressively during family problems (X26)	0.96
		Dealing with different types of passengers by Service Riders (X27)	0.73
Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	0.77	Illegal road crossing by pedestrians (X28)	0.69
		No safety gears properly by the passengers (X29)	0.89
		Use of mobile (X30)	0.64
		Uncertain Movement /opening of the door by parked vehicle (X31)	0.66
		Picking up and Dropping off the passengers in mid of the road (X32)	0.74

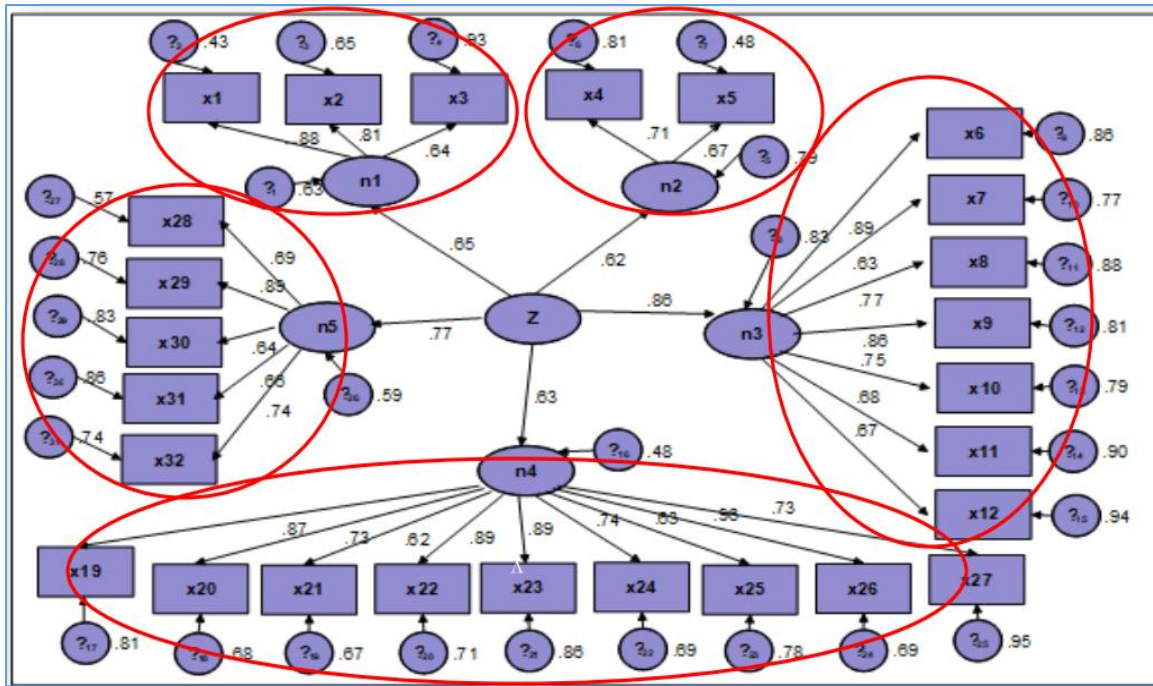


Fig. 4.11: 1<sup>st</sup> Order Confirmatory Factor Analysis (CFA)

As shown in Fig. 4.11, each of the five Latent variables has its own measurement model with the associated observed variables. Firstly, the 1<sup>st</sup> Order Confirmatory Factor Analysis (CFA) for all five measurement models of the Latent variables have been performed by the values of standardized factor loading and the  $R^2$  for all sub-constructs. For Example, the 1<sup>st</sup> order CFA for measurement model of n1(Road infrastructure), the Latent variable n1 is analyzed with its associated 03 observed variables X1(Absence of separate lane for motorcycle in mixed traffic flow), X2 (No footpath for walking or occupied footpath for other purpose) and X3 (Narrow road width/narrow bridge width). Similarly, the 1<sup>st</sup> Order CFA for measurement model of n2, n3, n4 and n5 are carried out with their associated 02 numbers, 07 numbers, 09 numbers and 05 numbers of observed variables respectively.

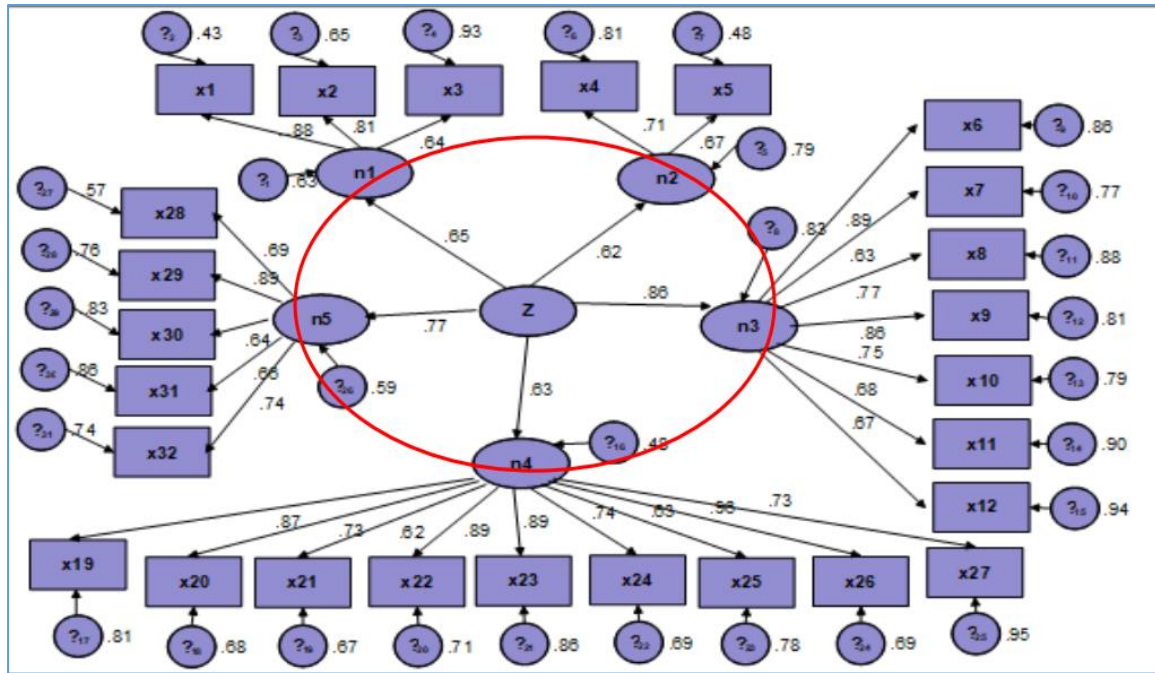


Fig. 4. 111: 2<sup>nd</sup> Order Confirmatory Factor Analysis (CFA)

Then, the 2<sup>nd</sup> Order CFA is also carried out between the Vulnerability / Safety Concerns of Motorcycle riding in Dhaka city (Z) construct and all measurement models of Latent variables like Road Infrastructure (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social aspects influencing riding of motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5) as shown in Fig. 4.12. Since the single headed arrow indicates a causal effect of the Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) on its latent variables, the model was needed to include the residual estimate for all sub constructs accordingly.

### 4.3 Discussion & Analysis of SEM-1 for Perceived Safety Concerns of Motorcyclists

In the SE Model of Fig. 4.10, the values of standardized factor loading reveal the degree of association among the variables (either Latent or Observed) as shown in Table 4.1 in both 1<sup>st</sup> Order CFA and 2<sup>nd</sup> Order CFA within own measurement model. It also helps to identify comparative important factors influencing respective Latent Construct within own measurement model. It is to be mentioned that standardized factor loading values of all the latent and observed variables in SEM-1 are above 0.60 and the squared multiple correlation or error term,  $R^2$  values are above 0.40 which indicate good association

among the variables in the model and no component should be dropped from the model (Awang, 2012).

For example, in the 1<sup>st</sup> Order CFA for the Measurement Model of n3(Reported Behaviour of Motorcyclists on Traffic Rules Violation), it is found that the latent variable n3 has seven observed variables [Disregarding speed limit (X6), Zig-zag driving (X7), Risky Overtaking (X8), Using footpath (X9), Taking wrong side of the road (X10), Using cell phone while driving (X11), Signal Violation at Junction (X12)] with standardized factor loading value of 0.89, 0.63, 0.77, 0.86, 0.75, 0.68 and 0.67 respectively. Here, firstly standardized factor loading values of all the observed variables are above 0.60 which indicate good association and also contributing factors as exhibited by the Reported Behaviour of Motorcyclists on Traffic Rules Violation. Secondly, amongst these seven observed variables, it indicates that X6 (Disregarding speed limit) is most influencing and contributing factor followed by X9 (Using footpath), X8 (Risky Overtaking), X10 (Taking wrong side of the road), X11 (Using cell phone while driving), X12 (Signal Violation at Junction) and X7 (Zig-zag driving) as per the safety perception of motorcyclists. Furthermore, the error Term,  $R^2$  values for all the seven observed variables (X6, X7, X8, X9, X10, X11 and X12) (Fig. 4.10) are high (0.86, 0.77, 0.86, 0.81, 0.79, 0.90 and 0.94 respectively) which reflect the all these seven observed variables have significant contribution on Reported Behaviour of Motorcyclists on Traffic Rules Violation. In other word, the perceived safety concerns of motorcyclists through their reported behaviour of traffic rules violation are well supported with its associated seven observed variables.

Similarly, the association of 05 latent variables with the overall Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) can be determined by 2<sup>nd</sup> Order CFA considering respective values of standardized factor loading. In the 2<sup>nd</sup> Order CFA, the factor loading of Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) on Road Infrastructure (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social Aspects Influencing Riding of Motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5) are 0.65, 0.62, 0.86, 0.63 and 0.77 respectively. So, it can be analysed that firstly standardized factor loading values of all five Latent variables are above 0.60 which indicate good association and also contributing factors for Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City. Secondly, amongst these five Latent variables, Traffic Rules Violation by

Motorcyclists (n3) is most influencing and contributing factor followed by Traffic Rules Violation by Other Road Users (n5), Road Infrastructure (n1), Psycho-social Aspects Influencing Riding of Motorcyclists (n4) and Poor Traffic Management System (n2) as per the safety perception of Motorcyclists. Furthermore, the error Term, values of  $R^2$  of all five latent variables (Fig. 4.10) are high (0.63, 0.79, 0.83, 0.48, and 0.59 respectively) which reflect that all the latent factors have significant contribution on Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City. In other word, the theory that Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) consists of five sub-constructs is well supported.

Table 4.2 depicts the Fitness of the developed model with required fitness indexes. It is observed that all fitness indexes for the second order have achieved the required level. Thus, no item deletion and modification are required. The results showed that The Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) construct loads well on its five latent constructs.

Table 4.2: The Fitness Indexes for SEM-1

Name of Category	Name of Index	Index Full name	Level of Acceptance	Reference Comments	Findings	Comments
Absolute fit	Chisq.	Discrepancy Chi Square	$P > 0.05$	Sensitive to sample size >200	Chisq =62.65; P-value =.001	Significant
	RMSEA	Root Mean Square of Error Approximation	RMSEA < 0.08	Range 0.05 to 0.1 is acceptable	0.065	The required level is achieved
	GFI	Goodness of Fit Index	GFI > 0.90	GFI = 0.95 is a good fit	0.941	The required level is achieved
Incremental fit	AGFI	Adjusted Goodness of Fit	AGFI > 0.90	AGFI = 0.95 is a good fit	0.985	The required level is achieved

	NFI	Normed Fit Index	NFI > 0.90	NFI = 0.95 is a good fit	0.956	The required level is achieved
	TLI	Tucker-Lewis Index	TLI > 0.90	TLI = 0.95 is a good fit	0.980	The required level is achieved
	CFI	Comparative Fit Index	CFI > 0.90	CFI = 0.95 is a good fit	0.950	The required level is achieved

In view of above discussion, it is quite evident that all the latent and observed variables are having good association and contributing to the overall Safety Concerns of Motorcycle Riding in Dhaka city. As such, there is a need to identify and prioritize which are the most Significant or influencing and comparatively less significant or influencing factors related to Safety Concerns of Motorcycle Riding in Dhaka city with a view to fulfilling the last objective of the research. Therefore, the observed variables are prioritized and grouped together basing on the standardized factor loading value to draw the final result of SEM-1. Here, observed variables having standardized factor loading value above 0.80 are considered as Most Significant/Important Factors and standardized factor loading value having below 0.80 are identified as Significant/Important Factors related to Safety Concerns of Motorcycle Riding in Dhaka city. The grouping of factors in SEM-1 is summarized below in Table 4.3:

Table 4.3: Identification of Most Significant and Significant Factors regarding Safety Concerns of Motorcycle Riding on Perceived Safety Concerns of Motorcyclists

Category of Factors	Latent Constructs	Observed Constructs	Standardized Factor Loading
<b>Most Significant/ Important</b>	Road Infrastructure (n1)	Absence of separate lane for Motorcycle in Mixed traffic flow (X1)	0.88
		No footpath for walking or occupied	0.81

<b>Factors (09)</b>		footpath for other purpose (X2)	
	Reported Behaviour of Motorcyclists on Traffic Rules Violation (n3)	Disregarding the speed limit by Motorcyclists when there is less traffic in road (X6)	0.89
		Using footpath by Motorcyclists while stuck in traffic on main road (X9)	0.86
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	Riding aggressively when there are any social or financial problems in the family (X26)	0.96
		Breaking traffic rules to reach the destination at the earliest (X22)	0.89
		Try to violate the traffic rules during office going time or office break time (X23)	0.89
		The 'maximum income within shortest possible time' influences the riding of the service providing riders (X19)	0.87
	Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	Not wearing helmet or other safety gears properly by the passengers (X29)	0.89
	<b>Significant/ Important Factors (17)</b>	Road Infrastructure (n1)	Narrow road width/narrow bridge width (X3)
Traffic Management System (n2)		Absence of road signage / non-functional Signal at a junction or roundabout (X4)	0.71
		Presence of unmarked elevated speed breaker (X5)	0.67
Reported Behaviour of Motorcyclists on Traffic Rules Violation (n3)		Overtaking any vehicle without proper precautions by Motorcyclists (X8)	0.77
		Taking wrong side of the road by Motorcyclists while stuck in traffic on road (X10)	0.75
		Using cell phone by Motorcyclists while riding motorcycle on the road (X11)	0.68



		Crossing the Junction by the Motorcyclists when 'the red light is on' or despite having 'No Go' signal given by Traffic Police (X12)	0.67
		Zig-zag driving (X7)	0.63
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	Become cautious in driving whole own family is on ride (X24)	0.74
		The driving fatigues for over-stressed riding time influence the driving behaviour of the service providing riders (X20)	0.73
		Dealing with different types of passengers throughout the day affects the driving behaviour of service providing riders (X27)	0.73
		Getting angered by another driver's aggressive behaviour or faulty driving skill (X25)	0.63
		Breaking traffic rules to reach the destination at the earliest (X22)	0.62
		Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	Picking up and dropping off the passengers by public transport Drivers in mid of the road (X32)
		Illegal road crossing by pedestrians (X28)	0.69
		Uncertain Movement /opening of the door by roadside parked vehicle (X31)	0.66
		Use of mobile while driving a vehicle or Walking on the road (X30)	0.64

#### **4.4 Key Findings and Interpretation of SEM-1 for Perceived Safety Concerns of Motorcyclists in Dhaka City**

This study presents the result of an investigation on safety concerns of motorcyclists regarding motorcycle riding through the reported behaviour of road users within the existing roadway characteristics and traffic management system in Dhaka city. The summary of key findings is appended below:

(i) Goodness-of-fit indices reveal that the model fits well as all are within accepted values (Chi-square=62.65; P-value=0.001, RMSEA= 0.065, GFI= 0.941, AGFI= 0.985, NFI=0.956, TLI=0.980, TLI= 0.950) and achieved the consistency with real life expected scenario.

(ii) Amongst the 05 safety concerns, Traffic Rules Violation by Motorcyclists is identified as the most determinant safety concerns of vulnerable motorcycle riding in Dhaka city. The result shows that Disregarding the speed limit by Motorcycle drivers when there is less traffic in road and Using footpath by Motorcyclists while stuck in traffic on main road are the Most Significant priority concerns as per the reported behaviours of Motorcyclists. The other reported behaviours of Motorcyclists like Frequent changing the lane by zig-zag driving, Taking wrong side of the road by Motorcyclists while stuck in traffic, Using cell phone by Motorcyclists while riding, Crossing the Junction by the Motorcyclists when ‘the red light is on’ or despite having ‘No Go’ signal given by Traffic Police and Overtaking any vehicle without proper precautions by Motorcycle drivers are also the Significant safety concerns of motorcycle riding vulnerability. The similar types of traffic rules violation by motorcyclists are cited by various reports of different newspapers (Masum, 2018; Akhtar, 2020; Alam and Syfullah, 2022). Disregarding the speed limit by Motorcyclists by the reported behaviours of Motorcyclists as the most Significant priority concerns is also testified by Malkhamah et al. (2018).

(iii) It is revealed in the analysis that motorcyclists’ attitudes and aggressive behavioural issues are influenced by various family and psychosocial issues. Riders experiencing family-related or social-related stress and those with an aggressive personality are more prone to have a motorcycle accident. The Most Significant factors are Riding aggressively when there are any social or financial problems in the

family, Breaking traffic rules to reach the destination at the earliest, Violating the traffic rules during office going time or office break time and ‘maximum income within shortest possible time’ influences the service providing riders. In addition, the influencing Significant factors are Become cautious in driving while own family is on ride, dealing with different types of passengers throughout the day affects the driving behaviour of service providing riders, Getting angered by another driver’s aggressive behaviour or faulty driving skill and Driving fatigue for over-stressed riding time by service providing Motorcycle drivers. The impact of psychological and behavioural attitude of motorcyclists on traffic rule violation and causing accident can be traced back in various researchers’ (Wedagama, 2017; Barry et al., 2007; Deborah et al.; Rahman, 2015) study papers. Attitudes like Riding aggressively when there are any social or financial problems in the family and becoming cautious in driving while own family is on ride are also the findings of Zehra et al. (2019).

(iv) The certain traffic rules violation by other Road Users (public transport drivers, private cars drivers and pedestrians) also has a significant contributing impact on vulnerability of motorcycle riding in Dhaka city. According to perception of Motorcyclists, Not wearing helmet or other safety gears properly by the passengers is the Most Significant reported behaviour of other Road Users. Picking up and dropping off the passengers by public transport Drivers in mid of the road, Illegal road crossing by pedestrians, Use of mobile while driving a vehicle or Walking on the road and Uncertain Movement /opening of the door by roadside parked vehicle are identified as Significant factors exhibited by reported behaviour of other road users. It is observed by Alam and Hoque (2018) that other road users like bicyclists, pedestrians and other motorized vehicles significantly contribute in occurrence of accidents in Dhaka.

(v) The study shows that Most Significant safety concerns in regards to road geometry and infrastructures of Dhaka city are Absence of separate lane for Motorcycle in Mixed traffic flow and No footpath for walking or occupied footpath for other purpose. The other Significant safety concern is Narrow Road width/narrow bridge width. Hoque et al. (2015) also considered that motorcycle crashes and injuries cannot be prevented until safety treatments are built on road infrastructure.

(vi) In respect of Traffic management System, no Most Significant factor is identified but Absence of road signage / non-functional Signal at a junction or roundabout and Presence of unmarked elevated speed breaker are considered as Significant safety concerns by the safety concern of Motorcyclists. The various newspaper reports (Dhaka Tribune Report, 2020; Prothom Alo Report, 2022) also testify that poor traffic management is the important cause of motorcycle related accidents in Dhaka city.

**CHAPTER 5**  
**RESULT AND DISCUSSION OF SEM-2 AND COMPARISON BETWEEN TWO**  
**DEVELOPED MODELS**

**5.1 Background/ Sample Characteristic**

This chapter presents a comprehensive and elaborate discussion that provides a clear understanding about the background characteristic of the participant concerning Other Road Users regarding motorcycle riding in Dhaka City. The characteristics of the respondents of Other Road Users regarding motorcycle riding in Dhaka city are described and analyzed in terms of following variables: Gender, Age, Income, Education, Marital status, Occupation, Number of accidents faced etc.

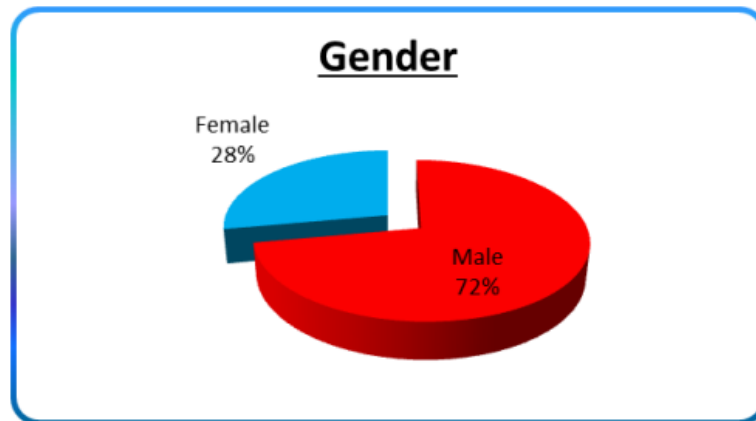


Fig. 5.12: Gender Distribution of Other Road Users in Dhaka City by the respondents

Fig. 5.1 shows that 72 % Other Road Users regarding motorcycle riding of Dhaka city by the respondents are male and 28% respondents only are female. So, it indicates that majority Other Road Users regarding motorcycle riding of Dhaka city are male.

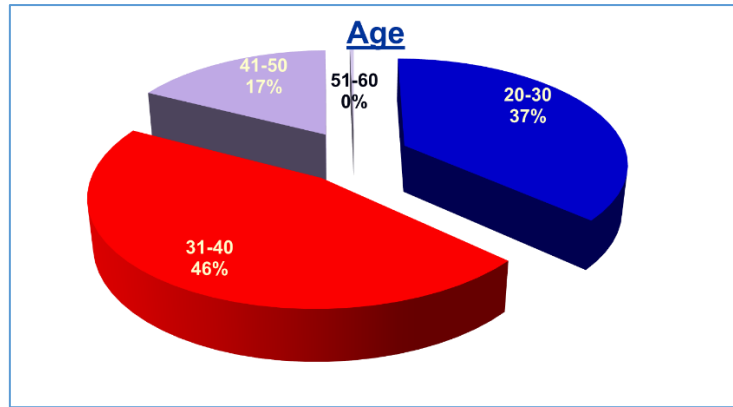


Fig. 5.13: Age Distribution of Other Road Users in Dhaka City by the respondents

Fig. 5.2 shows that 46 % Other Road Users regarding motorcycle riding of Dhaka city by the respondents are 31-40 age group, 37% respondents belong to 20-30 age group and only 17 % are at 41-50 age group. So, it indicates that majority of age of Other Road Users are 31-40 years.

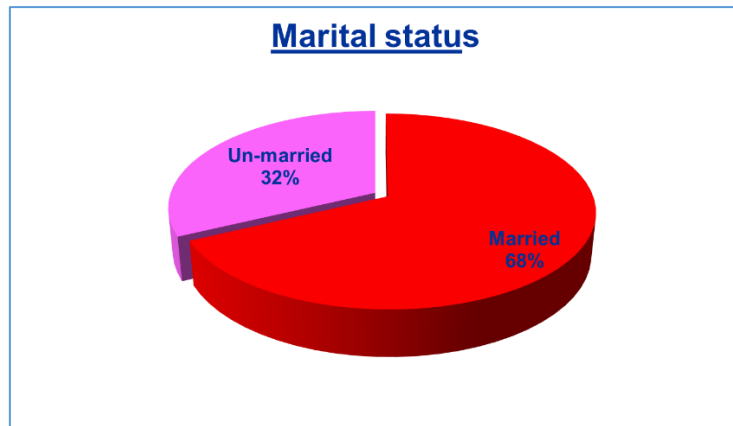


Fig. 5.14: Marital Status Distribution of Other Road Users in Dhaka City by the respondents

Fig. 5.3 shows that 68 % Other Road Users regarding motorcycle riding of Dhaka city by the respondents are married and rest are unmarried.

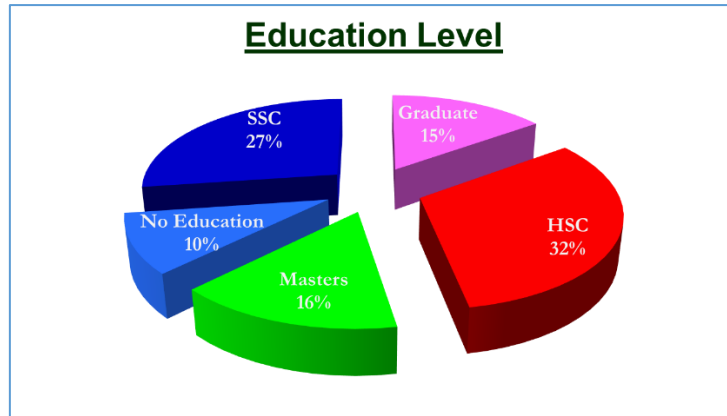


Fig. 5.15: Educational qualification of Other Road Users in Dhaka City by the respondents

Fig. 5.4 shows that 16% Other Road Users regarding motorcycle riding of Dhaka city by the respondents are post graduated, 15% respondents are graduated, 32 % are HSC completed, 27 % are SSC completed and 10 % have no education.

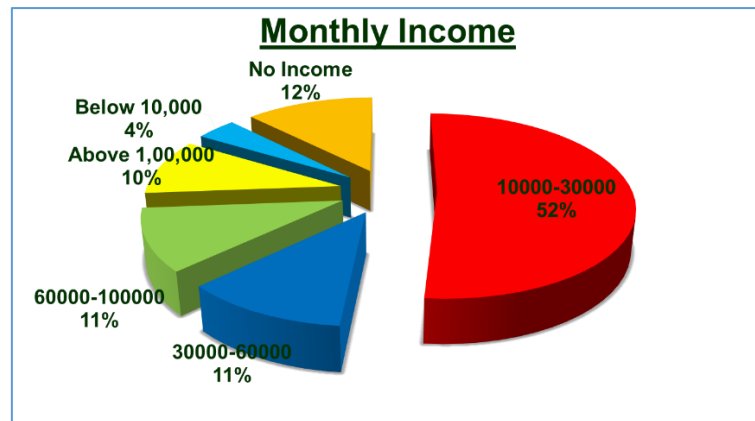


Fig. 5.16: Income Distribution of Other Road Users in Dhaka City by the respondents

Fig. 5.5 shows that 52 % Other Road Users regarding motorcycle riding of Dhaka city by the respondents have income of 10000-30000 taka, 11% respondents have income of 30000-60000 taka, another 11% have income of 60000-100000 taka and 12 % have no income.

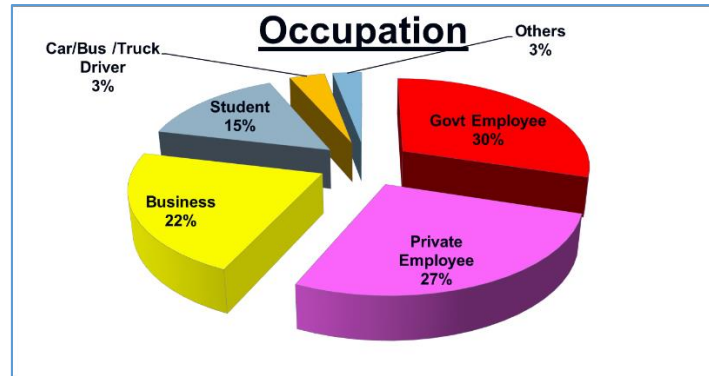


Fig. 5.17: Occupation of Other Road Users in Dhaka City by the respondents

From Fig. 5.6, it is found that about 30 % participants' occupation from other road users was Govt. Employee. About 27 % participant's occupation from other road users was Private employee, 22 % participants were Businessman, 15 % were Student and only 6% are Drivers and Others.

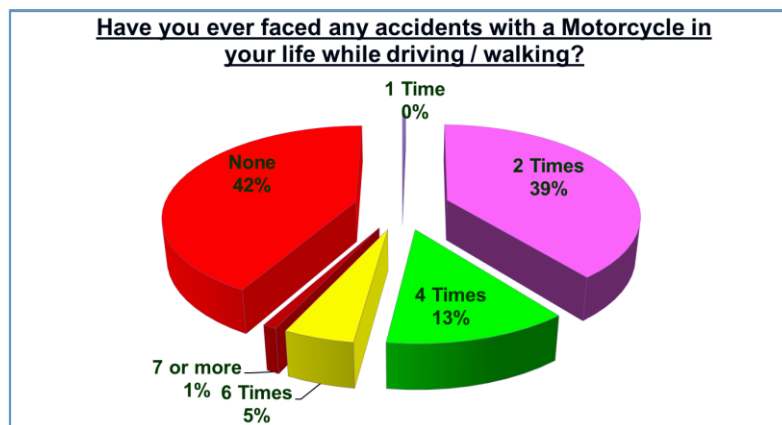


Fig. 5.18: Distribution of Number accident faced by Other Road Users regarding Motorcycle Riding in Dhaka City

From Fig. 5.7, it is observed that about 39 % other road users regarding motorcycle riding of Dhaka city have experienced accident two times. About 42 % other road users have experienced no accident, about 13 % Other Road Users have experienced accident four times, 5 % other road users have experienced accident 6 times and only 1% other road users have experienced accident 7 or more times in their whole life.



## 5.2 Construction of SEM-2 for Perceived Safety Concerns of Other Road Users

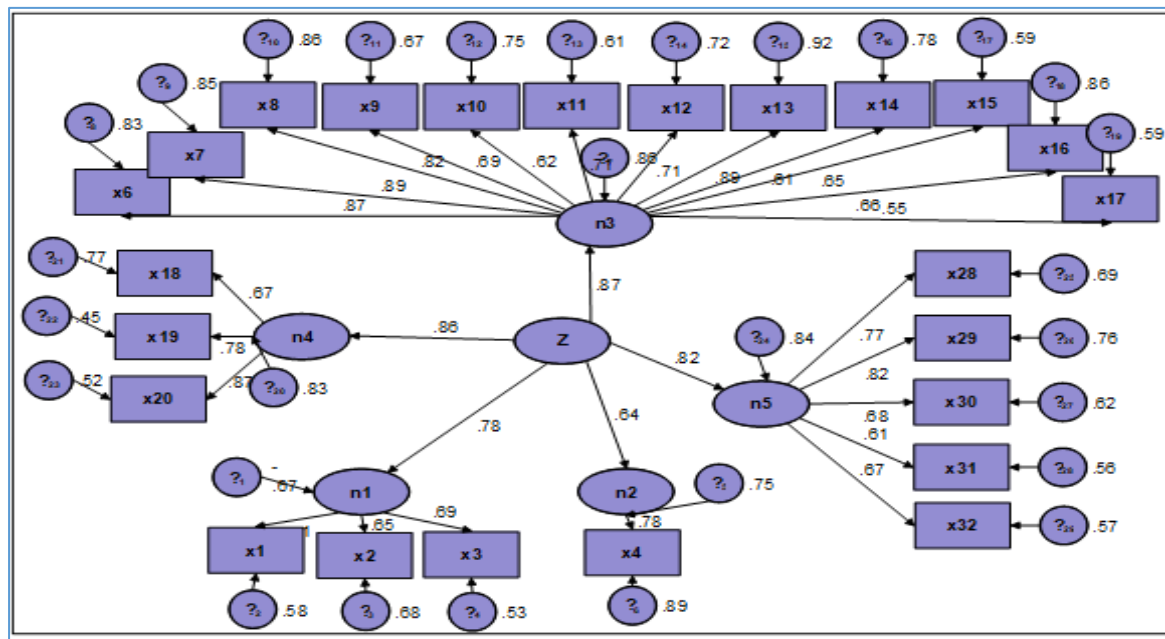


Fig. 5.8: SEM-2 showing Path Diagram of Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) with associated Latent and Observed Variables

SEM-2 shown in Fig. 5.8 represents perceived safety concerns of Other Road Users (Car drivers, public transport drivers and Pedestrians) regarding motorcycle riding in Dhaka city within the existing road infrastructure geometry and traffic management system. Firstly, in assessing the Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z), 05 latent variables are being considered such as Road Infrastructure (n1), Poor Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social Aspects Influencing Riding of Motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5). Simultaneously, associated observed variables (X1, X2.....X32) for each of the latent variables are also being considered to develop the model. Details of latent variables with associated observed variables with standardized factor loading values are shown in Table 5.1.

Table 5.1: The Latent and Observed Variables with Standardized Factor Loading

Latent Variables with Notation	Standardized Factor Loading	Observed Variables with Notation	Standardized Factor Loading
Road Infrastructure	0.78	Absence of separate lane for Motorcycle in Mixed	0.65

(n1)		traffic flow (X1)	
		No footpath for walking or occupied footpath for other purpose (X2)	0.65
		Narrow road width/narrow bridge width (X3)	0.69
Traffic Management System (n2)	0.64	Non-functional Signal at a junction (X4)	0.78
Reported Behaviour of Motorcyclists on Traffic Rules Violation (n3)	0.87	Disregarding speed limit (X6)	0.87
		Zig-zag driving (X7)	0.89
		Risky Overtaking (X8)	0.82
		Using footpath (X9)	0.69
		Taking wrong side of the road (X10)	0.62
		Using cell phone while driving (X11)	0.62
		Signal Violation at Junction (X12)	0.71
		Uncertain Movement of roadside parked Motorcycle (X13)	0.89
		Uncertain stopping of Motorcycle at bus stoppage/ junction (X14)	0.61
		Violating rules following other riders (X15)	0.65
		Not caring of safety helmet (X16)	0.66
Picking up and Dropping off the passengers in mid of road (X17)	0.55		
Psycho-social aspects	0.86	Service provider drivers are not liable about the	0.67

influencing riding of Motorcyclists (n4)		safety of the passengers (X18)	
		'Desire for maximum income' by Service riders (X19)	0.78
		driving fatigues (X20)	0.87
Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	0.82	Illegal road crossing by pedestrians (X28)	0.77
		No safety gears properly by the passengers (X29)	0.82
		Use of mobile (X30)	0.68
		Uncertain Movement /opening of the door by parked vehicle (X31)	0.61
		Picking up and Dropping off the passengers in mid of the road (X32)	0.67

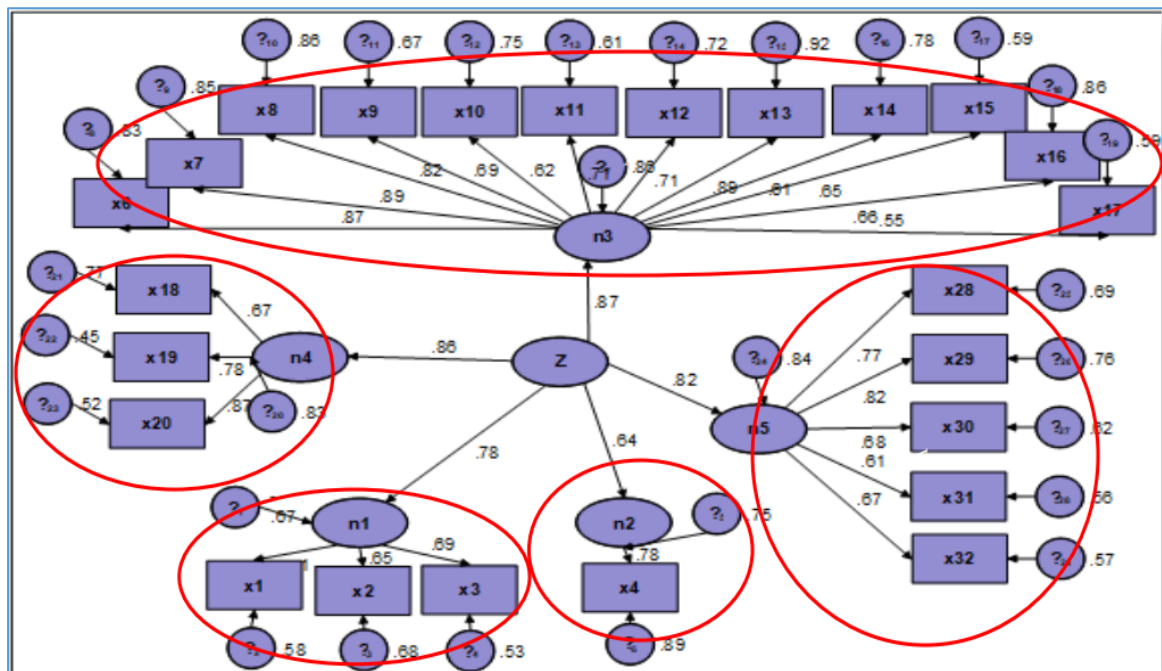


Fig. 5.9: 1<sup>st</sup> Order Confirmatory Factor Analysis (CFA)

As shown in Fig. 5.9, each of the five Latent variables has its own measurement model with the associated Observed variables. Firstly, the 1<sup>st</sup> Order Confirmatory Factor Analysis (CFA) for all five measurement models of the Latent variables have been

performed by the values of standardized factor loading and the  $R^2$  for all sub-constructs. For Example, the 1<sup>st</sup> Order CFA for measurement model of n1(Road Infrastructure), the latent variable n1 is analyzed with its associated 03 observed variables X1(Absence of separate lane for Motorcycle in mixed traffic flow), X2 (No footpath for walking or occupied footpath for other purpose) and X3 (Narrow road width/narrow bridge width). Similarly, the 1<sup>st</sup> Order CFA for measurement model of n2, n3, n4 and n5 are carried out with their associated 01 number, 12 numbers, 03 numbers and 05 numbers of observed variables respectively.

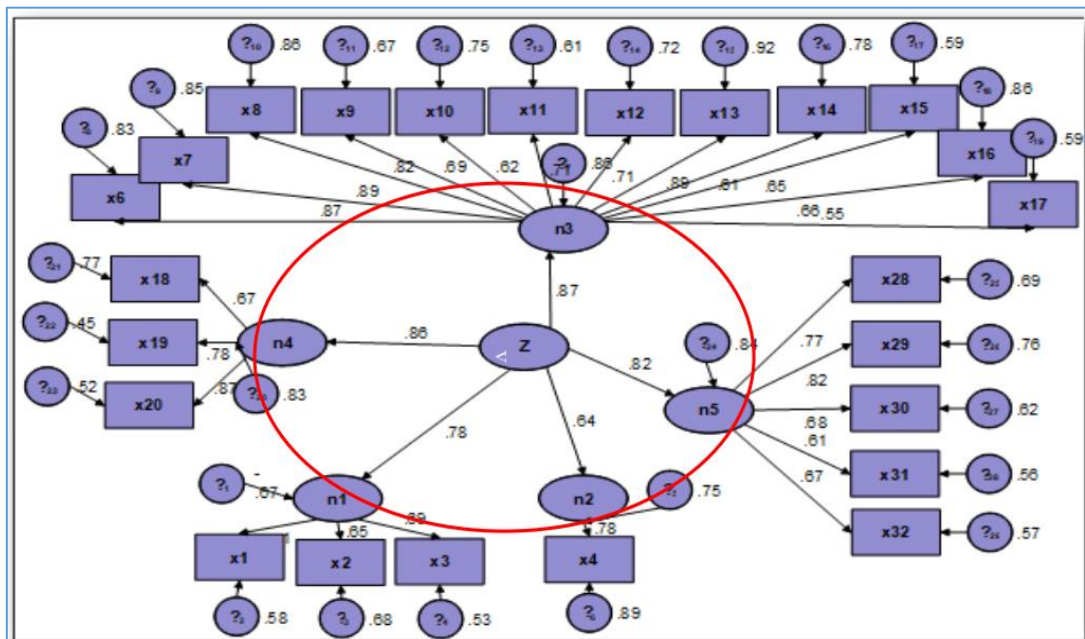


Fig. 5.190: 2<sup>nd</sup> Order Confirmatory Factor Analysis (CFA)

Then, the 2<sup>nd</sup> Order CFA is also carried out between the Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) construct and all measurement models of latent variables like Road Infrastructure (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social Aspects Influencing Riding of Motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5) as shown in Fig. 5.10. Since the single headed arrow indicates a causal effect of the Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) on its latent variables, the model was needed to include the residual estimate for all sub constructs accordingly.

### 5.3 Discussion & Analysis of SEM-2 for Perceived Safety Concerns of Motorcyclists

In the SE Model of Fig. 5.8, the values of standardized factor loading reveal the degree of association among the variables (either Latent or Observed) as shown in Table 5.1 in both 1<sup>st</sup> Order CFA and 2<sup>nd</sup> Order CFA within own measurement model. It also helps to identify comparative important factors influencing respective latent construct within own measurement Model. It is to be mentioned that standardized factor loading values of all the latent and observed variables in SEM-2 are above 0.60 except X17 (0.55 < 0.60) and the squared multiple correlation or error term,  $R^2$  values are above 0.40 which indicate good association among the variables in the model and no component should be dropped from the model except X17 (Awang, 2012).

For example, in the 1<sup>st</sup> Order CFA for the measurement model of n3(Reported Behaviour of Motorcyclists on Traffic Rules Violation), it is found the Latent variable n3 has twelve Observed variables [Disregarding speed limit (X6), Zig-zag driving (X7), Risky Overtaking (X8), Using footpath (X9), Taking wrong side of the road (X10), Using cell phone while driving (X11), Signal Violation at Junction (X12), Uncertain Movement of roadside parked Motorcycle (X13), Uncertain stopping of Motorcycle at bus stoppage/ junction (X14), Violating rules following other riders (X15), Not caring of safety helmet (X16), Picking up and dropping off the passengers in mid of road (X17) ] with standardized factor loading value of 0.87, 0.89, 0.82, 0.69, 0.62, 0.62, 0.71, 0.89, 0.61, 0.65, 0.66 and 0.55 respectively. Here, firstly standardized factor loading values of all the Observed variables are above 0.60 except X17 (0.55 < 0.60) which indicate good association and also contributing factors as exhibited by the Reported Behaviour of Motorcyclists on Traffic Rules Violation. So, X17 is not considered subsequently as significant factor. Secondly, amongst these twelve observed variables, it indicates that X7 (Zig-zag driving) and X13 (Uncertain Movement of roadside parked Motorcycle) are the most influencing and contributing factor followed by X6 (Disregarding speed limit), X8 (Risky Overtaking), X12 (Signal Violation at Junction), X9 (Using footpath), X16 (Not caring of safety helmet), X15 (Violating rules following other riders), X10 (Taking wrong side of the road), X11 (Using cell phone while driving) and X14 (Uncertain stopping of Motorcycle at bus stoppage/ junction) as per the safety perception of Other Road Users. Furthermore, the error Term,  $R^2$  values for all the eleven observed variables (X6, X7, X8, X9, X10, X11, X12, X13, X14, X15 and X16) (Fig. 5.8) are high (0.83, 0.85, 0.86, 0.67,

0.75, 0.61, 0.72, 0.92, 0.78, 0.59, 0.86 and 0.59 respectively) which reflect the all these eleven observed variables have significant contribution on Reported Behaviour of Motorcyclists on Traffic Rules Violation. In other word, the perceived safety concerns of other road users through the reported behaviour of Motorcyclists on traffic rules violation are well supported with its associated eleven observed variables.

Similarly, the association of 05 latent variables with the overall Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) can be determined by 2<sup>nd</sup> Order CFA considering respective values of standardized factor loading. In the 2<sup>nd</sup> Order CFA, the factor loading of Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) on Road Infrastructure (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social Aspects Influencing Riding of Motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5) are 0.78, 0.64, 0.87, 0.86 and 0.82 respectively. So, it can be analysed that firstly standardized factor loading values of all five latent variables are above 0.60 which indicate good association and also contributing factors for Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City. Secondly, amongst these five latent variables, Traffic Rules Violation by Motorcyclists (n3) is most influencing and contributing factor followed by Psycho-social aspects Influencing Riding of Motorcyclists (n4), Traffic Rules Violation by Other Road Users (n5), Road Infrastructure (n1) and Traffic Management System (n2) as per the safety perception of Other Road Users. Furthermore, the error Term, values of  $R^2$  of all five Latent variables (Fig. 5.8) are high (0.67, 0.75, 0.86, 0.83, and 0.84 respectively) which reflect that all the latent factors have significant contribution on Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City. In other word, the theory that Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) consists of five sub-constructs is well supported.

Table 5.2 depicts the fitness of the developed model with required fitness indexes. It is observed that all fitness indexes for the second order have achieved the required level. Thus, no item deletion and modification are required. The results showed that The Vulnerability / Safety Concerns of Motorcycle Riding in Dhaka City (Z) construct loads well on its five latent constructs.

Table 5.2: The Fitness Indexes for SEM-2

Name of Category	Name of Index	Index Full Name	Level of Acceptance	Reference Comments	Findings	Comments
Absolute fit	Chisq.	Discrepancy Chi Square	$P > 0.05$	Sensitive to sample size >200	Chisq =112.65; P-value =.001	Significant
	RMSEA	Root Mean Square of Error Approximation	RMSEA < 0.08	Range 0.05 to 0.1 is acceptable	0.85	The required level is achieved
	GFI	Goodness of Fit Index	GFI > 0.90	GFI = 0.95 is a good fit	0.901	The required level is achieved
Incremental fit	AGFI	Adjusted Goodness of Fit	AGFI > 0.90	AGFI = 0.95 is a good fit	.945	The required level is achieved
	NFI	Normed Fit Index	NFI > 0.90	NFI = 0.95 is a good fit	.978	The required level is achieved
	TLI	Tucker-Lewis Index	TLI > 0.90	TLI = 0.95 is a good fit	.989	The required level is achieved

	CFI	Comparative Fit Index	CFI > 0.90	CFI = 0.95 is a good fit	.975	The required level is achieved

In view of above discussion, it is quite evident that all the latent and observed variables are having good association and contributing to the overall Safety Concerns of Motorcycle Riding in Dhaka city. As such, there is a need to identify and prioritize which are the most significant or influencing and comparatively less significant or influencing factors related to Safety Concerns of Motorcycle Riding in Dhaka city with a view to fulfilling the last objective of the research. Therefore, the observed variables are prioritized and grouped together basing on the Standardized Factor Loading value to draw the final result of SEM-2. Here, observed variables having standardized factor loading value above 0.80 are considered as Most Significant Factors and standardized factor loading value having below 0.80 are identified as Significant Factors related to Safety Concerns of Motorcycle Riding in Dhaka city. The grouping of factors in SEM-2 is summarized below in Table 5.3:

Table 5.3: Identification of Most Significant and Significant Factors regarding Safety Concerns of Motorcycle Riding as per the Perceived Safety Concerns of Other Road Users

Category of Factors	Latent Construct	Observed Constructs	Standardized Factor Loading
	Road Infrastructure (n1)	Absence of separate lane for Motorcycle in Mixed traffic flow (X1)	0.88
	Reported Behaviour of Motorcyclists on Traffic Rules	Frequent changing the lane by zig-zag driving of Motorcycle drivers (X7)	0.89



<b>Most Significant/ Important Factors (07)</b>	Violation (n3)	Uncertain Movement of roadside parked Motorcycle drivers (X13)	0.89
		Disregarding the speed limit by Motorcycle drivers when there is less traffic in road (X6)	0.87
		Overtaking any vehicle without proper precautions by Motorcycle drivers (X8)	0.82
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	The driving fatigue for overstressed riding time influence the driving behavior of service providing Motorcycle drivers (X20)	0.87
	Reported Behaviour of Other Road Users on Traffic Rules Violation (n5)	Not wearing helmet or other safety gears properly by the passengers (X29)	0.82
<b>Significant/ Important Factors (16)</b>	Road Infrastructure (n1)	No footpath for walking or occupied footpath for other purpose (X2)	0.65
		Narrow road width/narrow bridge width (X3)	0.69
	Traffic Management System (n2)	Absence of road signage / non-functional Signal at a junction or roundabout (X4)	0.78
	Reported Behaviour of Motorcyclists on Traffic Rules Violation (n3)	Crossing the Junction by the Motorcyclists when 'the red light is on' or despite having 'No Go' signal given by Traffic Police (X12)	0.71

		Using footpath by Motorcyclists while stuck in traffic on main road (X9)	0.69
		Not caring the standard of safety helmet for the passenger by service providing Motorcycle drivers (X16)	0.66
		Following other rider by Motorcycle drivers knowing fully well that he is violating the traffic rules (X15)	0.65
		Using cell phone by Motorcyclists while riding motorcycle on the road (X11)	0.62
		Taking wrong side of the road (X10)	0.62
		Uncertain stopping of Motorcycle at bus stoppage/ junction due to no earmarked parking for motorcycle (X14)	0.61
	Psycho-social Aspects influencing riding of Motorcyclists (n4)	The 'maximum income within shortest possible time' influences the service providing Motorcycle drivers for rough driving (X19)	0.78
		Service provider Motorcycle drivers are not liable about the safety of the passengers (i.e no insurance coverage) (X18)	0.67
	Reported Behaviour	Illegal road crossing by	0.77

of Other Road Users on Traffic Rules Violation (n5)	pedestrians (X28)	
	Use of mobile while driving a vehicle or Walking on the road (X30)	0.68
	Picking up and dropping off the passengers by public transport Drivers in mid of the road (X32)	0.67
	Uncertain Movement /opening of the door by roadside parked vehicle (X31)	0.61

#### **5.4 Key Findings from SEM-2 for Perceived Safety Concerns of Other Road Users in Dhaka City**

This study presents the result of an investigation on safety concerns of other road users regarding motorcycle riding through the reported behaviour of motorcyclists within the existing roadway characteristics and traffic management system in Dhaka city. The summary of analysis is appended below:

(i) Goodness-of-fit indices reveal that the model fits well as all are within accepted values (Chi-square=112.65; P-value=.001, RMSEA= 0.85, GFI= 0.901, AGFI= 0.945, NFI=0.978, TLI=0.989, TLI= 0.975) and achieved the consistency with real life expected scenario.

(ii) Amongst the 05 safety concerns, Traffic Rules Violation by Motorcyclists is identified as the most determinant safety concerns of vulnerable motorcycle riding in Dhaka city. The result shows that Frequent changing the lane by zig-zag driving of Motorcycle drivers, Uncertain Movement of roadside parked Motorcycle drivers, Disregarding the speed limit by motorcycle drivers and overtaking any vehicle without proper precautions by motorcycle drivers are the Most Significant priority concerns as per the reported behaviours of Motorcyclists. The other reported

behaviours of Motorcyclists like Using footpath, Taking wrong side of the road, Using cell phone while driving, Signal Violation at Junction, Uncertain stopping of Motorcycle at bus stoppage/ junction, Violating rules following other riders, Not caring of safety helmet are also the Significant safety concerns of motorcycle riding vulnerability. The similar types of traffic rules violation by motorcyclists are cited by various reports of different newspapers (Masum, 2018; Akhtar, 2020; Alam and Syfullah, 2022). Disregarding the speed limit by Motorcyclists by the reported behaviours of Motorcyclists as the most Significant priority concerns is also testified by Malkhamah et al. (2018).

(iii) It is revealed in the analysis that motorcyclists' attitudes and aggressive behavioural issues are influenced by various family and psychosocial issues. Riders experiencing family-related or social-related stress and those with an aggressive personality are more prone to have a motorcycle accident. The Most Significant factors are Driving fatigue for over-stressed riding time influence the driving behavior of service providing Motorcycle drivers. In addition, the influencing Significant factors are 'maximum income within shortest possible time' influences the service providing Motorcycle drivers for rough driving and Service provider Motorcycle drivers are not liable about the safety of the passengers (i.e no insurance coverage). The impact of psychological and behavioural attitude of motorcyclists on traffic rule violation and causing accident can be traced back in various researchers' (Wedagama, 2017; Barry et al., 2007; Deborah et al.; Rahman, 2015) study papers. Psychosocial aspects like Driving fatigue for over-stressed riding time influence the driving behavior of service providing Motorcycle drivers and 'maximum income within shortest possible time' influences the service providing Motorcycle drivers for rough driving are also the findings of Zehra et al. (2019).

(iv) The certain traffic rules violation by other Road Users (public transport drivers, private cars drivers and pedestrians) also has a significant contributing impact on vulnerability of motorcycle riding in Dhaka city. According to perception of Other Road Users, Not wearing helmet or other safety gears properly by the passengers is the Most Significant reported behaviour of other Road Users which is also expressed by the Motorcyclists. Illegal road crossing by pedestrians, Use of mobile while driving a vehicle or Walking on the road, Picking up and dropping off the passengers

by public transport Drivers in mid of the road, Uncertain Movement /opening of the door by roadside parked vehicle are identified as Significant factors exhibited by reported behaviour of other road users. It is observed by Alam and Hoque (2018) that other road users like bicyclists, pedestrians and other motorized vehicles significantly contribute in occurrence of accidents in Dhaka.

(v) The study shows that Most Significant safety concerns in regards to road geometry and infrastructures of Dhaka city is Absence of separate lane for Motorcycle in Mixed traffic flow. The other Significant safety concern are No footpath for walking or occupied footpath for other purpose and Narrow Road width/narrow bridge width. Hoque et al. (2015) also considered that motorcycle crashes and injuries cannot be prevented until safety treatments are built on road infrastructure.

(vi) In respect of Traffic management System, no Most Significant factor is identified but Absence of road signage / non-functional Signal at a junction or roundabout is considered as Significant safety concerns by the safety concern of Other Road users. The various newspaper reports like (Dhaka Tribune Report, 2020; Prothom Alo Report, 2022) also testify that poor traffic management is the important cause of motorcycle related accidents in Dhaka city.

## **5.5 A Summary of Comparison between Two Developed Models**

In the study, two structural equation model on safety concerns of motorcyclists and safety concerns of other road users are being developed through the reported behaviour of motorcyclists and other road users within the existing roadway characteristics and traffic management system in Dhaka city. Comparing both models, it is found that all the perceived safety concerns of vulnerable motorcycle riding in Dhaka city are being recognized by both Motorcyclists as well as Other Road Users. There are some common important factors identified by the two models. Only there are differences of perception from both ends in prioritizing or ranking the safety factors in different safety aspects. The summary of comparisons of different factors are highlighted in subsequent paragraphs.

### 5.5.1 Priority of Safety Concerns

Priority of Factors	Perception of Motorcyclists	Perception of Other Road Users
1	Traffic Rules Violation by Motorcyclists (n3) 0.86	Traffic Rules Violation by Motorcyclists (n3) 0.87
2	Traffic Rules Violation by Other Road Users (n5) 0.77	Psycho-social aspects influencing riding of Motorcyclists (n4) 0.86
3	Road Infrastructures (n1) 0.65	Traffic Rules Violation by Other Road Users (n5) 0.82
4	Psycho-social aspects influencing riding of Motorcyclists (n4) 0.63	Road Infrastructures (n1) 0.78
5	Traffic Management System (n2) 0.61	Traffic Management System (n2) 0.64

### 5.5.2 Traffic Rules Violation by Motorcyclists

Priority of Factors	Perception of Motorcyclists	Perception of Other Road Users
Most Significant/ Important (Factor Loading Value > 0.80)	Disregarding the speed limit by Motorcycle drivers	Disregarding the speed limit by Motorcycle drivers
	Using footpath by Motorcyclists while stuck in traffic on main road	Frequent changing the lane by zig-zag driving of Motorcycle drivers
		Overtaking any vehicle without proper precautions by Motorcycle drivers
		Uncertain Movement of roadside parked Motorcycle drivers
Significant/Important (Factor Loading Value < 0.80)	Taking wrong side of the road by Motorcyclists while stuck in traffic	Taking wrong side of the road by Motorcyclists while stuck in traffic
	Using cell phone while riding	Using cell phone while driving
	Signal Violation at Junction	Signal Violation at Junction

	Frequent changing the lane by zig-zag driving	Using footpath by Motorcyclists while stuck in traffic on main road
		Violating rules following other riders
		Not caring of safety helmet

### 5.5.3 Psycho-social Aspects influencing riding of Motorcyclists

Priority of Factors	Perception of Motorcyclists	Perception of Other Road Users
Most Significant/ Important (Factor Loading Value > 0.80)	Riding aggressively when there are any social or financial problems in the family	Driving fatigue for over-stressed riding time influence the driving behaviour of service providing Motorcycle drivers
	Breaking traffic rules to reach the destination at the earliest	
	Violating the traffic rules during office time	
	'Maximum income within shortest possible time' influences the service providing riders for rough driving	
Significant/ Important (Factor Loading Value < 0.80)	Become cautious in driving while own family is on ride	'Maximum income within shortest possible time' influences the service providing Motorcycle drivers for rough driving
	Dealing with different types of passengers throughout the day affects the driving behaviour of service providing riders	Service provider Motorcycle drivers are not liable about the safety of the passengers (i.e no insurance coverage).
	Getting angered by another driver's aggressive behaviour or faulty driving skill	

	Driving fatigue for over-stressed riding time influence the driving behaviour of service providing Motorcycle drivers	
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#### 5.5.4 Reported Behaviour of Other Road Users on Traffic Rules Violation

Priority of Factors	Perception of Motorcyclists	Perception of Other Road Users
Most Significant/ Important (Factor Loading Value > 0.80)	Not wearing helmet or other safety gears properly by the passengers	Not wearing helmet or other safety gears properly by the passengers
Significant/ Important (Factor Loading Value < 0.80)	Picking up and dropping off the passengers by public transport Drivers in mid of the road	Picking up and dropping off the passengers by public transport Drivers in mid of the road
	Illegal road crossing by pedestrians	Illegal road crossing by pedestrians
	Use of mobile while driving a vehicle or Walking on the road	Use of mobile while driving a vehicle or Walking on the road
	Uncertain Movement /opening of the door by roadside parked vehicle	Uncertain Movement /opening of the door by roadside parked vehicle

#### 5.5.5 Road Infrastructures

Priority of Factors	Perception of Motorcyclists	Perception of Other Road Users
Most Significant/ Important (Factor Loading Value > 0.80)	Absence of separate lane for Motorcycle in Mixed traffic flow	Absence of separate lane for Motorcycle in Mixed traffic flow
	No footpath for walking or occupied footpath for other purpose	
Significant/ Important (Factor Loading Value < 0.80)	Narrow Road width/narrow bridge width	Narrow Road width/narrow bridge width



		No footpath for walking or occupied footpath for other purpose
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### 5.5.6 Traffic Management System

<b>Priority of Factors</b>	<b>Perception of Motorcyclists</b>	<b>Perception of Other Road Users</b>
Most Significant/ Important (Factor Loading Value > 0.80)	Absence of separate lane for Motorcycle in Mixed traffic flow  No footpath for walking or occupied footpath for other purpose	Absence of separate lane for Motorcycle in Mixed traffic flow
Significant/ Important (Factor Loading Value < 0.80)	Absence of road signage / non-functional Signal at a junction or roundabout	Absence of road signage / non-functional Signal at a junction or roundabout
	Presence of unmarked elevated speed breaker	

## CHAPTER 6

### CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 General

Motorcycle is the vibrant component in the mixed traffic situation of Dhaka city. The massive raise of the number of motorcycles due to the local production, cheap price and introduction of app-based ride sharing services has worsen the situation tremendously. During the last decade, motorcycle registrations have more than doubles and unfortunately, the record of motorcycle accident injuries and mortalities has incised by approximately the same factor. The increase in motorcycle accidents and consequent casualties is a growing problem for the urban dwellers of Dhaka metropolitan city. Motorcyclists are being forced to share the road with mixed traffic due to absence of separate motorcycle lane in road infrastructure. Thus, it has an associated safety concerns as well as psycho-social impacts on motorcyclists and other road users in Dhaka city. In view of the mixed traffic situation, the study has been intended to determine the overall vulnerability of motorcycle riding within the existing roadway characteristics and traffic management system of Dhaka city basing on the safety perceptions and reported behaviour of motorcyclists and other road users. These two-fold approach has help to assess a comprehensive picture of vulnerability of motorcycle riding based on safety perceptions and concerns of both the motorcyclists as well as other road users like public transport drivers, private car drivers and pedestrians. The outcome of this research can be a good instrumental tool for formulation of safety programs and policies for reducing the casualties and mortalities among motorcyclists and other road users of Dhaka city.

The research methodology is designed into three-steps procedures to develop and analyze the models. In the first step, a set of 26 SC variables have been selected for Perceived Safety Concerns of Motorcyclists regarding Motorcycle Riding in Dhaka City as well as a set of 24 SC variables have been selected for Perceived Safety Concerns of Other Road Users regarding Motorcycle Riding in Dhaka City. For building different models these variables are recognized as 1<sup>st</sup> Order latent, 2<sup>nd</sup> Order latent variables and observed variables to carry out confirmatory factor analysis and subsequent development of models as best suited with research technique. A comprehensive field and online questionnaire survey have been conducted within the Dhaka city preparing two sets of stated preference

survey questionnaire. First set of questionnaires was administered among motorcyclists including service riders. Second set of questionnaires was administered among other road users including pedestrians, car and public transport drivers in the Dhaka city amid the COVID-19 situation prevailing in the country. Then, two Structural Equation Models on the safety concerns of motorcycle riding have been generated by carrying out by 1<sup>st</sup> and 2<sup>nd</sup> Order CFA method using the Stata software. Finally, both the Models have been analyzed basing on the ranking values of standardized factor loading of all the latent and observed variables to determine the Most Important and Important factors related to the overall vulnerability/ safety concerns of motorcycle riding in Dhaka city.

## 6.2 Conclusions

This study presents the result of an investigation on overall vulnerability assessment of motorcycle riding in Dhaka city through the mirror image of both perceived safety concerns of Motorcyclists in one side and Other Road Users (Car drivers, Public transport drivers and pedestrians) on other side. As such, two structural equation models on safety concerns of motorcyclists and safety concerns of other road users are being developed through the reported behaviour of motorcyclists and other road users within the existing roadway characteristics and traffic management system in Dhaka city. This study concludes with the following findings:

- (i) Goodness-of-fit indices reveal that both the models fit well as per the accepted values [(For Model-1: Chi-square=62.65; P-value=0.001, RMSEA= 0.065, GFI= 0.941, AGFI= 0.985, NFI=0.956, TLI=0.980, TLI= 0.950) and (For Model-2: Chi-square=112.65; P-value=.001, RMSEA= 0.85, GFI= 0.901, AGFI= 0.945, NFI=0.978, TLI=0.989, TLI= 0.975)] as well as achieved the consistency with real life expected scenario.
- (ii) Comparing both models, it is found that all the perceived safety concerns of motorcycle riding in Dhaka city are being recognized by both Motorcyclists as well as Other Road Users. Only there are differences of perception from both ends in prioritizing or ranking the safety factors in different safety aspects. As such, in the mixed traffic situation of Dhaka city, the five safety aspects like Road Infrastructures (n1), Traffic Management System (n2), Traffic Rules Violation by Motorcyclists (n3), Psycho-social aspects influencing riding of Motorcyclists (n4) and Traffic Rules

Violation by Other Road Users (n5) are the determinant safety concerns and mutually influencing for the overall vulnerability assessment of motorcycle riding in Dhaka city. Amongst the 05 safety aspects, Traffic Rules Violation by Motorcyclists (n3) is identified by both Motorcyclists (0.86) and Other Road Users (0.87) as the most significant safety concerns for vulnerable motorcycle riding in Dhaka city. On the other hand, Traffic Management System (n2) is graded as less contributing factor by Motorcyclists (0.61) and Other Road Users (0.64). In view of the standardized factor loading value, ranking/ priority of latent constructs as per the perception of Motorcyclists are Traffic Rules Violation by Other Road Users (n5) (0.77) > Road Infrastructures (n1) (0.65) > Psycho-social aspects influencing riding of Motorcyclists (n4) (0.63). Consequently, ranking/ priority of latent constructs as per the perception of Other Road Users are Psycho-social aspects influencing riding of Motorcyclists (n4) (0.86) > Traffic Rules Violation by Other Road Users (n5) (0.82) > Road Infrastructures (n1) (0.78).

(iii) In regards to Traffic Rules Violation by Motorcyclists, the result shows that Frequent changing the lane by zig-zag driving (0.89), Disregarding the speed limit by Motorcycle drivers (0.89), Uncertain Movement of roadside parked Motorcycles (0.89), Using footpath by Motorcyclists while stuck in traffic on main road (0.86) and Overtaking any vehicle without proper precautions by Motorcycle drivers (0.82) are the most significant priority concerns as exhibited by the reported behaviours of motorcyclists. The other reported behaviours of Motorcyclists like taking wrong side of the road by motorcyclists while stuck in traffic (0.75), using cell phone by motorcyclists while riding (0.68), violating signal at junction by the motorcyclists (0.71), not caring the standard of safety helmet for the passenger by service providing motorcycle drivers (0.66), following other riders by Motorcycle drivers knowing fully well of violating the traffic rules (0.65), uncertain stopping of Motorcycle at bus stoppage/ junction (0.61) are also the important safety concerns for the vulnerable motorcycle riding in Dhaka city.

(iv) It is revealed in the analysis that motorcyclists' attitudes and aggressive behavioural issues are influenced by various family and psycho-social issues. Riders experiencing family-related or social-related stress as well as those who have an

aggressive personality are more prone to commit a motorcycle accident. The most significant psycho-social factors are riding aggressively during social or family crisis (0.96), breaking traffic rules to reach the destination at the earliest (0.89), violating the traffic rules during office time (0.89), ‘maximum income within shortest possible time’ by the service providing riders (0.87), driving fatigue for over-stressed riding time by service providing Motorcycle drivers (0.87). In addition, the influencing other important psycho-social factors are cautious driving while own family is on ride (0.74), dealing with different types of passengers throughout the day (0.73), not liable about the safety of the passengers (i.e no insurance coverage) (0.67) and getting angered by another driver’s aggressive behaviour (0.63).

(v) The certain traffic rules violation by other Road Users (public transport drivers, private cars drivers and pedestrians) also has a significant contributing impact on vulnerability of motorcycle riding in Dhaka city. The reported behaviour of other road users like not wearing helmet or other safety gears properly by the passengers (0.89) is identified as most significant safety concerns by both motorcyclists and other road users. Illegal road crossing by pedestrians (0.77), Picking up and dropping off the passengers by public transport drivers in mid of the road (0.74), use of mobile while driving or walking (0.68) and uncertain movement /opening of the door by roadside parked vehicle (0.66) are also significant factors that are being exhibited by other road users.

(vi) The study shows that road geometry and infrastructures of Dhaka city are not user-friendly and great safety concerns of motorcycle riding. The most significant safety concerns are absence of separate lane for Motorcycle in mixed traffic flow (0.88 which is rated as top priority concern by both Motorcyclists and Other Road Users) and no footpath for walking or occupied footpath for other purpose (0.81). The other important safety concern like narrow road width/narrow bridge width (0.69) is also the cause of accident in the mixed traffic situation of Dhaka city.

(vii) The study reveals that absence of road signage / non-functional signal at a junction or roundabout (0.78) and presence of unmarked elevated speed breaker (0.67) are the significant safety concerns as identified by both Motorcyclists and other road users in respect of traffic management system of Dhaka city.

### 6.3 Recommendations

In view of above discussions, the Recommendations are presented below:

(i) In the mixed traffic situation of Dhaka city, the perceived safety concerns of both Motorcyclists and other road users should be combined together for the overall assessment of Vulnerability of Motorcycle Riding in Dhaka City. In that, Road Infrastructures, Poor Traffic Management System, Traffic Rules Violation by Motorcyclists, Psycho-social aspects influencing riding of Motorcyclists and Traffic Rules Violation by Other Road Users are the determinant safety aspects and mutually influencing for the overall Vulnerability of Motorcycle Riding in Dhaka City. As such, any strategy of safety programs to improve the situation should be derived out of these above-mentioned 05 safety aspects and address the safety issues with adequate measures.

(ii) Amongst the 05 safety concerns, Traffic Rules Violation by Motorcyclists is identified as the most determinant safety concerns of vulnerable motorcycle riding in Dhaka city. As such, all the safety concerns or riding behaviours of Motorcyclists related to Traffic Rules Violation by Motorcyclists as mentioned in the overall findings of the study [Paragraph number 6.2 (iii)] should be either controlled or changed by appropriate traffic control measures or awareness campaign with utmost priority.

(iii) Since motorcyclists' attitudes and aggressive riding behaviours influenced by various psycho-social issues have significant impact and lead to motorcycle-prone accident, therefore the significant psycho-social factors as derived from the study [Paragraph number 6.2 (iv)] should be addressed with due attention. In view of that, Motorcycle Riders should be evaluated on psycho-social aspects during their driving tests and special emphasis should be given to improve the awareness of psychosocial and behaviour aspects of riding including stress management skills through driving training programs with a view to reducing the rate of motorcycle accidents.

(iv) Since the certain traffic rules violation by other Road Users (public transport drivers, private cars drivers and pedestrians) also has a significant contributing impact on vulnerability of motorcycle riding in Dhaka city, therefore public education

programs and safety policy should be formulated to improve the reported behaviour of Other Road Users as mentioned in the overall finding of the study [Paragraph number 6.2 (v)].

(v) The important safety concerns related to road geometry and infrastructures of Dhaka city mentioned in overall finding of the study [Paragraph number 6.2 (vi)] should also be taken care by appropriate measures to make it a user-friendly safe motorcycle riding.

(vi) The significant safety concerns in respect of traffic management system mentioned in overall finding of the study [Paragraph number 6.2 (vii)] should be addressed with priority by appropriate Traffic Demand Management of Dhaka city.

#### **6.4 Scope for Future Study**

A number of avenues for future research have been revealed by the output of this research. Few of the potential subject of future studies are highlighted below:

(i) A study may be undertaken on cross-section analysis of characteristics of motorcycle accident, injury patterns of accident victims, Accident Severity Analysis, Collision type and identifying accident prone area in the context of risk factors and causes of road traffic accidents with remedial measures within the purview of existing traffic condition of Dhaka city.

(ii) A study may be conducted on Risk taking behaviour such as riding motorcycle at speeds beyond their comfort level, performing stunts particularly by young riders and safety concerns of women riders. The underlying psychosocial aspects and behavioural influence of a competitive environment on risk taking behaviour vis-à-vis risk management strategy would be the main focus of the study.

(iii) A study may be carried out on motorcycle safety countermeasures for particularly motorcyclists to encourage safe riding and discourage risky riding developing a set program of rider training, education and awareness addressing the attitudinal and motivational influences on riding in the context of traffic situation of Dhaka city.

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**APPENDIX A**

**QUESTIONNAIRE SURVEY FOR MOTORCYCLE RIDERS ONLY ON PERCEIVED RISK OF MOTORCYCLE RIDING IN DHAKA CITY**

<b>Part-1: Socio-economic/ Demographic Information</b>						
<b>Serial Number</b>	<b>Questionnaire</b>	<b>Response</b>				
1.	Name					
2.	Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female				
3.	Age	<input type="checkbox"/> 20-30 <input type="checkbox"/> 31-40 <input type="checkbox"/> 41-50 <input type="checkbox"/> 51-60				
4.	Marital status	<input type="checkbox"/> Married <input type="checkbox"/> Un-married <input type="checkbox"/> Divorced/Separated				
5.	Education Level	<input type="checkbox"/> No Education <input type="checkbox"/> SSC <input type="checkbox"/> HSC <input type="checkbox"/> Graduate <input type="checkbox"/> Masters				
6.	Occupation	<input type="checkbox"/> Govt Employee <input type="checkbox"/> Private Employee <input type="checkbox"/> Business <input type="checkbox"/> Service Rider <input type="checkbox"/> Delivery man <input type="checkbox"/> Student <input type="checkbox"/> Others				
7.	Monthly Income	<input type="checkbox"/> No Income <input type="checkbox"/> Below 10,000 <input type="checkbox"/> 10,000-30,000 <input type="checkbox"/> 30,000-60,000 <input type="checkbox"/> 60,000-1,00,000 <input type="checkbox"/> Above 1,00,000				
<b>Part-2 : Use of Motorcycle (MC) and Riding History/ Travel Patterns of Respondents</b>						
1.	Do you own a Motorcycle?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Rented				
2.	What type of MC Rider you are?	<input type="checkbox"/> Recreational <input type="checkbox"/> Utilitarian <input type="checkbox"/> Both Recreational & Utilitarian <input type="checkbox"/> Service/Professional Rider				
3.	What is your experience of driving?	<input type="checkbox"/> Less than a year <input type="checkbox"/> 1-2 years <input type="checkbox"/> 2-5 years <input type="checkbox"/> More than 05 years				
4.	How often do you use MC?	<input type="checkbox"/> Everyday <input type="checkbox"/> 1-3 days in a week <input type="checkbox"/> Only on Weekend/holidays <input type="checkbox"/> Occasionally				
5.	How many MC accidents have you faced in your life while driving?	<input type="checkbox"/> None <input type="checkbox"/> 1-2 <input type="checkbox"/> 2-4 <input type="checkbox"/> 4-6 <input type="checkbox"/> 7 or more				
6.	How often have you been charged any fine by the Traffic Police for violating the traffic rule in last 03 years?	<input type="checkbox"/> Never <input type="checkbox"/> 1-3 <input type="checkbox"/> 3-5 <input type="checkbox"/> 5-7 <input type="checkbox"/> More than 07				
<b>Part-3: Psychosocial aspects Influencing Riding</b>						
<b>Question: In your opinion what are the Psycho-social aspects that often Influence the driving of a Motorcyclist while on road?</b>						
<b>1 - Strongly Agree , 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly Disagree</b>						
<b>Serial number</b>	<b>Reason of Feeling Unsafe</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1.	Getting angered by another driver's aggressive behaviour or faulty driving skill.					
2.	Riding aggressively when there are any social or financial problems in the family.					

3.	Feeling impatience/ distracted due to rough weather/huge traffic congestion on road.					
4.	Breaking traffic rules to reach the destination at the earliest.					
5.	Try to violate the traffic rules during office going time or office break time.					
6.	Become cautious in driving whole own family is on ride.					
7.	The 'maximum income within shortest possible time' influences the riding of the service providing riders.					
8.	The driving fatigues for over-stressed riding time influence the driving behaviour of the service providing riders.					
9.	Dealing with different types of passengers throughout the day affects the driving behaviour of service providing riders.					
10.	Situation provokes me to break traffic rules.					

**Part-4: The reasons of feeling unsafe while driving a Motorcycle on the road**

**Question: As a MC Rider if you feel unsafe then what is reason of feeling unsafe while on road?**

**1 - Strongly Agree , 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly Disagree**

<b>Serial number</b>	<b>Reason of Feeling Unsafe</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1.	Poor Traffic Management.					
2.	Illegal road crossing by pedestrians.					
3.	Absence of road signage / non-functional Signal at a junction or roundabout.					
4.	Presence of unmarked elevated speed breaker.					
5.	Not wearing helmet or other safety gears properly.					
6.	Use of mobile while driving a vehicle or Walking on the road.					
7.	Uncertain Movement /opening of the door by roadside parked vehicle.					
8.	Picking up and dropping off the passengers by public transport in mid of the road.					
9.	Absence of separate lane for Motorcycle in Mixed traffic flow.					
10.	No footpath for walking or occupied footpath for other purpose.					
11.	Narrow road width/narrow bridge width.					
12.	Disregarding the speed limit by Motorcyclists when there is less traffic in road (while raining/Early morning/late Night).					

13.	Changing the lane by Zig-zag driving by Motorcyclists while on road.					
14.	Overtaking any vehicle without proper precautions by Motorcyclists.					
15.	Using footpath by Motorcyclists while stuck in traffic on main road.					
16.	Taking wrong side of the road by Motorcyclists while stuck in traffic on road.					
17.	Using cell phone by Motorcyclists while riding motorcycle on the road.					
18.	Crossing the Junction by the Motorcyclists knowing fully well that 'the red light is on' or despite having 'No Go' signal given by Traffic Police.					
19.	Driving a Motorcycle itself is a safety concern					

**APPENDIX B**

**QUESTIONNAIRE SURVEY FOR OTHER ROAD USERS (CAR /PUBLIC  
TRANSPORT DRIVERS/ PEDESTRIANS) ON PERCEIVED RISK FROM  
MOTORCYCLISTS WHILE ON ROAD IN DHAKA CITY**

<b>Part-1: Socio-economic/ Demographic Information of Respondents</b>						
<b>Serial Number</b>	<b>Questionnaire</b>	<b>Response</b>				
1.	Name					
2.	Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female				
3.	Age	<input type="checkbox"/> 20-30 <input type="checkbox"/> 31-40 <input type="checkbox"/> 41-50 <input type="checkbox"/> 51-60				
4.	Marital status	<input type="checkbox"/> Married <input type="checkbox"/> Un-married <input type="checkbox"/> Divorced/Separated				
5.	Education Level	<input type="checkbox"/> No Education <input type="checkbox"/> SSC <input type="checkbox"/> HSC <input type="checkbox"/> Graduate <input type="checkbox"/> Masters				
6.	Occupation	<input type="checkbox"/> Govt Employee <input type="checkbox"/> Private Employee <input type="checkbox"/> Business <input type="checkbox"/> Service Rider <input type="checkbox"/> Delivery man <input type="checkbox"/> Student <input type="checkbox"/> Others				
7.	Monthly Income	<input type="checkbox"/> No Income <input type="checkbox"/> Below 10,000 <input type="checkbox"/> 10,000-30,000 <input type="checkbox"/> 30,000-60,000 <input type="checkbox"/> 60,000-1,00,000 <input type="checkbox"/> Above 1,00,000				
<b>Part-2 : Use of Motorcycle (MC) and Riding History/ Travel Patterns</b>						
1.	Do you / family own a car?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Rented				
2.	What is your experience of driving?	<input type="checkbox"/> Less than a year <input type="checkbox"/> 1-2 years <input type="checkbox"/> 2-5 years <input type="checkbox"/> More than 05 years				
3.	Have you ever faced any accidents with a Motorcycle in your life while driving / walking?	<input type="checkbox"/> None <input type="checkbox"/> 1-2 <input type="checkbox"/> 2-4 <input type="checkbox"/> 4-6 <input type="checkbox"/> 7 or more Type of Accident: <input type="checkbox"/> Minor <input type="checkbox"/> Major				
<b>Part-3: The reasons of feeling unsafe while driving / walking on the road</b>						
<b>Question: As a Driver/ Pedestrian if you feel unsafe while on road then what are the reasons of feeling unsafe in regards to Motorcycle driving?</b>						
<b>1 - Strongly Agree , 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly Disagree</b>						
<b>Serial number</b>	<b>Reason of Feeling Unsafe</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1.	Poor Traffic Management.					
2.	Uncertain Movement of roadside parked Motorcycle drivers.					
3.	Crossing the Junction by Motorcycle drivers knowing fully well that ‘the red light is on’ or despite having ‘No Go’ signal given by Traffic Police.					
4.	Disregarding the speed limit by Motorcycle					

	drivers when there is less traffic in road (while raining/early morning/late night).					
5.	Frequent changing the lane by zig-zag driving of Motorcycle drivers.					
6.	Overtaking any vehicle without proper precautions by Motorcycle drivers.					
7.	Using cell phone while riding on road by Motorcycle drivers.					
8.	Using footpath by Motorcycle drivers while stuck in traffic on main road.					
9.	Picking up and Dropping off the passengers in mid of road by Motorcycle drivers.					
10.	uncertain stopping of Motorcycle at bus stoppage/ junction due to no earmarked parking for motorcycle.					
11.	Following other rider by Motorcycle drivers knowing fully well that he is violating the traffic rules.					
12.	Taking wrong side of the road by Motorcycle drivers while stuck in traffic on road.					
13.	Absence of footpath or occupied footpath for pedestrians.					
14.	Narrow road width/narrow bridge width.					
15.	Absence of separate lane for motorcycle in mixed traffic flow.					
16.	Not caring the standard of safety helmet for the passenger by service providing Motorcycle drivers.					
17.	The driving fatigue for over-stressed riding time influence the driving behavior of service providing Motorcycle drivers.					
18.	Service provider Motorcycle drivers are not liable about the safety of the passengers (i.e no insurance coverage).					
19.	The 'maximum income within shortest possible time' influence the service providing Motorcycle drivers for rough driving.					
20.	Overall safety - Generally feel unsafe to drive/walk when motorcyclists are around on the road.					