Accident Analysis & Identification of Hazardous Highway Locations Using GIS: A Case Study of Dhaka-Bagura Highway

An Undergraduate Thesis

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Submitted to the Department of Civil and Environmental Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh in the partial fulfilment of the requirements for the degree of Bachelor of Science in Civil and Environmental Engineering.

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Thesis approved as to the style and content for the degree of B.Sc. in of Civil and Environmental Engineering.

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It is hereby certified that the undergraduate thesis work present in this paper here has been worked out under the supervision of Professor Dr. Aktarul Islam Chowdhury, Department of CEE and has not been submitted elsewhere for any purpose (except for publication).

June, 2019

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DEDICATED TO

Parvez Rahman Rakib

IPE 19 Batch

He Died from Motorcycle Accident

Before the Eid Day in 2019.

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ABSTRACT

In this modern era of urbanizations, a road traffic accident is the ninth leading cause of death and the first leading cause of young people (15-29 years old) death. Every year 1.25 million people have died in the road accident and 50 million people suffered from road accidents. The accidents and the fatalities are varied from country to country. The lower and middle-income countries which own only 54% of world vehicles, 84% of total accidents and 90% of total fatalities have occurred in those countries. Bangladesh is one of the lower middle-income country. Every year around 4000 people died and around 9000 people are suffered by the road accident in this country.

Dhaka-Bagura is one of the main portions of highways of this country. Most of the accident happened in rainy season (July to September). 76.6% of accidents happened in the day times (4 am-5 pm). 23.4% accident occurs in the whole night. 55.10% of these accidents occur from 6 pm to 9 pm. 69% accident occurs in no-junction area and 66.97% of that are fatal accident. There are 52.54% pedestrian hit accidents followed by head on and rear end which are 18.89% and 11.06%. Buses are responsible for 39% of accidents, followed by trucks 25% and 2-3-wheeler and non-motorized vehicles 13%. The black spot which scatters in only 12 km of road section found by GIS analysis, has 40.26% of total collusion. Among them, 57.14% are pedestrian hit accident followed by 14.29% head-on collision. Buses and trucks both of these are liable to 72% of accidents in the black spot. 44% of these are bus followed by the truck which is 28%. The non-motorized and 2/3-wheeler were involved in mentionable 12% of total accident in this section. Therefore, it can be said that road accident has become one of the major problems in Bangladesh. The necessary steps should be taken to improve the road safety conditions of the country as soon as possible.

KEYWORD: Accident, Road traffic, Fatalities, Death, Vehicle, Pedestrian, Black spot.

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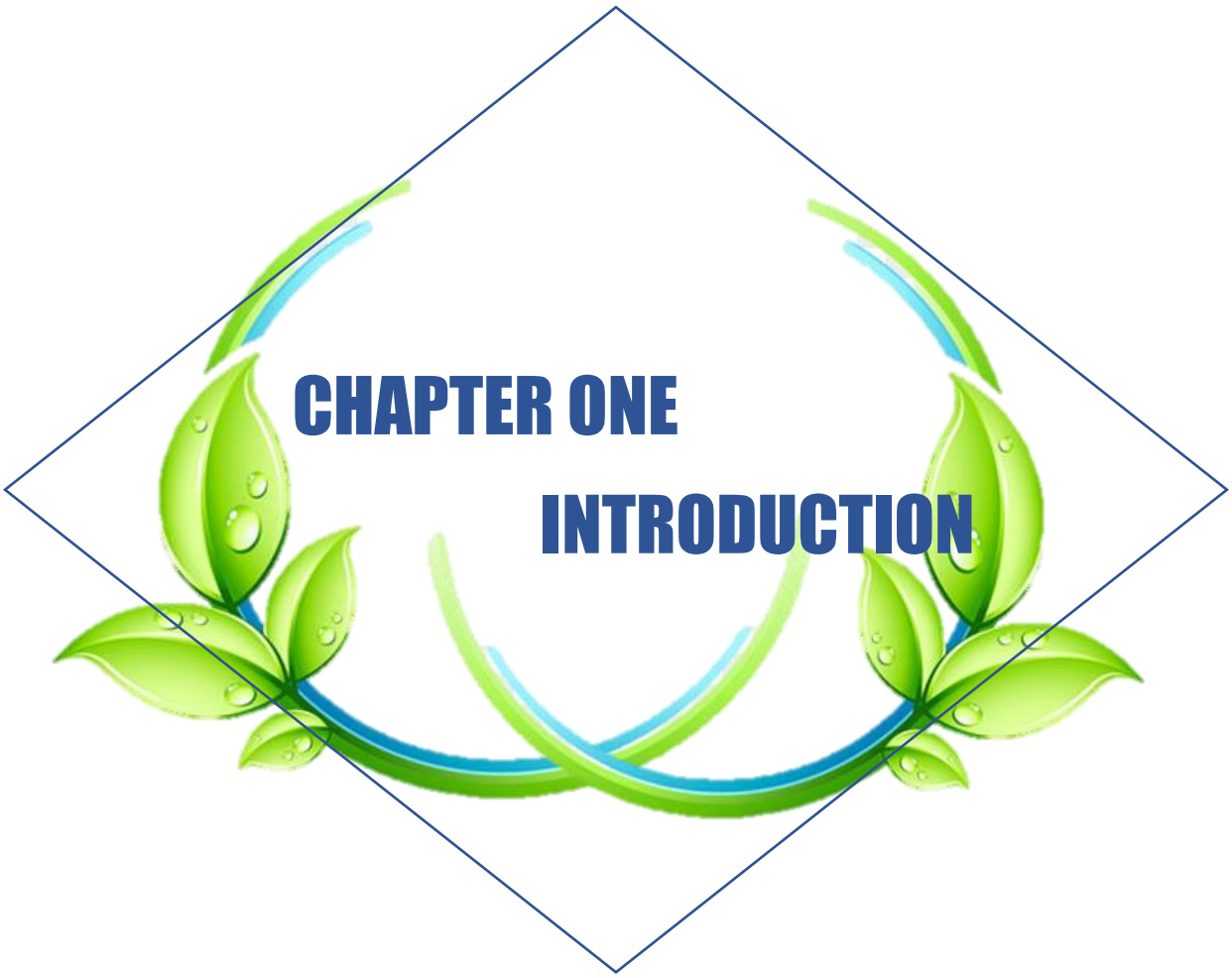
LIST OF ACRONYMS

Abbreviation	Elaboration
ARI	Accident Research Institute
BUET	Bangladesh University of Engineering
WHO	World Health Organization
BRTA	Bangladesh Road Transport Authority
FIR	First Information Report
N5	National Highway 5
RHD	Roads and Highways Department
RTA	Road Traffic Accident
MAAP	(Micro-Computer Accident Analysis Package
ARF	Accident Report Form
PCU	Passenger Car Equivalent
Head O	Head On
Rear E	Rear End
Deg	Degree
Obj	Object
Ped’n	Pedestrian
Park V	Park Vehicle
Sever	Severe



CHAPTER ONE

INTRODUCTION

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INTRODUCTION

1.1 Background

The world is in the age of rapid development. The process of rapid urbanization and increasing economic activities has resulted in the tremendous growth of road traffic that produces enormous road traffic accidents (Quanjun Chen, 2016).

Road accidents are one of the main issues of the road at the moment. The global context may be summarized as: about 1 million persons are killed every year, about 23-24 million persons injured every year and developing countries having less than 40% of global motor vehicle fleet, share about 86% of road accidents and consequent fatality, injury and loss (Naila Sharmeen, 2011).

The young generation regards it as a country's asset because it is a country's economic booster and driving force. But every year, road accident is responsible for 0.3 million youth deaths, making it the leading cause of youth death (WHO, 2015). Along with the social costs such as pain, grief, and suffering resulting from road accidents, there are also economic costs that can put a severe financial strain on the resource of a country. Road accident pulls back the economic growth of a country. Reference states that traffic accidents cost the developing countries annually between 1 to 3% of their GDPs. Reference points out that road traffic accidents cost the low- and middle-income countries annually what is more than the total aids they receive for development purposes (Abdelmageed, 2010). Road accident scenario is worse in Asia than another part of the world. In every day about 2000 people and about 15000 died in road accident in the Asian-pacific region (ESCAP, 2014). That's a death every forty seconds. Bangladesh is an Asian-Pacific region's small country. This country's accident scenario is highly critical. Bangladesh has a very high road accident fatality rate with official figures indicating more than 60 deaths per 10,000 motor vehicles. Everyday around eight persons die in road accidents. The actual rate of fatality is likely to be even higher (MITRA, 2005). There needs to be some serious study of country road accidents.

1.2 Declaration of the Problem

Bangladesh is one of the developing countries. It keeps up its monetary development from the year 2000. As per the World Bank, in 2017 the nation's financial development was 7.3%. The developed nation has its good transportation system. As Bangladesh is a developing country so it has to improve its road transportation system. Road transportation is the significant method of transport in Bangladesh and plainly it will proceed for decades to come. Streets, roadway, and lanes are essential to our transportation framework and more than 70 percent of our people uses the roads for transportation. There is no uncertainty that street transportation is the most essential to our monetary and social welfare. The financial development carries numerous potential outcomes with some serious issue like a road accident. The number of accidents has increased by 43% between 1982 and 2000, while the number of fatalities has increased by around 400% within the same period. This indicates that not only the occurrence of accidents is on the rise, the severity of accidents is also increasing. As the population, total road length and modal share of road transport continue to grow in the country, the number of casualties from road accidents are expected to maintain its rising trend (MITRA, 2005). According to the police report FIR, reliably 4000-5000 people kicked the basin in a road setback anyway the circumstance is dynamically genuine there is around 10 to 12 thousand people kicked the container in view of road traffic results and boundless are lived with an inadequacy and physical and enthusiastic prosperity issues shown by ARI, BUET. The nation has been losing around 5500- 7000 corers taka every year which is 2% of national GDP and about 30% of the national health budget. To increase road safety situation there, need much effort and investment to change the trend. To improve the condition, it is very essential to identify the factor and also understand the accident pattern. The improvement of hazardous location may play a very important role to minimize the road accident. The statistical analysis of accidents carried out periodically at critical locations or road stretches or zones will help to arrive at suitable measures to effectively decrease the accident rates. This study is mainly focused on the analysis of road accident and also the identification of the hazardous location on Dhaka to Bagura (N5, R505, N4, N405, and N5) highway of Bangladesh.

1.3 Importance of the Study

In Bangladesh up to this point, almost no work has been done to concentrate on an itemized range of investigation of mishaps for a sensibly full comprehension of the mishap issue and in this way create compelling countermeasures. Most appalling fact is that no endeavor has yet been made to assess the few estimates that have been taken up until now.

Road Traffic Crashes (RTC) comprises of a major public health problem worldwide. According to WHO, leading cause of deaths and the 9th leading contributory factor to the burden of disease all around and the situation will be worsen in coming days. About 1.2 million human fatalities are estimated with almost 50 million are injured. It is predicting that this number will rise by about 65% over the next 20 years unless new measures to prevent the hazard are taken (Mizanur Rahman, 2013).

The statistics reveals that Bangladesh has one of the highest fatality rates in road accidents higher than 73 deaths per 10,000 registered motor vehicles every year (H.M. Ahsan, 2011). The principal contributing factors of accidents are adverse roadway roadside environment, poor detailed design of junctions and road sections, excessive speeding, overloading, dangerous overtaking, reckless driving, carelessness of road users, failure to obey mandatory traffic regulations, variety of vehicle characteristics and defects in vehicles and conflicting use of roads. There is urgent need and scope for improving the road safety situation and for that there is obviously need for much efforts and investment in safety measures to reverse the trend.

Dhaka - Bagura highway plays a vital role in inter-district and interregional transport as it connects the northwestern region of Bangladesh with Dhaka. The road safety condition of the road is very poor that makes it one of the dead list roads of the country. Hoque recommended various low-cost safety measures including shoulder improvement, delineation, installation of guardrails, provision of overtaking lanes and narrow bridge approach etc. (Hoque, 1998).

In any case, tragically, until all around as of late, street security perspectives couldn't draw in the consideration of policymakers, in that capacity very little of assets were committed to this issue. RHD likewise keeps up a poor record of their works.

The study may improve the satiations. The black spots and accident-prone road area may improve on this highway. The study could bring in light of the road safety situation on this to the various government research organizations, donor agencies which may help to improve safety situation on it.

1.4 Justification of the Study

The identification of those spot diminishes the no. of accidents and fatalities. The identification of the causes behind the road accident in the blackspot my likewise help to cure the street accidents. Because most of the accident occurs in those places. 42% of total fatalities occurred in blackspot of the highway (Hoque, Rahman, Ashrafuzzaman, & Sarkar, 2006). The causes include the factors like street surface and shoulder condition, a faulty vehicle for accidents, climate conditions, light conditions, street geometries, admired street clients (motorized, non-motorized), impact type, etc. A mishap expectation model helps to comprehend the correlation between a mishap and different components that likewise makes the essential move to diminish the accidents.

The study will direct to recognize the black spots on the national highway (Dhaka-Bagura) of Bangladesh. The measurable and different screening technique will be accustomed to distinguishing and affirming the blackspot and GIS analysis will be performed to recognize the fatality road segment on that highway. In this study, there will likewise attempt to identify the causes like street surface and shoulder condition, a mindful vehicle for mishaps, light conditions, respected street clients (motorized, non-motorized, crash type, etc.) in charge of street accidents.

1.5 Objective of the Research

General objective

Accident analysis as well as the identification of hazardous highway locations.

Specific objective:

- To identify the hazardous locations by statistical analysis.
- To locate accident-prone sections using GIS's spatial analysis tools.
- To identify the most vulnerable vehicle class that are liable to more accidents.
- To identify the most vulnerable accident user groups by accident analysis.

1.6 Organization of the Thesis

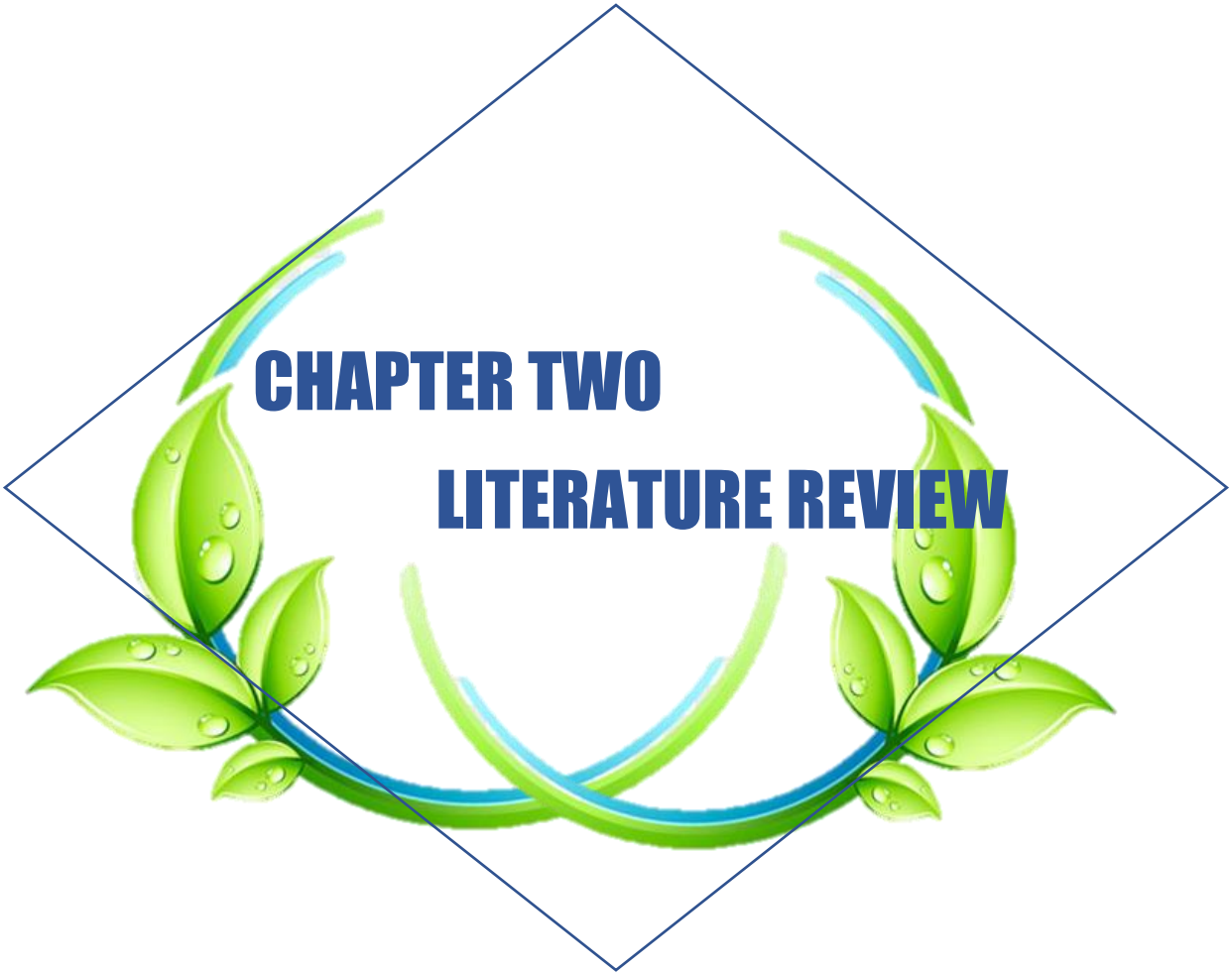
Apart from this chapter, the thesis has been divided into four chapters.

Chapter 2 contains the literature reviews, definitions and explanatory note, accidents problem in Global and Bangladesh perspective.

Chapter 3 discussed briefly, the theoretical and analytical aspects of study design as well as research methodology. The study area also is shown in this chapter.

Chapter 4 the descriptive statistical analysis of accident & casualties on the basis of year, month, day, time, light, vehicle, collision type, casualty type etc. along with Blackspot identification, GIS analysis.

Chapter 5 is the conclusion and recommendation chapter. It contains the major findings of the study along with some limitations and recommendation of future study.



CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO
LITERATURE REVIEW

2.1 General

Road accident is one of the main reasons for death and physical disability globally. In developing countries, it is one of the leading causes of unexpected death, physical and mental health problem. Bangladesh is a developing country in the south Asian region. Road accident is responsible for major social, economic and individual's problem because of the involvement of a high number of victims and the seriousness of the consequences for the victim themselves and their families as well.

Accidents are generally classified as (I) single vehicle accidents in which the vehicle is either colliding with fixed objects or with pedestrians or the vehicle which may fall into ditch or over-turn and (II) multiple vehicle accidents in which two or more vehicles can either collide head-on or one vehicle may collide with front of the vehicle or back of the vehicle or may have a side-swipe type collision.

The increment of road accident might relate to the rapid growth of populations, economic development, industrializations, rapid urbanizations, and poor road conditions. As it says previously, Bangladesh is a developing country. With the growth of the country economy, there is also growing its urbanizations like most of the other developing countries but studies show that most of the urbanizations are unplanned and unsustainable in this country (Rana, 2011).

The rapid urbanizations processes are responsible for high vehicular populations growth and that of the mobility, inadequate public transportation facilities, and policies. The various traffic mix with over-concentration of non-motorized vehicles, lack of dependable public transportation facilities, inadequate traffic management practices, and parking facilities have made the road condition worst.

There is now on the ever-increasing urgency for mitigating the complex transportation problem. The proper study of a road accident, the reason behind them may help to improve the road safety conditions and this may also help in future to build the safest road network.

In this thesis, the study areas involve Dhaka, Tangail, Sirajganj, Bagura, Rangpur, Dinajpur, Panchagor are northern districts of Bangladesh which play a vital role in the country's economy. Those areas are connected through this national highway (Dhaka- Banglabandha).

A various vehicle from different parts of Bangladesh come here to these areas. In the two Eid season, the roads become very busy in day and night. Besides the journey is very long. Such as the long journey which starts from Dhaka-Panchagor or Dhaka-Dinajpur passes through Dhaka-Bagura highway. Therefore, the AADT is very high in Dhaka-Bagura portion which may play a vital role in increasing accidents.

2.2 Standard Terminology

At the very outset of the study, few some widely used terms relating to accidents and accident locations are given below.

Accident:

A ***transport accident*** is an accident involving a device designed primarily for, or being used at the time primarily for, conveying persons or goods from one place to another.

A ***traffic accident*** is any vehicle accident occurring on the public highway [i.e. originating on, terminating on, or involving a vehicle partially on the highway].

A ***vehicle accident*** is assumed to have occurred on the public highway unless another place is specified, except in the case of accidents involving only off-road motor vehicles, which are classified as no traffic accidents unless the contrary is stated.

A ***no traffic*** **accident** is any vehicle accident that occurs entirely in any place other than a public highway.

An ***accident*** which occurred or originated on a road open to public traffic resulting in either injury or loss of life or damage to property, in which at least one moving vehicle was involved.

Fatal Accident:

There is some variation in how fatalities are defined. Most countries define a time limit following a crash during which a death must occur in order for the fatality to be considered caused by the crash. Thirty days is the most common limit. France has a time limit of eight days and Canada's limit is 12 months. Some countries do not have a specific time limit. Obviously, the longer the time limit, the more deaths will be included.

Grievous Injury Accident:

An accident in which a person who has received injuries such as fractures, concussions, internal lesions, crushing, severe cuts and lacerations, severe general shock requiring medical treatment and detention in hospital.

Simple Injury Accident:

An accident in which a person sustained injury but need not to be admitted to the hospital. It can also include an accident victim who sustained injuries and was treated in hospital but not detained overnight.

Property Damage / Collision Type Accident:

When motor vehicles hit a pedestrian, another vehicle in traffic, parked vehicle, animal, fixed object etc. in an accident.

Road:

A *public highway* [traffic way] or *street* is the entire width between property lines (or other boundary lines) of land open to the public as a matter of right or custom for purposes of moving persons or property from one place to another. A *roadway* is that part of the public highway designed, improved and customarily used for vehicular traffic. It excludes off-street parking, access areas, and other private property.

Carriageway:

One of the two sides of a motorway where traffic travels in one direction only usually in two or three lanes. It also includes shoulders and areas at the sides or center of the carriageway used for standing or parking of vehicles.

Intersection:

The place where two or more streets meet or cross each other is termed as an intersection. For this study, it also includes 15 meters area within the intersection.

Link/Midblock:

The length of the road beyond 15 meters of adjacent intersection is termed as link/midblock.

Footpath:

The part of the road which is ordinarily preserved for pedestrian movement as a matter of right or custom.

Pedestrian/Driver/Passenger:

A ***pedestrian*** is any person involved in an accident who was not at the time of the accident riding in or on a motor vehicle, railway train, streetcar or animal-drawn or another vehicle, or on a pedal cycle or animal.

A ***driver*** is an occupant of a transport vehicle who is operating or intending to operate it.

A ***passenger*** is any occupant of a transport vehicle other than the driver. It excludes a person traveling on outside of the vehicle.

Black spot/ Hazardous Road Location:

There is no universally accepted definition of a black spot, it may define as the section of road or junction where 3 or more fatal accident happened in between 1 to 5 years' time period.

Fatality Index:

The Fatality Index is usually defined as the percentage of fatalities out of the total number of road accident casualties: it is expressed in the following equation:

$$\text{Fatality index} = \text{Fatality} / \text{Total casualties}$$

2.3 Road Accident Problem

2.3.1 The Road Accident Problem: Global Perspective

As well as the social costs such as pain, grief, and suffering that arise as a result of road accidents; there are also economic costs which can place a severe financial strain on a countries' resource. Before the motorized era one of the main causes of death was an epidemic disease but in the motorized era, the scenario has been changed, the road accident has become one of the leading causes of death.

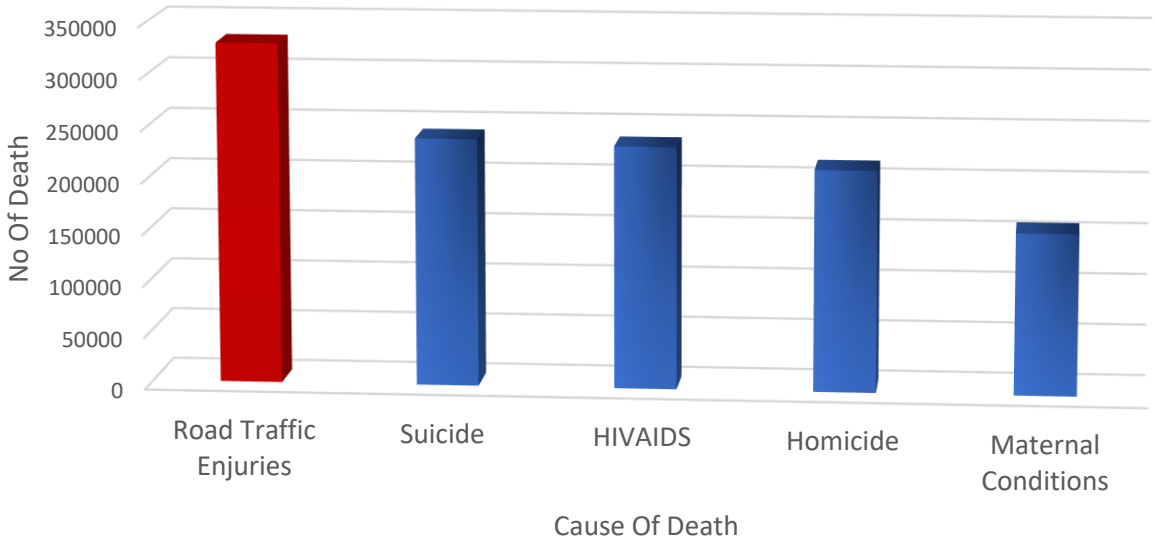


Figure 2. 1: Top Five Leading Cause of Death among the Young People 2012 (WHO, 2015).

According to the study of the World Health Organization (WHO), road accident is one of the main reasons for death worldwide. There are about 1.25 million people die every year worldwide (WHO, 2015). The data does not present the actual gruesomeness of the road accident. There is about 50 million people suffered in serious physical and mental health problem of a road accident.

The young generation considers as the asset of a country because they are the economic booster and driving force of a country. The brutal part of a road accident is that it is the leading cause of the death of 15-29 years old young people. Figure 2.1 shows that the road accident is the No.1 leading of death among young population worldwide. There are about 330 thousand young people (age 15-29) died in 2012 in road accidents.

The numbers of road accident and fatalities are varying from country to country, the country's economic condition plays a very important role in those numbers. Around 82% of populations are lived in the lower-income and middle-income counties of the world and about 90% of a total accident of the world happened in those countries (Figure 2.2) (WHO, 2015).

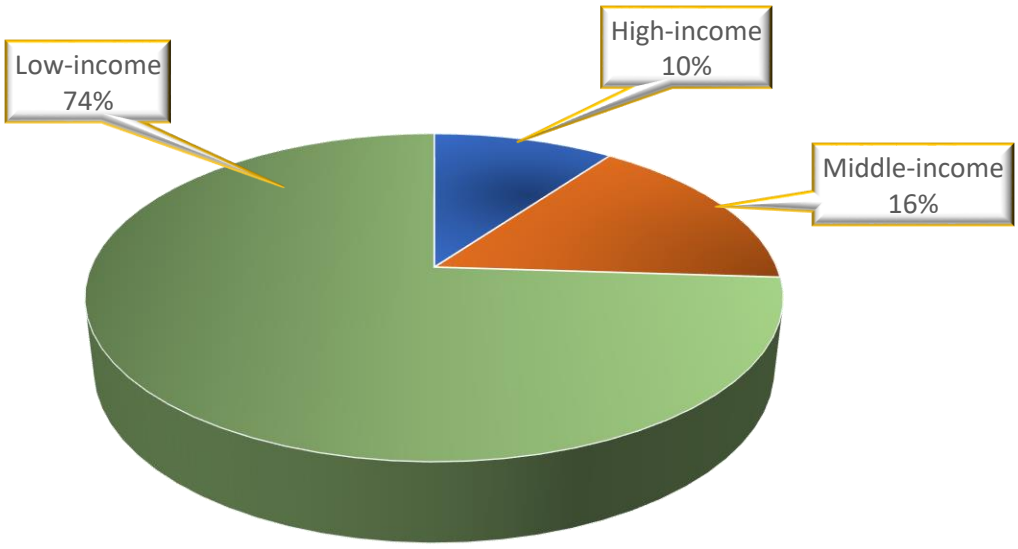


Figure 2. 2: Road Traffic Deaths by Country Income

The lower-income countries only owned 1% of the total vehicle but those countries are 16% of world total accidents. The cyclist, pedestrian, 2 -3-wheeler users are the most venerable road user group of the world. Figure 2.3 present that those road users are responsible for 49% of the total accident. Where motorized 2-3 wheelers shared 23% of a total accident followed by pedestrian which shears 22% of world total accident. The road accident brings economic burden to the victims' families as well as its country. About 5% of developing countries GDP loss in road accidents may use in countries education, health or others important sector.

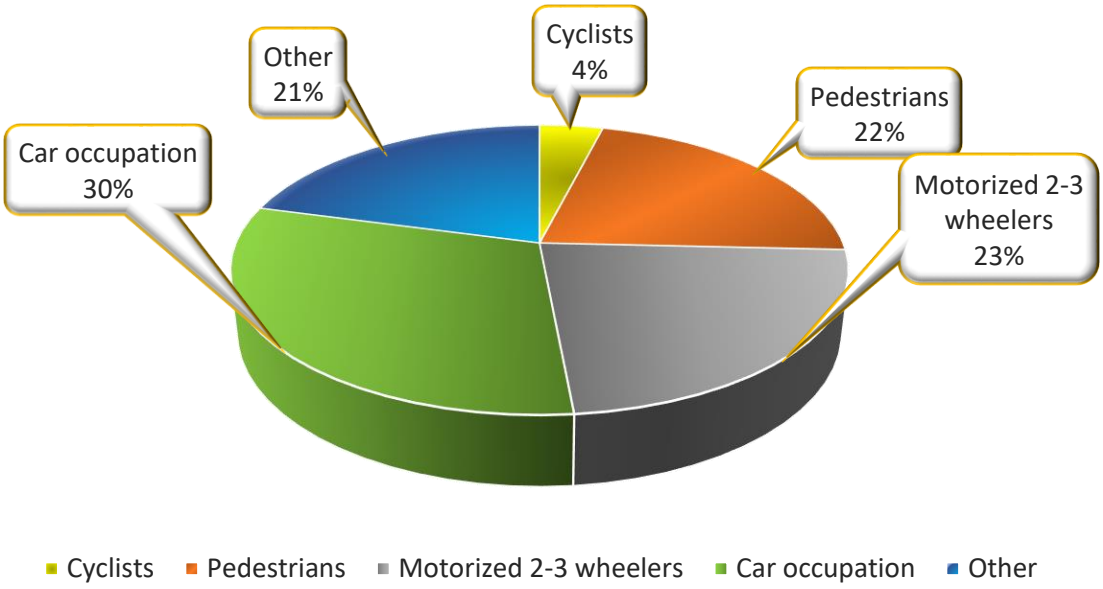


Figure 2. 3: Road Traffic Death in the World by Road User, by WHO Region (WHO, 2015).

2.3.2 Road Accident Problem: Asia

Most of the Asian countries are developing countries. According to the World Bank study, East Asia and Pacific remain one of the main world economic driving force of the world. This region has two fifth of world economic growth from past 2002 (Bank, 2018). From past 2000 to 2012 this region poverty decreases from 29% to 7.2% (Bank, 2018). Most of the Asian countries are developing country. The road rapidly grows due to the increasing the economic ability of this region. The rapid traffic has led to severe traffic congestion, lack of parking space, air pollution and unsafe road.

One person has been died in road accident in every 40 seconds, this is the road accident scenario in Asian Pacific region (ESCAP, 2014). There is about 2000 people died in road accident everyday about 15000 people in a week (ESCAP, 2014). According to The World Bank study, the accident related cost about 20 billion dollar which is more than of the World Bank contribution as lone in this region.

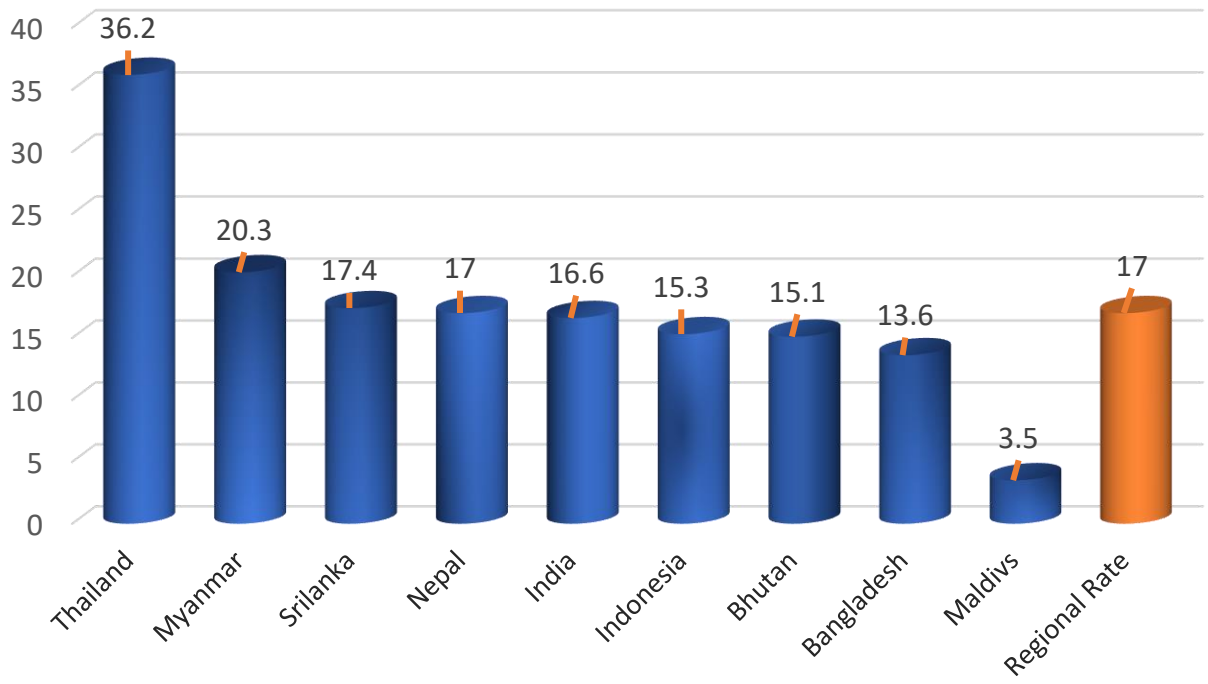


Figure 2. 4: No. of Fatalities Rate per 100,000 People in Asian Pacific Region.

The average fatalities rate per 100,000 population is 17.0 in the south-east Asia in 2013 (Figure 2.4). The maximum fatalities rate in region is in Thailand which is 36.2 followed by Sri-Lanka and Nepal where fatalities rate is about 17.4 and 17.0. The lowest accident in this region in Maldives though road is not the main transportation mode in this region. The second lowest fatalities rate in this region in Bangladesh which is 13.6.

The rate is pretty high compare to the first world county as those country owned about 54% of total world registered vehicle but only 10% road traffic fatalities happened in those regions. The main region behind this is the lack of emergency response system and lack of strict law enforcement.

2.3.3 Road Accident Problem: Bangladesh

Bangladesh is a rising financial nation. The district keeps up its financial development from the year 2000. As per the World Bank, in 2017 the nation's financial development was 7.3%. The financial development carries numerous conceivable outcomes with some serious issue like road accident. As indicated by the police report FIR, consistently 4000-5000 individuals died due to road accident. Yet the situation is more disjoining, there is around 10 to 12 thousand

individuals died because of road traffic results what's more, endless are live with incapacity and physical and psychological well-being issue as indicated by ARI, BUET. The country has been losing around 5500-7000 corer taka consistently which is 2% of national GDP and about 30% of nation health budget.

Figure 2.5 demonstrates the quantities of accident, death and injury in the nation from the year 2009 to 2015. It is clear that the quantities of accident were over 3300 in the year 2009. Despite the fact that the situation has been changed, the quantities of accident, death and injury have changed since 2013 to 2015 (Figure 2.5).

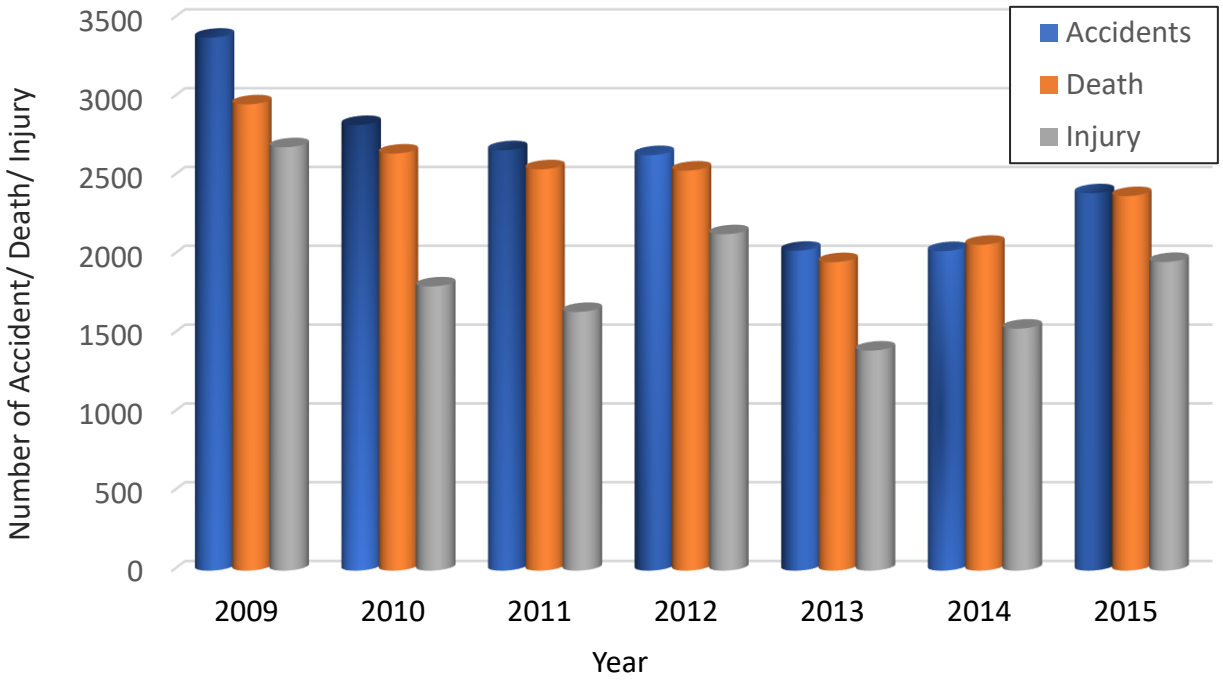


Figure 2. 5: Number of Road Accident & Fatalities in Bangladesh from the Year 2009-2015.

Other statistics show the fatality rate from the year 2003 to 2015 also with number of road accident. The road accident fatalities rate presents the actual scenario of road accident. The average accident fatalities rate per 100,000 was around 2.0 from the year 2003 to 2015 (Figure 2.6).

The accident fatalities were above 2.5 in the year 2003 and 2004 though the scenario started to be changed. The accident rate has been changed from around 2.5 to around 1.5 in just 10 years in this time, this nation population increase from 12 cores to 15 cores. Therefore, it can't be said the number of fatalities has decreased. The 1.5 fatalities rate is too high for a developing country like Bangladesh

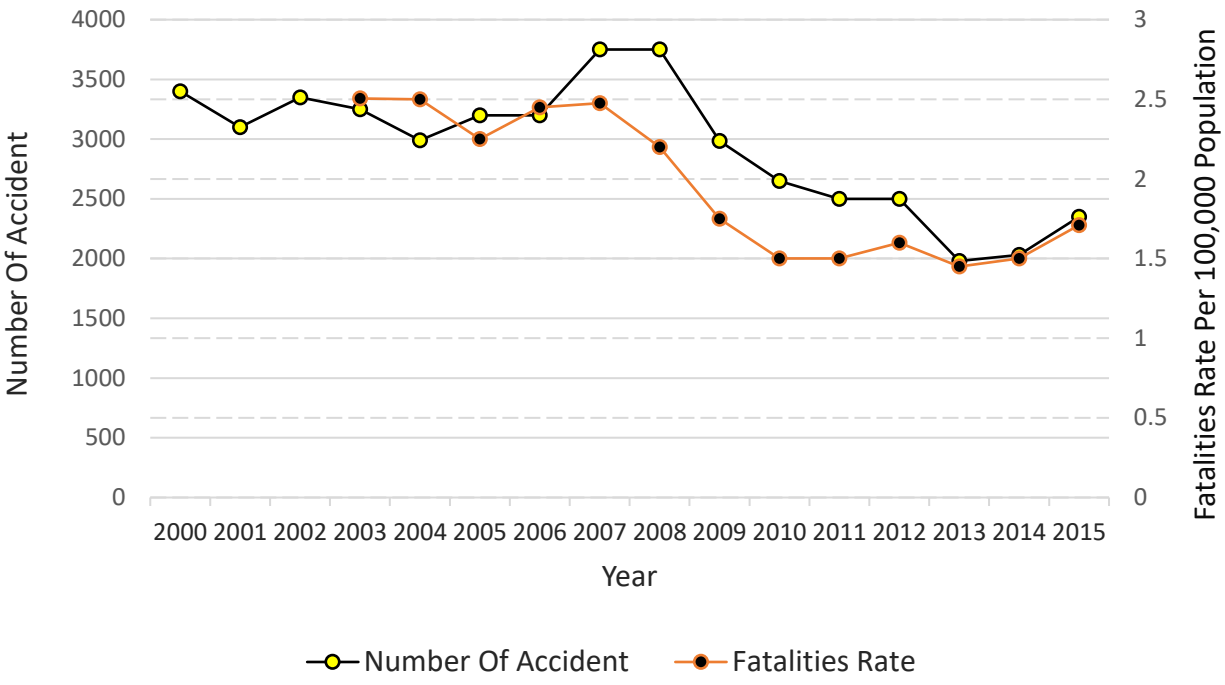


Figure 2. 6: Number of Road Accident & Fatalities Rate per 100,000 Population in Bangladesh.

The identification of venerable road user may help to improve the road safety situation of the country. Accordion to the BRTA (Bangladesh Road Transportation Authority) 2012 report shows that pedestrians are the most venerable road user group in the country followed by the 4-wheeler and light weight vehicle user. The pedestrians have shear 32% of total road accident death and the 4-wheeler and light weight vehicle user have 28% of total road accident deaths. The 2-3 wheelers user sheared 11% of total country road accident death (Figure 2.7)

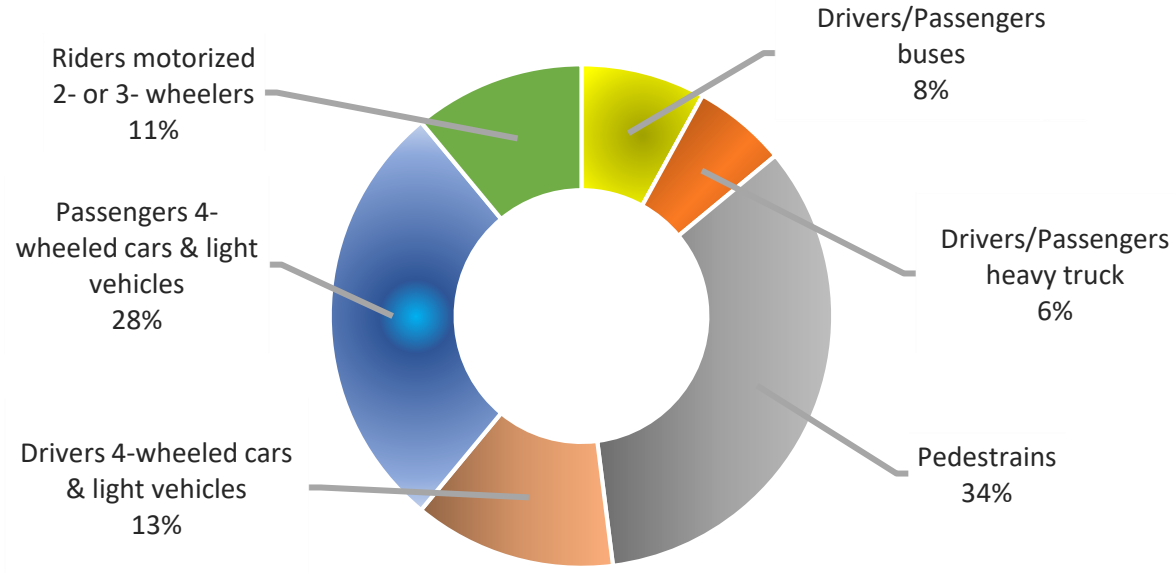


Figure 2. 7 Road Traffic Death by Road User (BRTA 2012).

2.3.4 Accident on National Highways

Accident research institute has prepared a detailed list of accident spots. In those spots there is about 3540 no. of accident happened from 1998 to 2007 which responsible for 3250 death (Ari 2007). In spite of the fact that most accidents happen on the highway, it isn't the situation that the whole length of the highway is accident prone. The PPRC investigation demonstrates that the greater part of the accident was thought inside complete length of just 54.7 Km. In this length a large portion of the mishap occurred in the jam-packed spot. In all significant roadway, most of the mishap occurred at the transport stand or close it pursued by Bazar region. Bus stand shear 40.90% also, Bazar shear 28.40% of total accident-prone area. In these two sorts of region, over 70% of the total accident occurred (Figure 2.8).

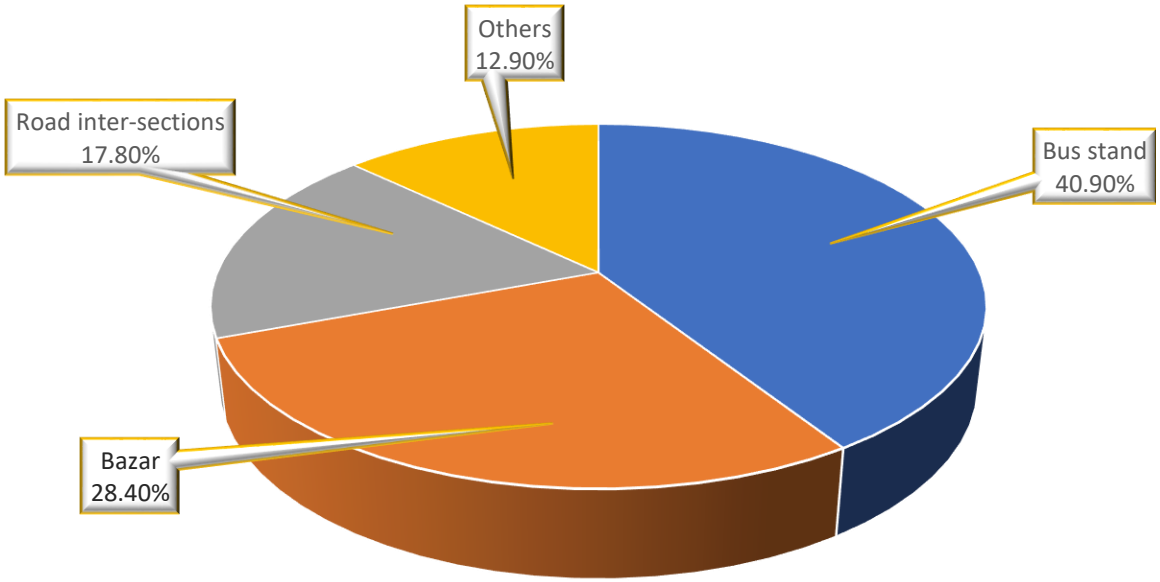


Figure 2.8: Accident Prone Area in Highway

2.3.5 Factors Influencing Exposure to Risk

Movement of people and goods on the road is necessary for social, economic and political reasons, but this need to travel leads to a risk of road traffic injuries. A range of factors determine who uses different parts of the transport system, how they use them and why, and at what times. It may not be possible in practice to completely eliminate all risk, but it is possible to reduce exposure to the risk of severe injury and to minimize its intensity and consequences. The specific modes and issues of importance when examining exposure to risk are fully discussed in the World report on road traffic injury prevention (WHO). A brief summary is given here:

2.3.5.1 Growth in number of motor vehicles

One of the principle factors adding to the expansion in worldwide street crash wounds is the developing number of engine vehicles. The issue isn't only the development in numbers and increment in introduction to the hazard yet additionally guaranteeing that fitting street wellbeing measures go with this development. The engine vehicle, alongside the ensuing development in the quantity of engine vehicles and in street framework, has brought societal advantage yet it has likewise prompted societal expense, to which street traffic damage contributes fundamentally. Without appropriate arranging, development in the quantity of engine vehicles can prompt issues for people on foot and cyclists. Truth be told, where there are no offices for walkers and cyclists, expanding quantities of engine vehicles for the most part lead to decreases in strolling and cycling. At present, engine vehicle development in low salary and center pay nations is occurring against a foundation of related issues. Just few individuals in these nations can bear the cost of vehicles, while the expenses of streets, parking spots, air contamination and street traffic wounds are borne by the entire society. In spite of the fast development in mechanized rush hour gridlock, most families in low salary and center pay nations are probably not going to claim a vehicle inside the following 25 a long time. As far as presentation to chance, the principle methods of movement in these nations within a reasonable time-frame are probably going to remain strolling, cycling and open transport. This stresses the significance of anticipating the requirements of these street clients, who, as was found in Unit 1, bear a high extent of the weight of street traffic wounds. Transports and trucks are a noteworthy method of movement in low-salary and center pay nations. High volumes of

travelers being transported affect the security, of the travelers themselves, yet in addition of helpless street clients.

2.3.5.2 Non-motorized traffic

Non-mechanized vehicles prevail in both provincial and urban zones in low-salary and middle -income nations. By and large in creating nations, person on foot and cyclist traffic has developed without going with upgrades in offices for these street clients. The high number of passerby and cyclist losses in these nations reflects not just the inborn weakness of these street clients, yet additionally lacking regard for their requirements in policymaking. Accident records reveal that in Bangladesh during 1998-2010 nearly 11 percent of the accidents involved non-motorized vehicles. Almost 67 percent of total accidents resulted in fatal. Therefore, casualties related to non-motorized vehicles accident are also high (nearly 50 percent of the victims died). Significant speed difference with motorized vehicle is one of the primary reasons of non-motorized vehicle accidents. Study indicates that in 32 percent cases rickshaws have collided with bus and in 25 percent cases heavy trucks hit rickshaws (Sufian, 2014).

2.3.5.3 Demographic factors

Distinctive gatherings of individuals have diverse exposures to hazard. As populaces change after some time, so their general introduction will change. Vacillations in the general sizes of various populace gatherings will strongly affect the street traffic toll. For example, in high-pay nations, youthful drivers and riders – at expanded danger of association in street crashes – are as of now overrepresented in setback figures. Statistic changes in these nations throughout the following 20– 30 years, however, will result in street clients more than 65 years old turning into the biggest gathering of street clients. The physical defenselessness of more seasoned individuals places them at high hazard for deadly and genuine wounds. In spite of the rising number of more established individuals holding driving licenses in high-pay nations, their declining driving capacity just as conceivable money related requirements will imply that a significant number of them should quit any pretense of driving. This may contrast from some low-salary nations where more seasoned individuals may never have driven in any case. In low-pay nations all in all, the normal statistic advancement proposes that more youthful street clients will keep on being the overwhelming gathering engaged with street car accidents.

Around the world, a substantial extent of more seasoned individuals will be subject to open transport or will walk. This delineates the significance of giving protected and short passerby courses, and sheltered and helpful open transport.

2.3.5.4 Transport, land use and road network planning

Arranging choices with respect to transport, land use and street systems effectively affect general wellbeing – as they influence the measure of air contamination by vehicles, the level of physical practice embraced by people, and the volume of street car accidents and wounds. The advancement of a system of streets or in reality of different types of transport, for example, railroads has a significant impact on networks and people. It impacts such things as monetary action, property costs, air and commotion contamination, social hardship and wrongdoing notwithstanding wellbeing. Long driving occasions debase the personal satisfaction and here for wellbeing. Stationary travel legitimately and antagonistically influences wellbeing. Without legitimate land use arranging, private, business and mechanical movement will develop in a heedless example, and street traffic will advance also to address the issues of these different exercises. This is probably going to create substantial progressions of traffic through neighborhoods, vehicles able to do rapid offering space to people on foot, and over whelming, long remove business traffic utilizing courses not intended for such vehicles. The subsequent presentation to street traffic damage might be high for vehicle tenants and much more for defenseless street clients, for example, people on foot, cyclists and motorized bike clients.

2.3.5.5 Choice and use of less safe forms of travel

Of the four principle methods of movement, street travel introduces the most noteworthy hazard in many nations – utilizing practically any proportion of presentation – highways and rail, air and marine travel. Inside this method of street travel, real varieties exist between walkers, cyclists, riders of mechanized bikes, tenants, and transport and truck travelers. The dangers for these street clients additionally shift enormously as per the traffic blend and consequently differ extraordinarily from nation to nation. As a rule, in high salary nations, riders of motorized bikes have the largest amounts of hazard.

2.3.6 Casual Factors for Road Traffic Accident

Dilapidated road conditions and rash driving of commercial vehicles are two foremost reasons for fatal accidents; among these reckless driving can be considered as the main reason. The highways are old and have not broadened and increased much in number, length or width; but the number of vehicles has gone up around 10% every year. At least 60% of the highways are in dilapidated condition even though highway maintenance work goes on round the year. A prompt review of literature reveals the following major factors that affect the number of fatal accidents and fatality rates:

- Driving habits
- Road-related factors
- Vehicle-related factors and
- Socio-economic and demographic factors (Naila Sharmeen, 2011)

Within these factors, several variables can be identified as being the most influential.

Table 1: Influential variables are presented for each factor.

Factors	Influential Variables
Driver Factor	Age, Alcohol, Fatigue, Seat Belt Usage, Speed, Aggressiveness, Violation History.
Road Factor	Posted Speed Limit, Roadside Safety Devices, Geometric Characteristics, Existence of Median and Barriers, Level of Pedestrian Traffic.
Vehicle Factor	Vehicle Type, Safety Equipment (Airbag, ABS), Vehicle Defects, Age of Vehicle.
Socio-economic and Demographic Factor	Income, Employment Levels, Poverty, Residential Density, Vehicle Ownership, Highway Network Density.

The Global Status Report on Road Safety (WHO) also highlight five casual factors and remedial
action areas:

- Excessive speed
- Drunk driving
- Non-use of motorcycle helmet
- Non-use of seat belt
- Non-use of child constraints

While all these are relevant for the countries like Bangladesh, there are a number of additional factors at work that need to be taken consideration.

- Untrained drivers
- Unfit vehicles
- Vulnerable road-side activity
- Faulty road design
- Poor traffic enforcement
- Culture of impunity and poor legal redress
- Lack of road safety awareness
- Simultaneous operation of motorized and non-motorized vehicles without separating and adequate rules.

To gain further depth to the casual analysis and remedial priorities, focus group discussions were held with key stakeholder groups. These include retired senior police personnel with extensive experience in the traffic management, leadership of the Bangladesh, Truck and Covered Van Owners' Association, drivers and local community. Insights from these FGDs (Rahman, 2014) are summarized below:

a) Police Personal:

1. Speeding
2. Deficiency of drivers
3. Violation of signals
4. Over-taking
5. Over-loading by trucks
6. Random line change
7. Mental annoyance of drivers for multiple reasons
8. Black spots (dangerous curves)
9. Over-speeding for time saving
10. Unfit vehicles
11. Bad roads
12. Slow and fast vehicles on same roads
13. Impunity for offences

b) Transport Owner

1. No road dividers on most roads
2. Huge increase in number of Vehicles on the road
3. Owners negligent on vehicle fitness
4. Poor knowledge of traffic rules by drivers
5. Poor knowledge of traffic rules by pedestrians
6. Unlicensed drivers
7. Lack of quality driving schools.
8. Unsecured railway crossings
9. Harassment by police leading to mental pressure on drivers

10. Road-side markets

11. Motorized and non-motorized transports on same lanes

12. Poor stoppage facilities for bus drivers

c) Drivers:

1. Defective vehicles

2. Over-taking and over speeding

3. Untrained drivers

4. Lack of sleep and tiredness

5. Radom presence of informal transports without indicator lights

6. Careless pedestrian use of roads

7. Absence of road markings and signals

8. Excessive roadside markets and shops

9. Police harassment and random stops

10. Drunk driving

11. Too many and unnecessary speed-breakers

12. Mental pressure on drivers due to financial obligations

d) Local Community

1. Too many vehicles face to face road space

2. Increasing presence of unauthorized 3-wheelers

3. Absence of well identified parking spots

4. Haphazard parking and inadequate bus stands

5. Jaywalking by pedestrians

6. Police harassment and random stoppages for extortion

7. Too many unmarked turning points on highway

8. Lack of hard shoulders and sadden drop on the sides

9. Lack of foot path to force people to walk on streets

10. Road-side vegetation blocking views at curves

11. Uncovered sand trucks create problem for motor-cyclists who are blinded by flying sand

2.4 Road Safety Engineering

Geometric Design Standard: Significant improvement works have taken place on National and Regional highways, District and Local roads all over the country. These include construction of new and strategic roads, re-alignment of existing roads, widening of roads, surface treatments, shoulder improvement, removal of vision obstruction. From an engineering point of view, safe road design is important. RHD geometric design manual addresses the safety issues like the AASHTO Green Book which is a widely accepted geometric design standard.

Horizontal and Vertical Curves: Curves in roads and highways are essential elements sometimes provided intentionally to enable transition and super-elevation. It is imperative to follow design standards of RHD manual or AASHTO green book in this regard.

Intersection Design: Intersections should be avoided as minimum as possible. Flyovers, interchanges, elevated and depressed portions of highways are provided to avoid intersections. In Bangladesh intersections in highways so far could not be avoided due to various reasons such as, road side activities all along the highways, poor access control, poor or no prediction of future road and land use. Inadequate survey and research, incompleteness of projects, inadequate funds as well as budgeting and presentation by inexperienced as well as nontechnical officers, above all bureaucracy and lack of proper

education and training provided to the officers and engineers involved in implementation process.

Grade Separation for Interchanges and for Different Modes of Traffic: Highways should be free from pedestrians, non-motorized or slow-moving vehicles. However, in Bangladesh because of the socioeconomic condition it is not possible to prohibit these kinds of vehicles to enter the highway. Therefore, extra lanes will have to be provided for these vehicles through grade separation.

Using Dividers, Islands, Flares, Tunnels for Safe Management of Traffic: Dividers can only be provided in highways with at least 4-lanes. Islands guide foe traffics to desired directions. Flares are very useful in intersections for uninterrupted flow of through traffics.

Designing of Roads Considering Sight Distances: Sight distance means the distance to allow the drivers to control the vehicles, such as, stopping sight distance and overtaking sight distance. These are considered during positioning the road furniture such as, road signs, islands or dividers as well as designing the curvature of the roads.

Fixing Speed Limits Depending on the Designs: Speed limits are provided in roads depending on the road condition like, condition of road surface, traffic congestion, use of traffic lanes, horizontal and vertical curves in roads. In Bangladesh, there are speed limits in some of the roads; however, so far these limits have been ignored both by the drivers as well as by law enforcing agencies. Separating different modes of traffic and lane management is required for effective use of speed limits that reduces accidents.

Quality of Road Structures: Patholes, rutting, cracking and raveling of road surface. Patholes means depression in roads, rutting is deformation along the wheel path of the vehicles, cracking and raveling are visible failures in roads on the relatively larger areas. These conditions in roads may result in losing of control of the vehicle by the drivers restating in accidents.

Skid Resistance at Road Surface: Sometimes a little roughness in roads proves to be helpful in resisting the skid of vehicle wheels particularly in narrow roads.

Hard Shoulder of Roads: In Bangladesh, most of the highways do not have hard shoulders because of limited space and fund constraints. Hard shoulders are normally constructed to provide extra space for the vehicles to avoid collision as well as to provide space for broken down vehicles. Hard shoulders are not in any case provided for slow moving vehicles.

Signs, Road Marking and Signals: Providing standard sign boards (Digital Boards) are for information of road ahead, such as, intersections, carves, exits, service stations, direction and distance of important locations, weather condition, road surface conditions, repair and maintenance works etc. Road markings, studs, cats' eyes are very important for managing the discipline of traffic system, lane discipline. Improved vision for drivers at night time etc. red, amber and green signals at die intersections or traffic police are provided to control the movement of traffic. Design of timing of the signals and enforcing law is very important for road safety.

Access Control and Road Side Activity: Access control is very important particularly for highway access of traffic to highways. If needed, should be provided with proper structure following geometric standards.

Roadside Activities: As minimum as possible road side activities should be allowed in the highways, however if essential, proper access controls have to be provided. In Bangladesh, generally, there are many market places grown up along the highways. These markets or bazars are often remaining crowded. Pedestrians, passengers of slow-moving vehicles, vendors, and buyers are always remaining vulnerable to become victims i.e. likely to be run over by fast moving vehicles.

Facilities for Pedestrians: Pedestrians are the most vulnerable group among the road users and as such proper road crossing facilities and barriers have to be provided for pedestrians. However, building awareness amongst pedestrians are also important so that the built facilities are appropriately used. The structures too should be designed in a way that ensures the use of the structures by the pedestrians.

Facilities for Disabled People: In Bangladesh, no consideration is given for access and use of roads and footpaths by disabled people. This is now time for thinking about dying issues that can help mobility of disabled people such as mere should be ramps in particular intervals on footpaths so that the wheel chair users can use the footpaths without any disruption and safety.

Road Safety Audit and Examples of Safety Measures: One issue which has already got attention from the engineers is that of black spots. RHD Road Safety Division has identified 209 such black spots of which remedial measures have been completed for only 17 such spots. The vulnerable T-junction near National memorial monument has been rectified by channelization of directions and so far, no recorded accident occurs after that the curvature on the Manikganj highway at which renowned film-maker Tareque Masud and journalist Mishuk Munir met tragic deaths has since been rectified. Planning Commission is currently reviewing a project proposal for rectification of 144 black spots.

- Typical engineering safety measures include incorporation and treatments of road shoulders
- Pedestrian facilities (segregated footways, crossings)
- Junction improvements
- Speed control devices
- Median barriers
- Access control
- Channelization
- Traffic islands
- Skid resistance treatment improved delineation devices
- Safety zones etc. including provision of divided roads

An important new engineering concept for road safety is road safety audit are earned out at discrete stages of the road development projects, namely, at feasibility stage, preliminary design stage, detailed design and pre-opening stage. Safety audit checklists are a key instrument and typically includes:

- Design consideration/approach
- Alignment: curvature, grades, visibility
- Intersections: layout, detailed geometric design, visibility, traffic controls
- Pedestrian facilities: provision for crossings, footpaths, refuge, segregation
- Cycle /non-motorized vehicle facilities: segregated/shared bicycle paths
- Motorcycle facilities: motorcycle lane, lane segregation
- Traffic signs and markings: sign location, visibility, delineation
- Road furniture: lighting, physical obstacles, bridge/culverts and
- Traffic management and operation: network management, parking, safety zone.

2.5 Constrain of Road Safety Research in Bangladesh

2.5.1 Institutional Weaknesses

Road safety improvement efforts and initiatives in Bangladesh seriously affected from several drawbacks and weaknesses in particular institutional weaknesses. Lack of support, coordination, cooperation, collaboration among safety stakeholders could be noted as the leading barrier for institutional capacity building.

2.5.2 Lack of Professional Capacity and Expertise

A road safety research unit ideally needs several members interacting to ensure a critical mass working together and maximizing the research's potential impact on road safety policy. University courses, short in-house courses, and overseas training should cover training needs. These are lack of a strong professional safety agency with adequate executive powers and responsibilities, fragmentation of responsibilities between agencies and insufficient inter-

agency coordination, low level of staffing and lack of professional capacity, lack of trained traffic police for effective enforcement and traffic regulations etc.

2.5.3 Under-reporting

A typical factor of focal significance in road safety for the executives is the gathering and utilization of exact and through information identified with road accidents. The understanding of those information can lead to a superior comprehension of operational issues, is a pre-essential for a precise determination of accident issues, aids the improvement of medicinal measures and enables us to assess the viability of road safety programs.

A far-reaching database is a fundamental essential for any viable road safety activity to be attempted. Every office, regardless of whether it is government or nongovernment, associated with road safety movement, ought to have an unmistakable comprehension of the nature, scale and conveyance example of the road accident issue they need to address.

The study uncovers that the present Accident Report Form (ARF) isn't sufficiently exhaustive to lead an inside and out examination. The structure contains 69 fields of data from which just the attributes examination of mishaps can be completed moreover, the structure is very hard for the police officers to comprehend and they are unfit to fill it property. Still pictures are significant for post-accident investigation however in the structure, there is no field to incorporate such kind of data. Indeed, even police officers don't have the alternative to take photos of the mishap situation in light of the fact that the police offices don't have any camera to catch the minute hello request to recognize the accident spots, police is utilizing an old chain age stock arranged in 1996 which is unequipped for distinguishing the real areas at present point of view. Moreover, police offices record those accidents only in which cases bend documented at the same time, as a rule, the accident that happen in our nation consistently, obviously no cases are documented at police headquarters and in this manner no records are reported there. Greetings any instance of accident First Information Report (FIR) is led in our nation.

At that point if there should be an occurrence of road accident, ARF is being filled. Inconsistencies are found by contrasting these data, which means that at the primary phase of chronicle we are trussing some significant accident information. Accident insights depend fundamentally on the precision of information itself and on the unwavering quality of the

succession of data joins. The wellsprings of accident information in our nation are one-sided because of bandit detailing, especially in tire instance of lower seriousness. The paper manages the detailing and recording framework in Bangladesh, ID of the association and their capacities in charge of keeping up the significant accident database, recognizable proof and evaluation of factors engaged with and surveys the potential wellsprings of blunders in accident information gathering just as distinguish the deficiencies of the present framework and propose some improvement choices.

In the same way as other different nations in the world, police are authoritatively in charge of announcing and recording of road accident.

2.6 Socio Economic Cost of Road Accident

Road vehicular accidents have been so incessant and regular to regular day to day existence that individuals tend to slight that these "high speed moving pieces of metal" are deadly and in some cases present as "weapons of mass annihilation". The issue in street security rises above the vehicle part. It is a health, social, and financial issue also.

Families are dislodged and their fates broke as a result of the abrupt end of their providers, which is a social welfare issue. Accidents lay off specialists, which in the end, if summed up, will mean a huge number of monies of potential lost profitability subsequently influencing local generation and kick the bucket economy.

It was seen that in our nation, traffic the board strategies have been actualized without much investigation, meaning disarray and in the end accidents. The scale and extent of the impacts of road accident on the lives of the general population included and the general public all in all must be obviously characterized for motivations behind bringing issues to light and as a contribution to kick the bucket arranging and assessment of the administration's street wellbeing intercession measures.

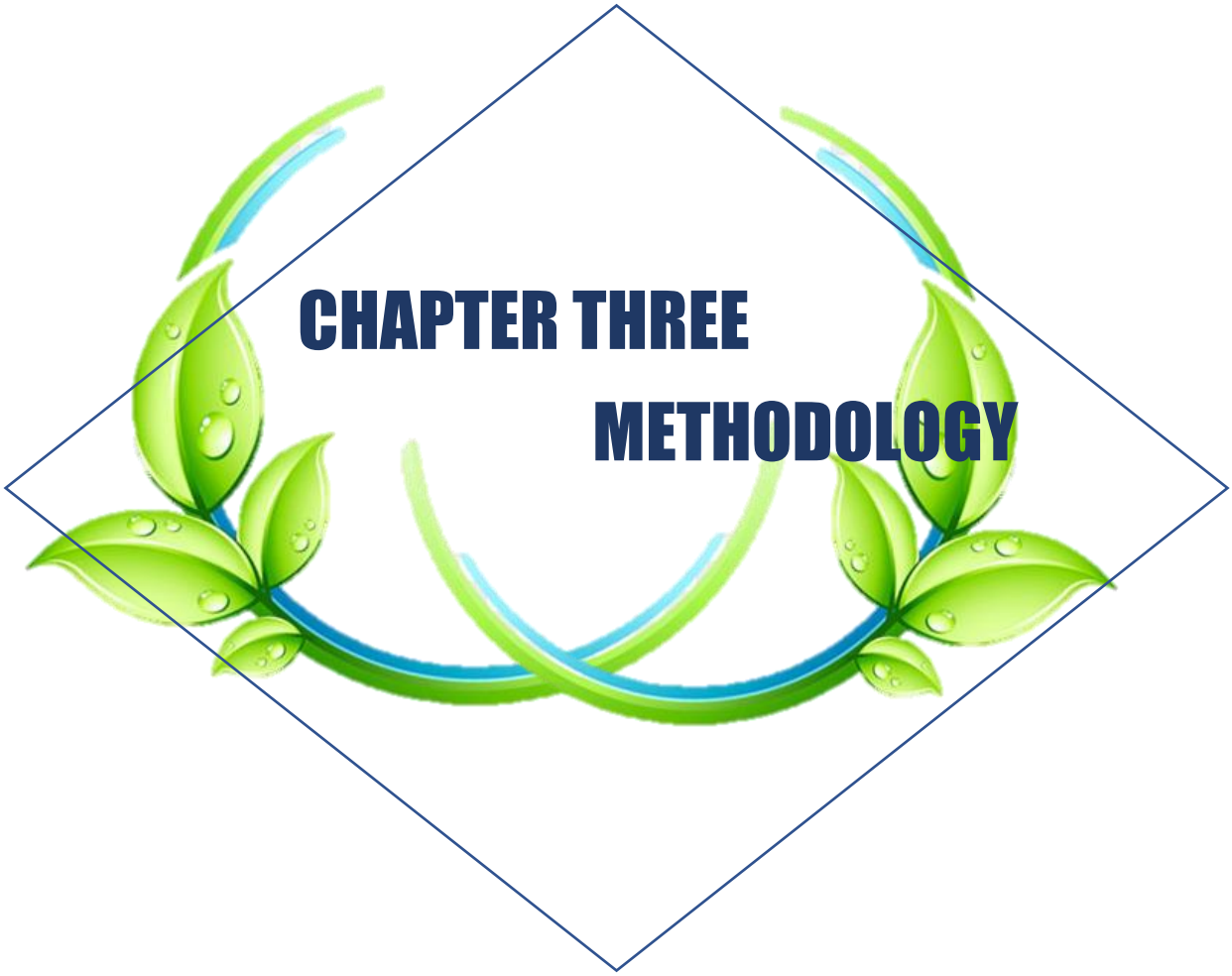
Utilizing the gross output strategy, which utilizes the human capital approach to costing, financial and social expenses of accidents have been resolved. The considered costs are:

- Medical cost
- Lost labor output
- Human cost: Pain, Grief & Sufferings
- Funeral cost
- Careers lost output
- Vehicle damage repair and vehicle maintenance
- Administration cost

Road safety should be given importance by providing a picture of the worsening effects of road accidents to our society and economy.

2.7 Summery

From literature review it uncovers a short review of road safety of the world alongside Bangladesh regarding its components, attributes, and need security improvement alternatives. Road infrastructure furthermore, environmental insufficiencies are especially common in accidents and casualties and building security out and about has obviously developed as a need issue in Bangladesh. Parts of Road infrastructure security improvement with regards to safe framework approach are hence illustrated. Specifically, the paper talks about blackspot medications, street security reviews and street investigation and evaluation. It is essential to note and discover that powerful security of the board of existing road network require infrastructure enhancements at focused areas all through the road organize separated from concentrating on only a couple of black spots.



CHAPTER THREE

METHODOLOGY

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METHODOLOGY

3.1 Introduction

The study can be comprehensively isolated into two fundamental subjects, initially investigation of the accidents and furthermore locate accident-prone utilizing GIS's spatial analysis tools. The identification of perilous highway area is a significant first venture for highway security improvement hazardous road location (HRL) program is a formal procedure, which intends to distinguish an area inside the road framework, which has an unsatisfactorily high rate of street mishaps, therefore to create fitting medications to diminish the expenses of mishaps. Once more, mishaps are additionally a component of highway working condition, roadside advancement, land use design, roadside action, dimension of authorization, traffic qualities which is a peculiar combination of motorized vehicle and non-motorized vehicle even in high standard national highways in Bangladesh.

Therefore, accident patterns are also related to these functions. In this chapter identification of hazardous road location, methodological consideration in accident analysis, various techniques to represent accident problem, evaluation methods including various statistical tests to ascertain the effectiveness of safety scheme, etc. are discussed.

In Bangladesh, we don’t have any digital road map or vector map exclusively for road traffic crash analyses. The digital map which is using for other purpose have lack of spatial information of every road segment that’s why it cannot co-relate with the crash data from police. Geographic Information System (GIS) has been identified as an excellent system for storing and managing these types of data and also as a potential tool from improving crashes analysis process (Mizanur Rahman, 2013).

3.2 Location of the Study Area

In this particular thesis following roads are included in the study area:

National Highway 5 (N5), Dhaka-Nobinogor. This portion road length is 25.7 km. After that R505 starts which continue at Chandra and it is 16.1 km then N4 starts which continue at Alenga. This portion length is 53.2 km. From Alenga N405 starts and it finishes at Hatikumrul. This road length is 42 km. Then again starts N5 road. It starts from Hatikumrul and continue to Bagura. This road length is 59.9 km and total road length is 196.9 km. Dhaka-Bagura is an important portion of the national highway network, forming the link between Dhaka and Bagura, the main connection to the Northwest part of Bangladesh. This road finishes at the last part of Bangladesh (Banglabandha, Panchagor) which passes through the districts namely Tangail, Sirajgang, Bagura, Rangpur, Kurigram, Nilfamari, Dinajpur, Thagoregaon and Panchagor. Therefore, Dhaka-Bagura is very important portion as the common highway of all.

The partial road network map of Bangladesh marked with study area is shown below:

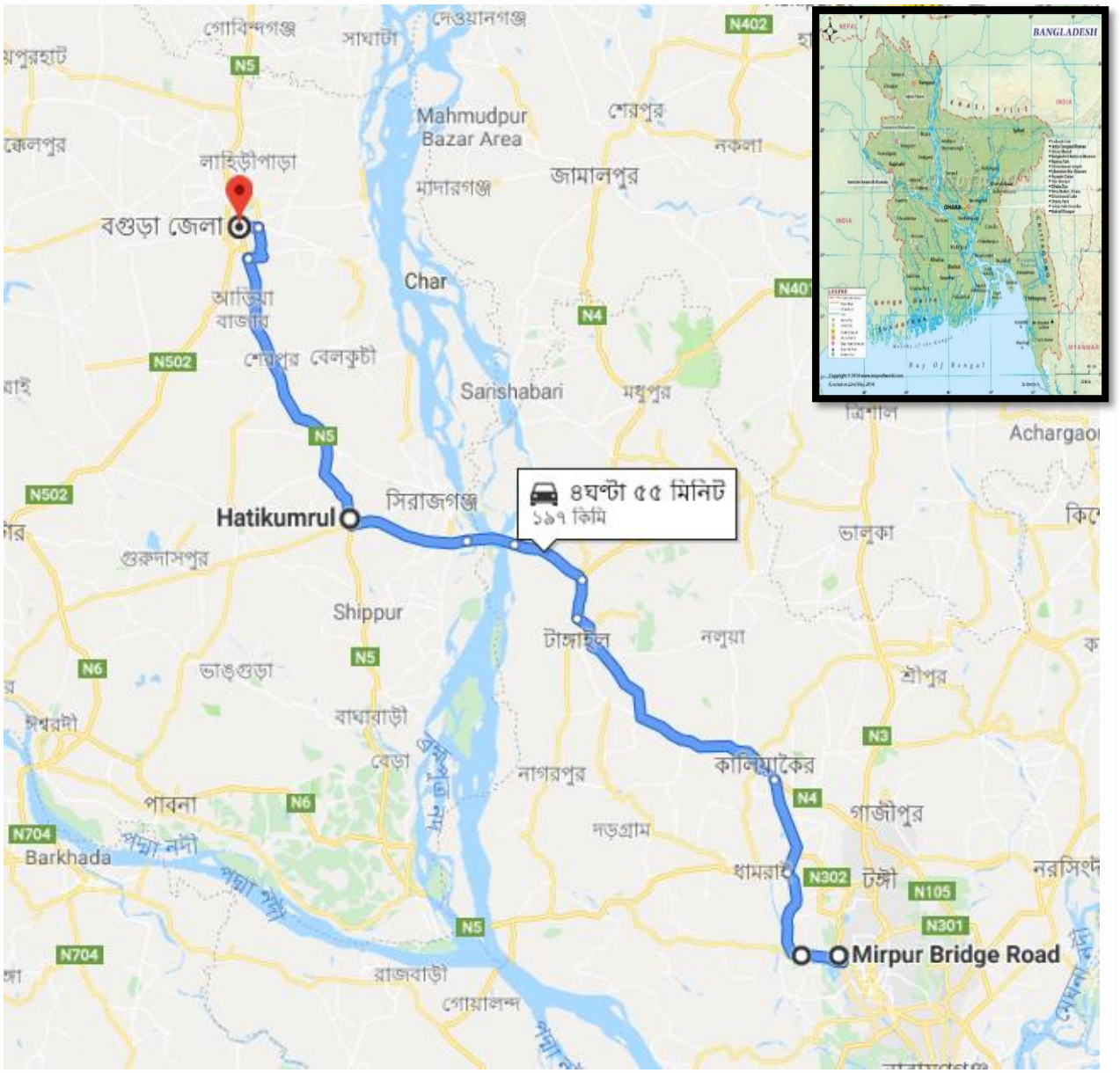


Figure 3. 1: Partial Road Network Map of Bangladesh Marked with Study Area.

3.3 Data Collection Procedure

Exact and thorough mishap information is the establishment on which all street security exercises ought to be based. An exact database encourages examination in both minute and naturally visible viewpoint. A mishap information framework ought to build up methodology for the gathering, stockpiling, examination, and spread of information for all car crashes. In

Bangladesh, the street car crash database is being kept up and refreshed by BRTA and ARI based on police information in MAAP5 (Micro-Computer Accident Analysis Package). Accident Report Form (ARF) was first presented in around 1995 in Bangladesh through sectorial activities subsidized by The World Bank and DFID. The framework was made across the nation by 1998.

MAAP5 programming bundle for putting away the mishap related information, was created by the Transport Research center of UK. The ARF on which the information is recorded has been made a necessary piece of First Information Report (FIR) documented by the police. The ARF structure has 69 distinctive sorts of inquiry, the most mentionable segments to the chronicle of the mishap information: Victim identity, Vehicle specifics, and conditions of mishaps. After complete numerous managerial methodologies, the FIR record winds up in ARI, BUET. The FIR information is then arranging, rectifying, and put away in MAAP5 programming.

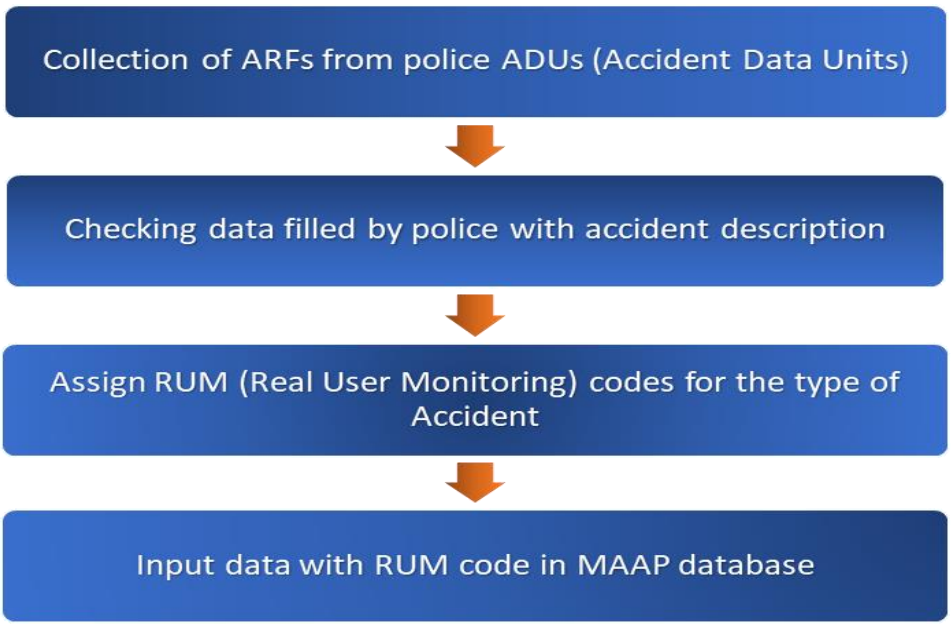


Figure 3.2: Flow diagram of ARI Accident Data Collection and Management.

As per ARI, the entire system takes in any event 2.0 years to finish. ARI takes the following advance in the wake of getting the mishap information to improve their database.

Accumulation of ARFs from police ADUs (Accident Data Units) checking information filled by police with mishap depiction assign RUM (Real User Monitoring) codes for the kind of accident information with RUM code in MAAP database. Though the police have been given

the obligation regarding recording the mishap information, there has not been relating endeavors to giving the important offices, learning, hardware, and capability to examine the street mishaps. Therefore, the scope of this study is confined, as many important aspects were not available due to data limitations. These problems relating to data availability and reliability are summarized below:

- As most of the accident data are extracted from crime index and FIR many important features like road conditions, lighting conditions the road surface etc. are not available.
- Difficulties in identifying the exact location. Most of these are mentioned as village, mouza or other prominent landmark and as a directional distance from police station, which varies widely for the same location. The same name covers a wide area; as such it was difficult to locate the exact position of the accident, sometimes the local name is used which creates confusion.
- Picture is very important for post-accident analysis but there is no photograph attach to the FIR file and police department does not have this facility. Though data has some weakness this is the only way to get the accident data. Therefore, the accident data is collected from ARI, BUET by using MPPA5.

The Roads and Highway Department (RHD) of BRTA have all the necessary records of the major highway of Bangladesh. BRTA also has the km post-coordinate and road maintenance records of all the regional highway and national highways. There is the only source to find those data of N4, R405, N5, and N505. The road maintenance data and km post-coordinate data are collected from RHD of Bangladesh. After collecting all the data, the whole data is classified, stored, standardized and prepared for accident analysis and blackspot analysis by GIS.

The flow chart describing the total procedure of the thesis work is shown below:

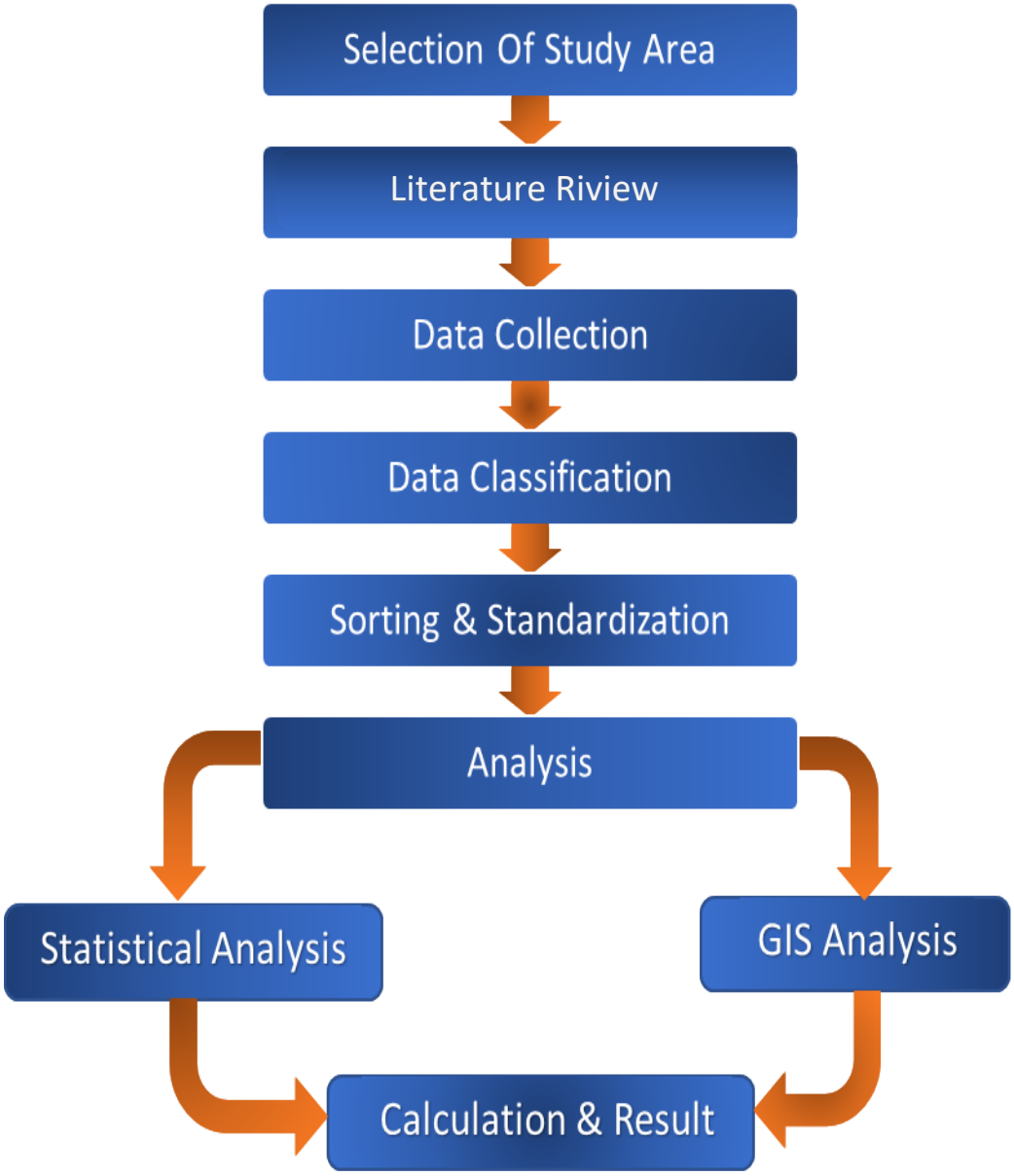


Figure 3. 3: Flow diagram of Methodological Step Followed in the Study.

3.4 GIS Technology

A Geographic Information System (GIS) is a computer system for capturing, storing, querying, analyzing and displaying geographic data. GIS represents a new paradigm for the organization of the information and the design of information system, the essential aspect of which is the use of concept of location as the basis of structuring of information systems. GIS technology can be viewed as an offshoot from two major software technologies i.e., database management system (DBMS) and computer aided design (CAD), with the addition of specialized functions for managing and analyzing spatial data i.e., data that can be referenced to a geographical location. The objective of any GIS system is to capture, store, manage, analyze, and visualize geographical data (Gupta, 2003).

GIS is a powerful computing tool for managing large amounts of heterogeneous data. A GIS can be effectively used to identify accident black spots on roads. The capability of GIS to link attribute data with spatial data facilitates prioritization of accident occurrence on roads and the results can be displayed graphically which can be used for planning and decision making. The process of registration, which involves conversion of vector data into raster data, helps in determining the suitability of horizontal curves provided on the roads. The results thus obtained can be combined using spatial and aspatial queries to obtain the desired results.

3.4.1 Black spot Identifications

There are no universal definitions for black spot location on roads. The definitions are varying from country to country. In normal séance, blackspot define as a site where significantly more accident happened then normal locations. There are no universal rules for identification of blackspot. The most frequently used methods are given below:

Method- 1:

The minimum section length 0.1 km and maximum section length 0.3km where 4 or more severe accident in 5 years' time period.

Method – 2:

The minimum section length 0.1 km and maximum section length 0.5 km where 2 or more fatal accident in 1 to 2 years' time period.

Method – 3:

Three or more accident in 3 years' time period, responsible for 3 or more fatalities. The minimum section length 0.1 km and maximum section length is 1 km.

In this study method, 3 has been used to identify the hazardous road location in this highway but the maximum section length is considered 1 km.

3.4.2 Spatial Interpolation

Spatial interpolation is a method that uses the known values at given locations to estimate a continuous surface. There are several types of spatial interpolation, including Inverse Distance Weighting (IDW), Spline and Kriging. Spatial interpolation is useful in a wide variety of contexts, such as estimating rainfall, groundwater pollution, temperature, soil science, geology, or the spread of a disease. It helps to fill in the gaps between known data points. A compression study between Kriging and IDW shows that the Kriging provides comparatively best result among them. Therefore in this thesis, Kriging method is used to analyze the Blackspot on Dhaka-Bagura to find out the faultiest section.

3.4.3 Kriging

Kriging is a progressed geostatistical strategy that creates an expected surface from a dissipated arrangement of focuses with z-values. Dissimilar to other insertion techniques in the Interpolation toolset, to utilize the Kriging apparatus successfully includes an intuitive examination of the spatial conduct of the wonder spoken to by the z-values before anybody chooses the best estimation strategy for producing the yield surface. The general formula for kriging interpolator is formed as a weighted sum of the data.

$$\hat{Z}(S_0) = \sum_{i=1}^{N} \lambda i \; Z(s_i)$$

Where,

$Z(s_i)$ = The measured value at the *I* th location

λ_i = An unknown weight for the measured value at the *I* th location

S_0 = The prediction location

n = The number of measured values

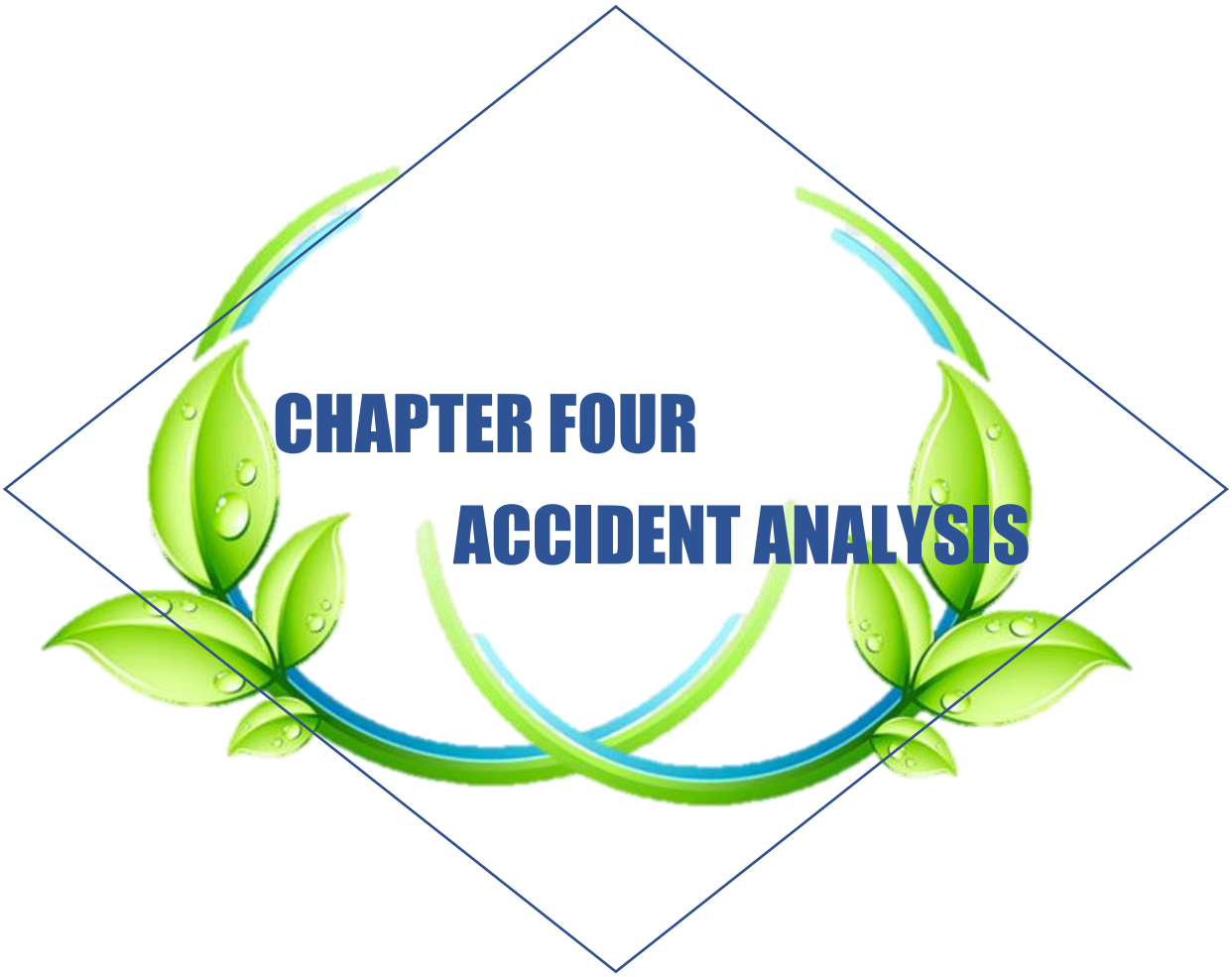
The kriging method is used in this thesis to identify the accident-prone road section on this highway, 9 years (2006 to 2014) data divided into 3 different classes as like blackspot analysis. The number of accidents uses as Z value. The accident data were collected from ARI (BUET) and accident location coordinate is collected from BRTA. ArcGIS 10.2 is used in this analysis.

3.5 Conclusions

Road safety has been an increasing concern to community in recent years in Bangladesh. This paper has discussed about the implementation of GIS in crashes analysis to make an effective way of analysis and represent the accident with the exact location and verification of the method for a major highway of Bangladesh. In the period of 2008 –2010, crashes occurred in only 2.2 percent length of N5 which clearly demonstrates that accidents are amenable to targeted and site specific. Four specific sections of these two national highways worthy of being treated as hazardous locations have been identified. In recent years, Dhaka-Aricha-Banglabandha highways have become very busy roads as it passes through three divisions of Bangladesh. On the basis of the results and findings, the necessary remedial measures should be provided to make the operation of this most important and widely used national highway (N5) of Bangladesh safe and efficient. Some potential measures are as follows:

- Effective and user-friendly pedestrian facility such as barrier, overpass, underpass, zebra crossing, pedestrian signal etc. should be established in those sections on the basis of its function. Also focus on speed reduction near bus stoppages also near schools, bazaar and residential should be considered.
- Head on and turn off collisions is also the dominating collision types at all the segments of the highway. Undivided highway, reckless overtaking are the main causes of head on collision. Therefore, divided highway and special overtaking sections should be provided. To arrest the vehicle turning off, vehicle fitness should be examined frequently.
- Appropriate signs, road markings, fencing, guardrails, junction modifications and improvements to visibility should be considered as remedial measure.

- Dangerous and inappropriate operation of heavy vehicles (buses and trucks) such as reckless overtaking, overloading and braking/stopping on roads and road sides are particularly a serious problem in all those segments. Therefore, adequate enforcement should also be considered.



CHAPTER FOUR
ACCIDENT ANALYSIS

CHAPTER FOUR

ACCIDENT ANALYSIS

4.1 INTRODUCTION

National highway (Dhaka-Bagura-Banglabandha) is one of the important and busiest highways in Bangladesh. The accident rate is very high on this highway. The road traffic accidents might increase with the rapid growth of populations and road traffic on this road. The in-depth scenario of the accidents from 2006-2015 is depicted by statistical data analysis and graphical representation. In the statistical analysis accidents and casualties have been classified and presented on the basis of different criteria vis-à-vis year, time of the day, month, the day of the year, junction type, the condition of light, casualty class, road user class, age and sex. That analysis helps to identify the most venerable types and road accidents and venerable road user. Also, the GIS analysis has been performed based on the number of the fatal accident and the number of the total accident in this portion of the highway.

4.2 STASTISTICAL ANALYSIS

4.2.1 Number of Accident and Accident Severity over the Year (2006-2015)

Dhaka- Bagura is one of the portions of the road Dhaka- Banglabandha. It is composed of N5, R505, N4, N405 and N5 respectively. This road is much accident prone. Very much accidents occur in 2006 (More than 80 accidents) and then dramatically changed it

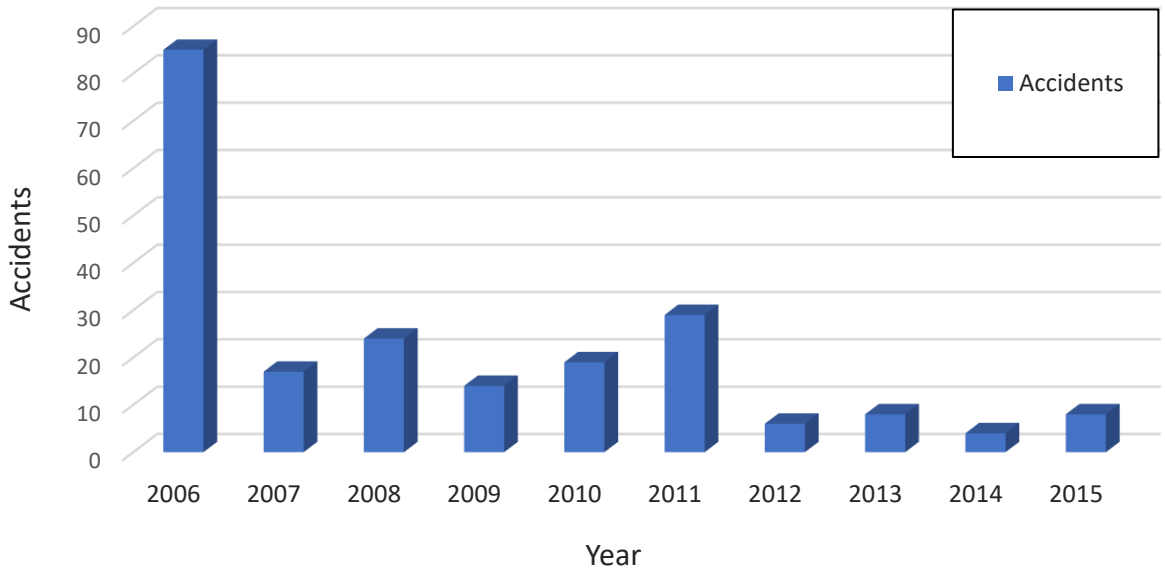


Figure 4. 1: Number of Accident Over the Year.

The casualty is also very high in 2006 (More than 120 numbers). As accidents decreases so casualties also decrease. In 2014, the less numbers of accidents occur and so less numbers of casualties occur.

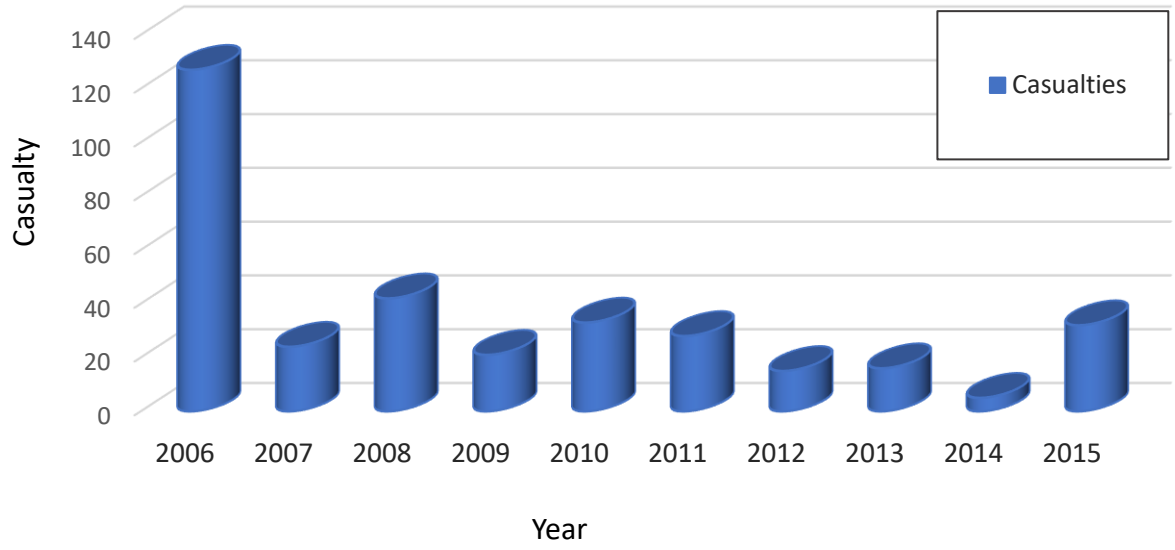


Figure 4. 2: Number of Casualties Over the Year.

4.2.2 Number of Accident per Month from Dhaka to Bagura.

The monthly accident data helps to understand the effect of weather condition in road accident. Although Bangladesh has six seasons but it has three distinct seasons, the pre-monsoon hot season from March through May, rainy monsoon season which lasts from June through October, and a cool dry winter season from November through February. However, March may also be considered as the spring season, and the period from mid-October through mid-November may be called the autumn. The following figure will demonstrate the road accident scenario of the month over the year 2006-2015 on the road of Dhaka to Bagura.

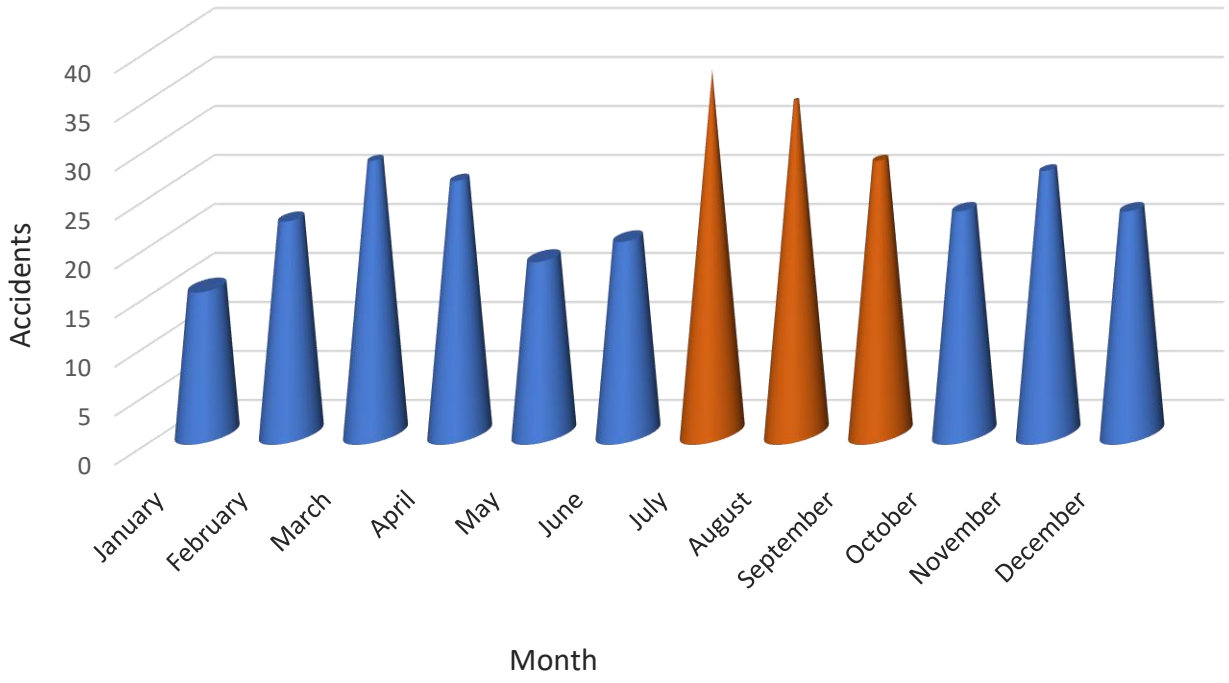


Figure 4. 3: Number of Accident Variation Over the Months (2006-2015).

Figure 4.3 shows that most of the accident happened from the month July to September. Therefore, it is clear that most of the accident happened in rainy season. In rainy season, the roads become muddy and slippery. Sometimes for excessive traffic, roads become damaged. This may cause the reason of excessive accidents.

4.2.3 Accident and Accident Severity Time of the Day Over the Year

The figure 4.4 shows the weakly accident. It shows that the less accident occurs in the Friday and most in the Monday. Actually because of Friday is the holiday it may be the one of the major reasons of the less accident. Most of the market, school, college and others institution remain closed at that day.

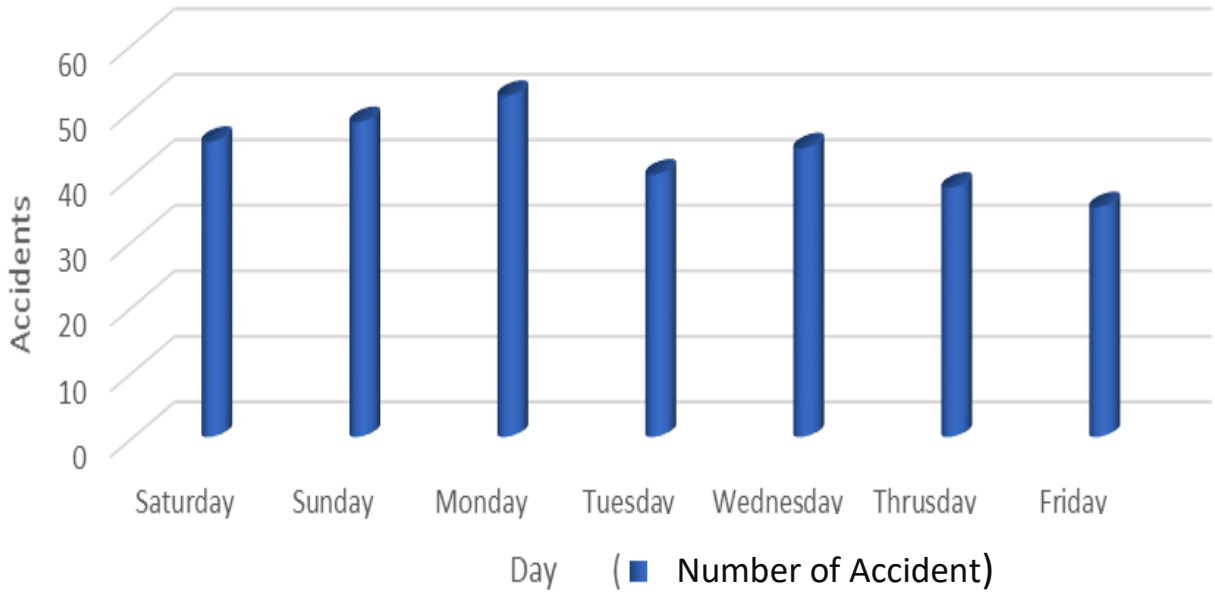


Figure 4. 4: Accident on the Day on the Weak Over the Year.

The Figure 4.5 shows that most of the accident occurs between 4 am to 5 pm. That means most of the accident occurs in the day time.

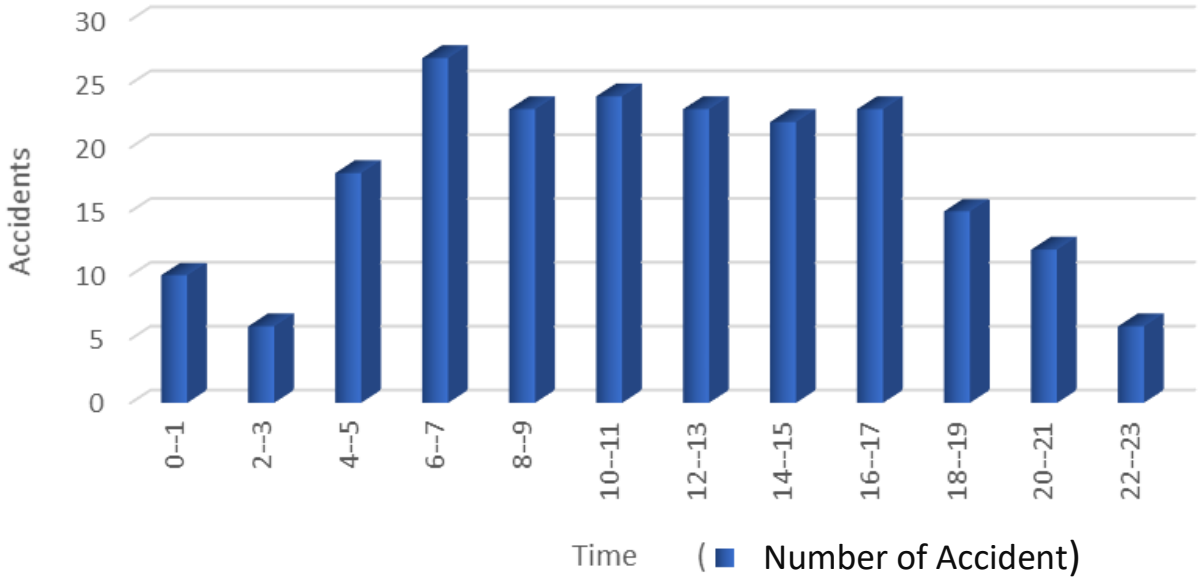


Figure 4. 5: Accident by Time of the Day Over the Year.

Actually 76.6% accident occurs in that time period and 23.4% accident occurs in the whole night. 55.10% of these accidents occur from 6 pm to 9 pm. Very much accident occurs in the 6 am and 7 am.

4.2.4 Accident Severity by Junction Type

There are total 272 numbers of bridges and culverts from Dhaka to Bagura. There are also many intersections are in the national highway. Therefore, the road geometry is very important factor to analysis of the accident. The figure 4.8 show that total 274 numbers of road accident were happened in the No-junction sections accident on national highway which were about 69% of total accident. Out of them, Cross junction and T-junction are worth mentioning. Besides significant numbers of accident occur in the other type of junctions. There was 12% of total accident occurred in the other type of junction on the national highway.

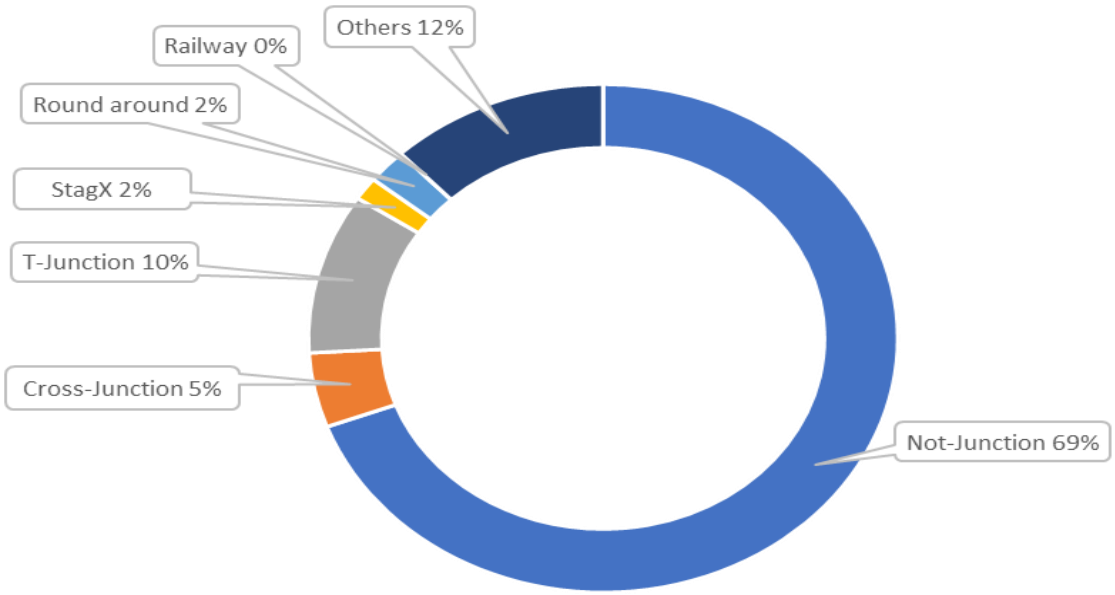


Figure 4. 6: Accident by Junction Type.

From the figure, it is easily understandable that most of the accident in the no junction area is fatal accident. Totally 148 numbers of fatal accident were occurred in the No-junction area which is about 66.97 % of total fatal accident. There is also significant number of griever accident happened in No-junction area. Totally 30 numbers of griever accident were happened in the No-junction area which is about 83.33% of the total griever accident on national highway. There is only one rail crossing in Ullahpara, Sirajgong on Dhaka to Bagura highway but it has no accident occured since 2009 to 2015.

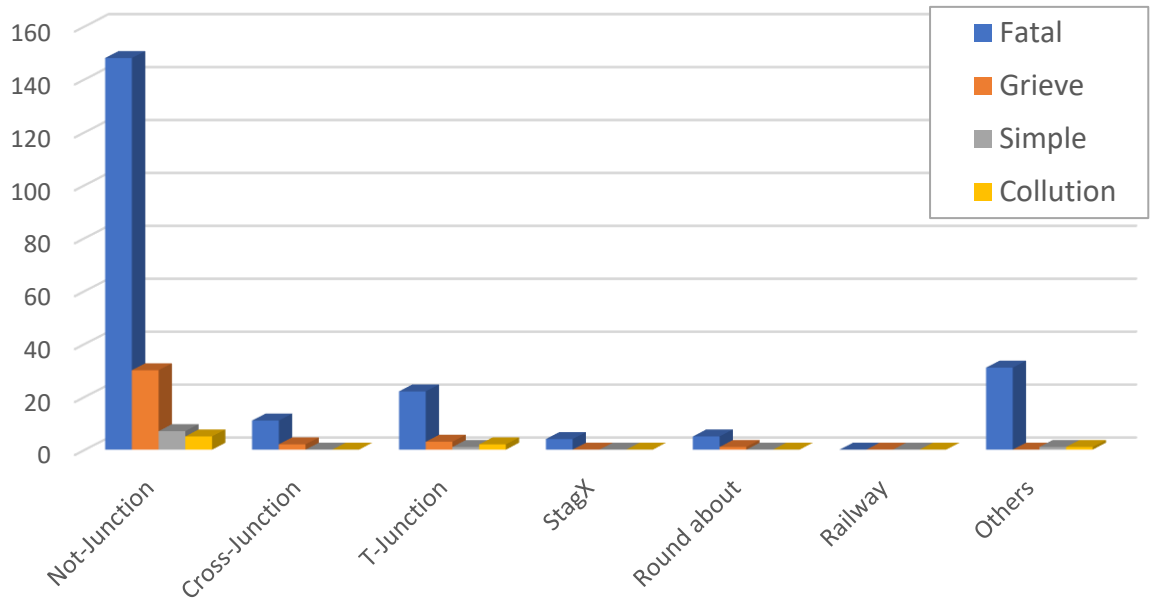


Figure 4. 7: Accident Severity in Junctions.

4.2.5 Accident Severity by Different Vehicle Class and Road User Class

According to the BRTA Bangladesh, the total vehicle of run across the country is divided into sixteen categories. Some of the vehicles are not motorized, some of them are lightweight class vehicle and other are heavy vehicles. The identification of most accident-prone vehicle classes may help to reduce the numbers of accident and the severity of accident. The pie chart below shows that most of the accident caused by the buses and trucks. Totally 154 numbers of accident caused by buses which is about 39% of total accident followed by truck which cause 100 numbers of accidents which is about 25% of total accident. In light class vehicle, the motorcycles are responsible for maximum numbers of accident which is about 5% and in non-motorized class vehicles rickshaws and cycles are responsible for 11 and 10 accidents respectively which is about 3% and 2% of the total accident.

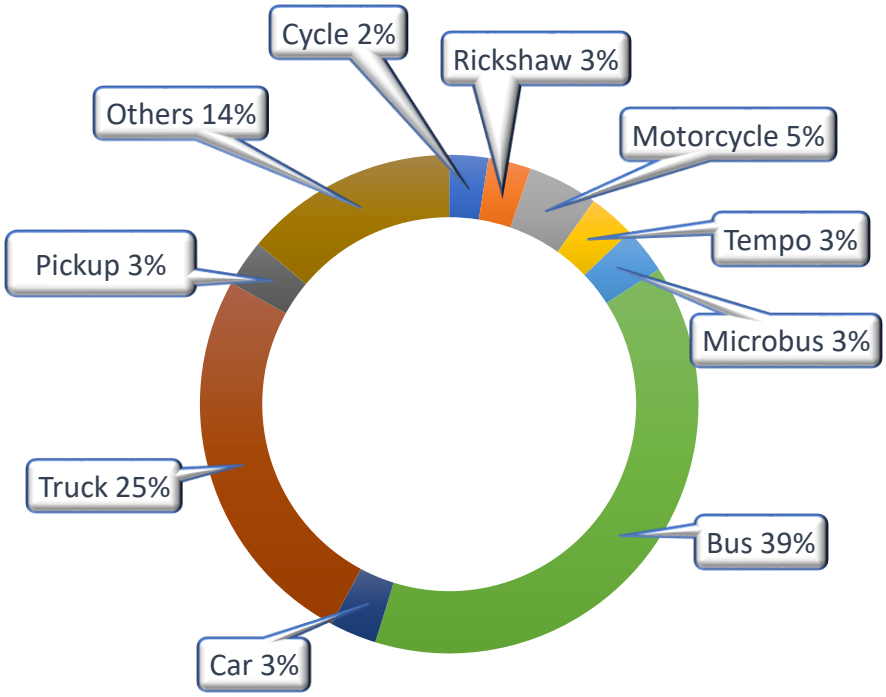


Figure 4.8: Accident Severity by Different Vehicle Class.

4.2.6 Accident Severity and Casualty by Collusion Type

Figure 4.9 shows that most of collusion on national highway is pedestrian accident. In Bangladesh, with a low level of motorization, the role of walking mode is quite significant. Pedestrians have received far less attention than vehicular traffic. Totally 217 numbers of accidents have been occurred on this region and shockingly the numbers of pedestrian accident are about 52.54% of the total accident. The most probable reason for this scenario might be illiteracy, lack of proper education of road user behavior, lack of fader road, footpath and road crossing and also lack of road safety. This is followed by head on (18.89%), rear end (11.06%) and overturning (5.53%) and side swipe (4.61%) types of accidents. Those all five accidents are sheared 92.63% of total accidents on this highway.

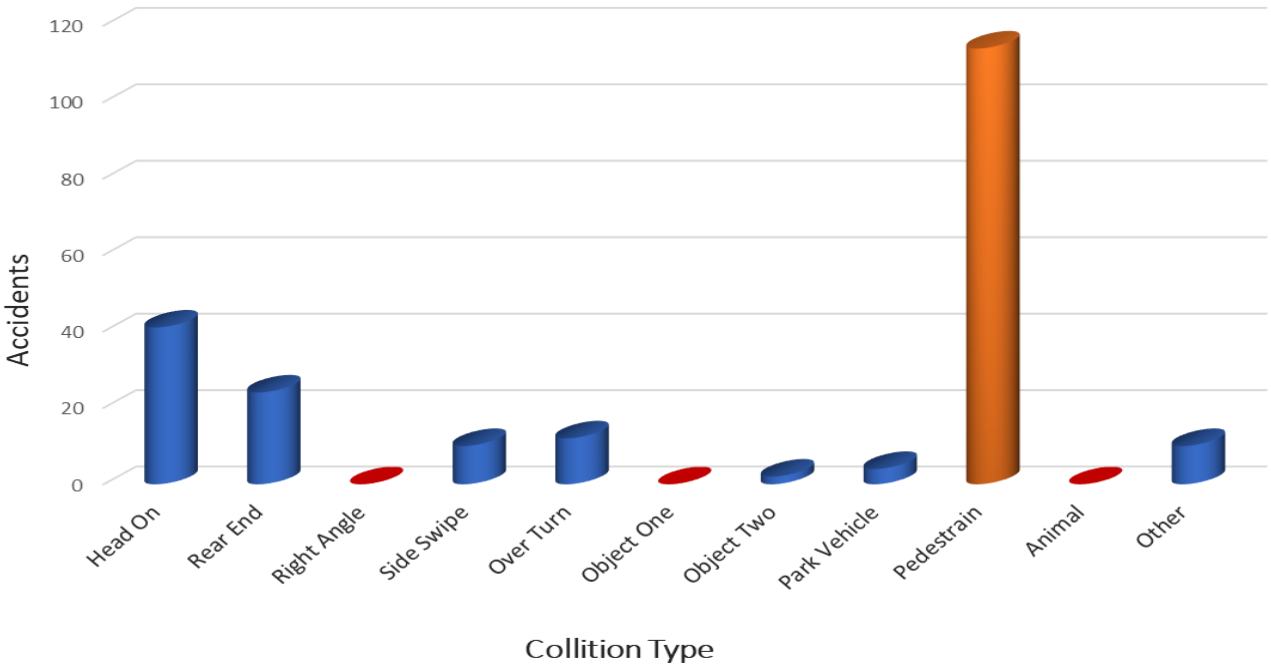


Figure 4. 9: Accident Severity by Collision Type.

Therefore, it is clear that pedestrians are most venerable road user group in Bangladesh accounting for 42% of all reported total accidents and 40% of total fatalities (Hoque, 2010). The global Status Report on Road Safety, 2013 confirm these observations pedestrians account for 41% of road accident followed by bus/car passengers which is 19% and two/three-wheeler passengers which is 16% (WHO, 2013) .

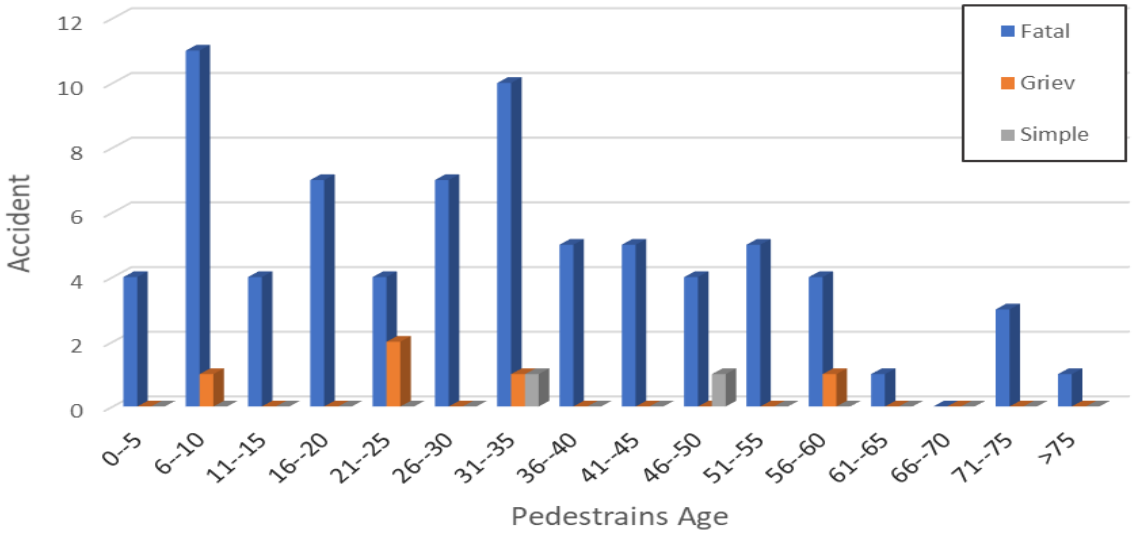


Figure 4. 10: Accident Number by the Pedestrian Age.

The young age people are very much liable to the pedestrian road accidents. From figure 4.10, it is seen that 6-10 years old and 31-35 years old people accidents are very much.

4.2.7 Accident Severity by Light

Figure 4.10 shows the severity of accident by conducting of light. It is obvious that the rate of accident is much higher during day compared to night though people think most of the accident occurs at night. From the survey carried out, it shows that 62.5% pedestrian thinks most of the accident happened at night. But from satirical data, it is seen that 76.6% accidents happened during day time. The reason behind it might be the higher percentage of the vehicle and pedestrian movement during the day time. It is alarming that the number of accidents at dawn is almost equal to that of night. Drowsiness of the divers may be the probable cause behind this.

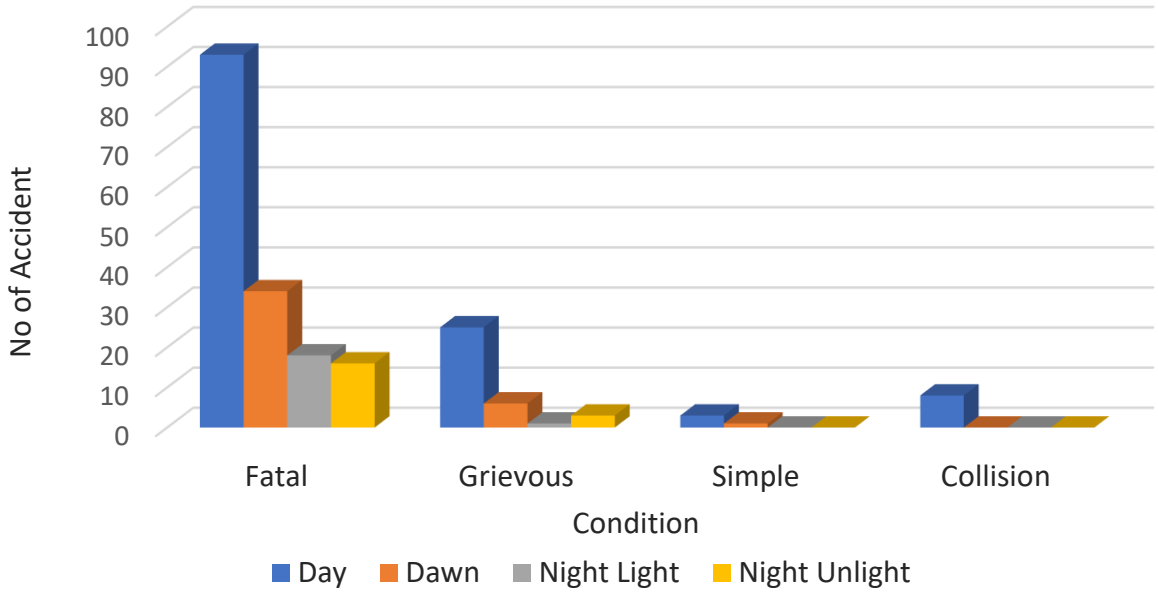


Figure 4. 11: Accident Severity by Light.

4.2.8 Accident severity by Age of people

Figure 4.12 shows that casualty rate is high for the people aged between 21 to 35. Causality is decreasing with the increasing of the people's age. People of 21 to 25, 26 to 30 and 31 to 35 age old causalities are 11.05%, 18.61% and 12.79% respectively and some of these are 42.45%.

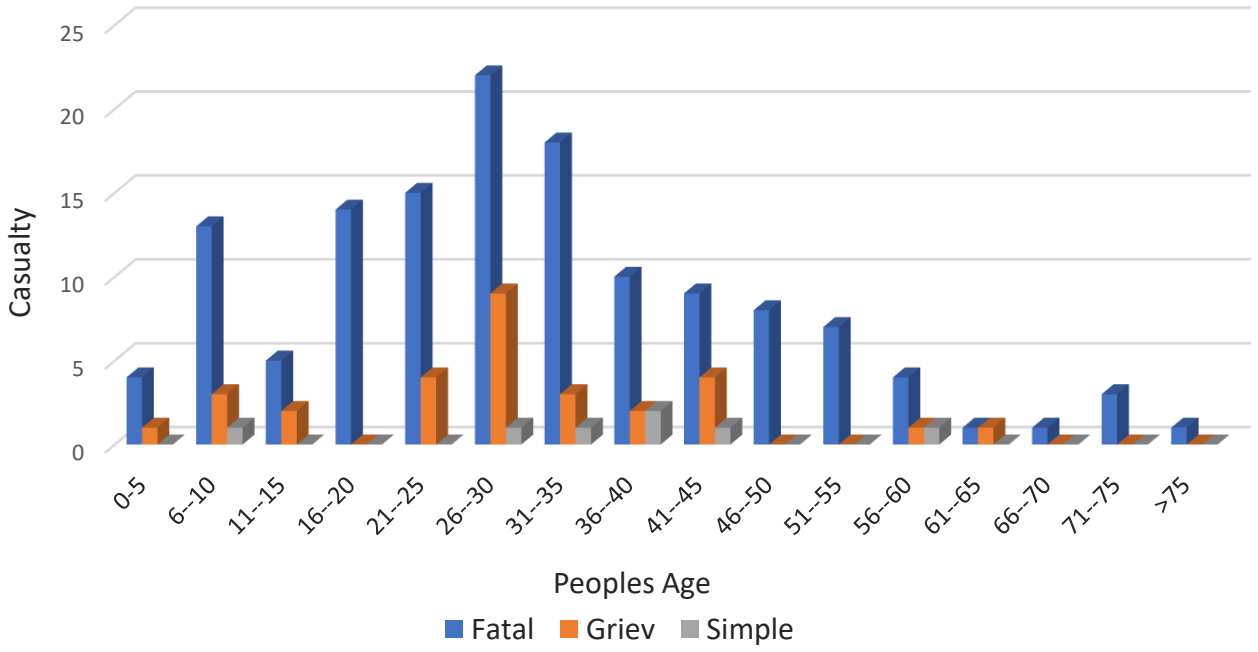


Figure 4. 12: Casualty by Peoples age.

4.2.9 Accident severity by Sex of people

From the figure 4.13, it is shown that the casualty of male is very higher in this road than the female. About 293 males injured in this highway (From Dhaka-Bagura) within 9 years and 69.28% of it is fatal accident. 38 numbers of fatal accident occur for female which is 76% of total female accident.

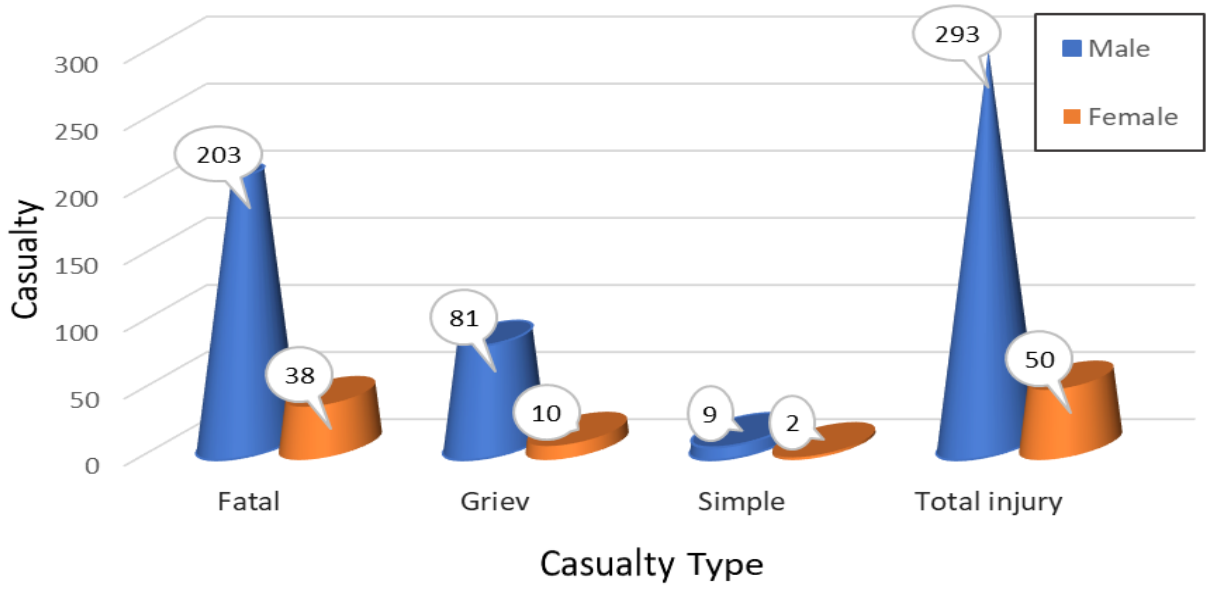


Figure 4. 13: Accident Severity by the Sex of People.

4.3 GIS Analysis

It is discussed earlier in methodology if 3 or more fatal accidents in the period of three years happened in 0.1km to 0.5 km length consider as black spot or hazardous road location more that 70 % of total accident happened in those location. The total length of black spot is small but scatters all over the highway. Therefore, it is very difficult to identify the faulty road section and cause behind the road accident. It is also difficult to understand which group is most venerable. Therefore, to identify the faulty road section and understand those factor GIS analysis need to perform that help to identify:

- Faulty road section
- Accident Severity by Collusion Type in the section
- Road user

The GIS analysis performed individually from 2006-14 every three year to demonstrate the black spot section variation over the years, also a final analysis has been performed to identify the faultiest road sections.

4.3.1 GIS Analysis (2006-2008)

Section Identifications:

From 2006-2008 just in three-year highest number of accidents happened on this road section. Total 77 numbers of road accident happened in just three year that responsible for 182 numbers of injuries where about 78.02% of them fatal. The GIS analysis help identify the most accident-prone road section. The analysis shows that most of the accident happened in just one section of the road (Figure 4.16). 31.32% of total accident and 35.21% of fatal accident (Figure 4.17) happened in this section. Figure 4.14 shows the overall scenario of this section.

Accident Severity by Collusion Type:

57.14% of pedestrian hit collision, 14.29% head on collision, 11.69% rear end collision were mentionable. 5.20% over turn collision was happened on this road, and the 77 numbers of collision were happened. 40.26% of total collision happened in this section.

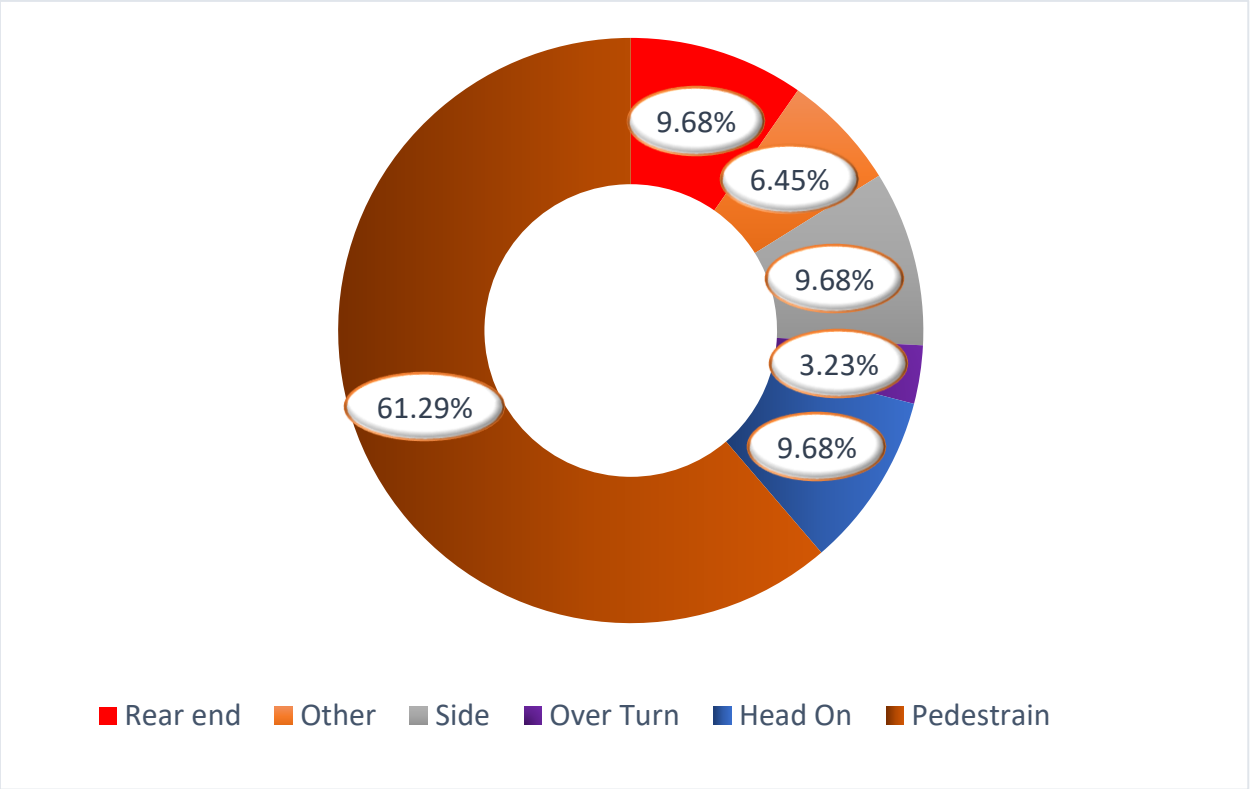


Figure 4. 14: Accident Severity by Collision Type in Black Spot Area.

Accident Severity by User Class

212 users from 16 different user groups were involved in 182 road accident from 2006-08, 78.02% of them were fatal accident. Buses and trucks involved into most of the accident. 45.28% buses and 24.06% trucks are responsible for the accident.

In this section, around 7 types of vehicle are involved in accident. Buses and trucks both of these are liable to 72% of accidents. 44% of these are bus followed by the truck which is 28%. The non-motorized and 2/3-wheeler were involved in mentionable which is 12% of total accident in this section.

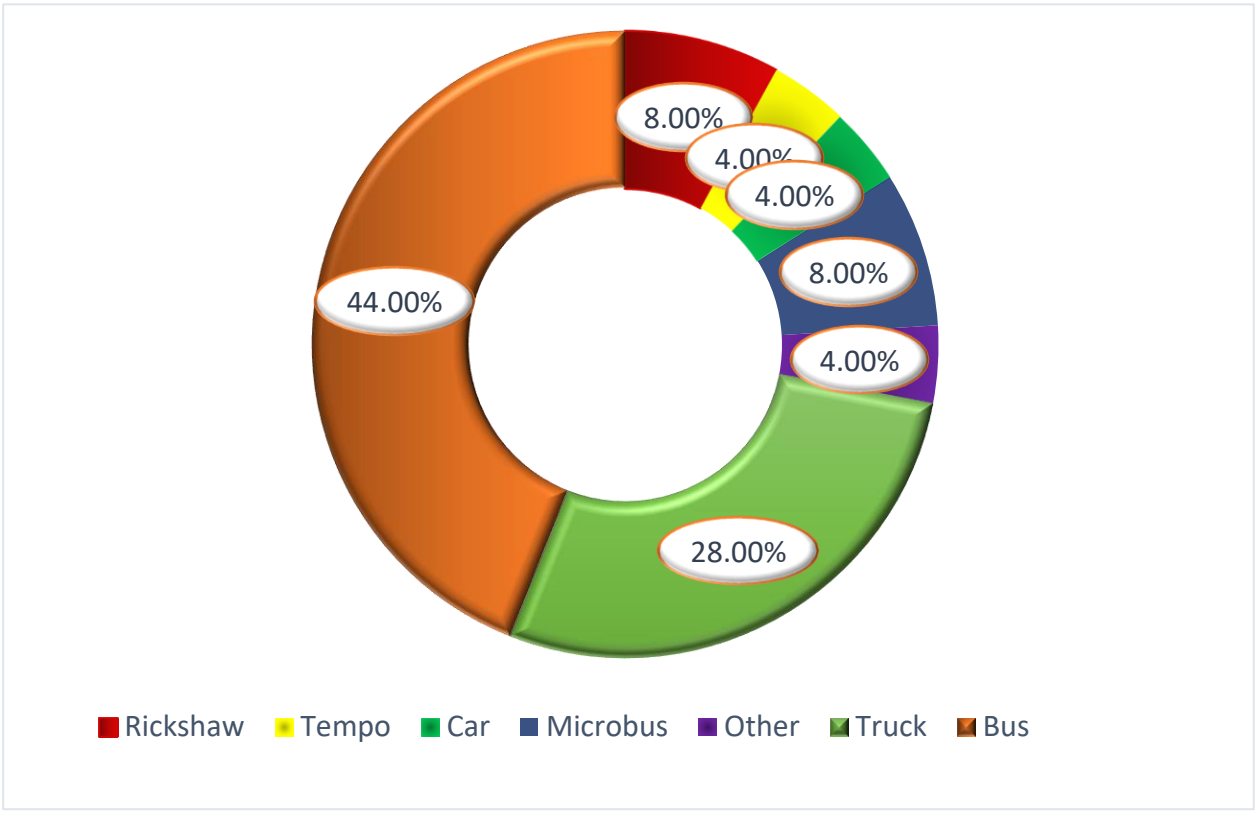
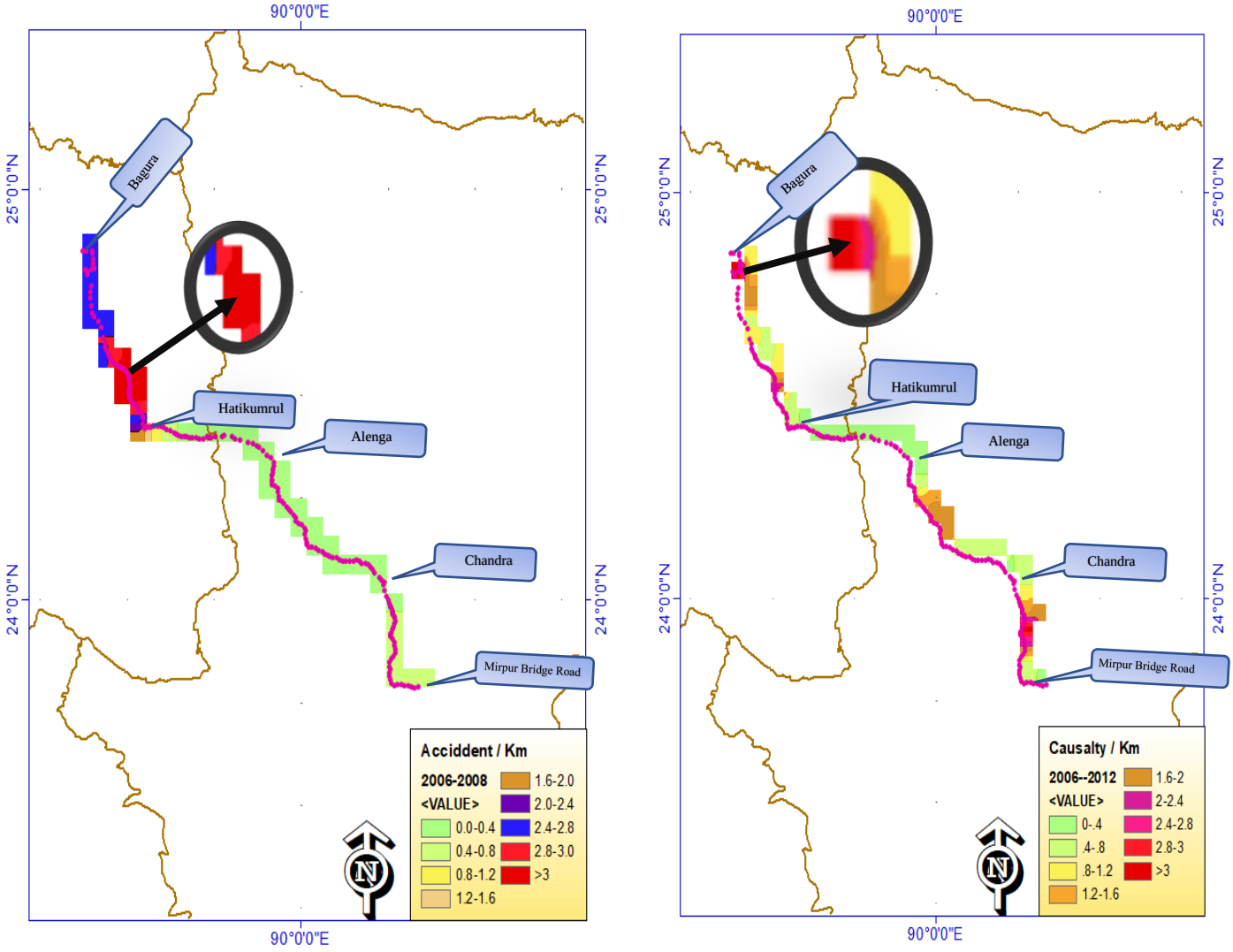


Figure 4. 15: Accident Severity by User Class in Black Spot Area.



The blackspot section starts from Royhati Bridge and finishes after 13 km (km post 149-162). In that point the road is not wide. Besides their remains a big bazar, a bus stand, a college. Therefore, it can be said that this portion may be very crowded.

4.3.2 GIS Analysis (2009-2011)

Section Identifications:

From 2009-2011 there were total 36 numbers of accident happened which were responsible for 79 numbers of casualties among them 72 numbers were fatal. Most of the accident happened just only in 9 km road section. 13.89% of total accident were responsible for 11.11% of fatal accident that happened in this section. Another 11.1% road accident occurred in 3 km road section (km post 146-148) and were responsible for 8.86% fatalities.

- Accident prone road section starts from km post 184-193 and also 146-148 (Its only 9+3=12 kilometers)
- 9 accidents happened here.
- No of casualties 15 and fatalities were 11 and grieve are 4.

Accident Severity by Collision Type

In these sections, 9 no. of collision happened of which 25% is of total collision. 55.56% of pedestrian hit which is 25% of total accident and 33.33% head on type collision which is 42.86% of total accident happened in these two sections. These two types of accident involved 88.89% in the blackspot area.

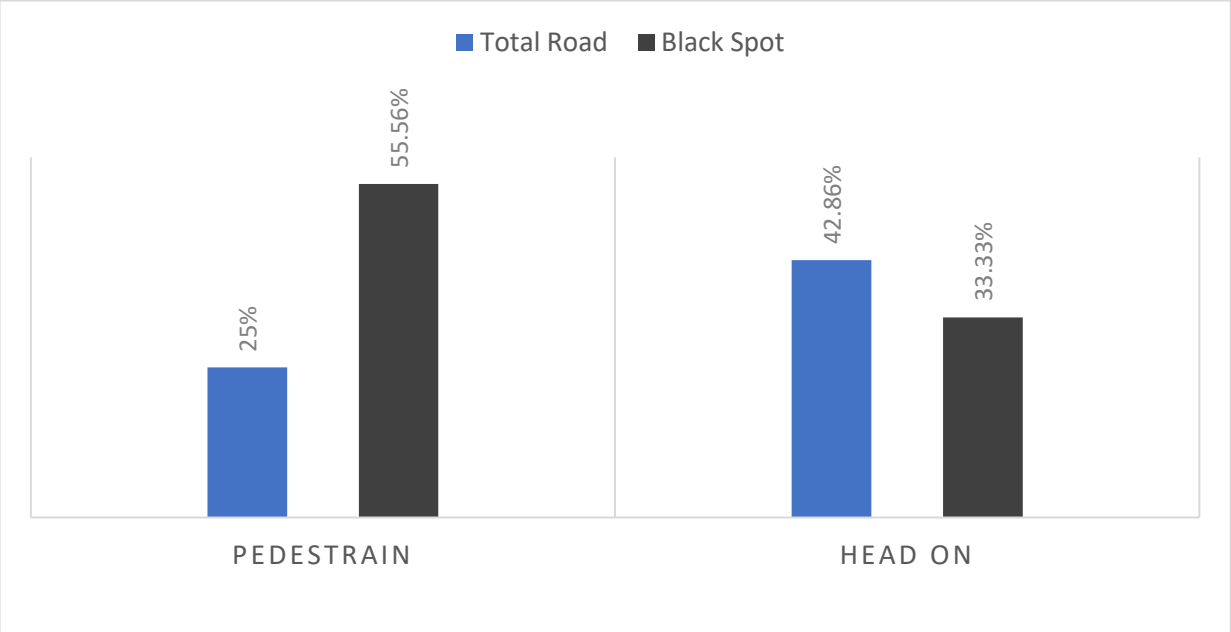


Figure 4. 18: Accident Severity by Collision Type in Black Spot area.

Accident Severity by User Class

104 different vehicles from 16 different user classes involved in road accident from 2009-2011 where buses and trucks were the most involvement group. 36 buses and 26 truck were involved in collision. In those two sections, 25% of total collision take place. 36.36% of all truck and 36.36% of all buses were involved in road accident in those sections (Figure 4.19).

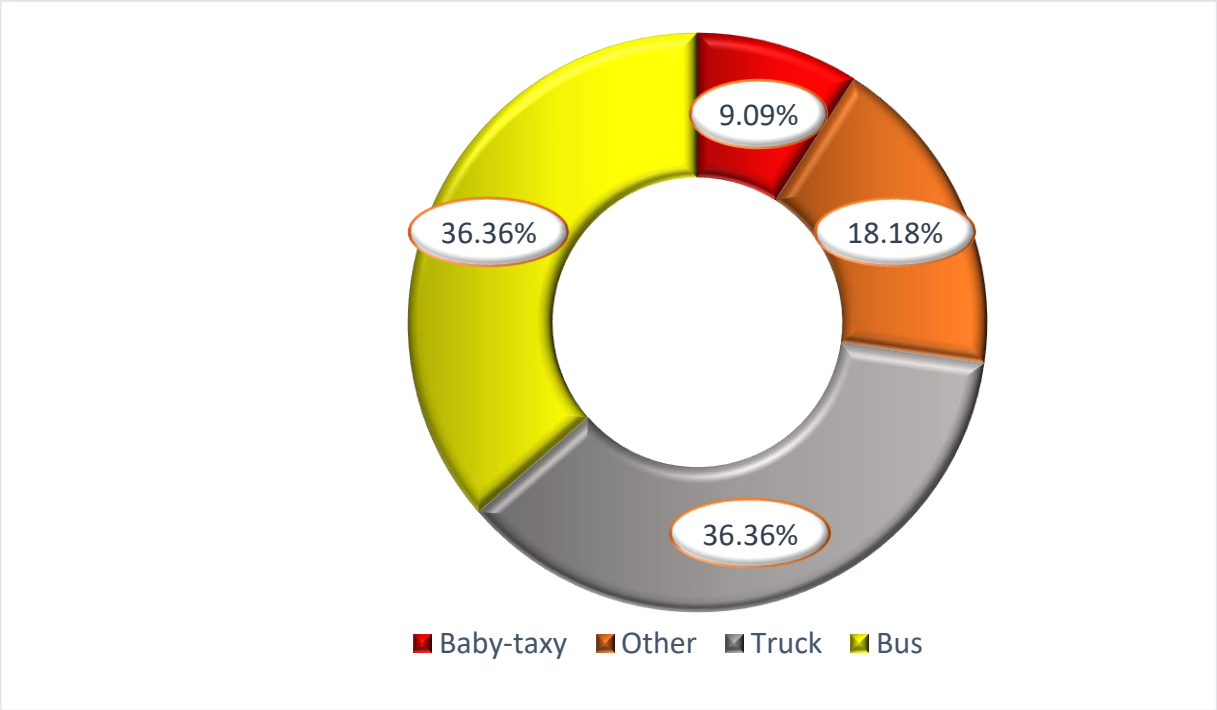


Figure 4. 19: Accident Severity by User Class in Black Spot

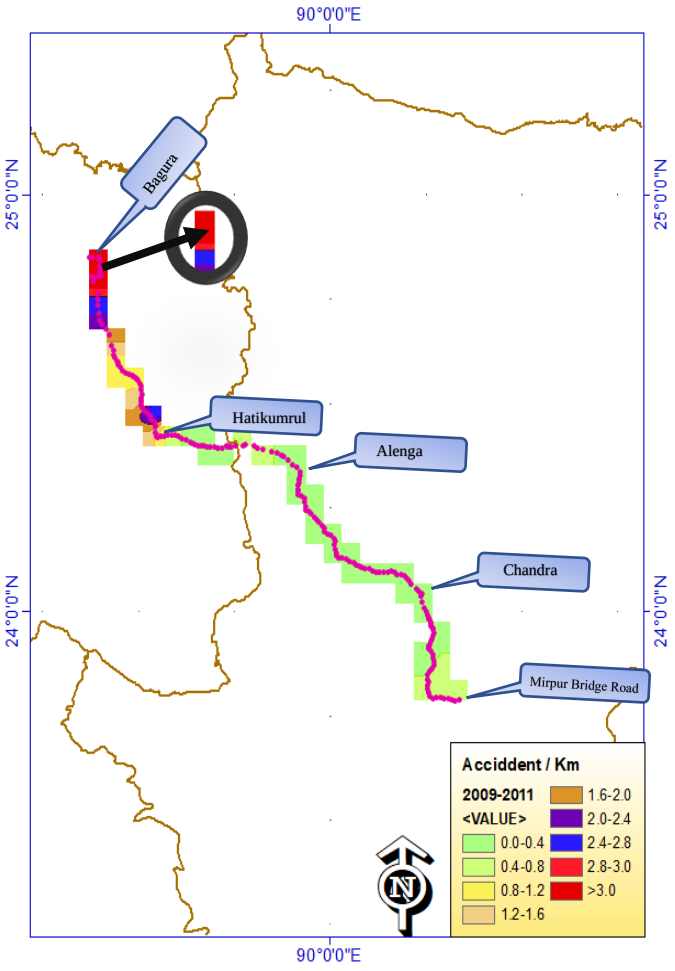


Figure 4.20: Number of Accident/km from Dhaka-Bagura.

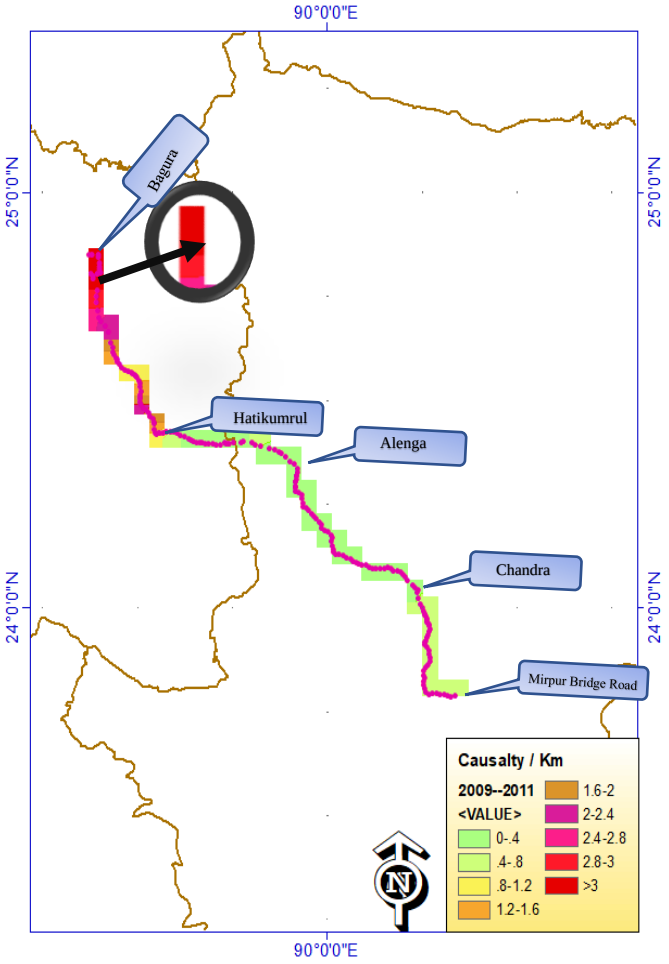


Figure 4.21: Number of Casualty/km from Dhaka-Bagura.

The hazardous road starts from the second bypass road of the Bagura. The second bypass road of Bagura is also very hazardous.

Another blackspot section starts after the Hatikumrul. It is around 3 km length.

4.4.3 GIS Analysis (2012-2014)

Section Identifications:

There were about 41 number of accidents happened in Dhaka-Bagura from 2012 - 2014, 43.90% of these are Head on type and 24.39% were Pedestrian type. Those accident were responsible for 108 casualties where 96 were fatal. GIS analysis shows that most of the accident happened in near the Bagura city. There were about 51.22% of total accident (Figure 4.24) and 44.79% of fatal accident (Figure 4.25) happened in this section.

- Accident prone road section starts from km post 181 and ends at km post 193 (Only 12 kilometers)
- Number of accidents happened here 21
- Number of casualties 46 and fatalities are 41.

Accident Severity by Collusion Type:

There were about 21 numbers of collision took place in this section. Most of them were head on collision followed by pedestrian hit accident.

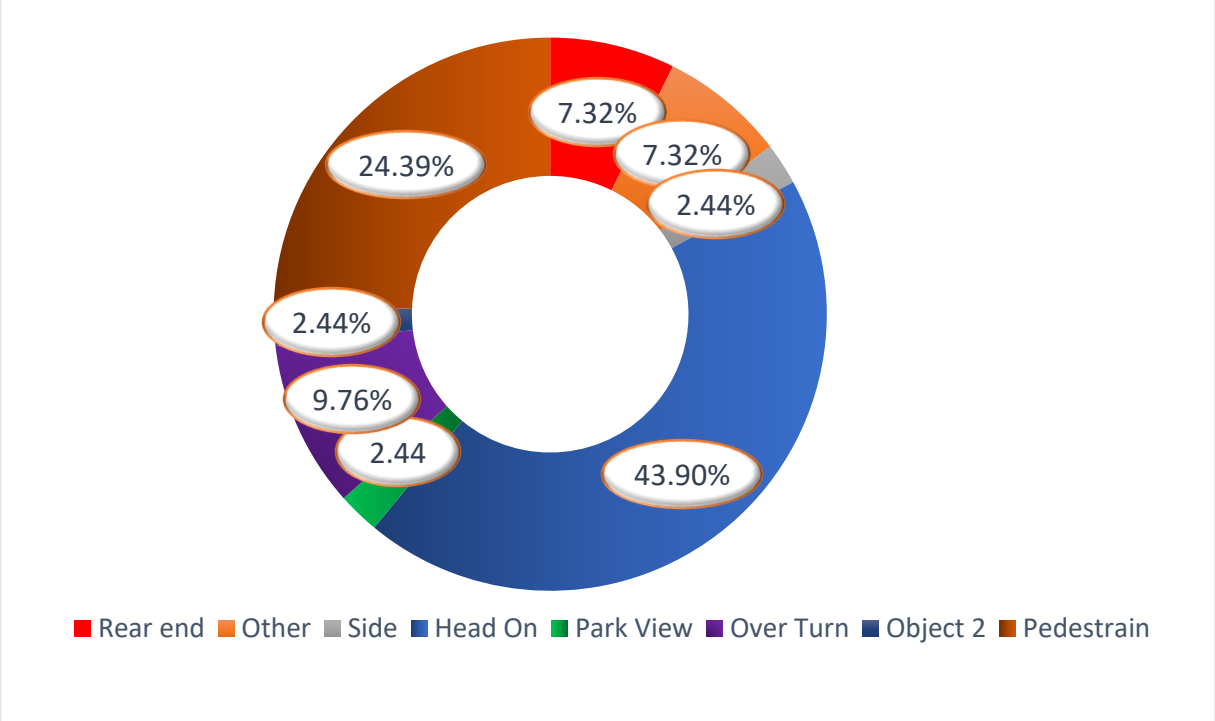


Figure 4. 22: Accident severity by Collision Type in Black Spot

In this section, totally 21 numbers of collision took place which was about 51.22% of total collision. 43.90% of these were Head on type and 24.39% were Pedestrian type. In this section 38.88% of total head on collision happened which was 43.90% of total collision and also 50% of pedestrian hit collision happened which 24.39% was of total collision.

Accident Severity by User Class

It is clear that trucks were mainly responsible for most of the accident followed by buses. These two vehicles involved in 54.32% of total accident. In this section, those two vehicles involved in 58.82% of accident of the sections which was 24.7% of total accident. The non-motorized and 2/3- wheeler were involved in mentionable 14.71% of total accident in this section.

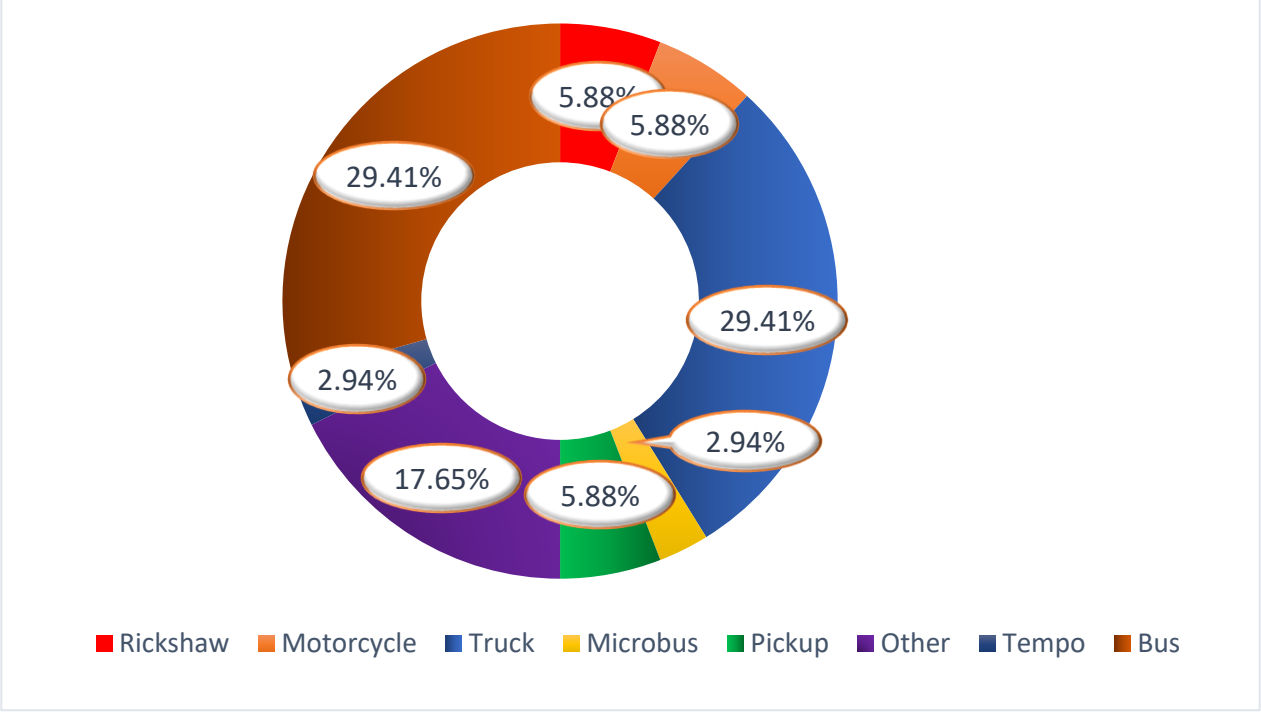


Figure 4. 23: Accident Severity by User Class in Black Spot

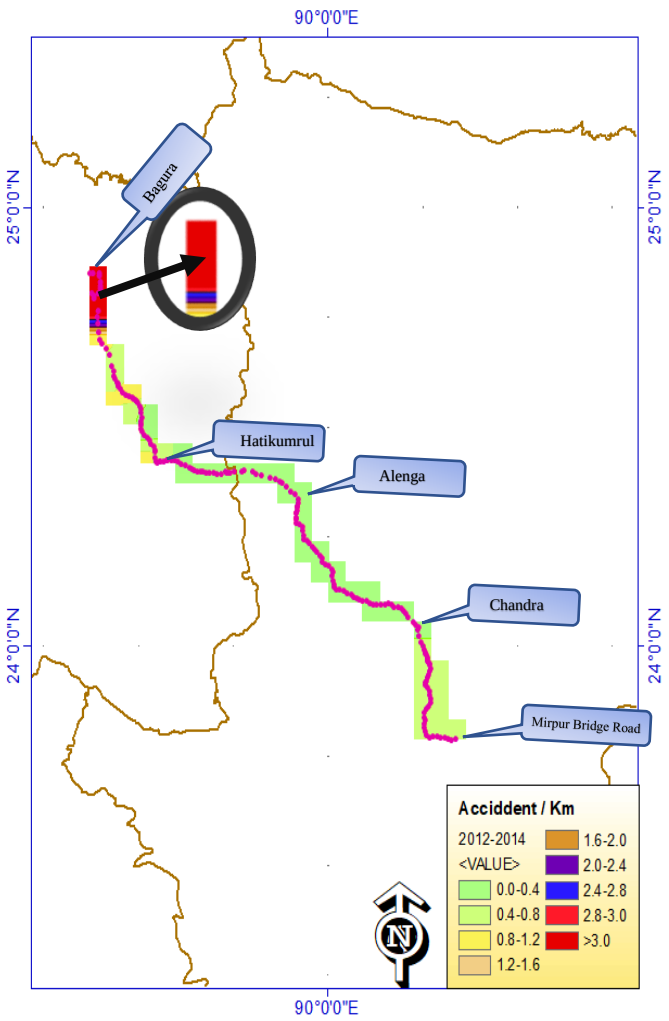


Figure 4. 24: Number of Accident/km from Dhaka-Bagura.

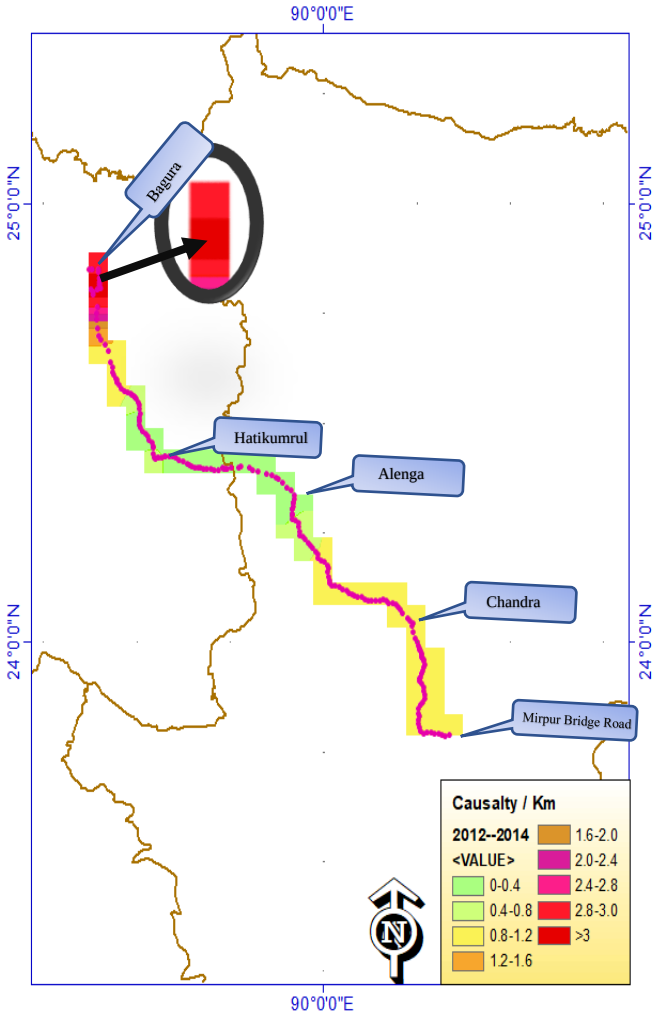
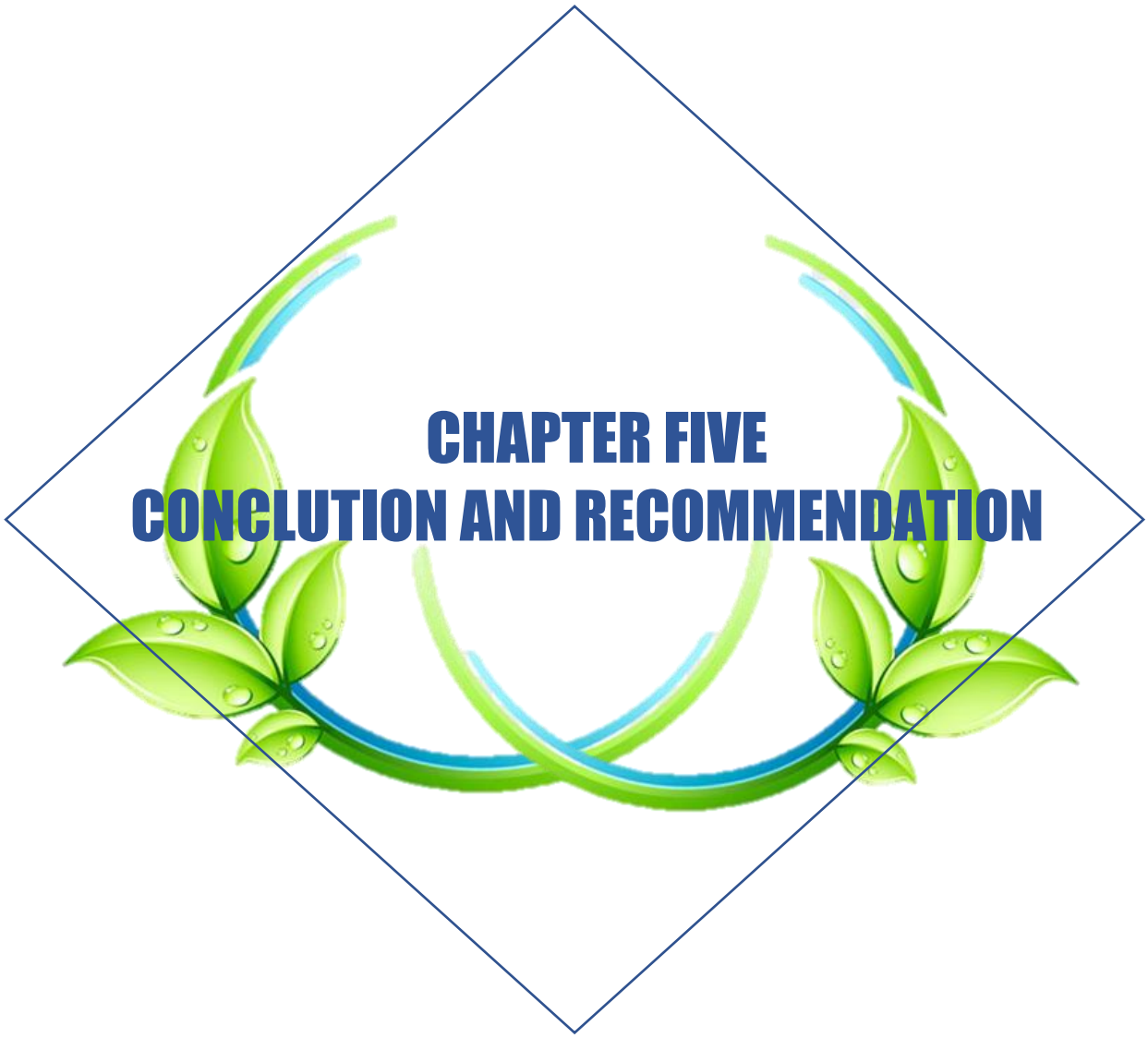


Figure 4.25: Number of Casualty/km from Dhaka-Bagura.

The hazardous road starts from Sajapur which was near to the second bypass road of the Bagura. The second bypass road of Bagura was also very hazardous.



CHAPTER FIVE
CONCLUTION AND RECOMMENDATION

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 General

This paper has highlighted the characteristics of the accident and accident scenario and evaluates the performances of installed safety features, along Dhaka-Bagura highway, for the entire study duration. The high rate of fatal accidents in this highway is the cause for alarming and unacceptable situation. Cost of the countries' economy is extensive and the financial impact of personal injuries can wreck families. Emotional cost is something that can't be measured to family members and friends when a person is killed or injured.

A concluding overview of the implications of this research is presented in this chapter in brief with specific research contribution. The summary of findings of this study, conclusions and understanding of the factors contributing to the frequent occurrence of accidents. Few recommendations are suggested which may lead to better design of safer highway in the future.

5.2 Major Findings of the Study

- Dhaka-Bagura highway is one of the most accident-prone highways of Bangladesh.
- About 35 – 40 percent of reported accidents (km post known) occurred in only 5 percent length of the highway.
- The fatal rate is about 1.5 per fatal accident which is pretty high.
- Accident rate is severe during July to September than any other time of the year.
- Most of the accident happened in the rainy season.
- About 76.6% of the total numbers of accident were happened between 4 am to 5 pm of the day times.
- 69% accident was happened in the no junction area which was about 79% of total fatal accident.
- Busses and Trucks were the mostly responsible for accident. Buses were sheared 39% of total accident followed by trucks which were caused 25% of total accident.
- Pedestrian were the most vulnerable group. 52.54% pedestrian hit accidents that were responsible for the leading cause of death on this highway. 2-3 wheelers had the sheared of 13% of total accidents.

- Head on, rear end and over turn were the other type of accidents which happened most next to hit pedestrian.
- There were a stereo type thinking that most of the accidents happened in night time but on this road but most of the accidents happened in day time about 76.6% of total accidents.
- The accident rates and fatal accident rates of those road obtained by GIS. The GIS analysis helped to identify the most accident-prone road section.
- The GIS analysis showed that most of the accident happened in just a section of the road. This section location was quite similar to all the years.

5.3 Limitation

- Many recorded accidents in the FIRs are not filled up by police in the newly introduced accident report form and thereby remain unreported.
- In the main FIR form and Crime Index, most of the time number of person killed/ injury and cause of accident are not filled up properly.
- Accidents photographs are very important for post accidents analysis but there is no logistic support to take the photograph by police personal.
- Sometimes exact location of the accident is not mentioned in the FIR/newly introduced form.
- Collection of primary data of RTA was not possible so the analysis was performed on the basis of secondary data.
- From data collection to data storage in ARI is taken almost 2 years, so it is impossible to find up to date data.
- For some administrative problem, the ARI does not provide there least data.
- For lacking of sufficient fund, the black spots locations surrounding can't be confirm.

5.4 Recommendation

The overall study on road accident analysis has highlighted some developing areas which should be concentrated to improve the service on Dhaka-Bagura highway. Deaths and serious injuries from driving accidents would be reduced as a result of the development and implementation of the following measures.

For Drivers

- In terms of recruiting drivers, the owner should pay attention in proper justification of their driving expertise.
- A continuous periodic training should arrange to keep the drivers, supervisors, and helpers up to date with recent journey issues like road and highways rules and regulation, accident information, passengers demand on journey, road security and safety, marking, traffic sign etc.
- Promoting partnership driving arrangements to encourage friends or co-workers to assist drivers in self-improvement efforts.
- They should not drive with drowsy eyes.
- Unnecessary overtaking should be avoided.

For Universal People

- Pedestrians should follow traffic rules and regulations in all circumstances as they are most prone to danger and should always be concerned about their surroundings while they move along or across the road.
- People should use footpath while they move along the road. On the other hand, foot over bridge and zebra crossing should be used at the time of crossing the road.
- Motor Cyclists should wear safety helmet.
- Passenger should wear seat belts.

For Administration

- Government should ensure implementation of the rules strictly and strict regulatory and law enforcement measures are important to reduce roadside frictions and hazards.
- Roads and Highway authority needs to give attention on Dhaka-Bagura to keep it safer to drive. To reduce accident, it is badly needed to use divider or one-way road at the black spot.
- Head on and Rear end collisions dominate collision types in this road. Therefore, RHD should provide divided highway and special overtaking sections to reduce head on collision and exclusive lane for NMV may reduce rare end collision
- Treatments of road shoulders, wide and strong shoulders are very much important for movement of pedestrian, cyclist, rickshaw, and animal drawn traffic in the highway.
- Pedestrian is the most vulnerable group. Therefore, pedestrian facility such as pedestrian barrier, overpass, underpass, zebra crossing, pedestrian signal etc. should be increased. Also focus on speed reduction near schools, bazar and residential should be considered.
- Physical separation of pedestrians from motorized traffic particularly on the sites in urban or bazaar areas where the concentration of pedestrian is very high.
- Adequate access control through proper geometric design modifications of access roads and placement of give way and stop signs and markings.
- Raised reflective pavement and edge markers, guide posts, chevrons are of critical importance to the safe and efficient operation of the road system and are vital in enabling drivers to locate the vehicle on the roadway and to make path selection and control decisions.
- Basic road safety education should be introduced in the primary and secondary curriculum importantly in the roadside school and colleges.
- Raising public awareness about accidents and road safety through motivational program as well as mass media, organizing rally, special days and weeks on accident and road safety.
- Better medical emergency services and infrastructure on highway and streets thus, more survivors after crashes.
- The accident rescue and immediate treatment may save many lives and many victims permanent health problem. Only one hospital between the blackspots may save many lives and prevent permanent health problem.

For Police

- To ensure the security, some police check posts can be provided at a controllable distance and additional police enforcement is needed particularly at day of Bazaar in some locations.
- Training of police personnel are vitally important for proper enforcing of traffic laws and regulation and proper recording and reporting of accident.
- Traffic policing have to be intensified on major roads. Dangerous offences especially those related to improper lane-change man oeuvres, wrong-way driving and undisciplined road user's behavior should not be tolerated.
- Dangerous and inappropriate operation of heavy vehicles (buses and trucks) such as reckless overtaking, overloading, and braking/stopping on roads and road sides are particularly a serious problem in all those segments. Therefore, adequate enforcement should also be considered.
- Illegal license should be prohibited strictly.

For Vehicle

- Out of fitness vehicle should be banned.
- Every important part of vehicles should be checked before starting a journey.
- Better designed vehicles thus equipped with crash proof designs and better safety drivers such as safety belt, air bag, child restrained car seat, shock absorption and controlled collapse, crash tests with dummies should be introduced that save lives.
- Black color can mark upper portion of head light of the vehicle.

5.4.1 Campaigns

Bangladesh is a developing country. One of the main reasons of road the accident is illiteracy and the illiterate people are unconscious. Therefore, there needs to be some steps to decrease the accidents. One of the main steps may be the campaigns.

By campaigning people will be conscious about the road accidents. Therefore, some priorities for campaigns might include:

- General awareness
  - Of accident problem
  - Knowledge of traffic rules
  - The size (and waste) of their rapidly increasing accident problem

- The segregation of different road users
  - Pedestrians and traffic
  - Motorized and non-motorized traffic (e.g. slow vehicles to left)
- Night-time conditions
  - Illuminating vehicles at night
  - Pedestrians wearing something light (to aid conspicuity)
- Pedestrian behavior
  - If possible don't walk in road
  - Walk facing on-coming traffic
  - Don't cross on roundabouts (e.g. spend less time in road)
  - Help and inform young and old
- In rural areas
  - Be careful of trucks and buses (don't count on other for your survival)
  - Vehicles take a long time to slow down and stop
  - At night drivers cannot see the passengers as well as passengers can see them (if they have lights)
- In urban areas
  - A loud horn does not give the passengers priority or safety
  - Give others more room

- **Information for Rickshaw Puller**

-Keep the rickshaw in a line.

-Always pull the rickshaw through he left side of the road.

-Get themselves to know the Road Safety Rules before they are in the road with a rickshaw.

-Without signal and suddenly do not turn their rickshaw.

-Do not park their rickshaw as you wish but park in the specified area.

-Do not keep them rickshaw in the turnabout.

-Do not try to overtake other rickshaw.

-When they are in the road please keep the license and other documents with them.

-Do not pull the rickshaw at night without light.

-Under aged and old man are not allowed to pull rickshaw.

-Check the brake before the start with rickshaw.

- **Information for General Public**

-If they wish to cross the road, first they have to look at right then left then right again. It is safe to cross the road

-Walk through footpath, if there is none, walk through the right side of the road.

-Cross the road through the nearby zebra crossing.

-While crossing the road take help from the Traffic Police if there is any.

-It is a request to the pedestrians, please get the knowledge about the Road Safety rules.

-It is a request to the general public to give the knowledge to their children about the road safety rules.

- **Information for Motor Vehicle Drivers**

-Do not drive the car roughly. Try to remember that life is more valuable than time.

-Park their vehicle in the specified area.

-Do not drive the faulty vehicle.

-Keep all the necessary valid documents with the driver.

-Do not drive the vehicle that emits black smoke.

-Do not use hydraulic horn on their vehicle.

-Follow the traffic rules and help the traffic police to apply these.

-Follow traffic signals.

-Use black paint on the upper portions of the head light at night.

-Reduce the speed of the vehicle in road junction, turnover and zebra Crossing.

-Do not use black paper and black glass in the vehicle.

-Do not use metallic number plate.

-The passengers will be in accident any time too. Think about everybody (Component, 1998).

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APPENDIX

Recommendation Letter:

Date 04.03.2019

To
The Director,

Accident Research Institute

BUET, Dhaka

Subject: Allowing student to get data to conduct B.Sc. Engineering Thesis.

Dear Sir,

With due to respect and humble that I am Dr. Mohammad Akhtarul Islam Chowdhury, Professor, Department of Civil and Environmental Engineering, Shahjalal University of science & Technology, Sylhet. One of my B.Sc. Engineering student named Zamiul Haque Sabit is conducting his thesis on "Accident Analysis and Identification of Hazardous Highway Location Using GIS: A Case Study of Dhaka-Bagura Highway" under my supervision. He needs the following data for B.Sc. engineering thesis purpose.

-Road Accident and Accident Location data of Bangladesh. A detail of thesis student is enclosed with the application.

I, therefore request you to take necessary action in this matter.

With kind regards and good wishes

Professor Dr. Mohammad Aktarul Islam Chowdhury

Thesis Supervisor

Department of Civil and Environmental Engineering

Shahjalal University of Science & Technology, Sylhet

Bangladesh

Enclosure:
1. Student details.

Table 1: Last 30 Km Post Accident data of N5 (2006-2008)

KM post	X co-ordinate	Y coordinate	Fatal	Grieve	Simple	Collision
164	89.4772	24.5705	0	0	0	0
165	89.4702	24.5723	4	0	4	0
166	89.4627	24.5794	0	0	0	0
167	89.4561	24.5859	0	0	0	0
168	89.4506	24.5918	0	0	0	0
169	89.4494	24.5979	0	0	0	0
170	89.4467	24.6007	0	0	0	0
171	89.442	24.6088	0	0	0	0
172	89.4399	24.6174	0	0	0	0
173	89.4372	24.626	0	0	0	0
174	89.4339	24.6391	1	1	0	0
175	89.4257	24.6652	0	0	0	0
176	89.4198	24.679	0	0	0	0
177	89.4078	24.6902	0	0	0	0
178	89.4009	24.7002	0	0	0	0
179	89.3982	24.71516	3	0	0	0
180	89.39545	24.7351	7	0	0	0
181	89.39544	24.75008	6	0	1	0
182	89.39817	24.76505	0	0	0	0
183	89.38646	24.79942	0	0	0	0
184	89.38733	24.79451	0	0	0	0
185	89.39749	24.80609	5	0	0	0
186	89.3813	24.8053	0	0	0	0
187	89.4063	24.8069	1	0	0	0
188	89.40375	24.81574	6	2	0	0
189	89.40477	24.82333	0	0	0	0
190	89.40385	24.83167	5	3	0	0
191	89.40089	24.84529	7	1	0	0
192	89.40035	24.85034	3	0	0	0
193	89.38549	24.84944	7	0	0	0
194	89.3748	24.85074	0	0	0	0

Table 2: Last 30 Km Post Total Casualty Table of N5 (2006-2008)

KM post	Head on	Rear end	90 deg	Side	Over T	Obj 1	Obj 2	Park V	Ped'n	Animal	Other
164											
165					1			1	1		1
166											
167											
168											
169											
170											
171											
172											
173											
174					1				1		
175											
176											
177											
178											
179					1						
180	1										
181											
182											
183											
184											
185				1							1
186											
187									1		
188		1							4		
189		1		2					6		1
190		1							5		
191									3		
192											
193	2										
194											

Table 3: Last 30 Km Post Accident data of N5 (2009-2011)

KM post	X co-ordinate	Y coordinate	Fatal	Grieve	Simple	Collision
164	89.4772	24.5705	0	0	0	0
165	89.4702	24.5723	0	0	0	0
166	89.4627	24.5794	0	0	0	0
167	89.4561	24.5859	0	0	0	0
168	89.450633	24.591833	0	0	0	0
169	89.449403	24.5979	0	0	0	0
170	89.4467	24.6007	0	0	0	0
171	89.442	24.6088	0	0	0	0
172	89.4399	24.6174	0	0	0	0
173	89.4372	24.626	0	0	0	0
174	89.43397	24.6391	2	0	0	0
175	89.4257	24.66529	0	0	0	0
176	89.4198	24.679	0	0	0	0
177	89.40785	24.690227	0	0	0	0
178	89.400983	24.7002	0	0	0	0
179	89.3982	24.71516	2	0	0	0
180	89.39545	24.7351	0	0	0	0
181	89.39544	24.75008	0	0	0	0
182	89.39817	24.76505	0	0	0	0
183	89.38646	24.79942	0	0	0	0
184	89.38733	24.794517	3	0	0	0
185	89.39749	24.80609	1	0	0	0
186	89.3813	24.8053	1	0	0	0
187	89.40638	24.80698	0	0	0	0
188	89.40375	24.81574	1	0	0	0
189	89.40477	24.823339	0	0	0	0
190	89.40385	24.831676	0	0	0	0
191	89.40089	24.84529	0	0	0	0
192	89.40035	24.850347	0	0	0	0
193	89.38549	24.84944	2	0	0	0
194	89.3748	24.85074	0	0	0	0

Table 4: Last 30 Km Post Total Casualty Table of N5 (2009-2011)

KM post	Head on	Rear end	90 deg	Side	Over T	Obj 1	Obj 2	Park V	Ped'n	Animal	Other
164											
165					1			1	1		1
166											
167											
168											
169											
170											
171											
172											
173											
174					1				1		
175											
176											
177											
178											
179					1						
180	1										
181											
182											
183											
184											
185				1							1
186											
187									1		
188		1							4		
189		1		2					6		1
190		1							5		
191									3		
192											
193	2										
194											

Table 5: Last 30 Km Post Accident data of N5 (2012-2014)

KM post	X co-ordinate	Y coordinate	Fatal	Grieve	Simple	Collision
164	89.4772	24.5705	0	4	0	0
165	89.4702	24.5723	3	0	0	0
166	89.4627	24.5794	0	0	0	0
167	89.4561	24.5859	0	0	0	0
168	89.4506	24.5918	0	0	0	0
169	89.4494	24.5979	0	0	0	0
170	89.4467	24.6007	7	0	0	0
171	89.4420	24.6088	0	0	0	0
172	89.4399	24.6174	0	0	0	0
173	89.4372	24.626	0	0	0	0
174	89.4339	24.6391	2	0	0	0
175	89.4257	24.6652	0	0	0	0
176	89.4198	24.679	0	0	0	0
177	89.4078	24.6902	0	0	0	0
178	89.4009	24.7002	0	0	0	0
179	89.3982	24.7151	0	0	0	0
180	89.3954	24.7351	0	0	0	0
181	89.3954	24.7500	7	0	1	0
182	89.3981	24.7650	0	0	0	0
183	89.3864	24.7994	0	0	0	0
184	89.3873	24.7945	2	1	0	0
185	89.3974	24.8060	5	0	0	0
186	89.3810	24.8053	0	0	0	0
187	89.4063	24.8069	15	0	0	0
188	89.4037	24.8157	5	0	0	0
189	89.40477	24.823339	0	0	0	0
190	89.40385	24.831676	3	0	2	0
191	89.40089	24.84529	0	0	0	0
192	89.40035	24.850347	0	0	0	0
193	89.38549	24.84944	6	0	0	0
194	89.3748	24.85074	0	0	0	0

Table 6: Last 30 Km Post Total Casualty Table of N5 (2012-2014)

KM post	Head on	Rear end	90 deg	Side	Over T	Obj 1	Obj 2	Park V	Pedon	Anim al	Other
164									0		
165											
166											
167											
168											
169											
170											
171											
172											
173											
174	1										
175											
176											
177											
178											
179		1									
180											
181											
182											
183											
184											1
185	1										
186									1		
187											
188									1		
189											
190											
191											
192											
193									1		
194									0		