

**IDENTIFICATION OF INJURY PATTERNS OF HOSPITALIZED
MOTORCYCLISTS AND DEVELOPMENT OF COUNTERMEASURES
FOR THEIR SAFETY IMPROVEMENT**

by

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A thesis submitted to the Department of Civil Engineering,
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of

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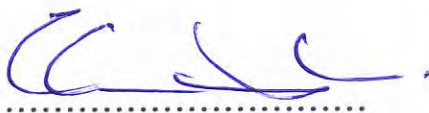
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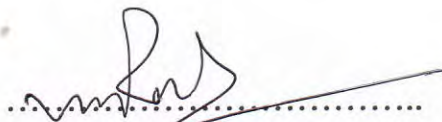
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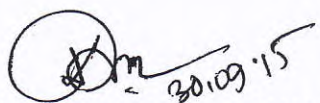


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DECLARATION

It is hereby declared that the thesis or any part of it has not been submitted elsewhere for any degree or diploma

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ABSTRACT

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 vehicle 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 previous studies mainly focuses motorcycle traffic trend analysis, motorcycle traffic volume and travel behavior. No study on casualty's injury in motorcycle accident has been found to be carried out previously in our country. This research may be the first attempt in this regard. For identifying distinctive features of motorcycle related accident and injury, motorcycle accident data have been analyzed in MAAP5 software. The accident data needed for analysis has been collected from Accident Research Institute (ARI), BUET.

To identify the injury pattern, characterize driving behavior and analyze the situation during accident a questionnaire survey has been conducted among at least 100 patients who are admitted to hospital as a result of motorcycle accident. They have been asked a series of questions about their riding habits and the type of accident in which they were involved and a series of questions about their motorcycles. 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.

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CHAPTER 1

INTRODUCTION

1.1 Background

Transportation system in Bangladesh is predominantly road based with different types of motor vehicles viz. motorcars, jeep, minibuses, taxis, buses, mini buses, trucks, 3 wheelers, motorcycles, and non motorized vehicles like rickshaw, rickshaw vans, push carts, animals down carts and bicycles. That is why road traffic accident is a very common phenomenon in our country and Road traffic injury has increased greatly in recent time. Road traffic injury is concerned as a critical public health burden as it leads to high mortality and morbidity worldwide, especially in low and medium income countries. About 1.3 million people are dying every year from road traffic injuries and about 50 million are prolonged to morbidity and disability. About half of those died people are pedestrians, cyclists and motorcyclists. The situation is badly increasing over time (WHO, 2009). The increasing numbers of transportation vehicles is pushing the death cases from Road Traffic Injury (RTI) higher in developing world. It has been estimated road traffic injury will be the third leading global public health burden in terms of cause of fatality by 2020 whereas it was 9th position in 1998 (Anjuman et.al.2007).

Road traffic injury is a leading cause of fatality in Bangladesh. Every day on an average 8 people are dying from road traffic injuries. The number of injuries has been increasing at an alarming rate also in Bangladesh (Maniruzzaman & Mitra 2005). Among them motorcycle injury contributes a notable proportion to the road traffic injury in Bangladesh as causing fatalities every year, though the number is underestimated as lots of cases are not reported (Ministry of communication Bangladesh). Motorcycle is the dominant in the composition of all motorized traffic. The use of motorcycle in traffic has increased greatly in recent time. During the last ten years, motorcycle registrations have more than doubles and unfortunately, the number of motorcycle accident injuries has incised by approximately the same factor. The most recent statistics show the number of fatalities attributed to motorcycle traffic accidents is approaching five thousand per year. At present time motorcycle accident contributed nearly 10% of the traffic accident fatalities while motorcycles are only one or two percent of the vehicles in traffic. In this way, the motorcycle appears to be the most dangerous form of motor vehicle transport. This problem has not escaped notice and much research has defined the obvious hazard are reveled many of the critical factors in motorcycle accidents.

Elementary considerations clearly established the prospects for injury of the motorcycle rider involved in collision with another motor vehicle, simply because of the lack of a protective envelope available within the conventional automobile. In addition, similar fundamental considerations established. The number of motorcycle has been almost tripled in 2012 compared in 2003. According to Bangladesh Road Transport Authority total number of registered motorcycle is 949047 up to June 2012, whereas, a major portion of total motorcycles are still unregistered. Besides the sale of motorcycle is increasing at an alarming trend, which is raising the possibility of more motorcycle, accident (Ara, 2012).

Among several types of road traffic accident, the motorcycle accident scenario is most painful and horrible and it is growing day by day in both urban and rural areas. Although traffic safety has improved in the recent years the number of road fatalities due to motorcycle is still unacceptably high. In 2006 total accident in Dhaka city is around 600, where motorcycle accidents were 29 (4.8%). At the end of 2013, the number of motorcycle accident was 45, about 13.2% of Dhaka city's total accident (341). The casualty resulting from motorcycle crashes in Dhaka has increased more than doubled during this 8 years period. The problem of death and injury because of motorcycle accidents is now acknowledged to be a global phenomenon with authorities in virtually all countries of the world concerned about the growth in the number of people killed and seriously injured on their road. 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 Dhaka city.

1.2 Importance of the Study

In Bangladesh Motorcycle is one of the most vulnerable motor vehicle and has a higher fatality rate per unit of distance traveled when compared with automobiles. Motorcyclists are more at risk of being killed or injured in a road traffic accident than any other type of vehicle user. In the event of an accident or a crash, a motorcycle rider is directly and fully exposed to violent impact or collision. Motorcyclist's risk of a fatal crash is 35 times greater than a passenger car per vehicle mile travel (NHTSA, 2007). In Bangladesh, the fatality rate per 10000 motorcycles is 3.4 whereas in Indonesia it is 2.5 (Hoque et. al., 2014). 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 2008-12, the percentage of motorcycle related accident and casualties maintains an

increasing trend and an average its share in all accident and casualties is 14% and 8% respectively (ARI, 2012).

The previous studies mainly focuses, motorcycle traffic trend analysis, motorcycle traffic volume and travel behavior. No study on casualties or injury in motorcycle accident has been found to be carried out previously in our country. However, this study will emphasize on identification of injury patterns of hospitalized motorcyclists and development of countermeasures for their safety improvement.

1.3 Objective of the Study

The overall objective of the study is to analyze the characteristics of motorcycle related accidents and resulting casualties occurring in Dhaka city. The study in particular aimed at identifying the injury pattern of accident victims along with the driving behavior and vehicular features in motorcycle accident. The specific objectives of the study are:

1. To identify the injury pattern of motorcyclists experiencing road accident
2. To analyze motorcyclists' driving behavior along with vehicular features
3. To identify the probable causes of the motorcycle accidents and resulting casualties

It is expected that the outcome of this research can be used to develop behavioral, vehicular and injury related countermeasures with identified contributing factors for motorcycle accident. The results can also be used to direct additional research into specific areas of need identified by this research.

1.4 Organization of the Thesis

The thesis has five chapters including this introductory chapter. The relevant literatures on motorcycle accident and injury pattern of motorcyclists experiencing road accidents are discussed in **chapter 2**. Efforts have been made to find out local problems on motorcycle in Bangladesh. **Chapter 3** deals with the methodology of the whole study. **Chapter 4** deals with the analysis of accident data from accident database as well as data collected from the questionnaire survey. It also includes the findings of analysis. **Chapter 5** deals with the conclusions, outcomes of the study, countermeasure, and scope for future study.

CHAPTER 2

LITEARATURE REVIEW

2.1 Introduction

Road traffic injury is a public health problem in Bangladesh. A public health intervention is needed to be developed to address this problem. For designing a public health intervention, it is important to know the people's perception. This study will help to explore the knowledge attitude and practice of the motor cycle drivers who are one of the most important groups in relation to road traffic injury. WHO has recommended for formulating policies by focusing public health approach for motorcycle injury prevention. Some studies proved that public health programs like health promotion can achieve an effective result to prevent motorcycle injury (Waller, 2001). The success of a public health program depends upon adequate understanding of the contextual aspects prevailing in the community. Knowledge, attitude and practice survey is most popular and commonly used method to assess and perceive the status of the targeted population. This methodology is appraised as easy design, quantifiable data, ease of interpretation and succinct presentation of findings, generalizability of tiny sample's results to a broad population and execution rapidity (Launiala, 2009). It will be helpful to understand the community for design preventing intervention of motorcycle injuries. Use of motorcycle as transportation is increasing at a rapid manner in Bangladesh. The major segment of motorcyclists belongs to young age group.

It is necessary to conduct a review of literature on the subject matter of thesis before carrying out performance evolution of safety scheme for motorcycle in developing countries. While consulting literature it revealed that, a fundamental problem in dealing which accident in developing countries like Bangladesh is that, not much is known about the accident problem characteristics and impact of motorcycle safety measure due to inadequate data. The important steps involved in motorcycle accidents studies are identification of the factors contributing to motorcycle accidents, reporting and collision procedure of accident data, nature of the accident problem leading to effective prescription of countermeasure and then finally monitoring and evaluation of safety schemes to assess their performance.

This chapter includes general understanding of motorcycle accident phenomena and literature emphasized on motorcycle accident and safety as well as characteristics of motorcycle rider. The public information of revenant research studied and investigation carried out both within

Bangladesh and abroad were tried to be collected. After reviewing the most relevant documents and information as well as impressive features of literature are conceptualized in this chapter.

2.2 Motorized Vehicles statistics in Bangladesh

In Bangladesh, there is an enormous change in the number of registered motorized vehicles. The growth of motorcycle in Bangladesh is relatively very high comparing with other kind of vehicles, in 2008 registered motorcycle was about 52% among all other registered vehicle. The number of registered motor vehicles is shown in the table 2.1 and figure 2.1

Table 2.1 Number of Registered Vehicles in Bangladesh (2009 – 2015 August)

Sl. No	Type of Vehicles	Upto-2009	2010	2011	2012	2013	2014	Upto August-2015	Grand Total
1	Ambulance	2506	287	219	181	243	338	352	4126
2	Auto Rickshaw	108436	18327	20423	23545	15697	19897	13487	219812
3	Auto Tempo	13977	289	175	626	395	500	741	16703
4	Bus	26016	1762	1761	1439	1107	1488	1383	34956
5	Cargo Van	2911	611	489	282	687	608	264	5852
6	Covered Van	3760	1898	2354	1421	2271	2869	1615	16188
7	Delivery Van	15564	1499	1004	774	894	1176	1082	21993
8	Human Hauler	5846	674	1152	715	385	225	446	9443
9	Jeep(Hard/Soft)	30162	2124	2134	1569	1314	1870	2228	41401
10	Microbus	59404	6975	4051	3044	2537	4313	3256	83580
11	Minibus	24749	895	276	249	148	256	185	26758
12	Motor Cycle	650147	109110	114616	101588	85808	90685	112813	1264767
13	Pick Up (Double/Single Cabin)	23273	8967	10460	7625	6553	9554	7104	73536
14	Private Passenger Car	196870	22960	12950	9224	10472	14699	13686	280861
15	Special Purpose Vehicle	5900	471	396	226	227	172	150	7542
16	Tanker	2379	327	317	195	226	362	170	3976
17	Taxicab	44361	19	75	172	51	374	76	45128
18	Tractor	16855	3745	5200	3494	1885	1522	1089	33790
19	Truck	73336	9535	7327	4335	5129	8136	4501	112299
20	Others	934	383	7	1	1080	1595	1246	5246
TOTAL		1307386	190858	185386	160705	137109	160639	165874	2307957

(Source: http://www.brta.gov.bd/images/files/statistics/stat_bd_08-15.pdf)

2.3 Motorcycle and Other Vehicles: Risk Comparison

One of the main reasons of motorcyclists being killed in crashes is because the motorcycle itself provides virtually no protection in a crash. They often share the traffic space with fast moving cars, buses and trucks. They traveled at a high speed compared to other vulnerable road user and they are less visible. In addition, their lack of physical protection makes riders

particularly vulnerable to being injured if they are involved in collision. Both the motorcycle accident and casualty in Dhaka city has an increasing trend during 2006 to 2015. Though the average percentage of motorcycle accident is only 7.2 percent comparing with vehicle accidents, it is vulnerable because most of motorcycle collision are fatal type and cause serious injury and death to the users.

2.4 Motorcycle Statistics in Asian Region

In many low-income and middle-income countries, motorcycles are an increasingly common means of transport. Due to their comparatively low cost, motorcycles tend to be the first affordable motor vehicles that can be purchased. Therefore, the motorcycle is not only popular in Bangladesh but also in different countries in Asia. Statistical yearbook shows the composition between the proportion of motorcycles in Bangladesh, Singapore, Thailand, Vietnam and Malaysia Statistical year book provides the relative growth rates of motorcycles in different countries over the years.

2.5 Description of Accidents in other Countries

A study on motorcyclist in Nigeria shows that 45.8% of the cyclists have been involved in crashes at one time or the other which is some sort of associated with their knowledge, attitude and practices regarding use of safety measures (Oginni, et.al., 2007). Another prospective study on motorcycle injury in same country identified that the risk of death for each kilometer travelled from a motorcycle crash is 20 times higher than from a motor vehicle crash. Without having a helmet the chance of having head injury among motorcyclist is 53.6%, co-riders and pedestrians are 32.1% and 14.3% respectively (Solagberu, et. al., 2006). Unsafe driving, loss of control on bend, reckless overtaking, use of mobile phone during driving, use of footpath and wrong direction for motorcycling, violation of traffic signals, over-speeding, driving without having license, vehicular defects, over riding of capacity, non-use of helmets, inferior road, shortage of knowledge and consciousness among road users, lack of training on maintenance of motor vehicle etc. are the contributing factors to motorcycle injury (Clarke et.al., 2004). Head injuries from motorcycle crashes contribute 88% of fatalities which can be minimized by wearing helmet. The consequences of head injuries for survivors and their families cost higher as it requires specialized and long-term care than other injuries. WHO recommended preventing motorcycle crashes, minimizing injuries and their consequences by safety strategy and action plan for mandatory wear of

helmets, enforcing speed limit, and create awareness, especially focusing on particular occupational groups (WHO, 2006).

The problem of death and injury as a result of road accidents is now acknowledged to be a global phenomenon with authorities in virtually all countries of the world concerned about the growth in the number of people killed and seriously injured on their roads. The accidents are classified by the involvement in the accident. Pedestrian, cyclist, motorcyclists, motorized four wheelers are the major group of classification. Statistical year book shows that pedestrian is the major contributor in national trend of accidents. Motorcycle accident percentage is also another important factor especially in Asian country Norway, Australia, USA it is not significant in compared with Asian country like Malaysia (57 percent), Indonesia (42 percent), and Thailand (36 percent). This may due to repaid increasing use of motorcycle in Asian country. As in developed country number of four wheeler motorized vehicle is seen more than two wheeler vehicle so also the number of accidents by four wheeler vehicles is significant but not in Asian country. By analyzing motorcycle accident in different country, it is seen that in Malaysia maximum motorcycle percentage occurs.

2.6 Motorcycle Fatality in Different Countries

Motorcycles have a higher fatality rate per unit of distance traveled when compared with automobiles. According to the NHTSA, in 2006 18.06 cars out of 100,000 ended up in fatal crushes. The rate of motorcycles is 55.82 per 100,000. In 2004, figures from department of transport in the UK indicated that motorcycles have 121 corresponding figure for motorists.

A national study by Australian Transport Safety Bureau (ATS) found that:

- Motorcycle rider death rates increased among all riders age groups between 1998 and 2000
- Motorcycle riders deaths were nearly 30 times more than drivers of other vehicles
- Motorcycle riders aged below 40 are 36 times more likely to be killed than other vehicles operators of the same age
- Motorcycle riders aged 40 years and over are around 20 times more likely to be killed than other vehicles operators of the same age

According to 2005 data from the National Highway Traffic Safety Administration NHTSA, 4,008 motorcycle occupants were killed on United States road in 2004, an 8% increase from 2003.

During the same period, Drivers of automobiles showed a 10% increase in fatalities and cyclist showed an 8% increase in fatalities. Pedestrians also showed 10% increase in fatalities. In 2008 a total of 37,423 automobiles fatalities were happened on USA roads where 14% in motorcycle fatality. By analyzing motorcycle accident in different country from IRTAD it is seen that Malaysia maximum percentage occurs where motorcycle fatality is about 60% of total fatality in 2008. Higher Motorcycle fatality percentage out of total fatality in other country is also a reason of headache.

2.7 Motorcycle Studies in Bangladesh

Before entering in to the theme of present study, it is desirable and informative to review the past transport studies in Bangladesh specially those relating to motorcycle studies. This section summarizes those past motorcycle studies. Gluing cell phone to ear for talking, even by one hand or by neck while motorcycling, is a common phenomenon in Bangladesh. Talking over cell phone while piloting leads the cyclist distracted from driving like a ageing person. To minimize the chance of destruction from the cause legally prohibition can be good approach. According to the provision of Bangladeshi law, use of cell phone while driving will have to pay financial penalty or one month imprison or both. Government order also prohibited wearing earphone or cell phone using while driving. But it's rare that the laws have been enforces where violation of law is a common tendency in Bangladesh (The Daily Star, 2011).

2.7.1 Motorcycle Traffic Trends and Operational Characteristics in Bangladesh

A study of motorcycle traffic trend analysis and its travel behavior and rider characteristics was conducted by Imran (1996). He carried out field survey on the major road intersections and interview survey was carried out all over Dhaka city. He also covered the average occupancy of motorcycles and average travel distance of motorcycle riders. It was found that average annual growth rate of motorcycle was about 8.65% from 1986 to 2007 periods. In Dhaka, the maximum hourly volume of motorcycle was found to be 624 on Sahabag to Bangla motor road, which was followed by Karwan Bazar to Banglamotor road (604 motorcycle/hr). Dhanmondi to Asad Gate road also had a high number of motorcycle (484 motorcycle/hr).on mirpur road, the composition of motorcycles among all traffic was found

to be 10% at 5pm to 6 pm. In 1996, the hourly volume of motor vehicles and motorcycles on different major road ways at peak hours varied from 1662 to 7927 and 96 to 347 respectively. In 2008 on Mirpur road there was an increase in motorized traffic of about 1.6 times than that of 1996 and in case of motorcycle the increase was about 7.56 times. Field interview results all are male, age group 26-30 was the highest user group, service holders were highest occupation group of motorcycle drivers, average trip length was 46 km per day and reduce time was the main purpose for using the motorcycle. Overall 72% of all motorcycle riders used helmet and that percentage was 86 for motorcycle riders, 99% of motorcycle riders were male and about 44% of minor accidents and 100% of severe accidents were belonged to 20 to 25 year age group.

2.7.2 Motorcycle Traffic Study in Dhaka City

A study regarding motorcycle riders all over Dhaka city was conducted by Hossain (1996). He carried comprehensive field survey and made an analysis regarding the characteristics of motorcycle traffic volume and their travel behavior. On Mirpur road highest proportion of motorcycle traffic was found accounting for near 7% during 10 a.m. to 11 a.m. The results of the field survey revealed that average occupy of motorcycle was 1.3 riders per motorcycles. By the field interview result it seems that , age group of 30-39 was the highest user group, service holders were highest occupation group of motorcycle drivers, average trip length was 46 km per day and reduce time was the main purpose for using the motorcycle. The percentage of motorcycle riders male female and children pillion passenger were 79%, 11% and 10% respectively. In motorcycle accidents 35% occurred due to collision with buses, mini buses and trucks, 68% occurred at day time and 53% were rear end collision

2.8 Overseas Research on Motorcycle Traffic

2.8.1 Research

Two major scientific research studies into the cause of motorcycle accidents have been conducted in North America and Europe: the hurt report and the MAIDS report.

2.8.1.1 Hurt Report

Hurt report, Published in 1981 with data collected in Los Angeles and surrounding rural areas. It concluded with 55 finding, as well as several major recommendations for law enforcement and legislation. Among these 75% of accidents were found to collision with

other vehicles. 75% of accidents were found to involve a motorcycle and a passenger vehicle while the remaining 25% of accidents were single motorcycle accidents. Almost 50% of fatal accidents show alcohol involvement and injury severity increase with speed, alcohol involvement and motorized size. The reports additional finding shows that the wearing of appropriate gear, specially helmets and double garments, mitigates crush injuries substantially. Vehicle failure accounted for less than 3% of these motorcycle accidents, and most of these were single vehicle accident where control was lost due to puncture flat and weather is not a factor. The failure of motorist to detect and recognize motorcyclist in traffic the predominating cause of motorcycle accident, and accidents involvement is significantly reduced by the use of motorcycle head lamps on in daylight and wearing of high visibly yellow, orange or bright red jackets.

2.8.1.2 MADIS report

MADIS report carried out in five European countries in 1999-2000, using the rigorous OECD standards, including a statistically significant sample size of over 90 crash incidents and over 900 control cases. The MAIDS report tends to support most of the hurt report finding, for example 69% of the OV (other vehicle) drivers attempted no collision avoidance maneuver, suggesting they did not see motorcycle. In largest number of PTW (powered two wheeler) accidents is due to perception failure on the part of the OV drivers or the PTW rider. And the data indicates that the 68.7% of all cases, the helmet was capable of preventing or reducing the head injury sustained by the rider (33.2%+35.5%). In 3.6% of all cases, the helmet was found to have no effect upon head injury and there was no reported case in which the helmet was identified as the contact code for a serious or maximum neck injury.

2.8.2 Risk Analysis, Driver Behavior and Traffic Safety at Intersection in Motorcycle-Dominated Traffic Flow

Huyen (2009) analyzed some safety improvement behavior in high density motorcycle area like Vietnam. This Study is basic attempt to understand the behavior motorcycle. It was observed that the presence of a high number of motorcycles in the network interfered with the flow of other vehicles, reducing their average speed drastically. The research explained establishment of a modular structure to conduct risk analysis of driver behavior relating to violating traffic regulations at instructions in motorcycle dominated traffic flow. Motorcycle dominated traffic flow is very much different from car traffic flow. Motorcycles

distinguishing characteristics (which can be summarized as flexibility and maneuverability). Therefore, there appears the need to evaluate and verify such findings and measurements concluded from car traffic flow before applying in the MD traffic flow. After general analysis the situation, the study focuses on the main causes of traffic unsafely in Vietnam nowadays: driver behaviors of violating road traffic regulations.

2.8.3 Key Components of a Motorcycle-Traffic System

Hussain et.al. (2005) made a comprehensive study to establish the characteristics of key components of a motorcycle-traffic system in Malaysia, i.e. the motorcycle/rider unit, motorcyclist space requirement and riding manner along motorcycle paths of various lane width. According to their field analysis, it was found that 99 percent were small and medium sized motorcycles of engine size 150cc below, thus representation the “design” motorcycle-vehicles having 0.8 breadth and 2.0m length. This study showed that typical motorcyclist needs width between 0.9 m and 1.7m to operate, while the mean operating width is 1.3m and an “ideal lane” is expected to lie between 1.4m and 1.7m lane widths.

2.8.4 Analysis of Motorcycle Accidents in Developing Countries: A Case Study of Khon Karen, Thailand

Imtrakul et.al. (2003) employed the unconventional method to analyze the motorcycle accident problem in Khon Karen Thailand. This study presented the results of the investigation of the factors that contributed to motorcycle accidents occurrence through that 66percent accidents victims were male, age group 16-25 was the highest victim group, about one third of motorcycle victims involved in accidents were drunk drivers and 77% of motorcyclists involved in accidents did not use helmets. The study recommended safety improvements and strict regulations as well as policy actions such as enforcement of helmet use and prohibiting impaired driving.

2.8.5 Motorcycle Helmet: Biomechanics and Computational Issue

Suaieb, et.al. (2002) was devoted to review the current status related to motorcycle helmet crash studies from biomechanics and computation point of view. It also reviewed the importance of motorcycle helmet in the statistical background. The paper is divided in two main sections, in first section, the biomechanics issues are highlighted and head injury

classification are presented the injury mechanism of different injury types analyzed and related helmet head impacts were identified. In second section, insights into the computational issue that are critical to the understanding of the helmet safety are presented.

2.8.6 Injured Motorcyclists in Malaysia

Pang, et. al. (2000) examined the characteristics of injured motorcyclist in Malaysia to identify who were a high fatality risk and subsequently be the fatality group for the fatality reduction countermeasures. This study showed that about 55% were seriously injured but survives and remaining was fatally injured. The fatality prone age group was found to be below 25 years. Among the fatalities, 92.5% were drivers and 7.5% were pillion passengers. In the case surviving victim, about 86% were drivers. It was seen that more fatalities occurred with large engine capacity machines. Most common vehicles stuck were the passenger car accounting for 39.7 % of seriously injured motorcyclist and 36.6% of fatal riders. This study showed that crashes in non-junction sites were more likely to result in fatal outcome and highest fatality rate was seen in head-on collision.

2.8.7 Compliance of People Per Safety Helmet Usage in Motorcyclists

Kulantyayan, Umar, Hariza, Nasir and Harwnt examined the compliance of people safety helmet using motorcyclist in Kajang, Selangeor, Malaysia. This study showed the helmet use of male and female motorcyclists were 50.1% and 65% respectively. The helmet usages of people below 20 years and above 40 years of age were 69.2 and 37.2% percent respectively. Riders without prior accident involvement had a higher accident percentage proper usage of cash helmets (58.5%). Helmet compliance level was low among novice riders.

2.9 Overview

A review of these literature reveals that a few research has been conducted on the motorcycle accident analysis within developing country. The growth of motorcycle user in Bangladesh that discussed on the previous research concludes the need of motorcycle accident analysis. Overseas research provided some insights into the growth of motorcycle and the motorcycle user characteristics in Thailand, comparatively assessment in image processing and analysis in Vietnam and with respect of Malaysia context, accidents characteristics of injured motorcyclists and compliance of helmet usage and motorcycle traffic components.

CHAPTER 3

METHODOLOGY AND DATA COLLECTION

3.1 Introduction

This chapter covers methodological concepts that are followed in conducting the study. To accomplish the objectives as described in Chapter 1, a systematic approach has been adopted to study the motorcycle related accidents and injuries. A brief description is as follows.

- Development of questionnaire
- Selection of study site for data collection
- Data collection through questionnaire survey
- Crash data collection for the analysis of motorcycle accident in Dhaka city using MAAP5 software to identify the characteristics of motorcycle related accidents and resulting casualties occurring in Dhaka city.
- Analysis of questionnaire data to identify injury pattern and driving behavior

3.2 Development of questionnaire

A structured self administered questionnaire has been developed to assess the injury pattern of hospitalized motorcyclists experiencing road accident. Review of different relevant studies has been conducted for the development of questionnaire with appropriate variables and parameters. The questionnaire was translated in Bengali for effective communication with the respondents. It has been taken a written consent from the respondents and provided the questionnaire for filling who gave the consent to participate in the survey. The study is mainly concerned with the objective information relevant to motorcycle accidents, injury pattern and driving behavior i.e. the facts only such as WHERE, WHEN, HOW accident occurred and WHAT was the injury pattern of the victim; WHAT are their usual behavior during riding. Therefore, the questionnaire includes question on:

- Information regarding injury pattern of hospitalized motorcyclists (e.g. head injury, bone fracture, spinal cord etc)
- Information regarding accident (e.g. type of accident, vehicle, helmet use etc)
- Information regarding driving attitude
- Information regarding Motorcycle (e.g. Company name, headlight, indicator engine condition etc)

3.3 Selection of Study Site and Study Period

The study has been conducted at five specialized hospital compounds in Dhaka city mainly. Those include Dhaka medical college hospital; Sir Salimullah Medical College Mitford Hospital; Shahid Shuhrawardi Medical College Hospital; National Institute of Traumatology and Orthopedic Rehabilitation hospital (NITOR); and Trauma centre. Usually patients are taken to the mentioned hospital in Dhaka city after any road traffic injury happened on the road. Therefore, it is very easy to get motorcycle accident related information from those hospitals. The whole study duration was spanned from March to August 2015. During these period design of questionnaire, data collection from field visit and data analysis have been conducted.

3.4 Data Collection through Questionnaire Survey

Data has been collected using the developed questionnaire from the five selected hospitals in Dhaka city with the help of an assistant. A questionnaire survey has been conducted among 100 patients who are admitted to hospital as a result of motorcycle accident. They have been asked a series of questions about their riding habits and the type of crash in which they were involved and a series of questions about their motorcycle and injury pattern.





Figure 3.1: Some glimpses of data collection

3.5 Crash Data Collection for Analysis of Motorcycle Accident

9 years of Motorcycle accident data from 2006 to 2014 has been collected from Accident Research Institute (ARI), BUET. Afterwards those had been analyzed in Micro-computer Accident Analysis Package (MAAP5) software.

3.6 Analysis of Questionnaire Data

The data collected through questionnaire survey has been entered into MS Excel 2007 and analyzed.

CHAPTER 4

DATA ANALYSIS AND FINDINGS

4.1 Background

This chapter deals with the analysis of accident data from accident database as well as data collected from the questionnaire survey. It also includes the findings of analysis.

4.2 Analysis of Motorcycle Accident Data in Dhaka City

9 years of accident data from 2006 to 2014 has been analyzed to characterize motorcycle accident in Dhaka city.

Table 4.2.1 illustrates yearly statistics of total accident and casualty in Dhaka as well as motorcycle related accident and casualty in Dhaka. It is seen from the table that on average motorcycle related accident is more than 7% during 9 years from 2006 to 2014 in Dhaka city and 6% the share of motorcycle related casualty is 6% during that same period.

Table 4.2.1: Yearly Statistics of All and Motorcycle related Accident and Casualty

Year	Number of Total Accident in DMP	Number of Motorcycle Accident in DMP	% of Motorcycle accident out of DMP's Total	Number of Total Casualty in DMP	Number of Motorcycle Casualty in DMP	% of Motorcycle Casualty out of DMP's Total
2006	603	29	4.81	636	25	3.93
2007	565	23	4.07	590	15	2.54
2008	642	50	7.79	673	46	6.84
2009	525	34	6.48	546	37	6.78
2010	458	35	7.64	516	39	7.56
2011	400	31	7.75	455	34	7.47
2012	372	31	8.33	420	20	4.76
2013	341	45	13.20	404	40	9.90
2014	323	27	8.36	417	32	7.67
Total	4229	305	7.21	4657	288	6.18

Table 4.2.2 demonstrates the yearly motorcycle related accident, casualty and casualty index. It is clearly observed from the figure 1 that casualty/accident has been increasing since 2012. During the 9 years, the overall casualty index has also been raised from 0.85 in 2006 to 1.20 in 2014.

Table 4.2.2: yearly motorcycle related accident, casualty and casualty index in Dhaka city

Year	Number of Motorcycle accident in Dhaka	Number of Casualty in Motorcycle accident in Dhaka	Casualty Index (Casualty/Accident)
2006	29	25	0.86
2007	23	15	0.65
2008	50	46	0.92
2009	34	37	1.09
2010	35	39	1.11
2011	31	34	1.10
2012	31	20	0.65
2013	45	40	0.89
2014	27	32	1.19
Total	305	288	0.94

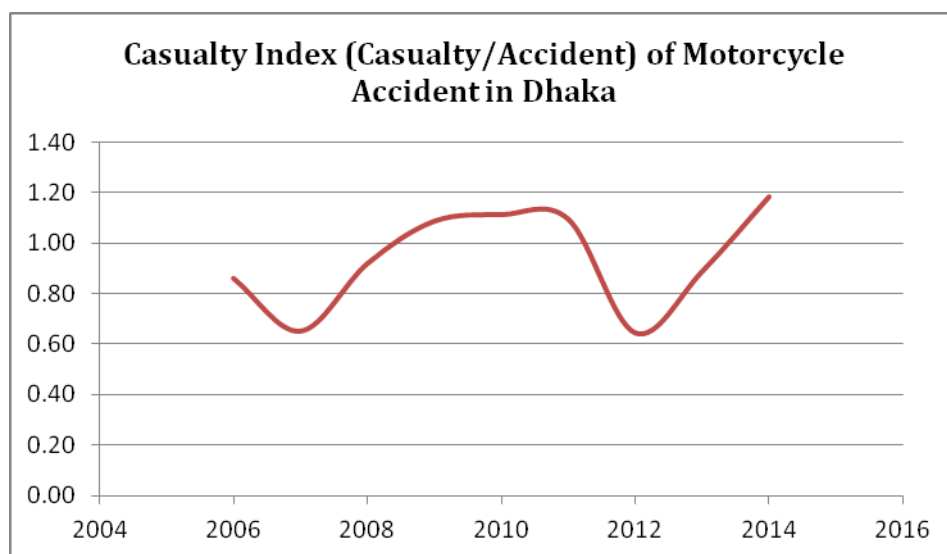


Figure 4.2.1: Trend of Casualty Index of Motorcycle Accident in Dhaka

Yearly variation in severity of motorcycle accidents is shown in Figure 4.2.2. The most significant type of accidents is Fatal and Grievous. The bar diagram shows that on average more than 50% motorcycle accident is fatal and about 40% accident is grievous.

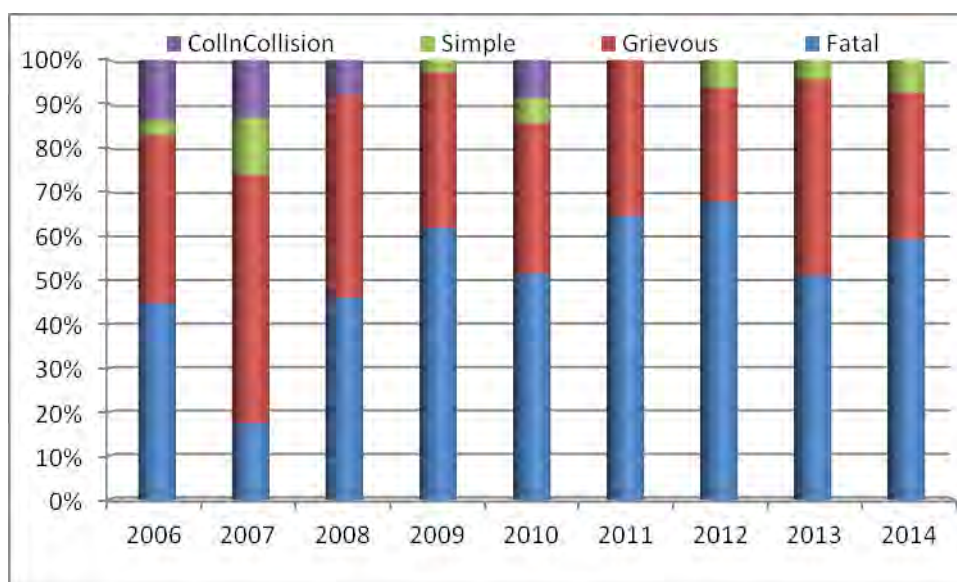


Figure 4.2.2: Yearly Variation in Severity of Motorcycle Accidents in Dhaka

Table 4.2.3: Motorcycle Accident Severity by Year in Dhaka City

Year	Fatal	% of Year's Total	Non Fatal	% of Year's Total
2006	13	44.8	16	55.2
2007	4	17.4	19	82.6
2008	23	46.0	27	54.0
2009	21	61.8	13	38.2
2010	18	51.4	17	48.6
2011	20	64.5	11	35.5
2012	21	67.7	10	32.3
2013	23	51.1	22	48.9
2014	16	59.3	11	40.7

It has been found from table 4.2.3 that fatal motorcycle accident demonstrates an upward trend from 44.8% in 2006 to 59.3% in 2014, while non-fatal motorcycle accident maintains a decreasing trend from 55.2% in 2006 to 40.7% in 2014. Figure 4.2.3 illustrates the trend of motorcycle accident in Dhaka city during 9 years.

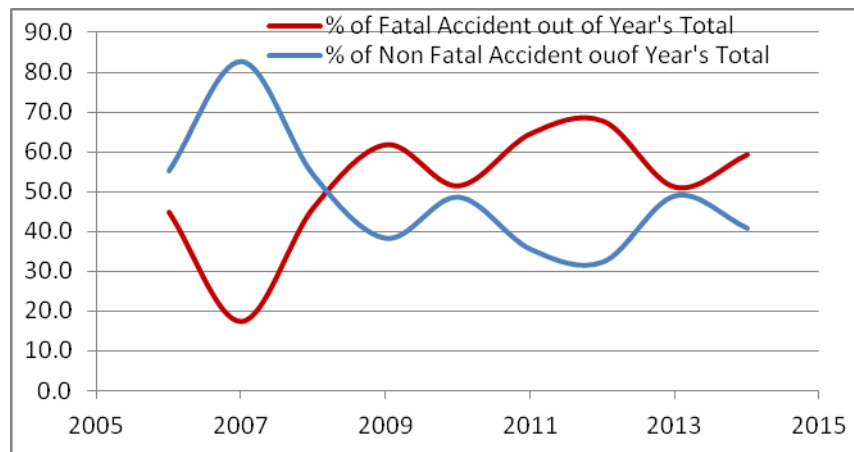


Figure 4.2.3: Trends of Fatal and Non Fatal Motorcycle Accident in Dhaka City

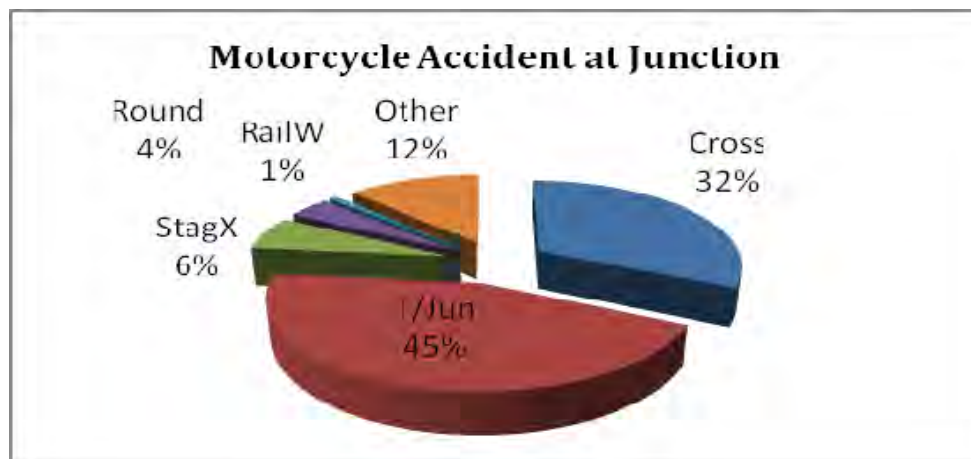


Figure 4.2.4: Distribution of Motorcycle Accident at Junction in Dhaka City

Figure 4.2.4 depicts motorcycle accident at various junction types in Dhaka city. It is clearly seen from the figure that most of the motorcycle accident occurring at junction occurred at T and Cross junction (45% and 32% respectively).

Figure 4.2.5 illustrates different types of motorcycle accident in Dhaka city. It is very obvious that rear-end collision is the predominant accident type with 55% concentration and followed by hit pedestrian (19%) and head-on (15%) accident respectively.

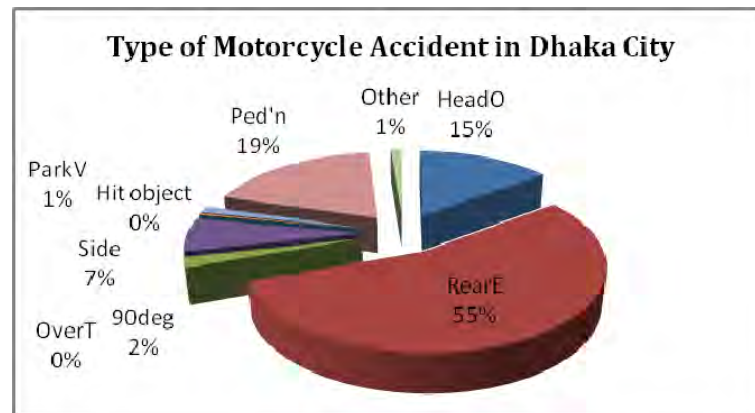


Figure 4.2.5: Different Types of Motorcycle Accident in Dhaka City

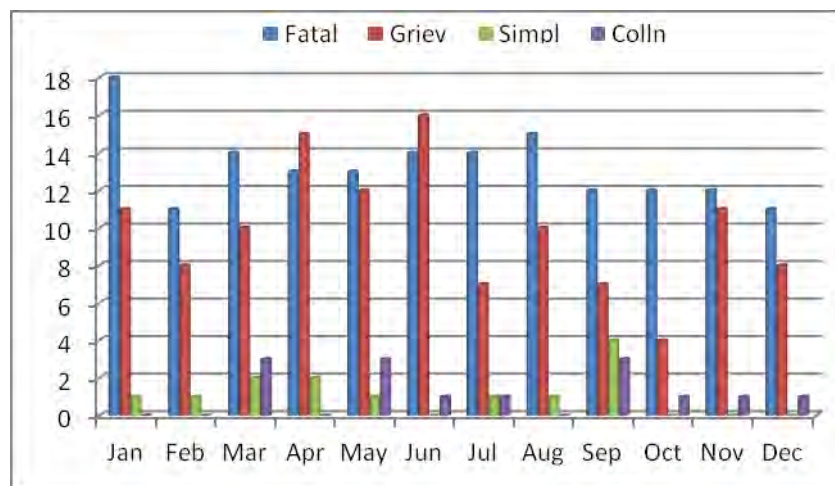


Figure 4.2.6: Monthly Distribution of Motorcycle Accident in Dhaka City

Figure 4.2.6 describes monthly distribution of motorcycle accident in Dhaka city. The figure shown that fatal accident is the predominant in the month of January and grievous accident is the highest in the month of June. Only in the month of April and June grievous accident exceeds the fatal accident. In the month of July fatal accident doubles the grievous accident.

Temporal distribution of motorcycle accident in Dhaka city is illustrated in Figure 4.2.7. Accident occurred between 8 am to 2 pm is highest in frequency. Most of the accident occurred between 8 am to 8 pm.

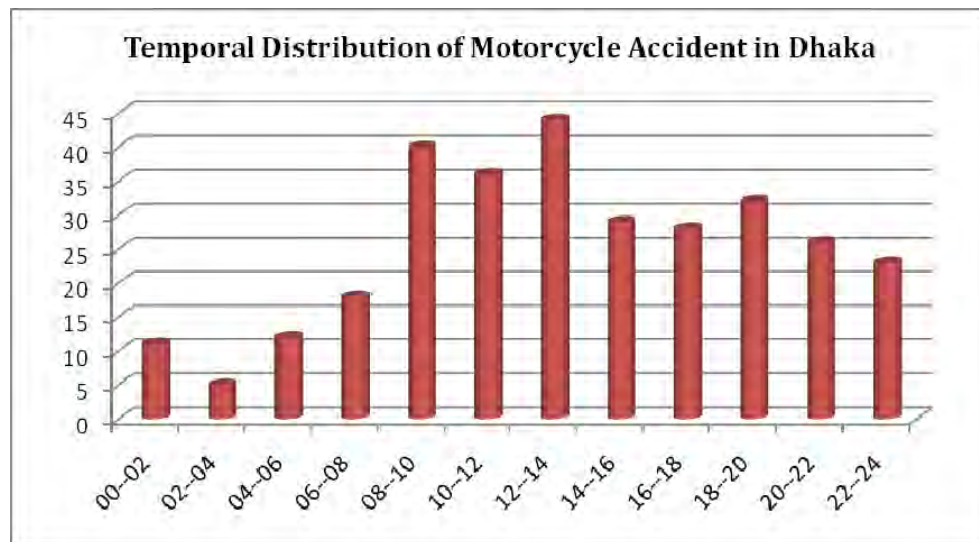


Figure 4.2.7: Temporal Distribution of Motorcycle Accident in Dhaka City

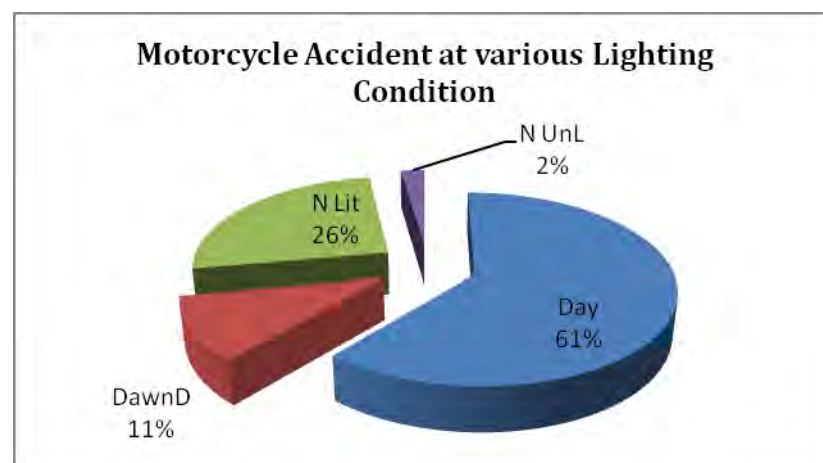


Figure 4.2.8: Motorcycle Accident in various Lighting Condition in Dhaka

From Figure 4.2.8 it is seen that 61% accident occurred at day-time, more than one-fourth accident occurred at night without any lighting facilities and only 11% accident occurred at dawn/dusk.

Table 4.2.4: Motorcycle Accident in different Weather Condition

Severity	Fair	Rain	Wind	Fog	Total
Fatal	159	0	0	0	159
Grievous	116	2	0	1	119
Simple	13	0	0	0	13
Collision	14	0	0	0	14
Total	302	2	0	1	305

It is seen from Table 4.2.4 that rain, wind or fog is not the contributory factor for motorcycle accident in Dhaka. Almost all the accident occurred when weather condition is fair.

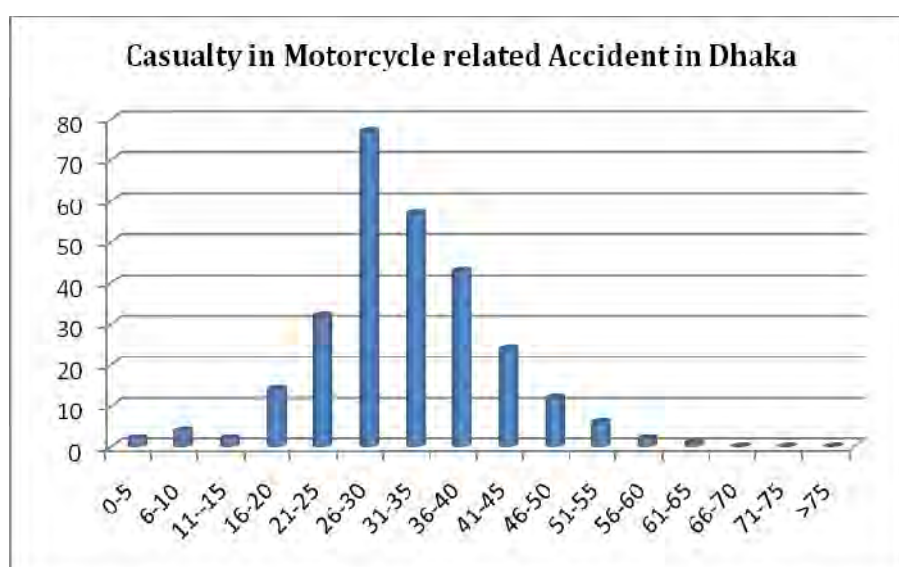


Figure 4.2.9: Age Distribution of Casualties in Motorcycle Accident in Dhaka

Figure 4.2.9 illustrates the age distribution of casualties in motorcycle accident in Dhaka city. Most of the casualties are within age group of 21 – 40 years and this age group is the earning group.



Figure 4.2.10: Use of Helmet of Casualties in Motorcycle Accident in Dhaka

Figure 4.2.10 illustrates distribution of helmet use of motorcycle riders at the time of occurring accident. It shows that 30% casualties did not wear a helmet when riding.

4.3 Analysis of Questionnaire Survey

A questionnaire survey has been conducted among 100 patients who are admitted to hospital because of motorcycle accident. They have been asked a series of questions about their injury along with the information regarding accident in which they were involved. A series of questions about their riding habits and their motorcycle were also asked.

Figure 4.3.1 to Figure 4.3.4 illustrates the demographic characteristics of hospitalized motorcyclists. Among the 100 respondents age group 31 to 35 years comprises the highest proportion (28%). The next group is 26 to 30 years contributing to 22% and followed by 36 to 40 years age group. No motorcyclists below 15 years or over 45 years was found.

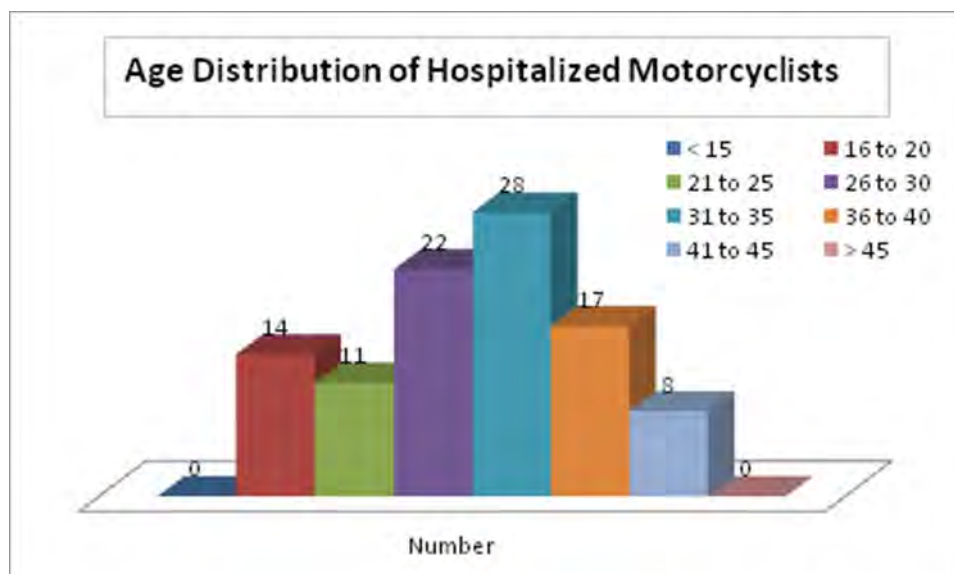


Figure 4.3.1: Age Distribution of Hospitalized Motorcyclists

Figure 4.3.2 illustrates that about 40% of the respondents are married and the rest 60% are unmarried.

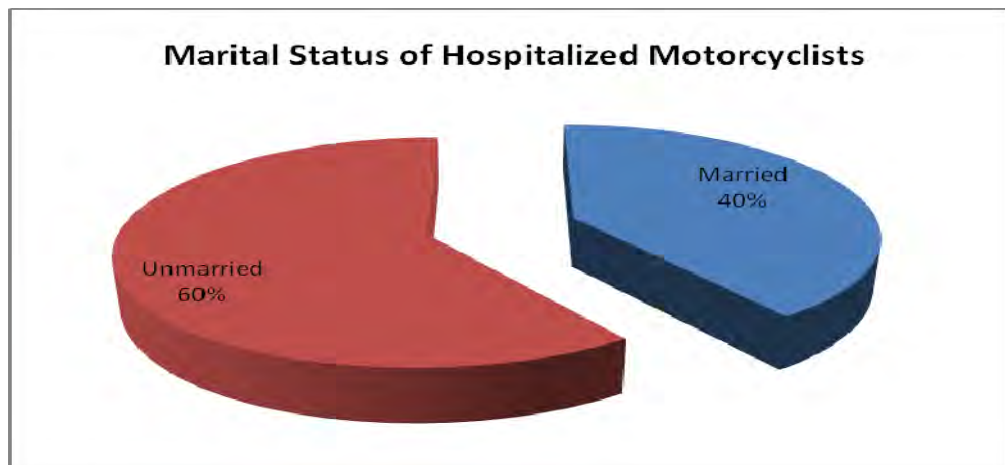


Figure 4.3.2: Marital Status of Hospitalized Motorcyclists

Figure 4.3.3 illustrates the educational level of the respondents. It is clearly observed that about 50% is well educated with higher education; while only 17% is below SSC level.

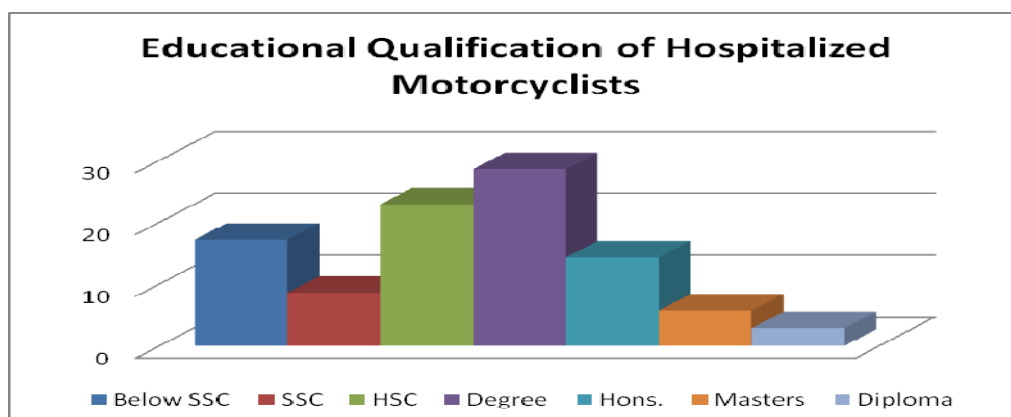


Figure 4.3.3: Educational Level of Hospitalized Motorcyclists

It is clearly seen from Figure 4.3.4 that about 46% respondent is in service and 27% is businessman. Around 23% is student. Only 4% is unemployed.

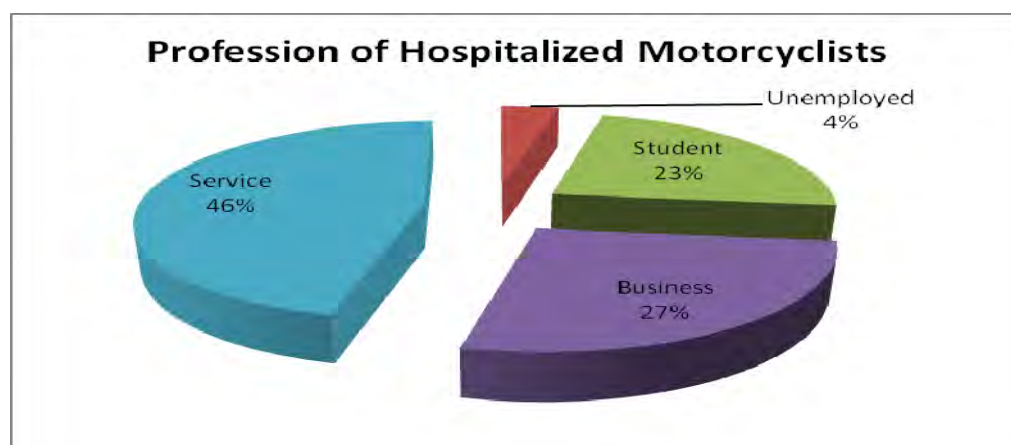


Figure 4.3.4: Profession of Hospitalized Motorcyclists

Which part of the body is injured due to motorcycle crash is initially identified through physical observation of hospitalized motorcyclists and later confirmed by asking them regarding their injury. Table 4.3.1 and Figure 4.3.5 summarize the injury pattern. It is very clear that fracture in the right leg has the largest share comprising 22% of total injury pattern. It is followed by fracture in left leg, which is 15%. Of the others, injury in right lower leg and fracture in the right hand is 10% and 9% respectively. Head injury, fracture in left hand and fracture in right knee equally share 7% each.

Table 4.3.1: Injury Pattern of Hospitalized Motorcyclists

Injury Pattern	Number
Head Injury	7
Fracture in Left Hand	7
Fracture in Right Hand	9
Fracture in Left Elbow	2
Fracture in Left Wrist	3
Chest and Backbone	3
Fracture in Waist	1
Fracture in Left Leg	15
Fracture in Right Leg	22
Fracture in Left Knee	5
Fracture in Right Knee	7
Fracture in Left Ankle	2
Fracture in Right Ankle	4
Injury in Right Lower Leg	10
Right Knee Cut-off	3
Total	100

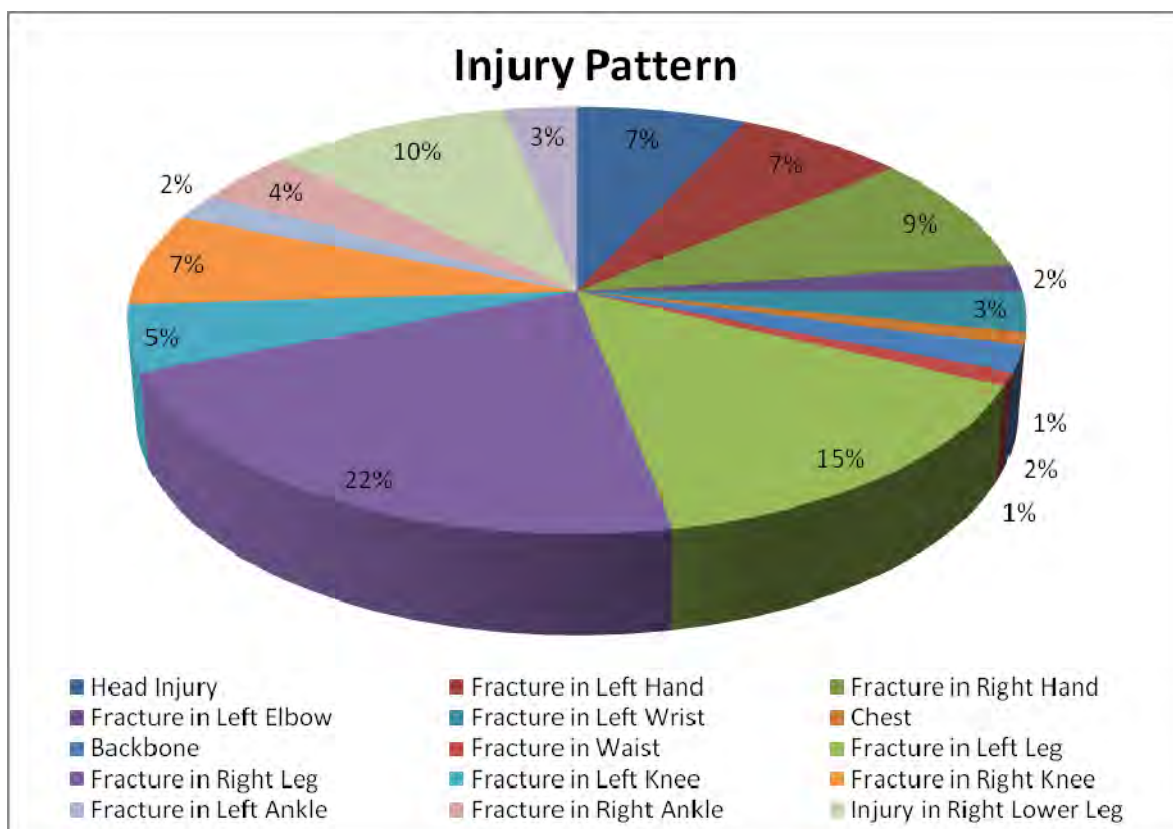


Figure 4.3.5: Percentage of Injury Pattern among Hospitalized Motorcyclist

Table 4.3.2 and Figure 4.3.6 illustrate number and percentage of injury in various parts of human body. It is clearly understood that about half of total injury is in the right leg and more than one-fifth is in left leg. This figure implies that the lower part of the body is mostly prone to injury for motorcycle crash with 68% injury and upper body including hand is less susceptible to injury with 32% injury.

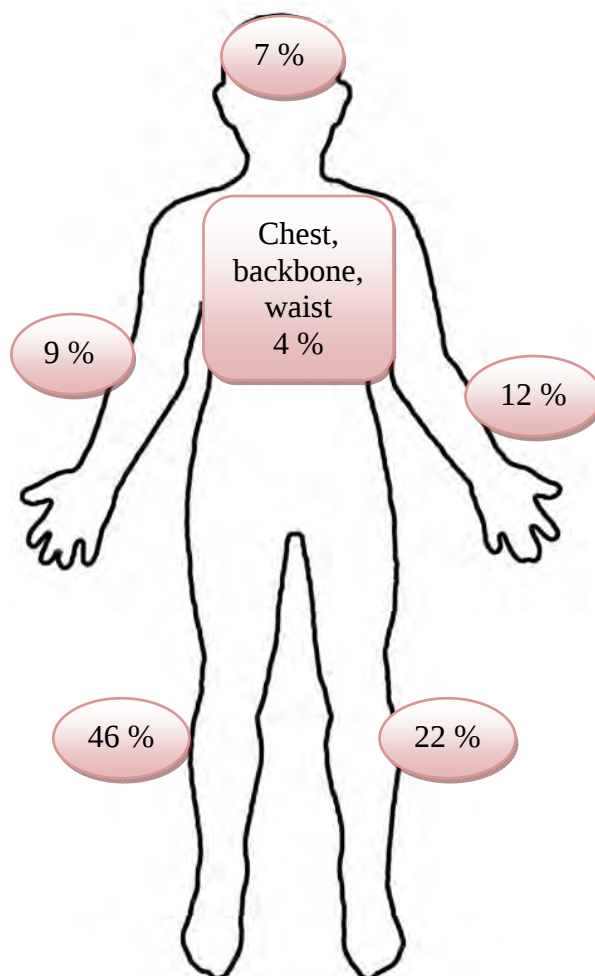


Figure 4.3.6: Percentage of Injury in different Body Parts among Hospitalized Motorcyclist

Table 4.3.2: Injury in Specific Part of Body

Injury in Specific Part of Body	Number
Head Injury	7
Injury in Left Hand	12
Injury in Right Hand	9
Injury in Left Leg	22
Injury in Right Leg	46
Other	4
Total	100

Figure 4.3.7 illustrates different types of accident that result in right leg injury. It is found that about 50% is due to side-swipe accident followed by head-on collision (35%) and overturning (11%).

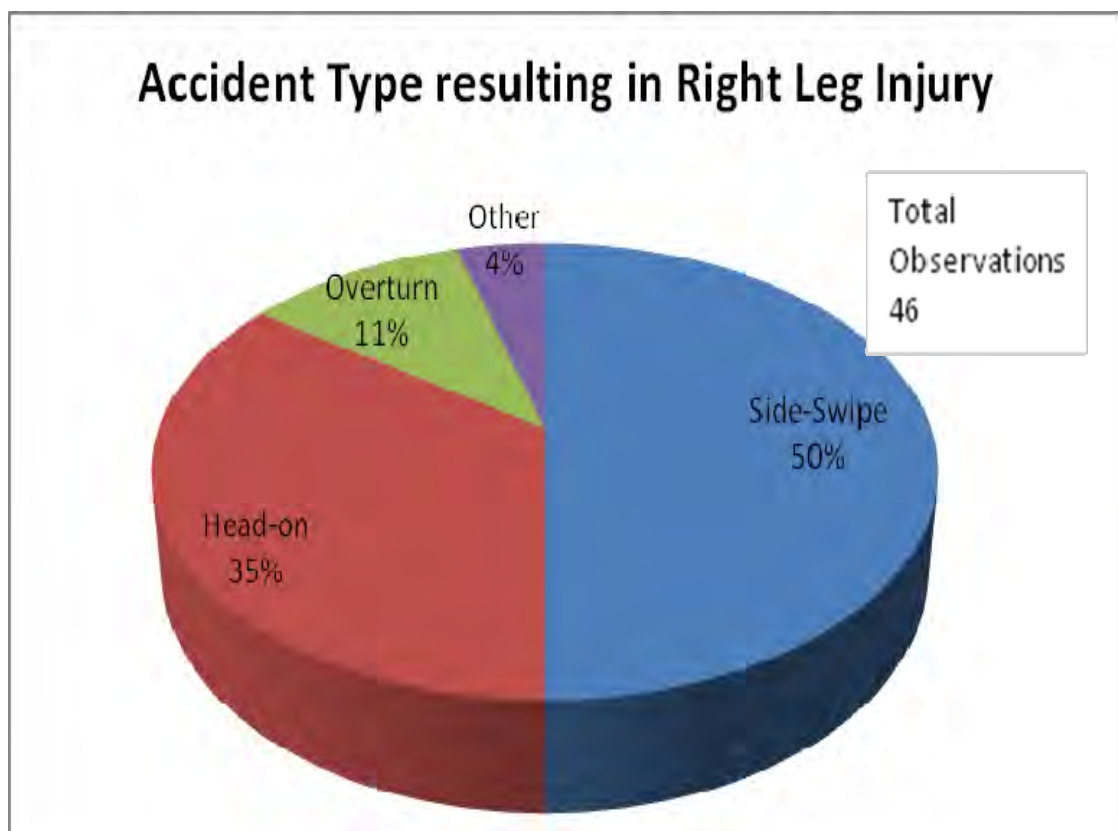


Figure 4.3.7: Accident Type resulting in Right Leg Injury

Among the 100 hospitalized motorcyclists, about 39% told that they were involved in side swipe accident. As illustrated in Figure 4.3.8, another 34% fall in head-on collision and some 17% were overturned on the road. Other accident types were not of that significance.

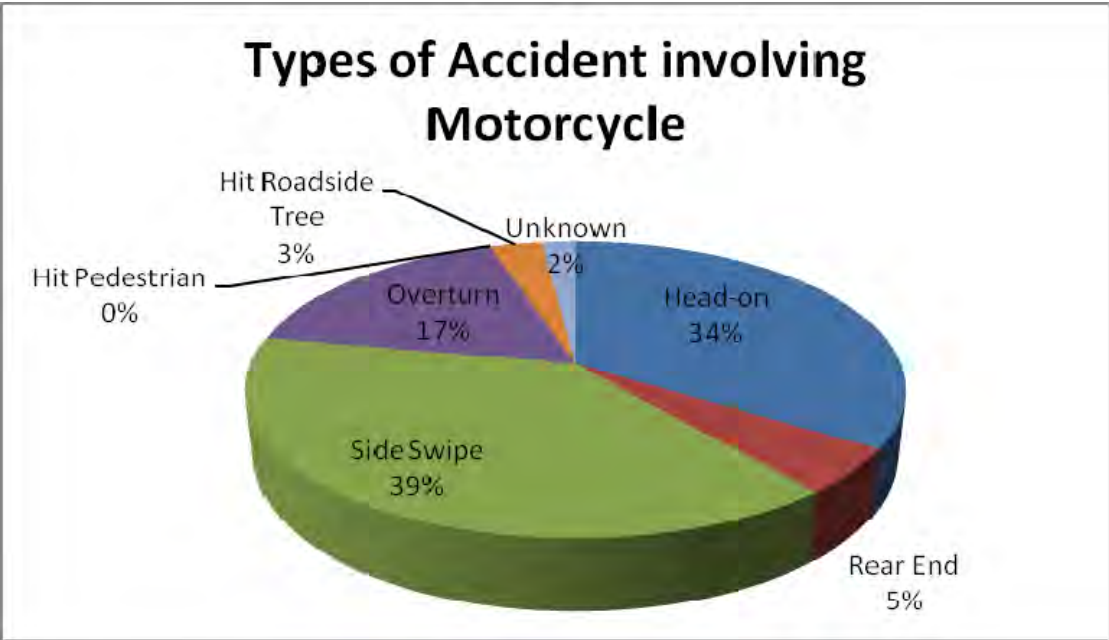


Figure 4.3.8: Types of Accident involving Motorcycle

Figure 4.3.9 depicts the types of vehicles that are in collision with a motorcycle. According to 17% respondents there was no other vehicle involved in accident i.e. those were single vehicle accident. The most prominent vehicles, which collided with motorcycle, were 3-wheelers (Auto, CNG and locally modified vehicle “Nosimon”) contributing altogether around 44%. Among others, heavy vehicles (bus, truck) add to about 17%.

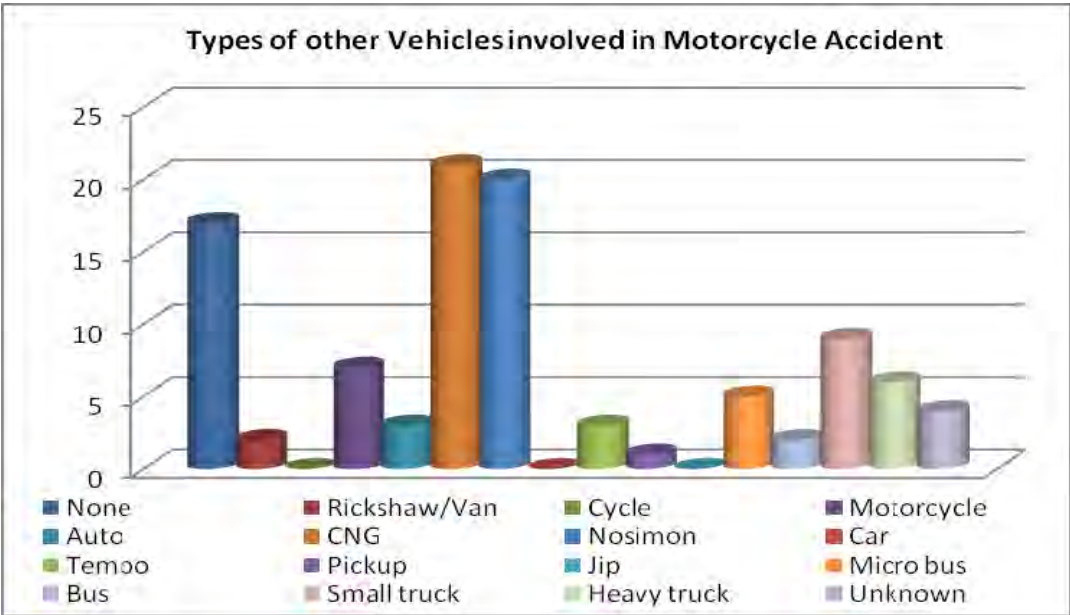


Figure 4.3.9: Types of other Vehicles involved in Motorcycle Accident

Hospitalized motorcyclists were asked about the reasons of their accident. Their responds are illustrated in Figure 4.3.10. It is clear from the chart that fault of drivers of other vehicles, contributing to 44%, are mainly responsible for the accident. Higher speed of the motorcycle is being liable to 14% accident, followed by overtaking (10%). Road geometric problem is to be blamed for only 11% accident. In about 8% cases, pedestrian's sudden and overhasty behavior were to be blamed for accident. According to all of the motorcyclists surveyed, there is no problem in brake, engine, tyre, gear, head light, tail light or indicator of their motorcycles at the time of accident. Every part of bike is effective and well enough to control. Therefore there is no vehicle factor for their accident.



Figure 4.3.10: Causes of Motorcycle Accident

According to the respondents, motorcycle accident might be reduced through driver training of other vehicle drivers, carefully driving motorcycles, improvement of road geometry, thorough checking of fitness and licensing, correcting pedestrian faulty behavior and withdrawing 3-wheeler from highways. Figure 4.3.11 illustrates their views in percentage.

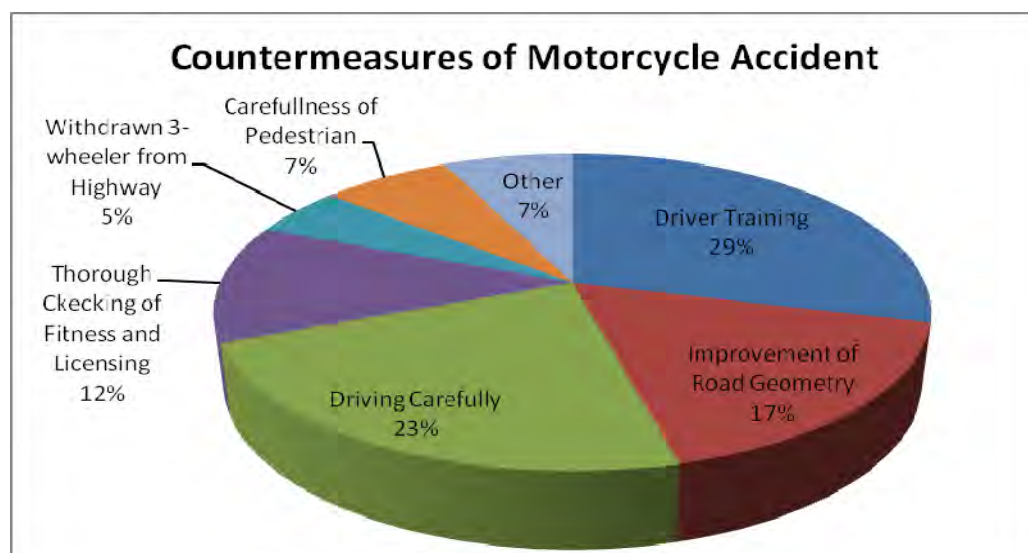


Figure 4.3.11: Countermeasures of Motorcycle Accident

Post incident time management i.e. time taken to hospital is one of the most important segments of road accident and trauma management. Figure 4.3.12 in the form of a pie-chart demonstrates that around 22% motorcyclists were hospitalized within 10 minutes and other 35% were taken to hospitals within 10 to 30 minutes after accident took place. 28% respondents did not reply as they were being unconscious at that time.

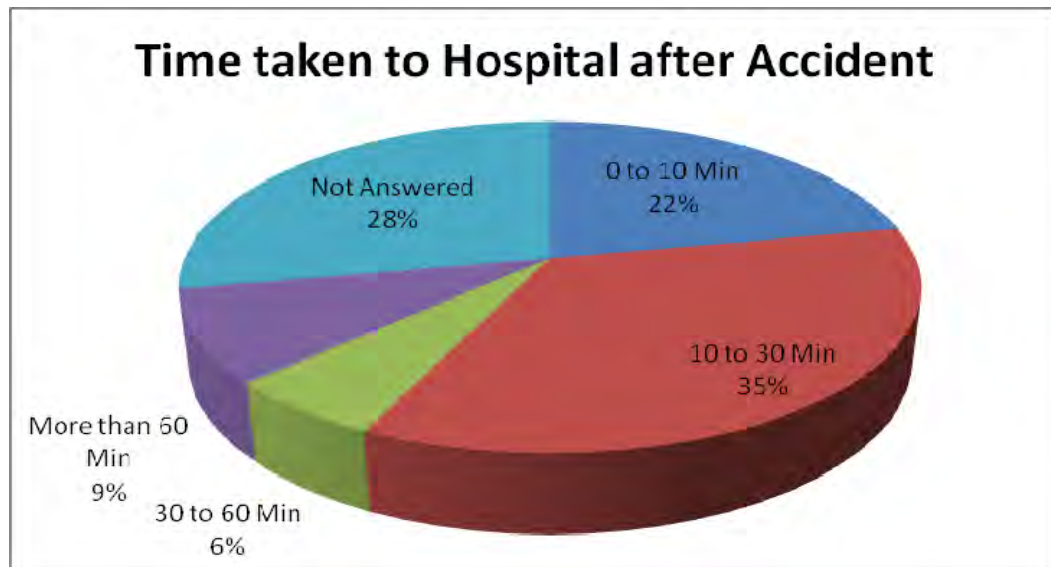


Figure 4.3.12: Time taken to Hospital after Accident

In response to the question of whether the motorcyclists were carrying pillion passenger at the time of accident, 63% respondents answered positively while 36% replied negatively and the rest 1% did not answer (Figure 4.3.13).



Figure 4.3.13: Motorcyclist carrying Pillion Passengers at the time of accident

Among the 63 motorcyclists who were carrying pillion passengers at the time of accident, 76% was carrying one pillion riders and 19% was carrying two riders. Only 3% was carrying three riders (Figure 4.3.14).



Figure 4.3.14: Pillion Passengers with Motorcyclists at the time of accident

Whether motorcyclists were wearing helmet or not at the time of accident, 58% responds that no they were not wearing helmets at the time of accident (Figure 4.3.15). Only 41 % motorcyclists were using helmets during the time of accident.

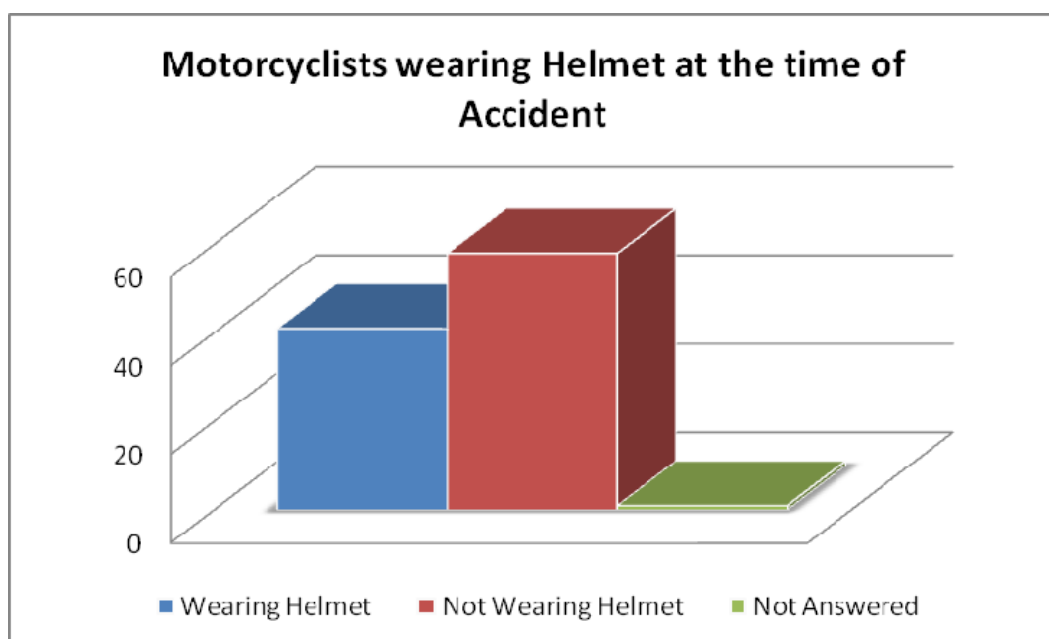


Figure 4.3.15: Motorcyclists wearing Helmet at the time of Accident

The surveyed motorcyclists were asked about their riding habits. These consist of lots of question regarding their attitude and behavior. According to Figure 4.3.16, around 50% of the motorcyclists ride between 1 and 2 hour daily. 32% motorcyclists ride daily less than one hour. 12% respondents told that they daily travel on motorcycle between 2 and 4 hour. Only 6% ride more than 4 hours daily.

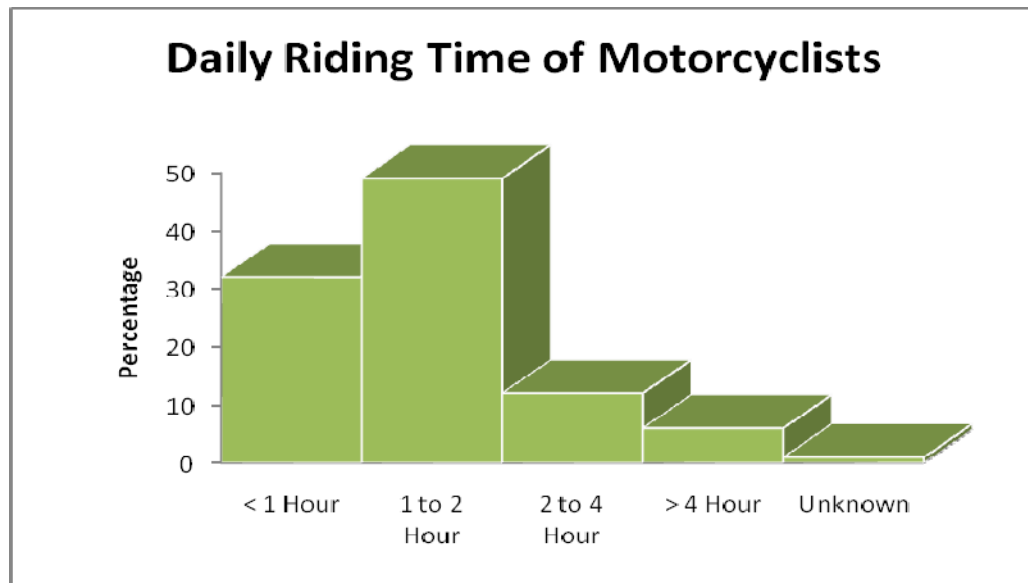


Figure 4.3.16: Daily Riding Time of Motorcyclists

Whether the motorcyclists use indicator while changing the lane or not is described in Table 4.3.3. It is clearly seen that 61% always use indicator and 36% uses sometimes. Only 3% never uses indicator.

Table 4.3.3: Number of Motorcyclist using Indicator on Lane changing

Sometimes	36
Always	61
Never	3
Total	100

In what speed ranges do motorcyclists ride usually? Majority of the surveyed motorcyclists told that they ride with a little higher speed. According to Figure 4.3.17, about 67% rides with speed higher than 50 km/h. About 51% rides with speed ranges from 60 km/h to 80 km/h. Only 8% motorcyclists ride with speed lower than 40 km/h. These figures might be indicative of motorcyclists' travel path. From the questionnaire analysis it is seen that nearly 15% of the

motorcyclists surveyed usually travel on city road with a speed below 40km/h while the rest travel on rural areas with speed higher than 50 km/h.

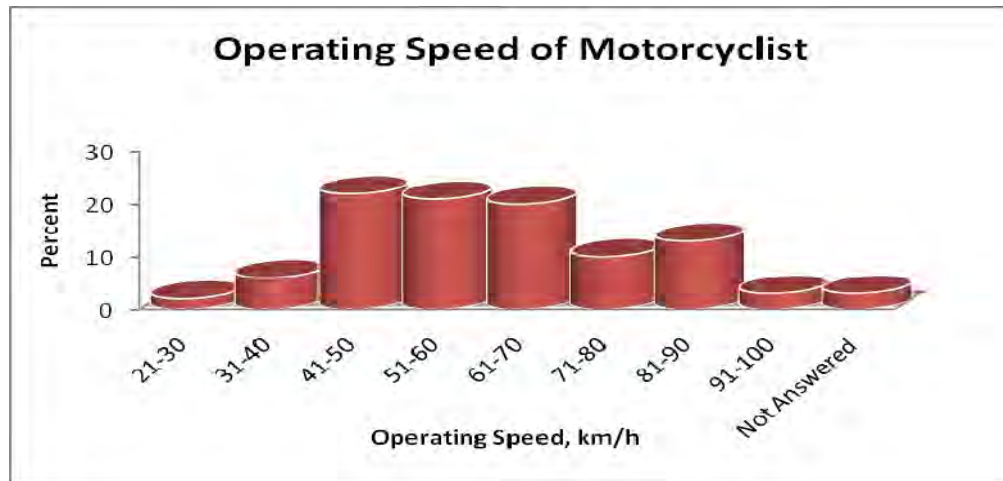


Figure 4.3.17: Operating Speed of the Motorcyclists

How often do motorcyclists carry more than one pillion passengers? Table 4.3.4 shows that, 72% motorcyclists carry only sometimes, 13% always carry and the rest 15% never carry more than one co-rider.

Table 4.3.4: Number of Motorcyclist carrying more than one pillion passengers

Sometimes	72
Always	13
Never	15
Total	100

Figure 4.3.18 illustrates about how often motorcyclists talk with Pillion passengers while driving. It is clearly observed that 77% motorcyclist sometimes talk while 21% never talk. Only 2% rider always talks with co-passenger.

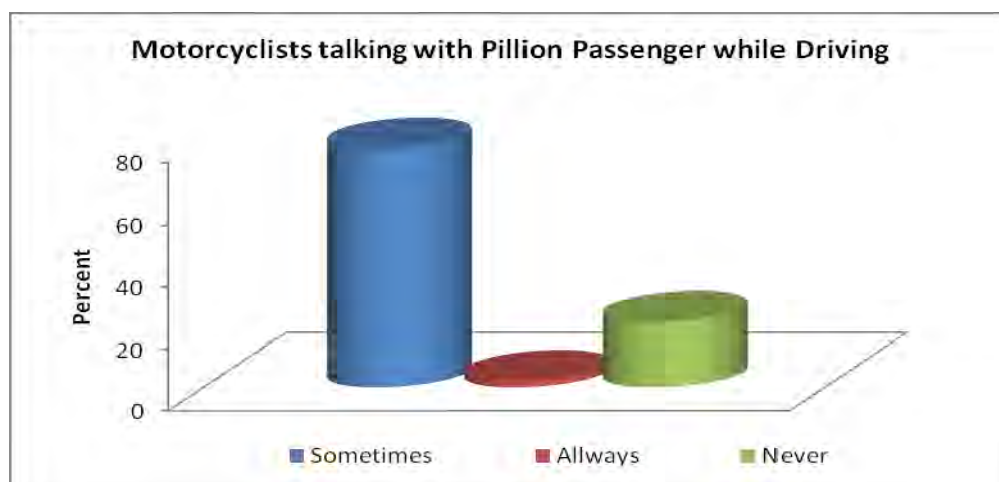


Figure 4.3.18: Motorcyclists talking with Pillion Passenger while Driving

Whether the motorcyclists talk over the mobile phone during driving or not is represented by Figure 4.3.19. It is seen that 15% talk very rarely, 35% talk sometimes and 41% talk never. Only 8 % stop and then talk.

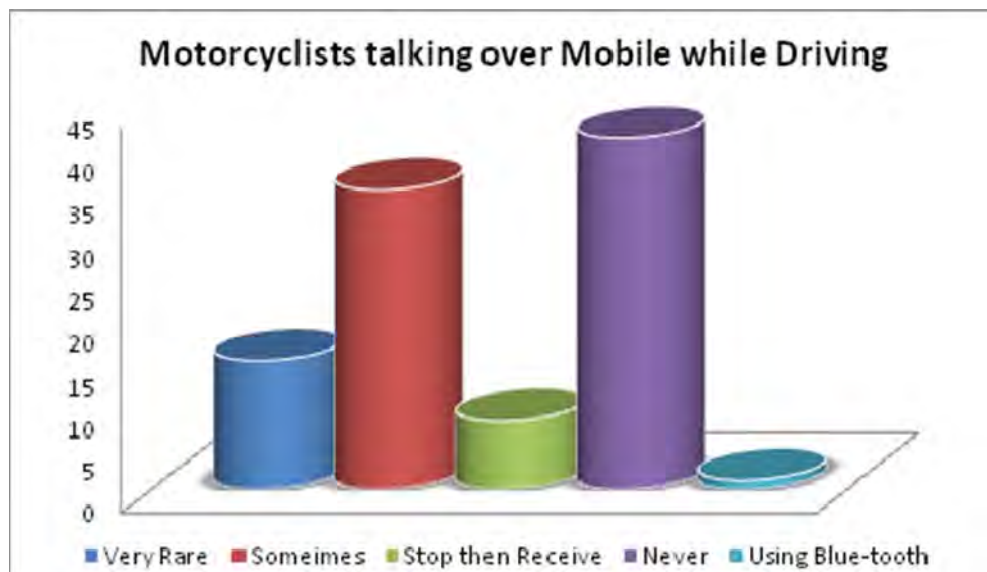


Figure 4.3.19: Motorcyclists talking over mobile during driving

Wearing helmet is mandatory for every motorcyclist. However, they do not wear helmets while driving. Figure 4.3.20 presents the scenario of how often the motorcyclists wear helmets. 58% motorcyclists wear helmets sometimes, 21% uses always and 18% never uses helmets. Only 3% rider wear helmet when they drive on the highway.

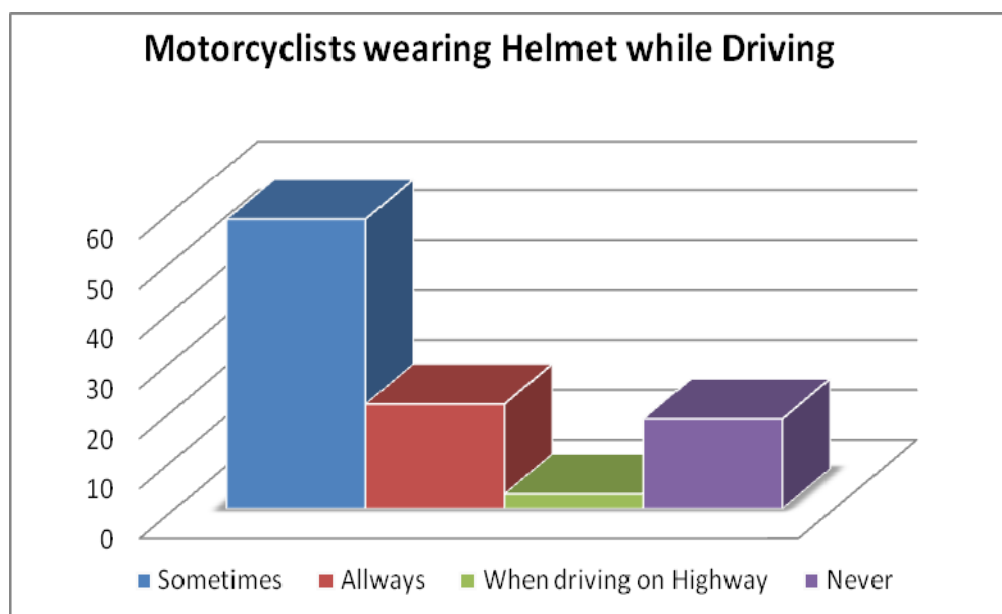


Figure 4.3.20: Motorcyclists wearing Helmets while Driving

What could restrain the motorcyclists to wear helmets during riding? Their responses were very interesting. Figure 4.3.21 gives a pie-chart. 43% respondents told that they feel hot if wearing for longer time. That's why they usually refrain from wearing helmet. Another 25% do not use helmet simply because of the thought that helmets are uncomfortable. 11% do not use helmet when they are in a shorter distance trip. Only 5% do not have any helmet.

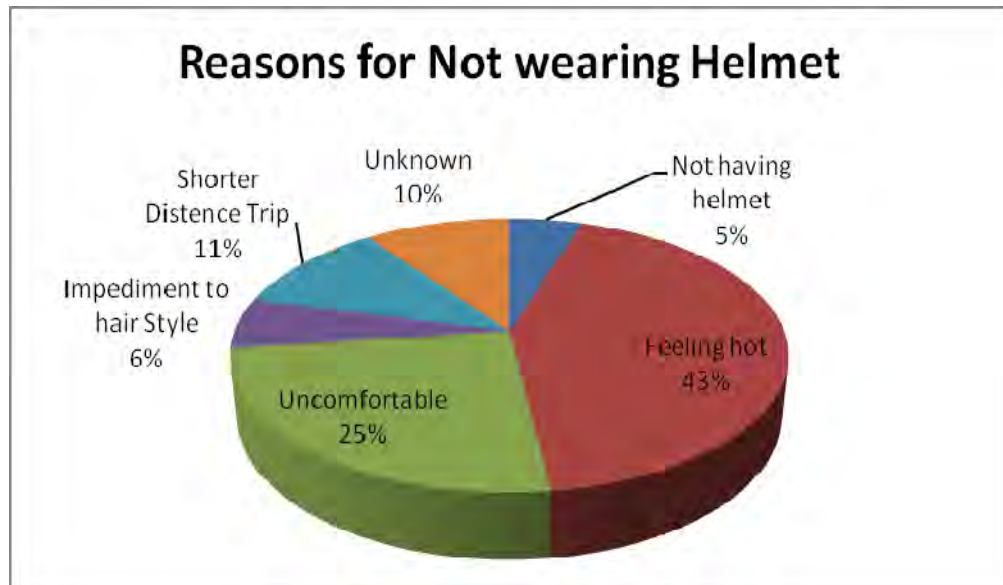


Figure 4.3.21: Reasons for not wearing Helmets during riding

What type of helmet is usually used? The response was half-face, full-face and open-face. Figure 4.3.22 indicates that 64% uses full-face helmet, while another 30% use half-face helmet. Only 1% use open-face. 5% respondents do not have any helmet.

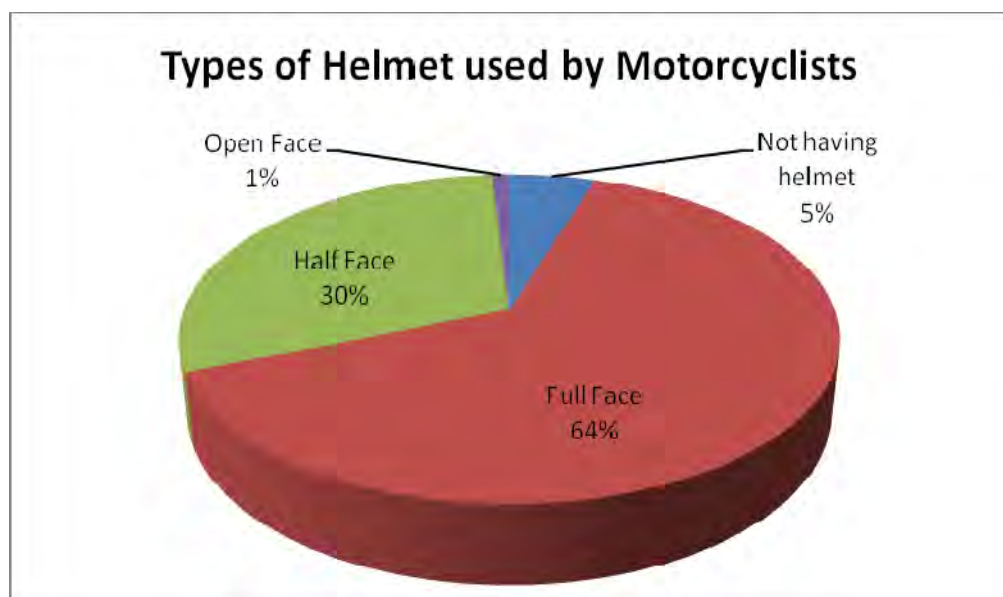


Figure 4.3.22: Types of Helmet used by Motorcyclists

How many accidents the motorcyclists have during the last 5 years? Figure 4.3.23 depicts that 88% fall in accident at least once during the specified period. 7% have more than one accident and only 5% there was no accident.

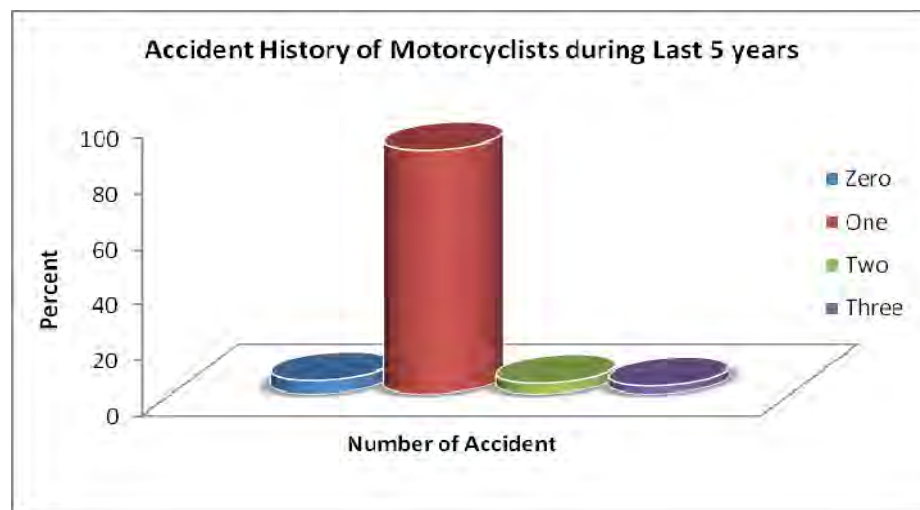


Figure 4.3.23: Accident History of Motorcyclists during Last 5 years

Figure 4.3.24 illustrates about the information of motorcycle registration, driving license, motorcycle insurance and whether motorcyclists are fined charges or not. 65% motorcyclists have their vehicle registered while the rest 35% don't. 61% respondents have valid driving license and the rest 39% don't. 60% motorcycle is under insurance. For violating traffic law, some 12% motorcyclists were fined charges by traffic police.

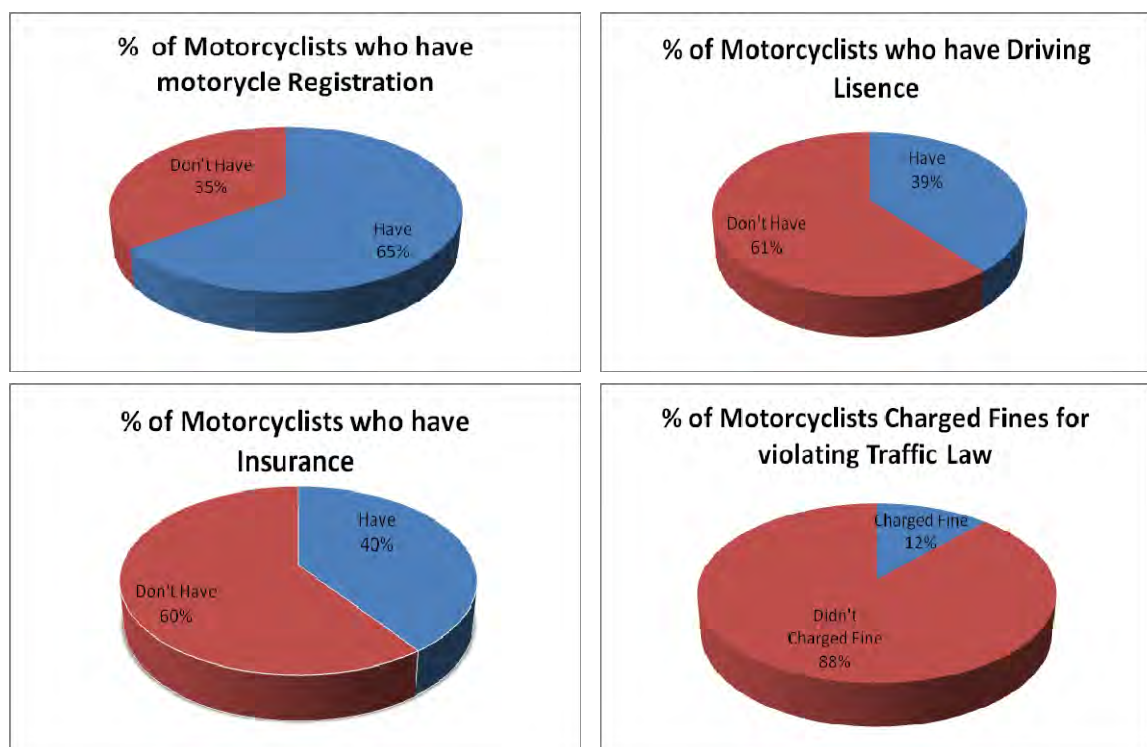


Figure 4.3.24: Information regarding Motorcycle registration, Driving License, Motorcycle insurance

Motorcyclists are asked about their bike. None of them told whether there is any defect in their motorcycles. Every part is ok.

Regarding the types of motorcycles, 23% is Hero, another 11% is Yamaha, some 9% is Discovery and some 8% is Bajaj (Figure 4.3.25).

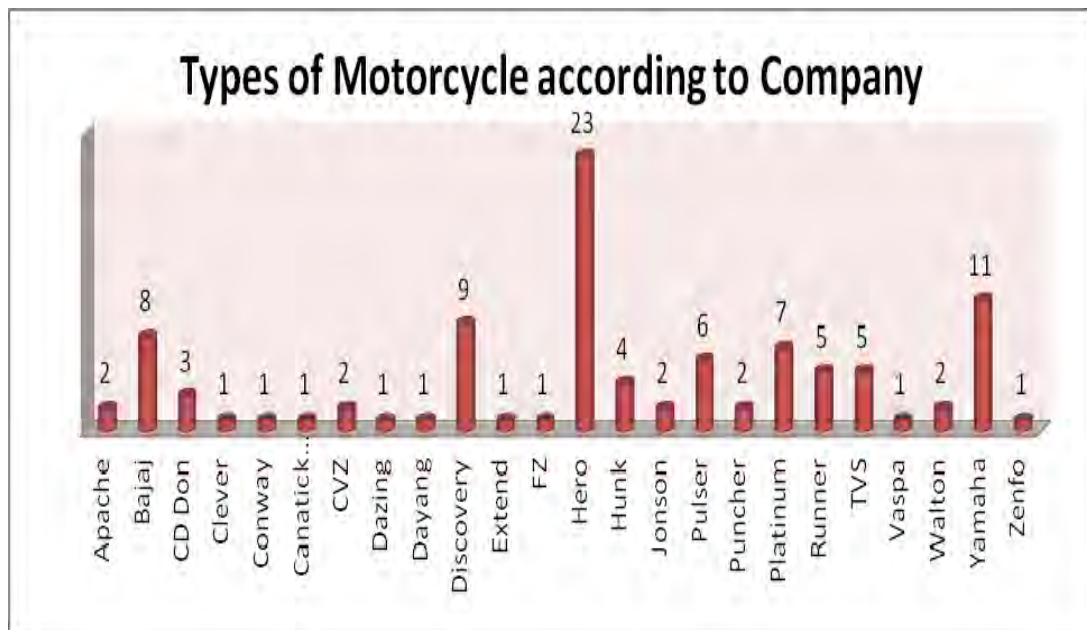


Figure 4.3.25: Types of Motorcycles used by the Riders

Regarding the engine capacity, 48% respondents told that they use 150 cc bikes and 28% use 100 cc bikes (Figure 4.3.26). Another 11% use 125 cc bikes.

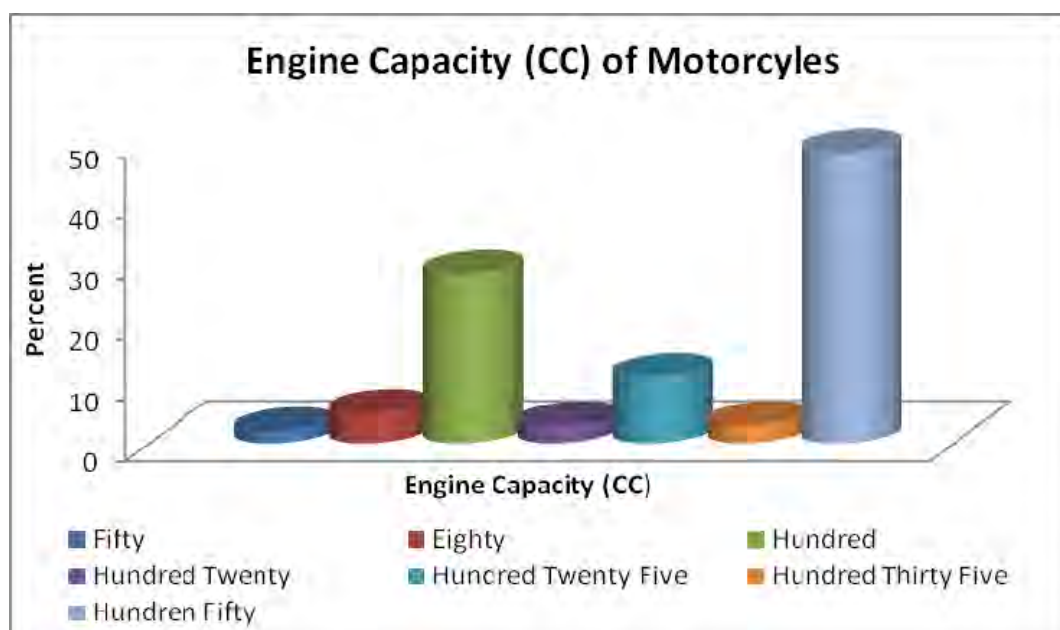


Figure 4.3.26: Engine Capacity of Motorcycles used by the Riders

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

The study has been intended to identify general characteristics of motorcycle accidents in Dhaka city. The specific objective is to identify the injury pattern of hospitalized motorcyclists, the information regarding accident, their driving attitude, and bike characteristics.

5.2 General observations from accident data analysis

- Out of Dhaka city's total accident and casualty, both the motorcycle accident and casualty have been doubled during 9 years from 2006 to 2014.
- During the 9 years, the overall Casualty Index (casualty per accident) has also been raised from 0.85 in 2006 to 1.20 in 2014.
- On average more than 50% motorcycle accident is fatal and about 40% accident is grievous.
- Fatal motorcycle accident demonstrates an upward trend from 44.8% in 2006 to 59.3% in 2014, while non-fatal motorcycle accident maintains a decreasing trend from 55.2% in 2006 to 40.7% in 2014.
- Rear-end collision is the predominant accident type with 55% concentration and followed by hit pedestrian (19%) and head-on (15%) accident respectively.
- Around 45% of the motorcycle accident occur at T junction and about 32% occur at Cross junction
- 61% accident occurred at day-time, more than one-fourth accident occurred at night without any lighting facilities and only 11% accident occurred at dawn/dusk.
- Statistics of vehicular involvement in road accident shows that motorcycle's involvement is only 6% while the involvement of bus, car and heavy truck is 28%, 15% and 13% respectively in Dhaka city. One reason might be that the travel time of motorcycles is much less than that of other vehicles.

- Most of the casualties are within age group of 21 – 40 years
- 30% casualties did not wear a helmet when riding

5.3 Specific observations from questionnaire analysis

- Legs, right leg in particular, are more prone to injury than any other parts of the body. About half of total injury is in the right leg and more than one-fifth is in left leg, while there is 21% injury in both hands together
- 39% hospitalized motorcyclists were involved in side swipe accident, 34% fall in head-on collision and some 17% were overturned on the road
- 44% motorcycle accidents involve 3-wheeler vehicles while 17% involve heavy vehicles; only 17% accidents were single motorcycle accidents. Around 73% cases the motorcyclists tried to avoid the collision but could not succeed- the fact tend to support the Hurt and Madis report that the driver of other vehicles could not see motorcycle clearly.
- Fault of drivers of other vehicles, involved in motorcycle accident, is responsible for 44% of motorcycle accident. Higher speed of the motorcycle is being liable to 14% accident, followed by overtaking (10%). Road geometric problem is to be blamed for only 11% accident. In about 8% cases, pedestrian's sudden and overhasty behavior were to be blamed for accident.
- According to 29% respondents, motorcycle accident might be reduced through driver training of other vehicle drivers. 23% have the opinion that careful driving might help reducing motorcycle accident. 17% told about improvement of road geometry.
- About 57% injured motorcyclists were hospitalized within 30 minutes of accident
- At the time of accident 63% motorcyclists were carrying pillion passenger. 73% of them were carrying one passenger
- 58% respondents were not wearing helmets at the time of accident which implies that there are no direct relationships of head injury with wearing helmets.

- Around 50% of the motorcyclists ride between 1 and 2 hour daily. 32% motorcyclists ride daily less than one hour.
- About 51% hospitalized motorcyclists ride with speed ranges from 60 km/h to 80 km/h.
- 77% motorcyclist sometimes talk with pillion passengers during riding, while 21% never talk
- In case of talking over mobile phone during driving, 15% talk very rarely, 35% talk sometimes and 41% talk never. Only 8 % stop and then talk.
- 21% respondents always wear helmets while driving and 18% never.
- 43% respondents told that they feel hot if wearing for longer time. That's why they usually refrain from wearing helmet. Another 25% do not use helmet simply because of the thought that helmets are uncomfortable.
- 64% uses full-face helmet, while another 30% use half-face helmet.
- 88% fall in accident at least once during the specified period. 7% have more than one accident and only 5% there was no accident.
- Above 60% of the motorcyclists have their motorcycle registered, have valid-authentic driving license and have their bike insured
- 23% motorcyclists use Hero, another 11% use Yamaha, some 9% have Discovery and some 8% have Bajaj
- 48% respondents told that they use 150 cc bikes and 28% use 100 cc bikes. Another 11% use 125 cc bikes.

5.4 Recommendation

The analysis is based on questionnaire survey among 100 hospitalized motorcyclists only; therefore, it is difficult to provide recommendations on overall motorcycle accidents and casualties. However, some recommendations are as follows.

- The study reveals that legs are more vulnerable in motorcycle accident. Therefore, motorcycle rider should protect their legs and feet by using “Leg Guard” such as knee high boot, long pants made of Abrasion-resistant materials like leather or ballistic nylon.
- To avoid accident the motorcyclist should drive at moderate speed. There should have less overtaking and it should be done very carefully.
- Road geometric condition should be improved.
- Post incident time management should be given priority. Hospitalization within 30 minutes of accident should be made possible for every accident.
- Motorcyclists should be self-aware of wearing helmets and not talking over the phone or not talking with pillion passenger during driving.

5.5 Scope for Future Study

- Different type of study such as traffic conflict study, capacity study, sight distance study, roadway inventory study and accident study on arterial or collector road may be undertaken and must be coordinated with motorcycle behavior.
- Research priority on accidents in city as well as rural areas may be undertaken to find the details cause and long term remedy for motorcycle accident.
- Research based on effectiveness of intelligent Transport System on motorcycle safety can be carried out.
- Analyze of motorcycle needs at roads and the possibility of implement those suggestions on existing road.

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APPENDICES

APPENDIX A

Questionnaire Survey

Questionnaire for Survey on

Identification of Injury Patterns of Hospitalized Motorcyclists and Development of Countermeasures for their Safety Improvements

Please answer the following questions by filling the gaps in short form and putting tick (✓) mark for options available.

Part-1: About The Respondent	
Q-1.1: What is your name? (You can provide a Pseudonym):	
Q-1.2: What is your Age? (in total completed years):	
Q-1.3: What is your current Marital Status?	1 Married. 2 Unmarried. 3 Divorced/Separated. 4 Widowed.
Q-1.4: What is your Highest Educational Qualification?	1 SSC or equivalent. 2 HSC or equivalent. 3 Degree or equivalent. 4 Honors or equivalent. 5 Masters or equivalent. 6 Others.
Q-1.6: What is your profession?	
Part 2: Regarding Injury Pattern	
1. What type of injury you have in this accident?	1. Head Injury (Front /Back /Left /Right /Upper) 2. Bone Fracture: i. Hand-Left / Right ii. Leg- Left / Right iii. Chest iv. Abdomen 3. Spinal Cord 4. Others
2. How many days are you in hospital?	
3. How much is the cost?	

Part 3: Regarding Accident	
Location of Accident Spot:	
1. What type of accident you involved?	i. Head-on ii. Rear-End iii. Side swipe iv. Overturn v. Hit object on road vi. Hit object off road vii. Hit pedestrian viii. other
2. Which other vehicles involved?	1. Rickshaw (motorized / Non-motorized) 2. Cycle 3. Motorcycle 4. CNG 5. Car 6. Tempo 7. Pickup 8. Jip 9. Micro bus 10. Small bus 11. Large bus 12. Small truck 13. Heavy truck
3. At the time of accident you were in	1. Straight Road i. Left most lane (near side of footpath) ii. Mid lane iii. Right most lane (near side of median/divider) 2. Junction/Intersection i. Cross ii. T iii. Roundabout iv. Staggered

4. Were you carrying any other rider with you?	Yes No If Yes: How many riders? Were they injured?
5. Did you wear helmet?	Yes No
6. After how much time you were taken to hospital?	
7. According to you what were the reasons of accident?	1. Higher speed 2. Talking over mobile 3. Absent minded for any reason 4. Violating traffic rules 5. Could not notice other vehicle/object/pedestrian 6. Motorcycle defect i. Brake fail ii. Tyre puncture iii. Indicator not functioning iv. Other 7. Fault of drivers of other vehicles 8. Road geometric problem
8. According to you what measures should be taken to reduce motorcycle related accident?	

Part-4: Regarding Driving Attitude	
1. How much time in a day you spent on motorcycle by driving?	1. Less than 2 hours. 2. 2 to 4 hours. 3. 5 and above.
2. While you drive in a free road, generally what speed limit you follow?	1. Less than 30 Km/hour. 2. 31 to 40 km/h 3. 41 to 50 Km/hour. 4. 51 to 60 Km/hour. 5. 61 to 80 Km/hour. 6. 81 Km/hour and above.
3. How often do you use indicator before changing the lane?	1 Always. 2 Most of the time. 3 Sometimes. 4 Very rare. 5 Never.
4. How often do you take more than 1 co-rider (except you) with you while driving motorcycle?	1 Always. 2 Most of the time. 3 Sometimes. 4 Very rare. 5 Never.
5. Do you talk to the co-rider with you while driving motorcycle?	1 Always. 2 Most of the time. 3 Sometimes. 4 Very rare. 5 Never.
6. How often do you talk over mobile phones while driving motorcycle?	1 Always. 2 Most of the time. 3 Sometimes. 4 Very rare. 5 Never.

7. How often do you wear helmet while motorcycling?	1 Never 2 Always 2 Most of the time. 3 Sometimes.
8. What is the reason behind not wearing helmet?	
9. What type of helmet you are using currently?	☐ 1 Full face...  ☐ 2 Open-face...  ☐ 3 Half-face...  ☐ 4 Other.....  ☐ 5 I don't wear helmet currently.
10. How many motorcycle accidents have you had in your life while driving?	0. None. 1. 1 to 2. 2. 3 to 4. 3. 5 to 6. 4. 7 or more.
11. Is your motorcycle insured?	1 Yes. 2 No.
12. Do you have motorcycle driving license?	1 Yes, valid license. 2 Yes, but invalid/expired license. 3 Learner's license. 4 No, I don't have any driving license.
13. Do you have motorcycle registration number?	1 Yes, valid registration plate. 2 Not yet, applied for registration (AFR). 3 No, on test and others.
14. Have you ever been charged any fine by traffic police or by other authority for noncompliance of traffic rule during the last one year?	1 Yes. 2 No.

Part-5: Regarding Motorcycle	
1. Model of motorcycle	Company: Model: CC:
2. Was the brake effective at the time of accident?	Yes No
3. Was there any problem in gear?	Yes No
4. Was the indicator effective at the time of accident?	Yes No
5. Was the headlight/tail light effective at the time of accident?	Yes No
6. Was there any defect in tyre at the time of accident?	Yes No
7. Was the engine effective at the time of accident?	Yes No

APPENDIX B

Injury Patterns of motorcyclists from Road accidents

	Fracture in left hand		Fracture in right leg
	Fracture in right ankle		Right knee cut-off



Fracture in right knee



Fracture in left hand and leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in left knee



Fracture in right leg



Fracture in left leg



Injury occurred at right leg



Left hand injury



Head Injury



Fracture in left leg



Injury in right lower leg



Left leg Injury



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Right knee cut-off



Fracture in right leg



Fracture in right leg and hand



Fracture in right leg



Fracture in right knee



Head Injury



Injury in right lower leg



Head Injury



Fracture in left hand



Fracture in right leg and left hand



Fracture in left leg



Fracture in right leg



Fracture in right leg



Fracture in right leg



Injury in right hand and right leg



Fracture in right leg



Injury in right lower leg



Injury in both hand



Left hand injury



Fracture in right leg



Injury in right hand and right leg



Fracture in right leg



Injury in both leg



Fracture in right leg



Chest and head Injury



Fracture in right leg



Injury in right lower leg



Fracture in right leg



Chest injury as well as fracture in both hand & leg



Fracture in right leg



Fracture in right leg



Fracture in left leg



Fracture in right leg



Fracture in right leg



Injury in right lower leg



Fracture in right knee



Fracture in right hand



Fracture in left leg



Injury in left leg



Fracture in left leg



Fracture in right leg



Head Injury



Fracture in right leg



Head Injury



Head Injury and slightly at whole body



Backbone and head injury



Head injury



Fracture in left leg



Fracture in left leg